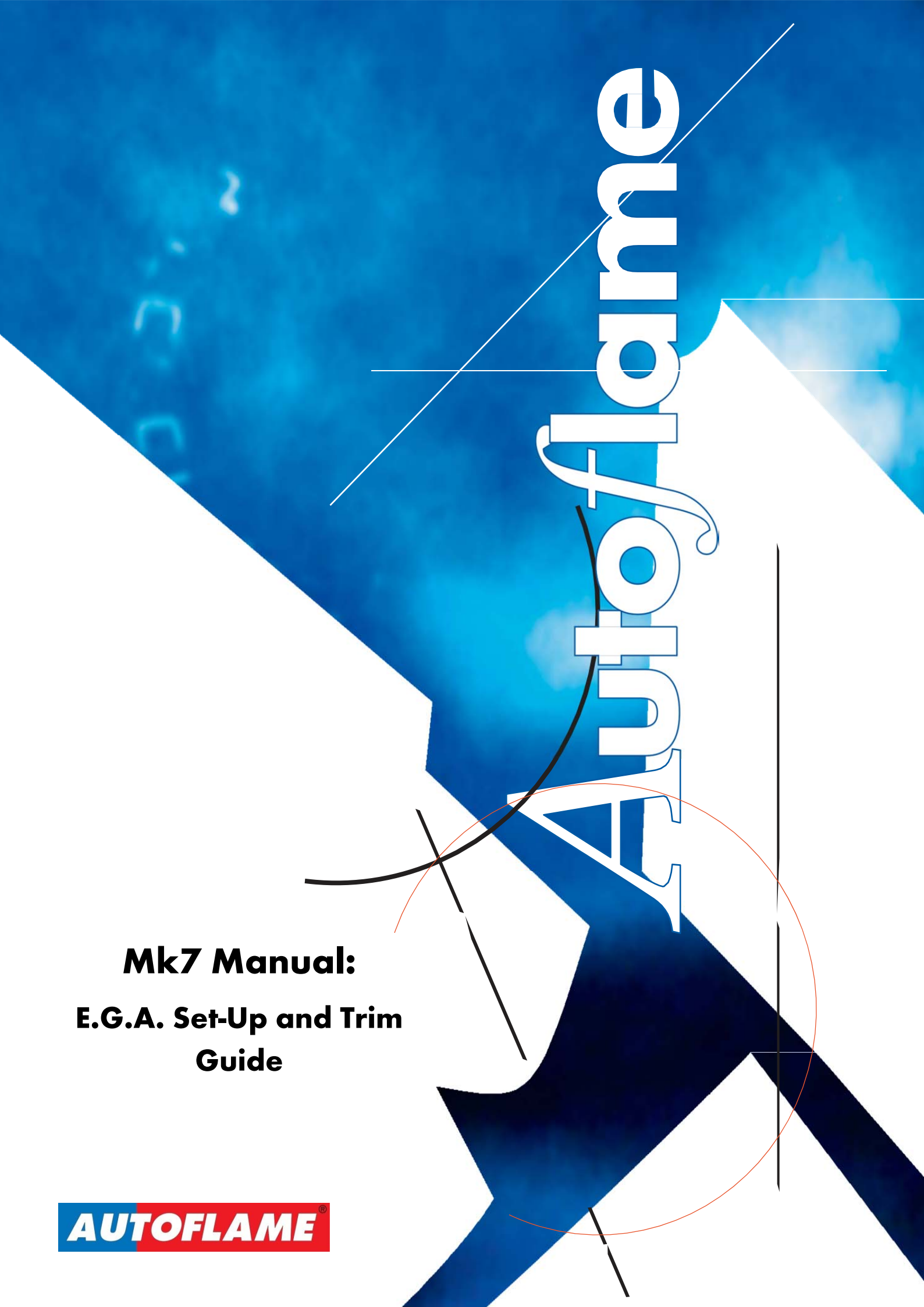

Mk7 Manual:

E.G.A. Set-Up and Trim Guide

AUTOFLAME®

Mk7 Manual:

E.G.A. Set-Up and Trim Guide

THE QUEEN'S AWARDS FOR ENTERPRISE: INNOVATION 2007

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Important Notes

A knowledge of combustion related procedures and commissioning is essential before embarking work on any of the M.M./E.G.A. systems. This is for safety reasons and effective use of the M.M./ E.G.A. system. Hands on training is required. For details on schedules and fees relating to group training courses and individual instruction, please contact the Autoflame Engineering Ltd. offices at the address listed on the front.

Short Form - General Terms and Conditions

A full statement of our business terms and conditions are printed on the reverse of all invoices. A copy of these can be issued upon application, if requested in writing.

The System equipment and control concepts referred to in this Manual MUST be installed, commissioned and applied by personnel skilled in the various technical disciplines that are inherent to the Autoflame product range, i.e. combustion, electrical and control.

The sale of Autoflame's systems and equipment referred to in this Manual assume that the dealer, purchaser and installer has the necessary skills at his disposal. i.e. A high degree of combustion engineering experience, and a thorough understanding of the local electrical codes of practice concerning boilers, burners and their ancillary systems and equipment.

Autoflame's warranty from point of sale is two years on all electronic systems and components.
One year on all mechanical systems, components and sensors.

The warranty assumes that all equipment supplied will be used for the purpose that it was intended and in strict compliance with our technical recommendations. Autoflame's warranty and guarantee is limited strictly to product build quality, and design. Excluded absolutely are any claims arising from misapplication, incorrect installation and/or incorrect commissioning.

Contents

1 INTRODUCTION

1.1 Overview and Benefits

1.1.1 Features and Benefits

The Mk7 Exhaust Gas Analyser (E.G.A.) monitors the emissions in the flue produced from the burner/boiler system. The E.G.A. can improve combustion, increase efficiency, reduce fuel consumption and improve safety through its 3 parameter trim function and combustion safety limits.

1. Stand-Alone: When in stand-alone mode, the E.G.A. can be used without a Micro-Modulation (M.M.) module to monitor the combustion gases. The M.M. trim function and the combustion safety limits are not activated in this stand-alone mode of operation. The emissions levels can be accessed via the full colour E.G.A. touch screen.

2. With M.M.: When interfaced with an M.M., the E.G.A. can monitor emissions or the 3-parameter combustion trim and safety limits can be activated. The emissions levels are monitored by the E.G.A. and the M.M. makes small adjustments to the air damper to trim the online exhaust gas data back to the commissioned values. The E.G.A. information is accessible through the full colour E.G.A. touch screen, the Data Transfer Interface module (D.T.I.), or 6 x 4-20mA signals.

The main benefits of the E.G.A. include the ability to monitor the exhaust gases and bring them to the safe commissioned levels. Setting the combustion limits on the M.M. in conjunction with the E.G.A. prevents unsafe combustion scenarios, reducing the fuel consumed in bad combustion.

1.1.2 System Operation

The Mk7 E.G.A. samples the combustion gases via the stack mounted sampling probe (purchased separately from the analyser). The exhaust gases are drawn from the stack by a pump mounted internally within the analyser. Only the supplied sample tubing should be used between the sampling probe and analyser. The internal diameter of the sampling tube is 3mm; if a large diameter tubing is used the sample gas remains resident in the tubing for a longer period. The E.G.A. will then not be able to respond in time to combustion changes, resulting in incorrect operation of the trim function.

Once the exhaust gases have entered the E.G.A. the chiller block reduces their temperature and dries the sample to remove the condensation from the gases prior to entering the cells. The condensate accumulated in the chiller unit is drained every 4 minutes when running, and every 10 minutes when the E.G.A. is in idle mode, automatically through the drain solenoid.

The exhaust gas is then filtered through the dry filter, which is a fine filter used to remove any dust particles carried over from the cooling process. If the burner is firing on heavy or dirty oil, an external particulate filter must be used to remove the excess dirt particles. On leaving the filter, the exhaust gas pressure is checked again to ensure that a vacuum is maintained prior to entering the pump and on exiting the pump, the pressure produced by the pump is checked. Both these pressure sensors modulate the flow rate of the sample into the E.G.A. for consistent operation. Once the exhaust gases have been conditioned, they are ready for an accurate sampling by the cells. After the gases have been sampled by all the cells, the remaining sample is pumped out of the E.G.A. from the clear tubing at the bottom of the E.G.A. casing.

Note: The E.G.A. needs to vent to atmosphere via the drain solenoid on the bottom; this is also where the E.G.A. performs its air calibrations. Care should be taken to ensure the outlet is not restricted or that contamination from exhaust gas occurs.

1.2 3-Parameter Trim

The 3-parameter trim function can be enabled when the Mk7 E.G.A. is used in conjunction with an M.M. module to manage the combustion. When the E.G.A. detects any differences in the online exhaust gas readings to the original commissioned values, the trim function will make small corrections to the air damper (and channel 5 if optioned for trim), to bring those online values back to the commissioned readings. The trim function controls the combustion of the burner by adding air (air rich) or taking away air (fuel rich) from the commissioned air positions to keep the volume of O_2, CO_2 and CO close to their commissioned values without compromising safety. The air rich and fuel rich limits are set by adding trim data when commissioning the burner or through single point change for 'quick commission.' This trim data is translated into a combustion map, which shows how the burner reacts when air is added or removed from the combustion process during commissioning. The Autoflame system continually monitors 3 parameters O_2, CO_2 and CO to create the safest and most efficient way of trimming the combustion process.

Ingress of tramp air through an ill-fitting boiler or flue section will distort the O_2 reading and show an increase in this value. This results in the E.G.A. reading the tramp air influence in the sample rather than just the actual combustion gases.

Single parameter O_2 trim systems would see both of these conditions as rich (excess air) combustion and start to trim back on the air by closing the air damper. In reality this trim process is not trimming the combustion gases at this point, but is in fact trimming the exhaust gases with the excess O_2. This can potentially lead to the formation of excessive amounts of CO but more importantly this can lead to incomplete combustion with dangerous consequences.

Similarly, single parameter CO_2 trim systems would interpret of air as lower CO_2 levels in the flue, inflicting similar dangerous conditions in the boiler.

Another benefit of the 3 parameter trim is that the E.G.A. is continually measuring the formation of CO compared to its commissioned value. A higher CO reading can be contributed to both lean and rich combustion. A lack of air will produce incomplete combustion and the formation of CO. Also, excess air around the flame envelope can chill the flame edge causing incomplete combustion and higher CO levels.

By referencing all 3 parameters against mapped combustion performance the burner can be trimmed back to the original commissioned values whilst maintaining the highest degree of safety.

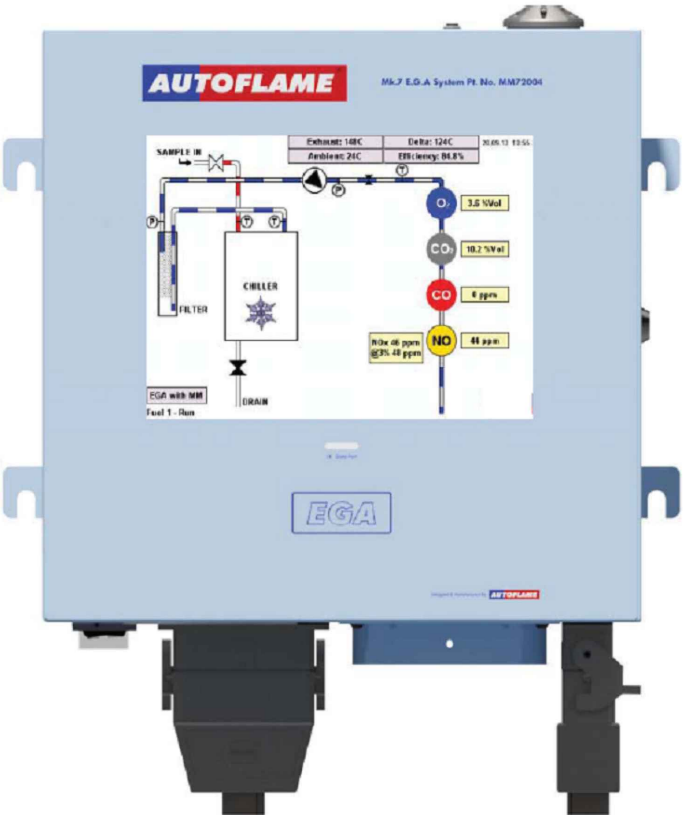
When the trim function adds air to bring back the combustion to the commissioned values, as the burner modulates to a new position, the deviation in air damper movement is added to each air position. In this way, optimum combustion is maintained during modulation, through carry forward trim.

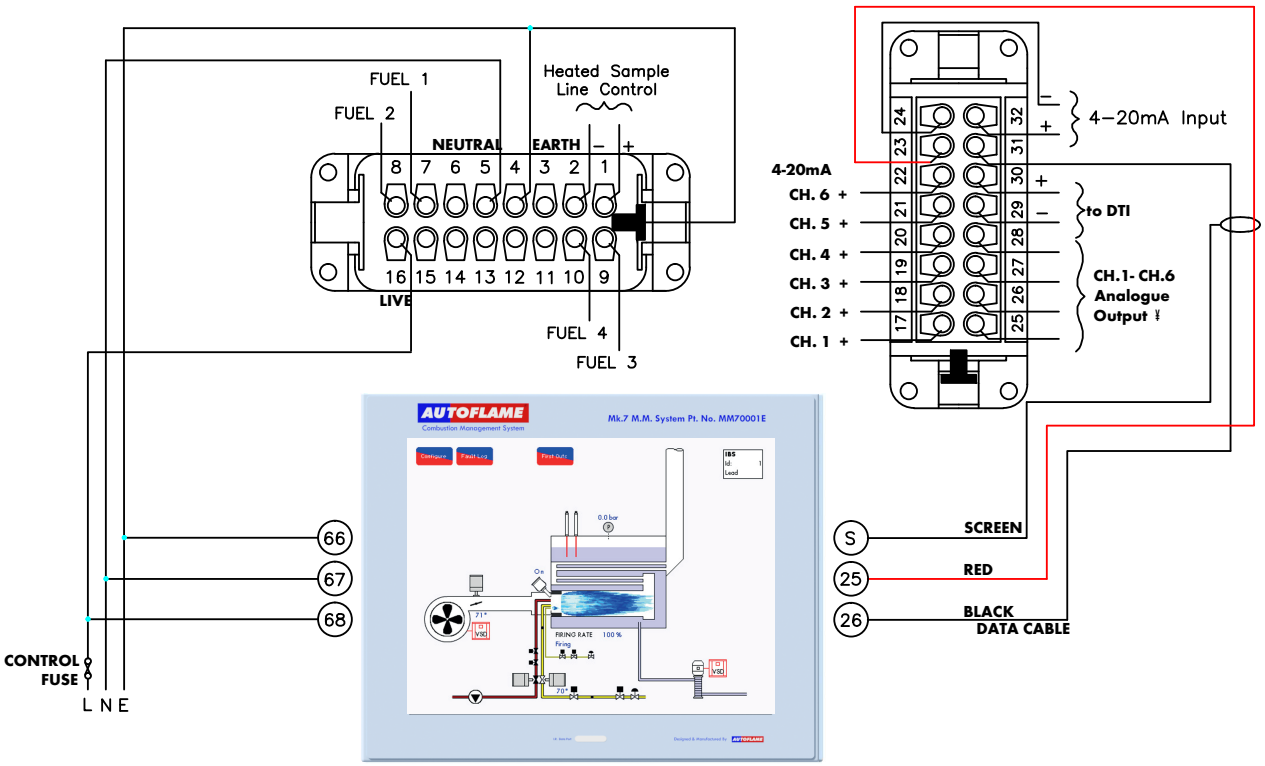
As a safety feature, as the air is being taken away, the fuel to air ratio will return back to the commissioned positions when the burner modulates, for every 10 degrees of fuel valve movement. Once this new position is held the system will determine whether the air damper should be closing. This ensures safe combustion at all times without any compromise.

2 WIRING AND COMPONENTS

2.1 Electrical Schematics

2.1.1 Interconnection between E.G.A. and M.M. Module





2.1.2 CEMS E.G.A. with D.T.I.

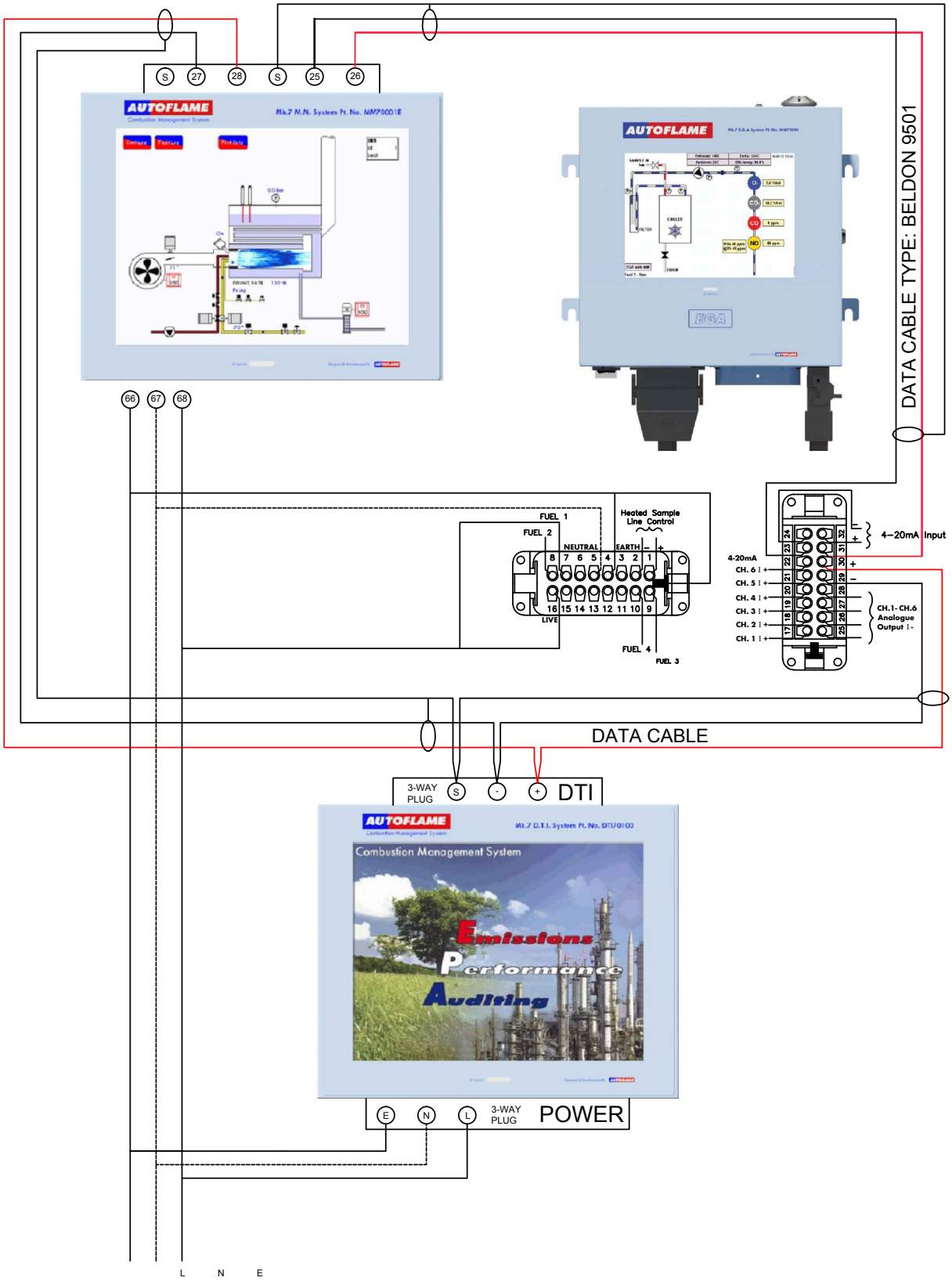
The Mk7 CEMS E.G.A. is the Continuous Emissions Monitoring System; it logs the exhaust gas data for up to 2 years including the gas readings, flue temperature and calculated efficiency.

When using a standalone CEMS E.G.A. a direct connection as shown in section 2.1.3 will be required to view and log up to 2 years of data on the D.T.I. The D.T.I. will need to be setup as 'E.G.A. direct' through the 'Edit Boiler' screen and the E.G.A. setup for standalone operation (E.G.A. selects fuel).

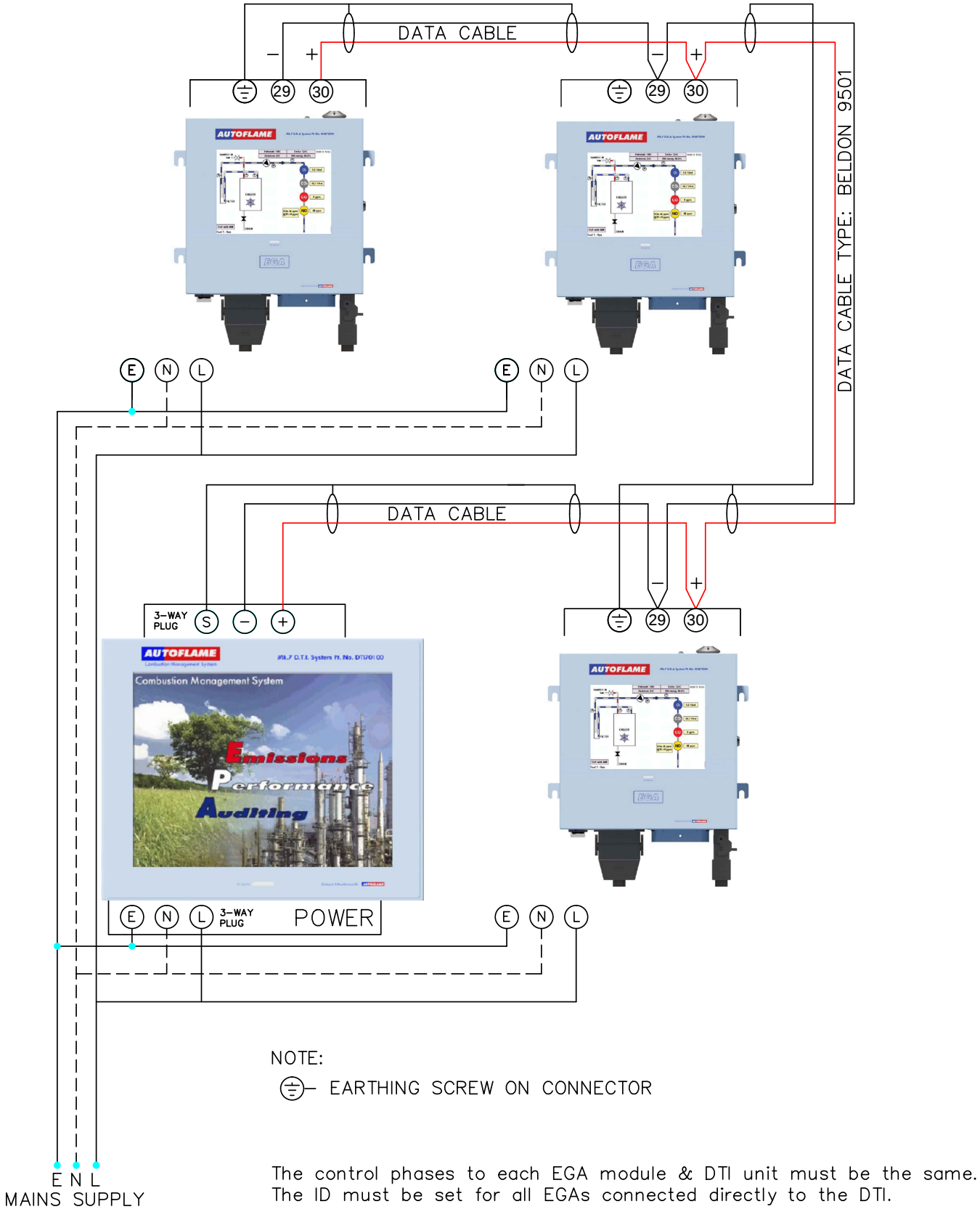
Using the CEMS E.G.A. in conjunction with the Mk7 M.M. module and D.T.I, a data link will be required between the M.M. and E.G.A. and from the E.G.A. to the D.T.I. (see section 2.1.2.1). The D.T.I. will need to be setup as 'E.G.A. Direct' **not** 'E.G.A. through M.M.'

When using a Standard E.G.A. (without CEMS) the D.T.I. can be setup as 'E.G.A. Direct' or 'through M.M.', however the data logging is only for 24hrs.

2.1.2.1 Wiring

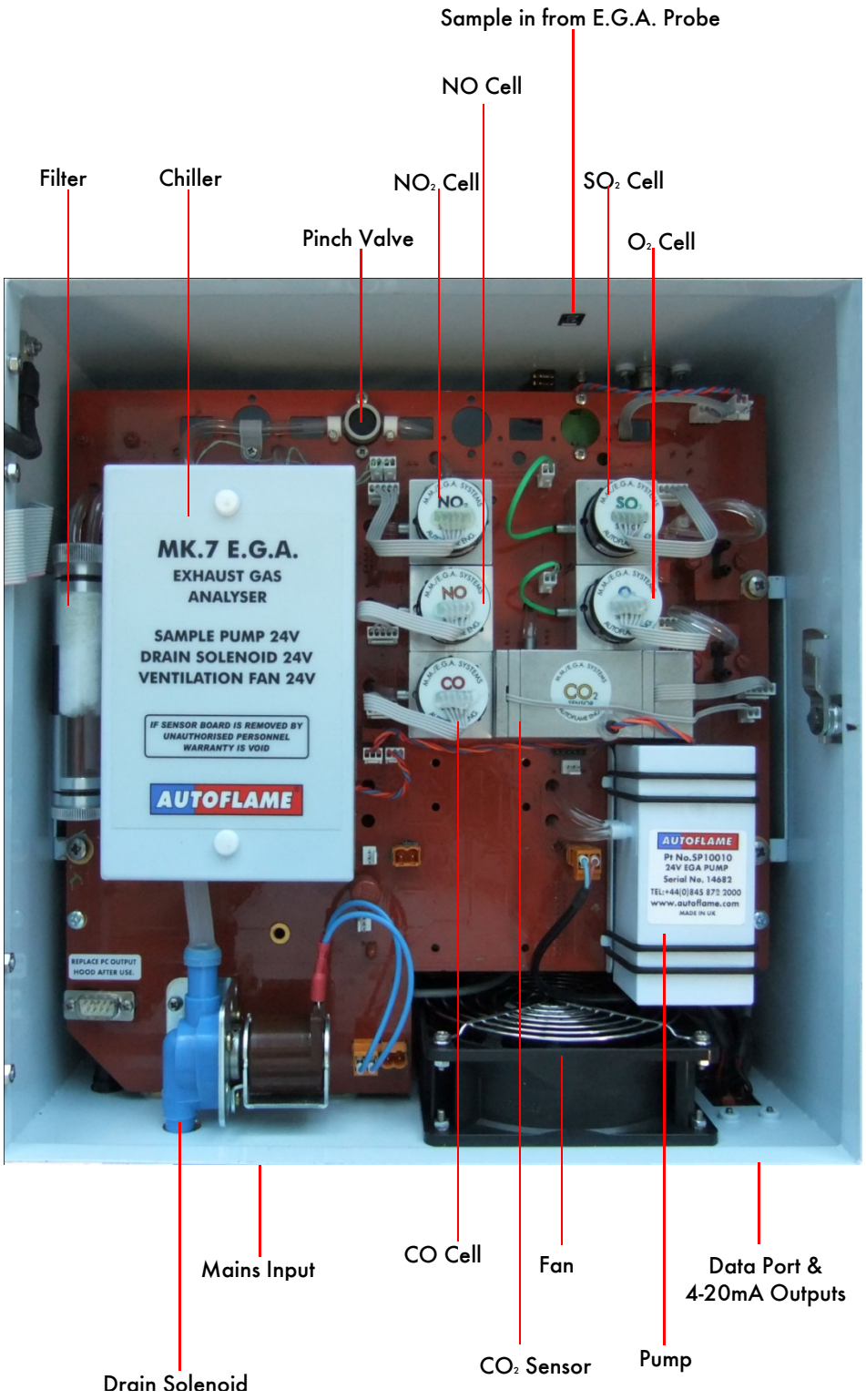

S
27
28
S
25
26
AUTOFLAME
Mk.7 M.N. System Pt. No. MM70001E
AUTOFLAME
EGA
DATA CABLE TYPE: BELDON 9501
66
67
68
FUEL 1
FUEL 2
NEUTRAL
EARTH
8 7 6 5 4 3 2 1
16 15 14 13 12 11 10 9
LIVE
FUEL 4
FUEL 3
Heated Sample Line Control
4–20mA Input
4-20mA
CH. 6
CH. 5
CH. 4
CH. 3
CH. 2
CH. 1
CH.1- CH.6 Analogue Output
DATA CABLE
3-WAY PLUG
S
-
+
DTI
AUTOFLAME
Combustion Management System
Emissions
Performance
Auditing
E
N
L
3-WAY PLUG
POWER
L
N
E

2.1.3 Interconnection between Stand-Alone Mk7 E.G.A. and Mk7 D.T.I



2.2 Components

2.2.1 Inside View



2.2.2 Inside View Schematic

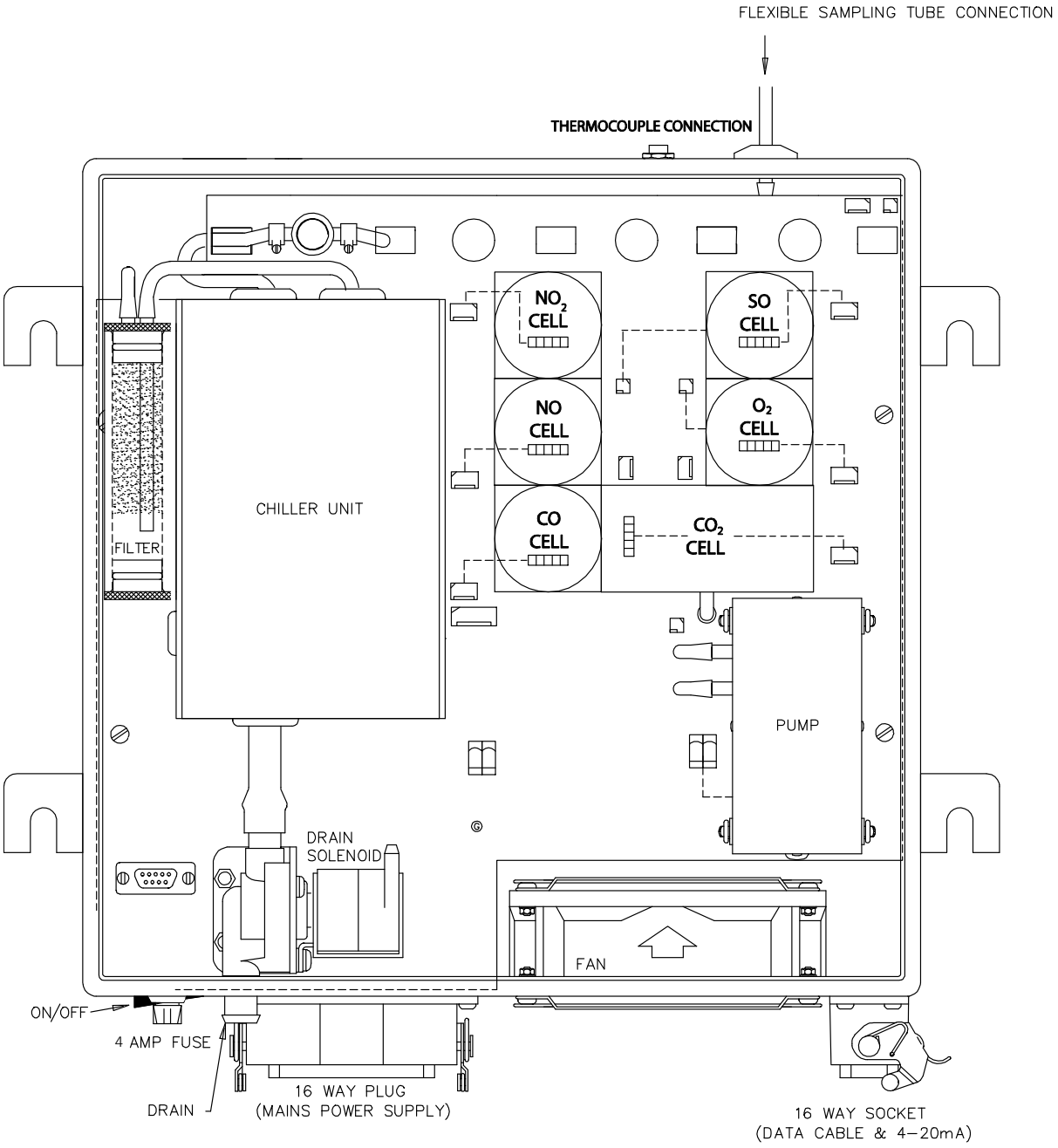


Figure 2.2.2.i E.G.A. Inside View Schematic

2.3 Cell Characteristics

2.3.1 O_2 Cell

This electrochemical cell is used for the detection of oxygen covering a concentration range of 0 to 20.9%. Due to the construction of the cell they offer a long life and a high resistance, even when used with high sulphur content fuels, therefore making it capable of analysis when firing heavy or light fuel oil.

The oxygen cell incorporates a lead oxygen cell with a Lead anode and a Gold cathode, using a specific acid electrolyte. Oxygen molecules which diffuse through a non-porous Teflon membrane into the electromechanical cell are reduced at the Gold electrode. The current flow between the electrodes is proportional to the oxygen concentration in the flue gases measured. The O_2 readings are not influenced from CO, H_2, S, NOX and SOX so there is no cross-sensitivity.

Figure 2.3.1.i O_2 Cell

Operation Ranges:

Detection Range	0 – 20.9% O2
Accuracy	± 0.3 % Vol O2
Operating Temperature	5°C to 40°C (41°F to 104°F)
Shelf Life	6 months from date of dispatch
Long Term Output Drift	< 1% signal/month typically < 10% over operating life

As the O_2, CO, NO, SO_2 and NO_2 cells all have a 6 month shelf-life, it may be better to request for the cells to be shipped when the E.G.A. is being installed on site. Depending on the conditions and environment the E.G.A. is in, the cell's life expectancy can go up to 2 years. It is important to replace the cells when the E.G.A. flags this up on the screen. Cells will need to be changed every 9 to 12 months firing on gas, and 6 to 9 months firing on oil.

2.3.2 CO, NO, NO_2 and SO_2 Cells

The CO, NO, NO_2 and SO_2 electromechanical cells which are specifically managed by the calibration philosophy within the Mk7 E.G.A. unit. The accuracy of these cells is within limits of ± 5% at 100ppm. From experience we would expect to see a drift of ± 10ppm per annum without calibration. In our view, this drift would not be detrimental to the operation or application of the E.G.A. The life of the cells depends on the concentration of the gases measured over time. In order to optimise the life of the CO cell, the electronics will detect when the signal level from the cell reaches or exceeds 500ppm and will stop sampling and purge the system. The sample gas flow to these cells is restored once the O_2 and CO_2 readings are restored to a level within the pre-programmed limits.

Figure 2.3.2.i NO, and CO Cells

	Gas (range)	Fuel Oil (range)	Resoltuion at 20°C	Repeatability	Shelf Life
CO	0-1000ppm	Optional	1ppm	1% of signal	6months from dispatch
NO	0-1000ppm	Optional	1ppm	2% of signal	6months from dispatch
SO_2	Optional	0-1000ppm	1ppm	1% of signal	6months from dispatch
NO_2	Optional	0-200ppm	0.5ppm	2% of signal	6months from dispatch

2.3.3 CO2 Sensor

The CO_2 sensor is manufactured in-house at Autoflame; the technology used is non-dispersive Infra-red. This sensor has no moving parts and is not an electrochemical cell. The accuracy of the reading is ±0.3% of the reading. The cross-sensitivity is virtually zero to other gases due to the method of calibration within the E.G.A. unit. The lifetime is usually no less than two years of gas firing. The lifetime on oil firing is dependent on the Sulphur content of the fuel.

Figure 2.3.3.i CO_2 Cell

Measurement Range: 0-20%
Shelf-Life: 12months from dispatch
Accuracy of reading: 0.3%

3 SET-UP

3.1 E.G.A. Set-Up

3.1.1 Sampling Screen

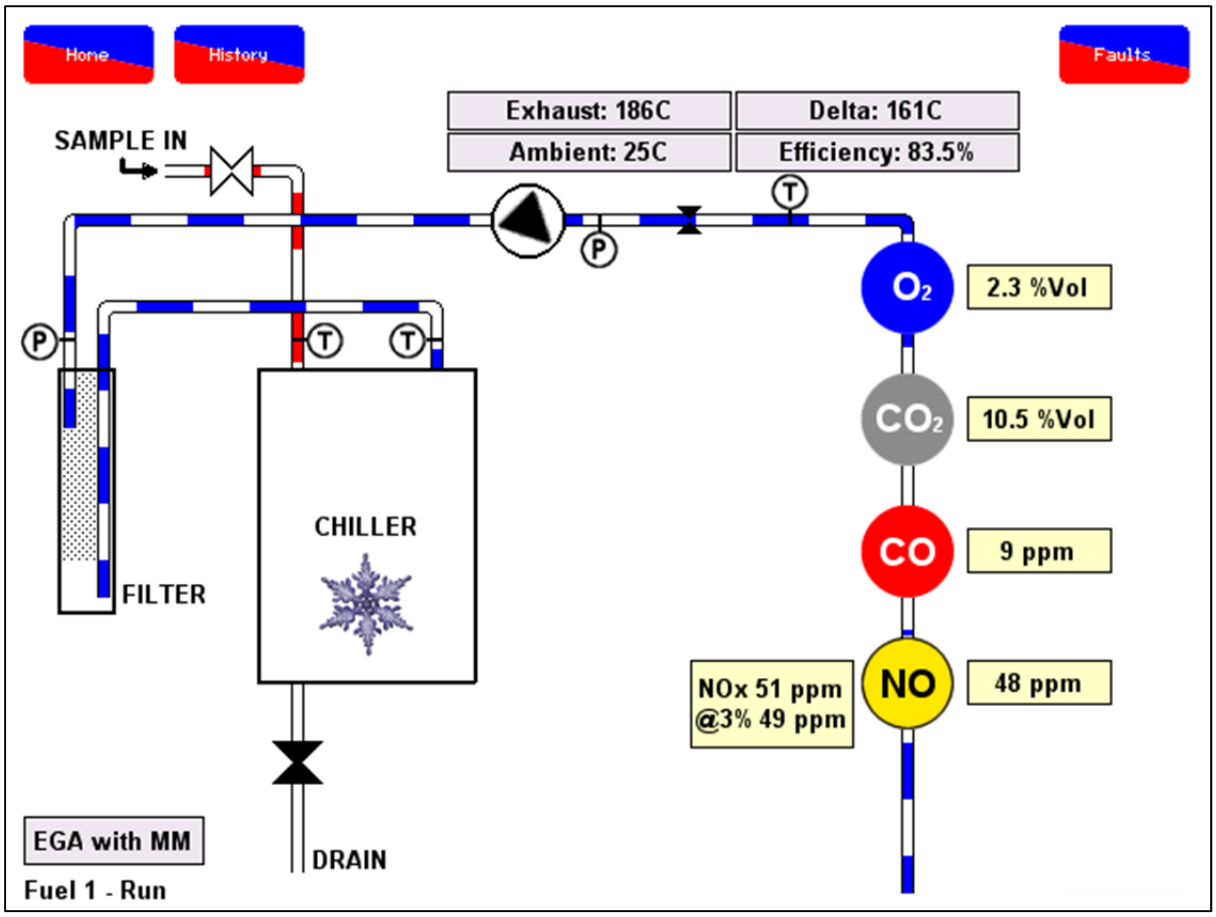


Figure 3.1.1.i. Sampling Screen

The sampling screen presents the user with detailed information about the current operation of the E.G.A. components shown on this screen.

- Fuel being fired and current E.G.A. status (Air calibration, run etc.)
- Exhaust gas temperature
- Ambient air temperature surrounding E.G.A.
- Delta temperature (difference between the exhaust gas and ambient temperatures)
- Current combustion efficiency (see section 3.3.6)

Cells

Carbon Monoxide

Carbon Dioxide

Nitric Oxide

Nitrogen Dioxide

Oxygen

Sulphur Dioxide

System Components


Piping (no flow)


Piping (gas flowing)


Piping (water/condensate draining or air sample flowing)


Pump


Pinch Valve Open


Pinch Valve Closed

Temperature Sensor

Pressure Sensor


Chiller Status


Restrictor

Note: Components that are not ready/malfunctioning are denoted by a  .

3.1.2 Mk7 E.G.A. Settings

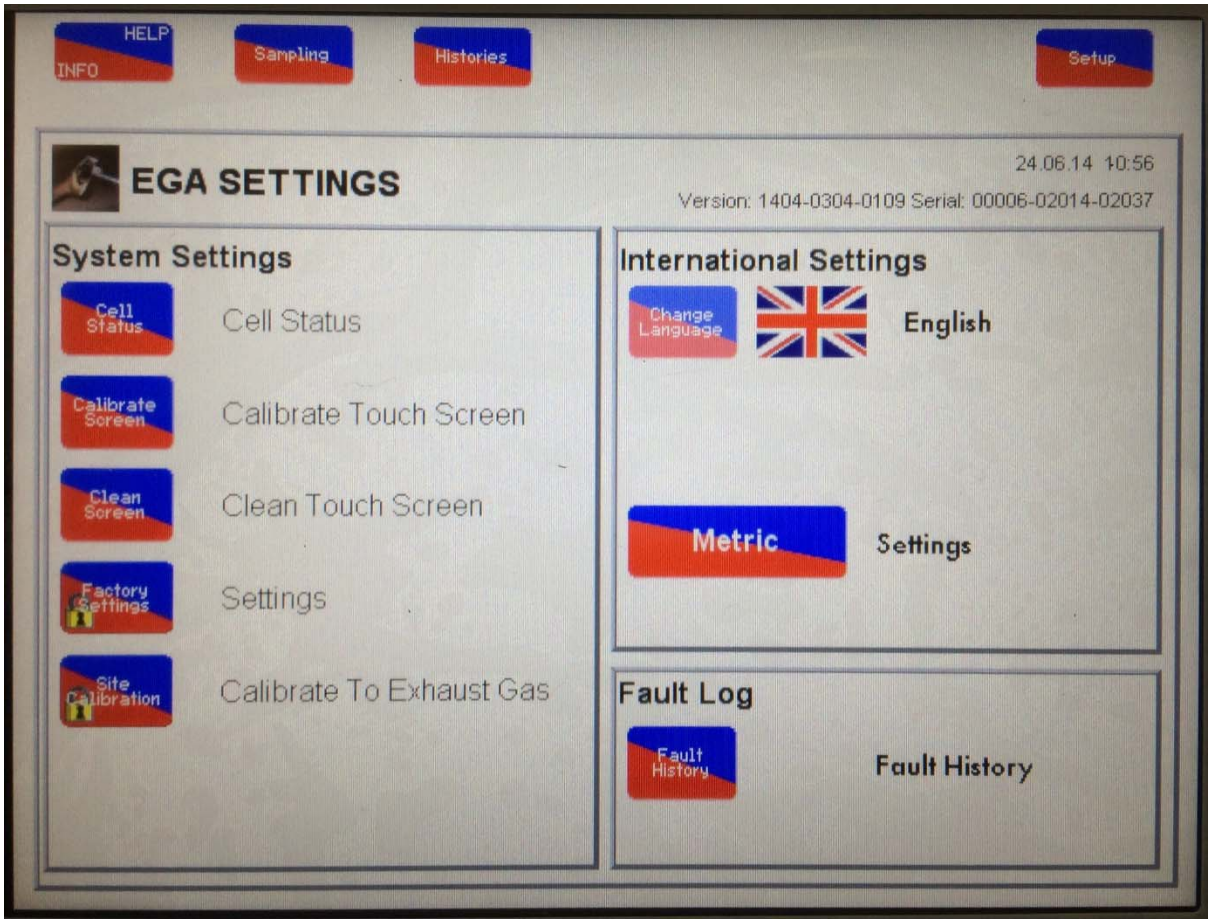


Figure 3.1.2.i. E.G.A. Settings Screen

The E.G.A. settings screen is the first of two main settings screens.

Note: Buttons with the 🔒 symbol are password protected.

This will take you to the Cell Status screen, including information on calibration dates and any errors, see section 3.2.3.

Press here to calibrate the touch screen. Follow the on screen commands to calibrate the touch screen.

Press this button to clean the touch screen. The screen will then be locked for 30 seconds to allow it to be cleaned.

Press this button to access the setting screens such as operating mode, time and date, cell calibration etc.

Press this button to calibrate the E.G.A. on exhaust gases if required.

Press this button to toggle the units used by the system. The text displayed indicates the unit currently selected.

This will take you to the Fault History where up to 10 faults are recorded, see section 3.2.4.

3.1.3 Cell Status Screen

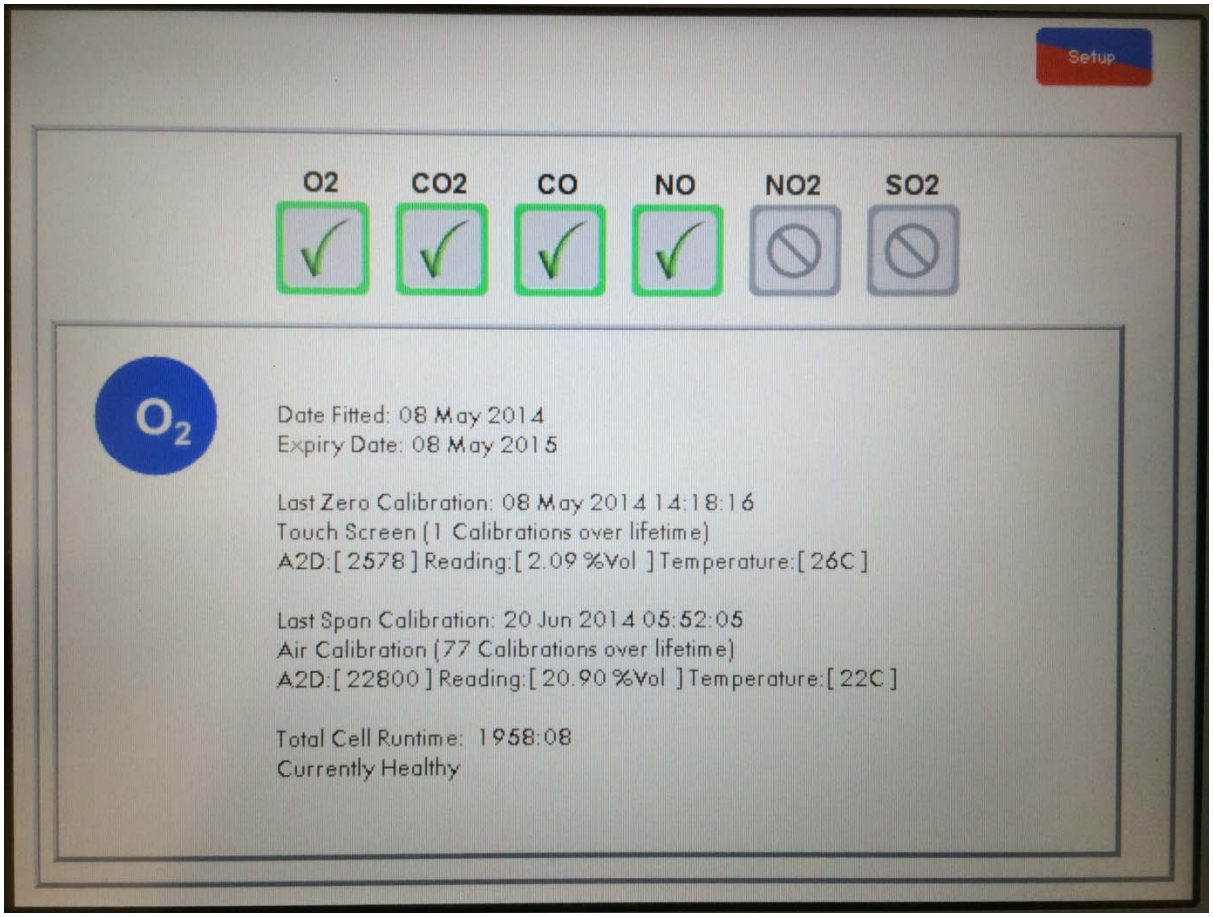


Figure 3.1.3.i Cell Status Screen

The cell status screen displays information of all fitted cells. This information is arranged as follows:

1. Image of the cell currently selected.
2. Detailed information on the cell currently selected.

The status icons are:

OK – Indicates the cell is healthy.

Not Fitted – Indicates the cell is not fitted. Refer to Section 3.1.7 on how to enable cells if they are present.

Error – Indicates there is an error with the cell. Press to get further information.

3.1.4 Fault History

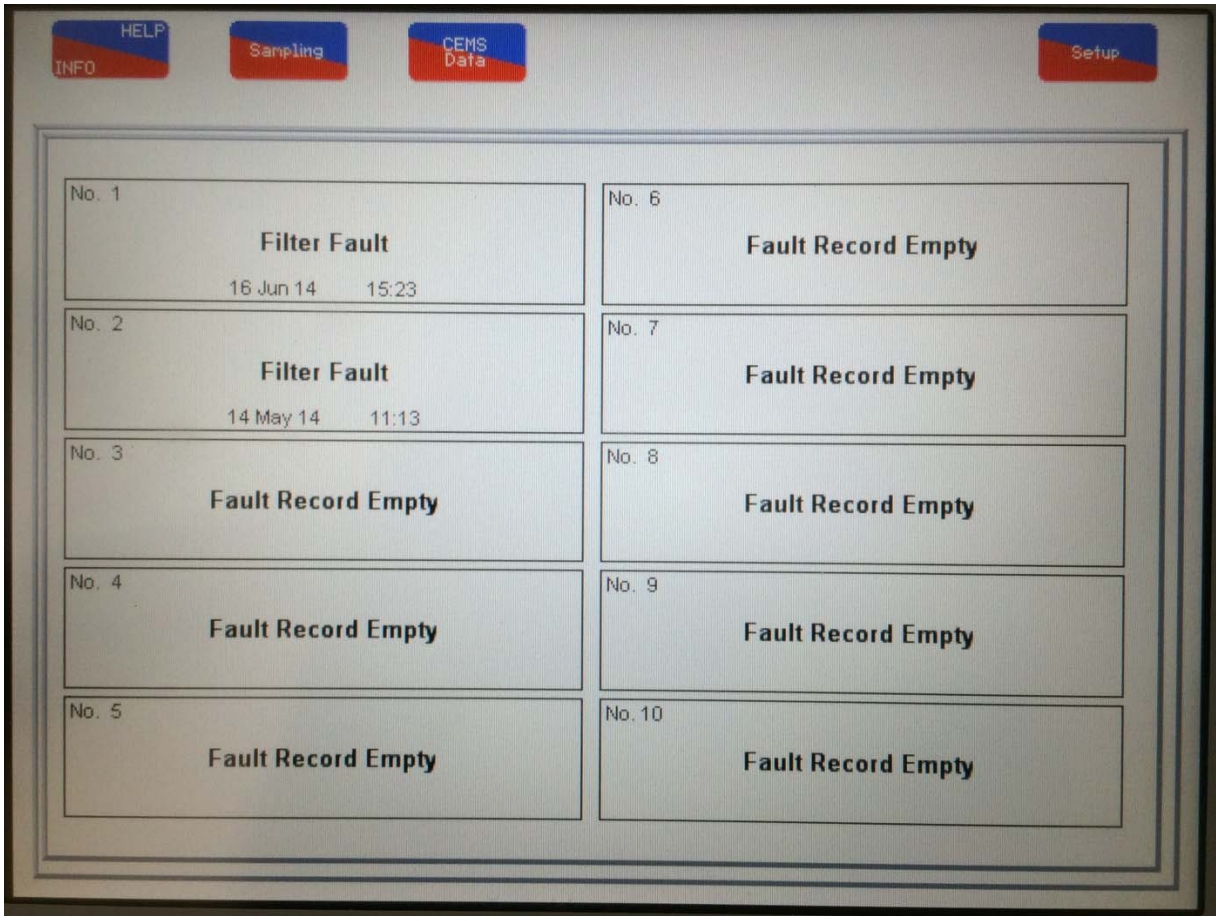


Figure 3.1.4.i Fault Log Screen

When a fault is detected a popup box will appear with information on the error. This error is then logged onto the Fault Log and can be accessed at any time by pressing the 

button on the settings screen.

The last 10 faults are logged on this record and can be downloaded through an M.M. (if used). Each fault contains the following information:

- Fault number (in reverse chronological order).
- Type of fault.
- Date and time at which the fault occurred.

See Section 5 for possible faults and solutions.

3.1.5 Factory Settings Screen

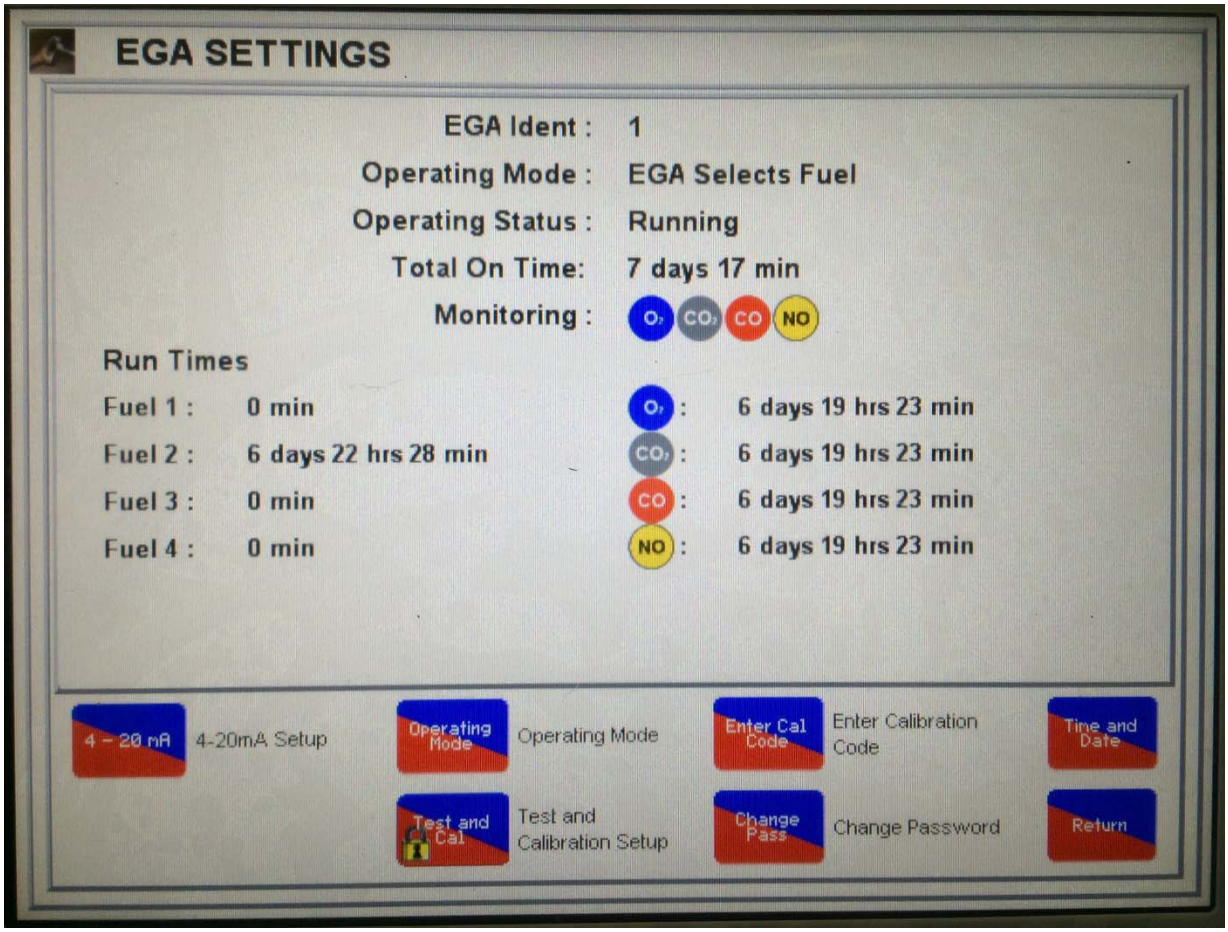
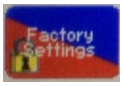


Figure 3.1.5.i Factory Settings Screen

To access this screen press 

on the settings screen from Figure 3.2.2.i and enter the password on the keypad displayed.

Upon entering the factory settings screen, an overview of the E.G.A. since first start-up will be displayed. The factory settings screen displays the following information:

- The E.G.A. ID, current operating mode, E.G.A. status and cells selected.
- The run times for each fuel and totalised run time.
- Each cells run time.

3.1.6 4-20mA Set-up

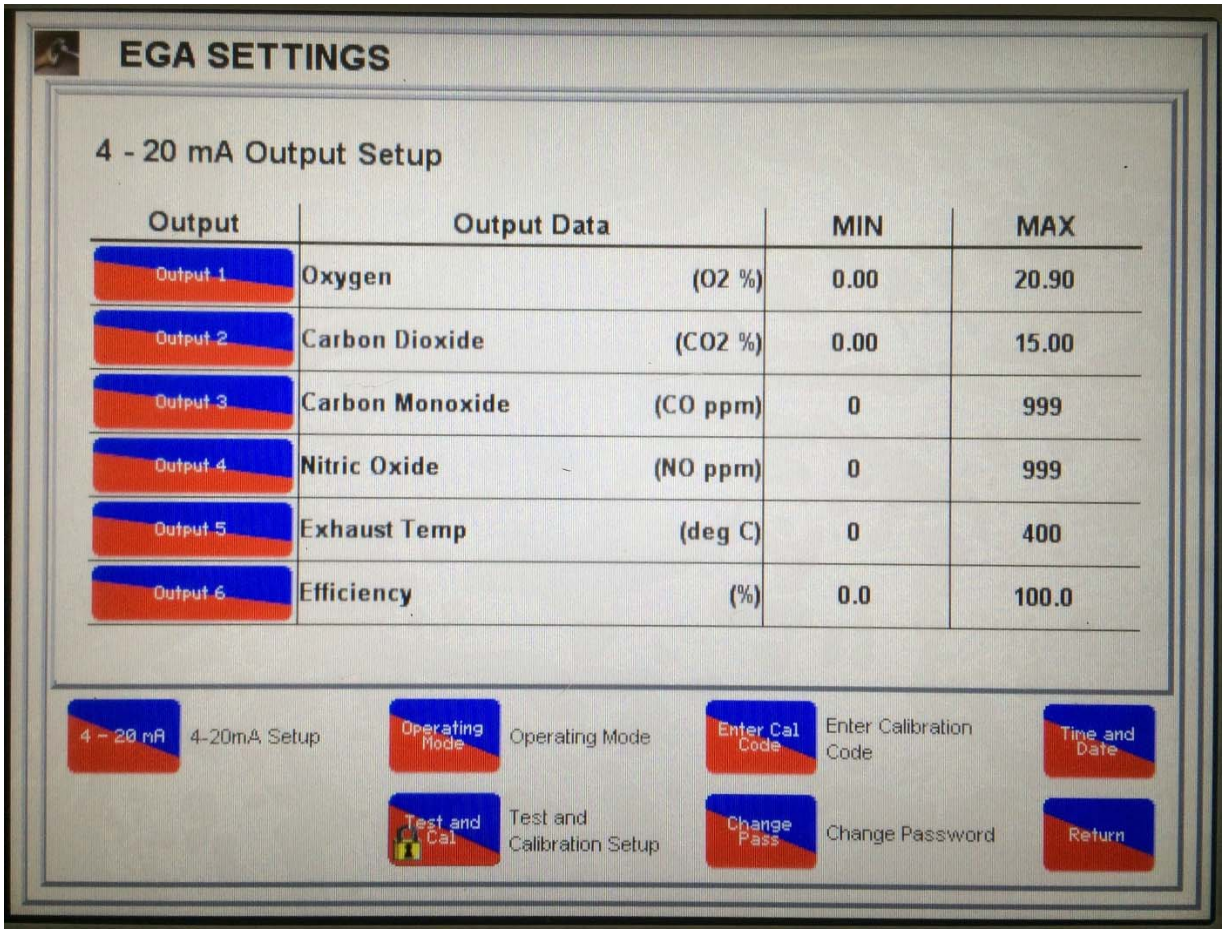


Figure 3.1.6.i 4-20mA Set-up Screen

Press 

on the settings screen to display the screen above. The above screen is used to set-up the 4-20 mA outputs from the 4-20mA terminals. To setup each 4-20mA output:

1. Press 

. This will display a menu showing all possible data output types.
2. Select the desired data output by pressing on the appropriate button from the menu.
3. A number pad will now appear allowing the minimum value of the data selected to be entered. Enter the minimum value on the key pad followed by  to confirm. If the value is entered incorrectly press the 

button on the keypad to delete the last number entered. To cancel entering the minimum value press the  button.
4. Once the minimum value has been entered the system will require the maximum value for the data to be entered. This is the same procedure as entering the minimum value.
5. Repeat steps 1 to 4 for each output as desired.

Note: All changes will be stored for immediate effect.

3.1.7 Operating Mode Set-up

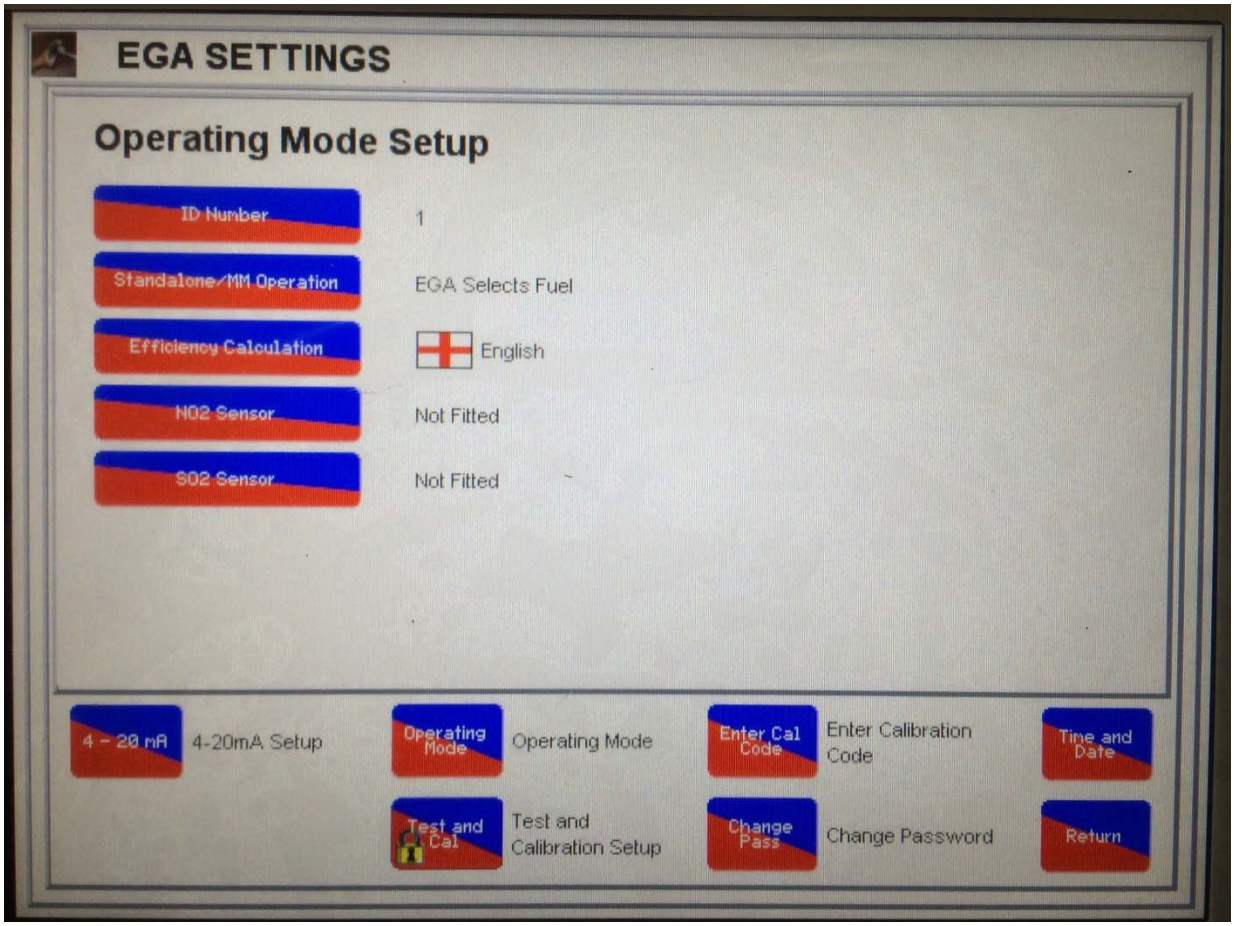


Figure 3.1.7.i Operating Mode Set-up Screen

Pressing 

on the settings screen will display the above screen. The Operating Mode screen is used to setup the E.G.A. The following settings can be changed at this screen:

- ID number (1-10). If using an E.G.A. in standalone mode with a D.T.I. it is necessary to give each E.G.A. a different ID number.
- Mode of operation (E.G.A. with M.M., E.G.A. selects fuel).
- Efficiency calculation (European, English).
- Presence of NO_2 and SO_2 cells (Fitted, Not Fitted).

To change any of the settings above, press the corresponding button and select from the available options.

If setting the E.G.A. for standalone operation, the operation mode should be selected as 'E.G.A. selects fuel.'

3.1.8 Cell Calibration

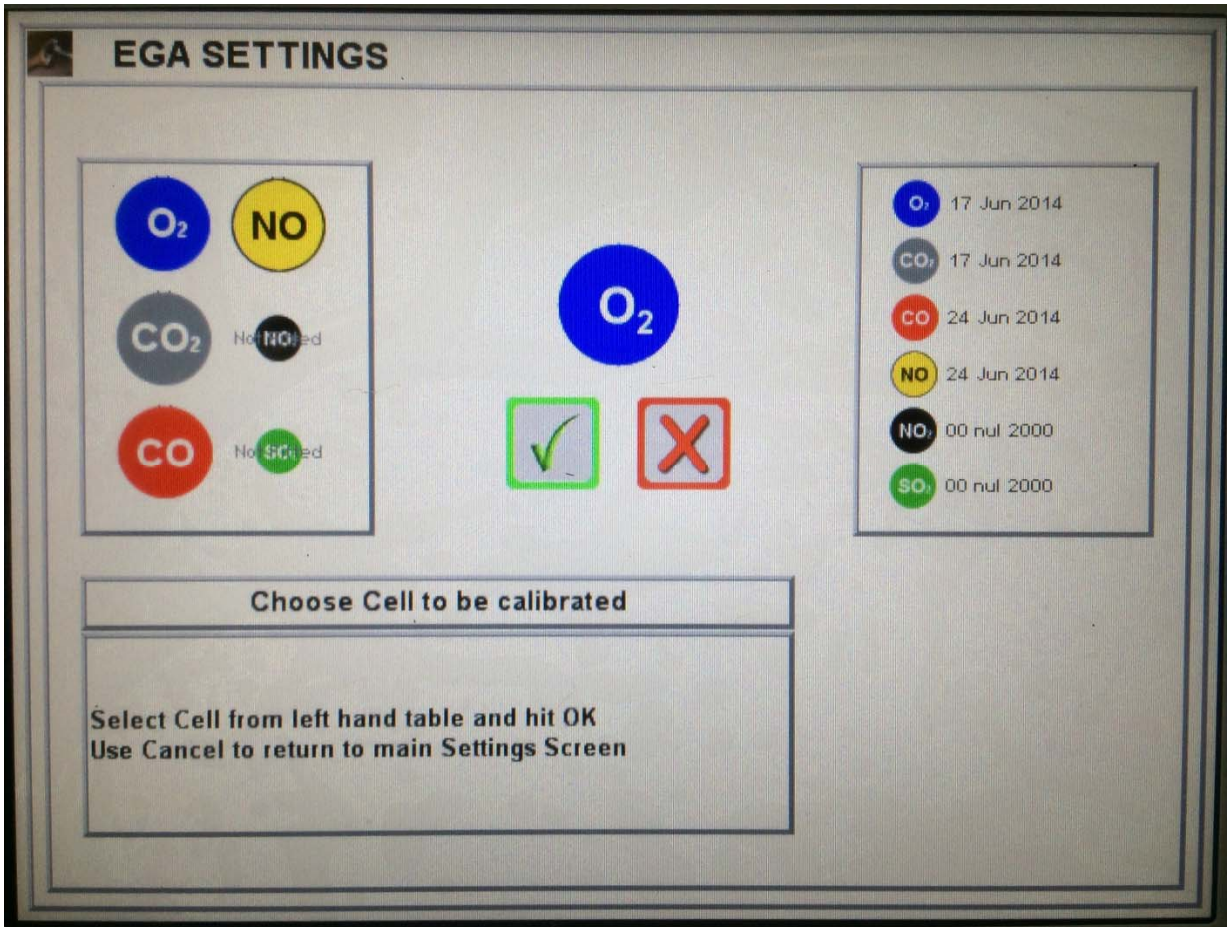


Figure 3.1.8.i Cell Calibration

Pressing 

on the setting screen will display the screen above. This screen is used to calibrate cells using calibration codes and is divided into three main sections.

To return to the previous screen press the  button.

To enter a calibration code follow the steps below:

1. Select the cell to be calibrated by pressing on the cell symbol.
2. Verify the correct cell has been selected. Press the  button to begin entering the calibration code.

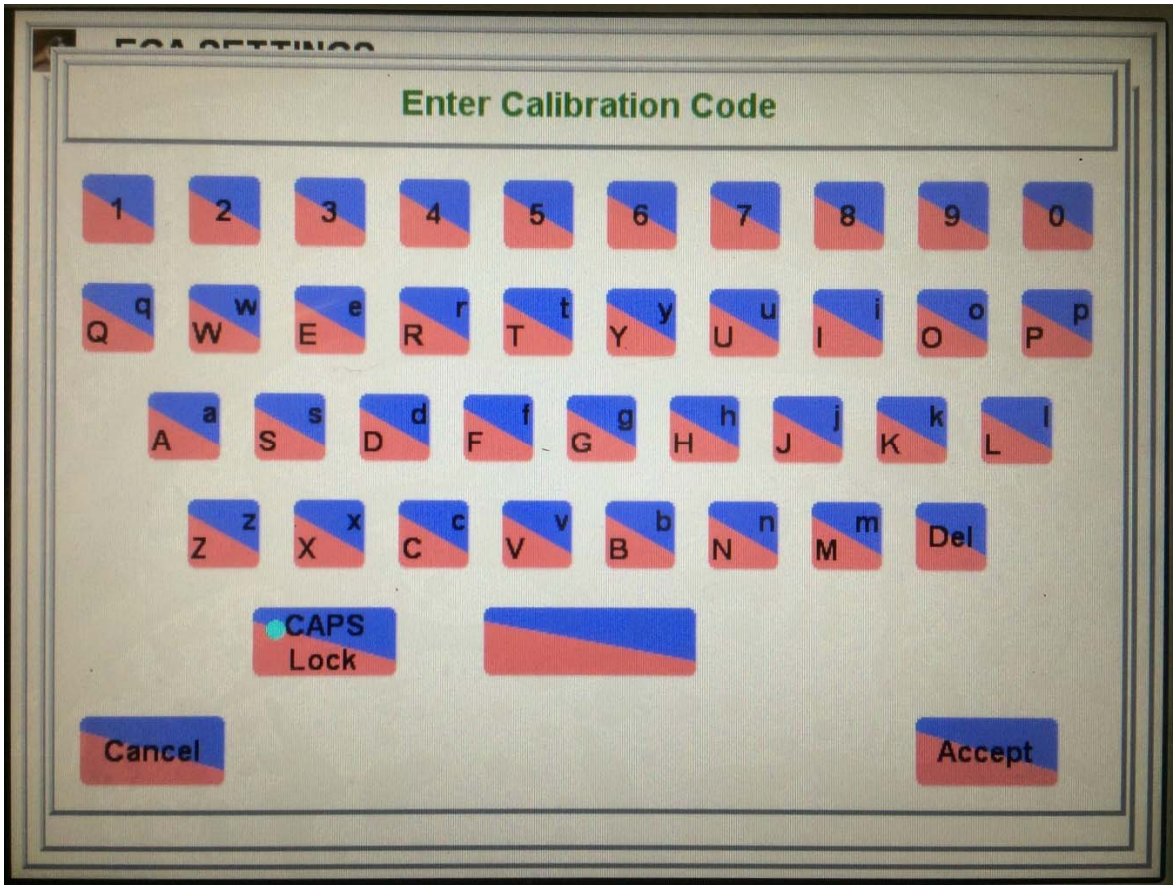


Figure 3.1.8.ii Calibration Code

3. A keyboard will appear allowing the cell code to be entered. Enter the 30-digit cell calibration code supplied by Autoflame on the keyboard.

   Note: The cell calibration code is case sensitive. Use the CAPS Lock button to switch between upper case and lower case.

4. Once all 30 digits have been entered the keys will be disabled. Ensure the code has been entered correctly. If a mistake has been made use the Del to delete digits. If the code has been entered correctly press the Accept button to confirm the entered button.

   Alternatively press Cancel to discard the entered code and return to the previous screen.
5. A text block will now appear to confirm if the code has been accepted or was incorrect. Press the ✓ button to return to the factory settings screen.

3.1.9 Time and Date

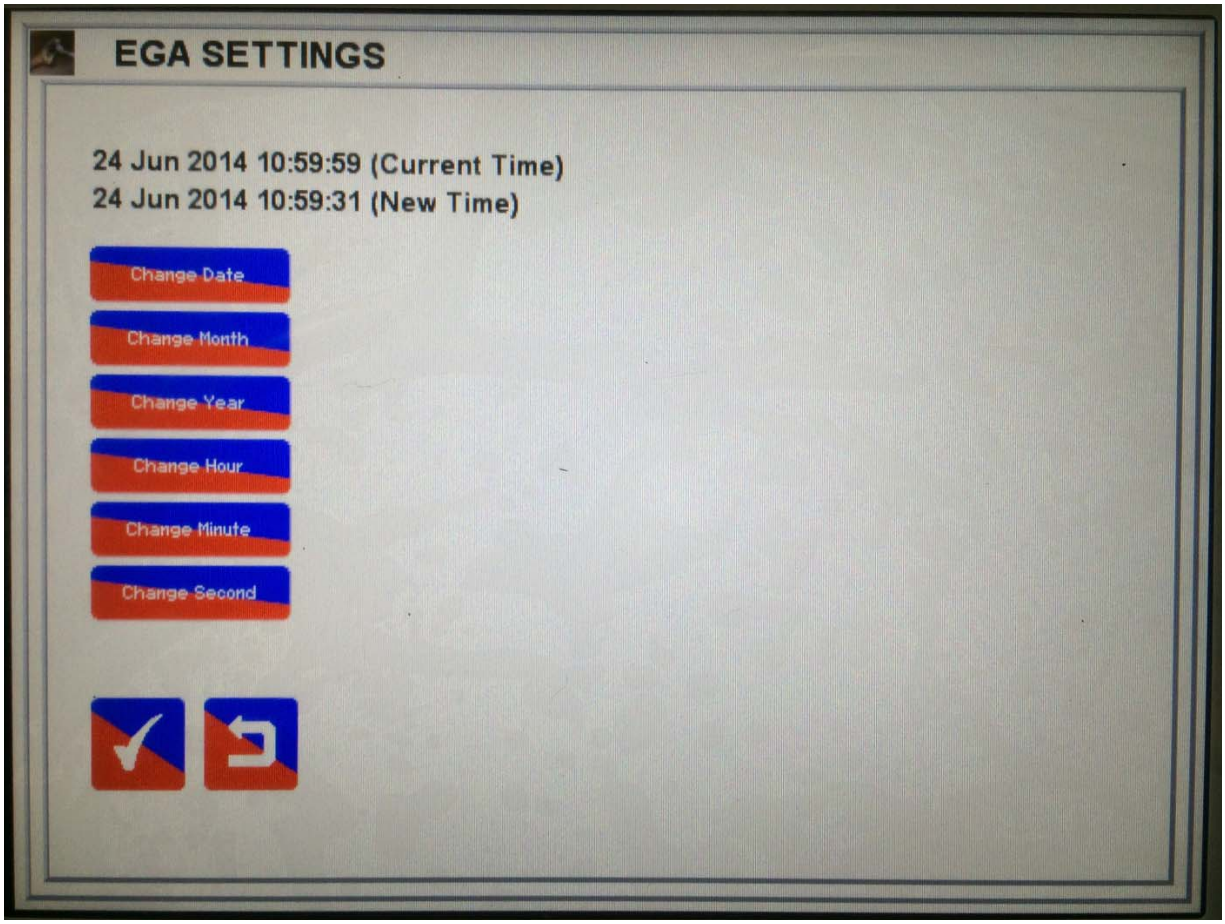


Figure 3.1.9.i Time and Date Screen

Pressing 

on the settings screen will display the screen above, where it is possible to change the time and date. To change the settings for the time and date press the relevant button and enter the required value into the keypad that appears. Each button has the following ranges:

Range: 1 – 31

Choose from the available options.

Range: 0 – 99

Range: 0 – 24.

Range: 0 – 59.

Range: 0 - 59.

3.1.10 Change Password

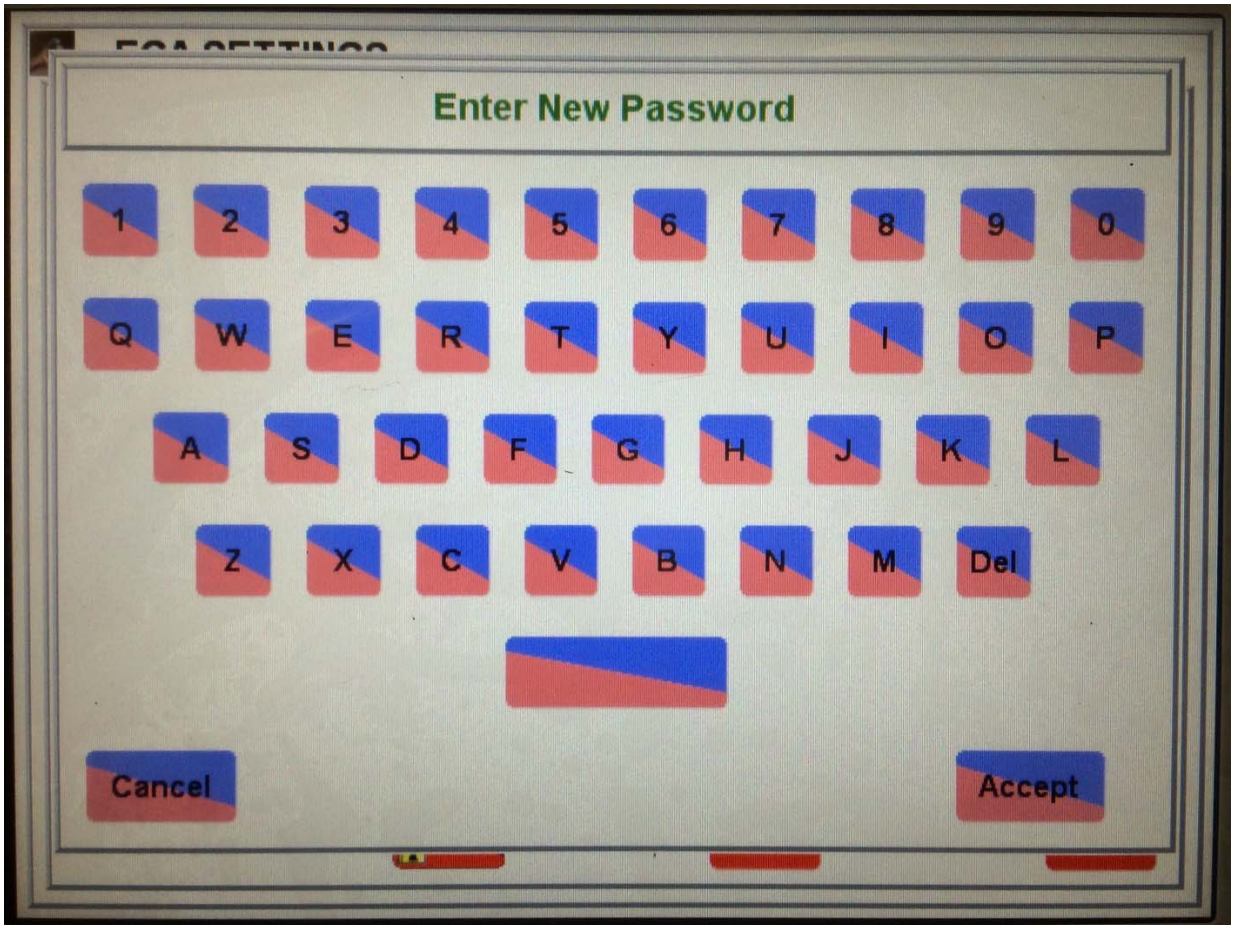
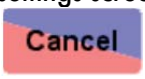


Figure 3.1.10.i Change Password Screen

It is possible to change the password from its default by pressing 

on the settings screen. To exit this screen shown in Figure 3.1.10.i without changing the password, press the 

button at any time. To proceed with changing the password, follow these steps:

1. Enter the new desired password using the keyboard. Note this password down for future reference.
2. Press 

.
3. A prompt stating "Retype New Password" will appear. Re-enter the password entered in 1 and press 

.

If the passwords entered in steps 1 and 3 are identical a box will appear stating "Password Changed". Should the passwords not match or if the 

button is pressed a box will appear stating "Password Not Changed".

3.1.11 Emissions History Screens

Pressing 

on the main sampling screen opens up the emissions history screens.

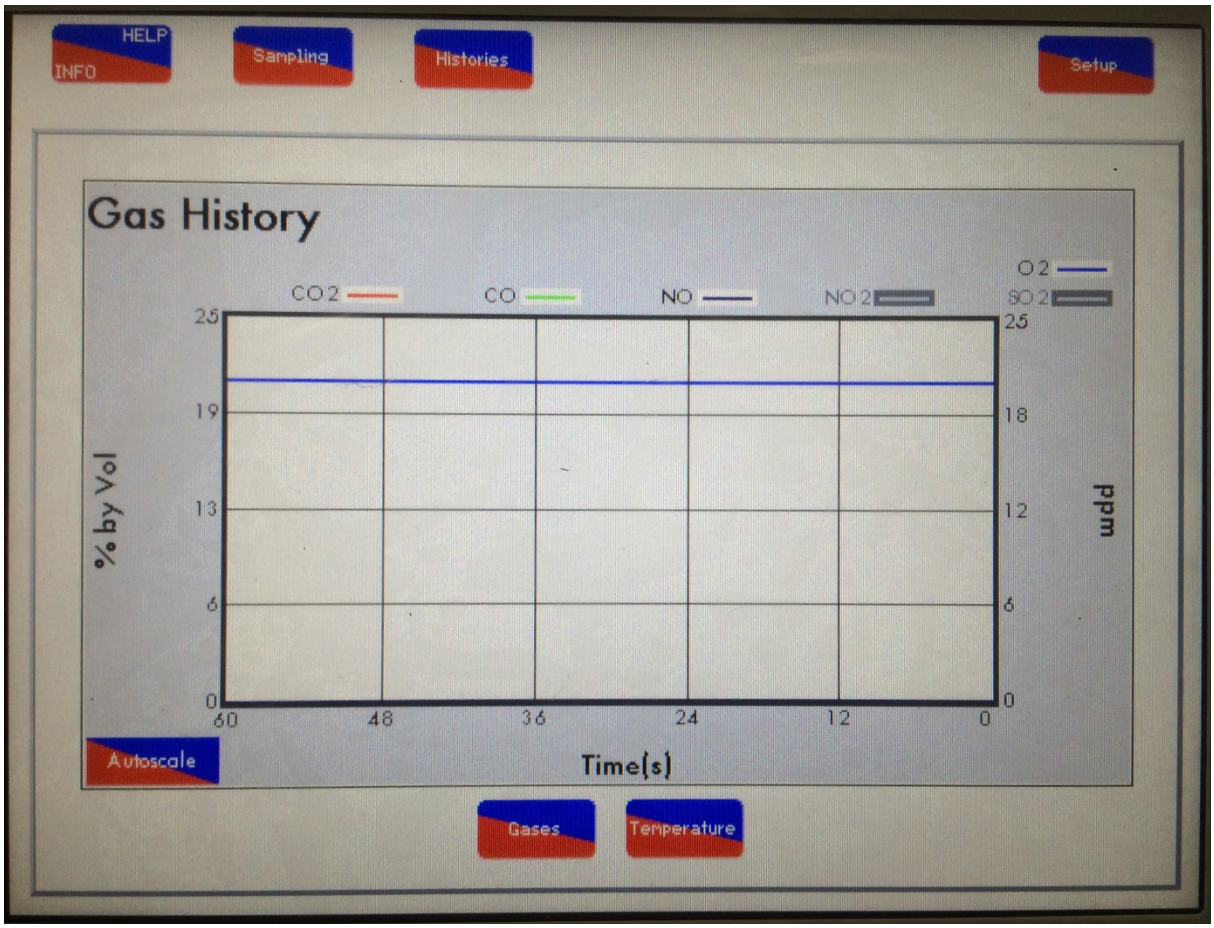


Figure 3.1.11.i Gas History

Press 

to view the cell readings in % volume or ppm for the measured exhaust gases. The graph displays the concentration of each gas for the last 24 hours. This graph can be manipulated by pressing on the axis and moving the axis to either expand the graph or focus in on certain points of the graph. It is possible to select/deselect which gas concentrations are shown on the graph by pressing which gas you wish to select/deselect at the top of the graph.

The Mk7 CEMS E.G.A. displays the exhaust gas data, temperature and combustion efficiency for up to 2 years.

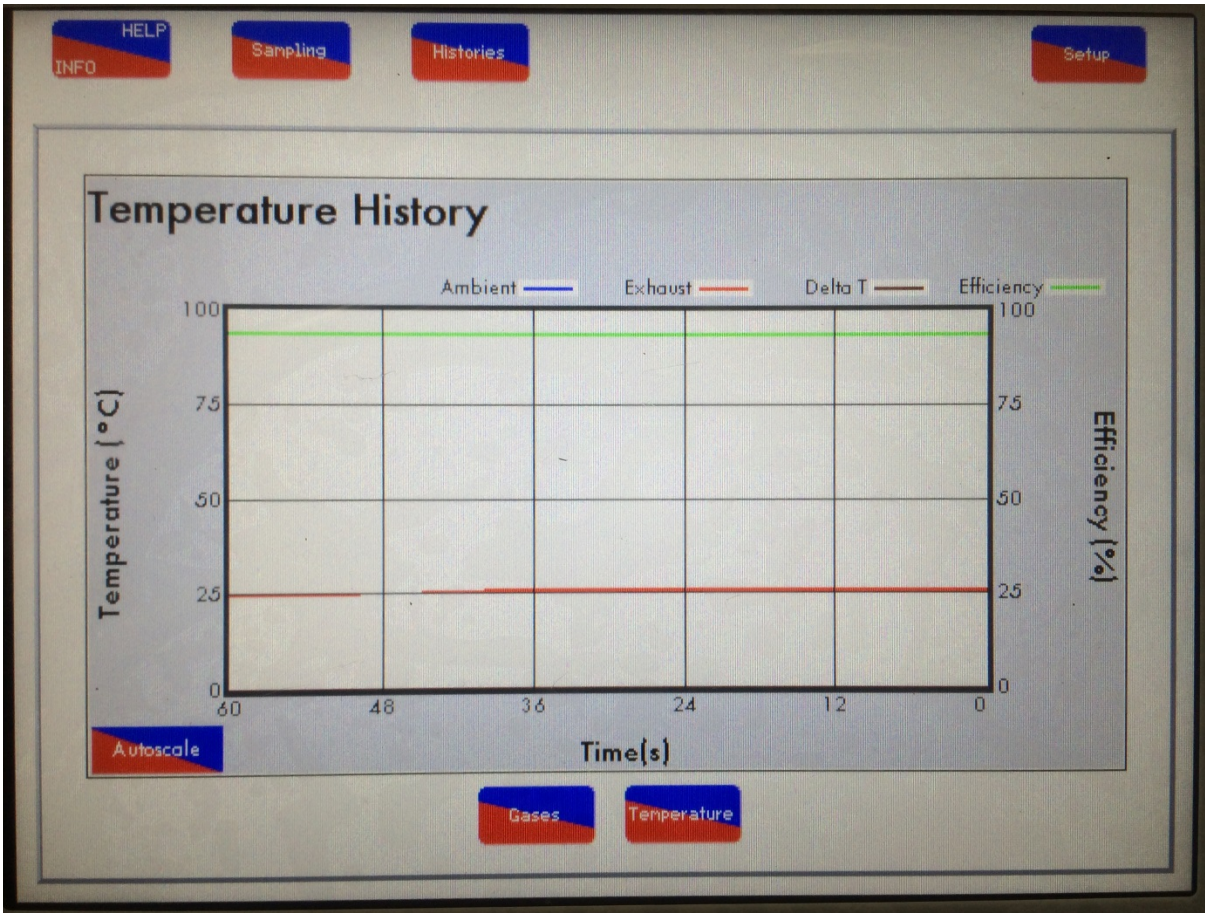
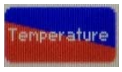


Figure 3.1.11.ii Temperature History

Pressing 

button will display the recent temperature history graph. This graph shows the ambient temperature, exhaust temperature, delta T and efficiency from the past 24 hours. As with the gas history graph the graph can be manipulated and it is also possible to select/deselect what data is shown on the graph.

3.2 Trim Settings

3.2.1 Relevant M.M. Options

The following table gives all the options in the Mk7 M.M. which are relevant to the E.G.A. settings. When changing the options for the E.G.A. such as the alarm operation, trim threshold and trim delay, it is good practice to adjust one and check the effects on the trim operation before adjusting another.

Option No.	Factory Setting	Option Value	Description
12	**0**		**E.G.A. Options:** If this option has a setting of 1 - 9, then the E.G.A. will trim and the burner must be commissioned with the E.G.A. operational. The trim is applied to channel 2 or 5, dependent on how option 76 is set.
		0	E.G.A. not optioned
		1	If an E.G.A. error occurs, then the burner will continue to fire. The servomotors will return to the original commissioned fuel/air ratio and the trim function will not be operational until the E.G.A. error is reset. No combustion/single point changes can be made whilst the E.G.A. is in an error condition. Terminal 79 is not energised in the event of an E.G.A. error.
		2	If an E.G.A. error occurs, then the burner will stop firing. The burner will not start until the E.G.A. error has been cleared and the E.G.A. is inside its operating temperature range. Terminal 79 is not energised in the event of an E.G.A. error.
		3	Same as 1, except terminal 79 is energised in the event of an E.G.A. error.
		4	Same as 2, except terminal 79 is energised in the event of an E.G.A. error
		5	Same as 1, plus the combustion limits are also tested (Options 19 - 27)
		6	Same as 2, plus the combustion limits are also tested (Options 19 - 27)
		7	System commissioned on M.M. Only - E.G.A. used only for monitoring and display purposes.
		8	Same as 5, except terminal 79 is energised in the event of an E.G.A. error.
		9	Same as 6, except terminal 79 is energised in the event of an E.G.A. error.
17	**0**		**NO & CO Displayed when running on oil:** If fuels 2 or 3 are selected, then the displaying of CO & NO can be on or off. This option is only relevant if an E.G.A. is operational on the system.
		0	NO & CO not displayed
		1	NO & CO is displayed normally.
18	**1**		**Carry Forward of Trim:** When the system modulates, the correction that may exist on the air damper position can be carried forward. This option is only relevant if an E.G.A. is operational on the system.
		0	No carry forward of trim.
		1	Trim carried forward.
19	**0.0**		**Upper Offset Limit % O_2:** This is an offset limit from the commisioned values. E.G.A. Limits: Options 19 - 27 are only relevant if an E.G.A. is operational on the system. Option 12 must be set to 5,6, 8 or 9 for combustion limits to be set.
		0 - 100	% O_2
20	**0.0**		**Upper Offset Limit % CO_2:** This is an offset limit from the commissioned values.
		0 - 100	% CO_2
21	**0**		**Upper Offset Limit ppm CO:** This is an offset limit from the commissioned values.
		0 - 200	ppm CO
22	**0.0**		**Lower Offset Limit % O_2:** This is an offset limit from the commissioned values.
		0 - 100	% O_2
23	**0.0**		**Lower Offset Limit % CO_2:** This is an offset limit from the commissioned values.
		0 - 100	% CO_2
25	**0.0**		**Absolute Value % O_2:** System checks for O_2 values lower than the value specified in this option regardless of the commissioned values.
		0 - 200	% O_2
26	**0.0**		**Absolute Value % CO_2:** System checks for CO_2 values higher than the value specified in this option regardless of the commissioned values.
		0 - 200	% CO_2
27	**0**		**Absolute Value ppm CO:** System checks for CO readings higher than value specified in this option regardless of the commissioned values.
		0 - 200	ppm CO

Option No.	Factory Setting	Option Value	Description
28	**20**		**Trim Threshold:** This option is only relevant if an E.G.A. is operational on the system. The value set in this option is subtracted from the required setpoint. If the actual value is below this offset, then the E.G.A. will not trim. If the trim is to be effective at all times, then set this value to zero. This Option must also be set to zero for the E.G.A. to operate when external modulation is optioned.
		0 - 50	If Centigrade, Fahrenheit or PSI units effective.
		0 - 5.0	If Bar units effective.
			Note: *No single point changes can be made if the actual value is below the offset value.*
32	**20**		**Trim Delay:** After ignition, the E.G.A. does not sample for the period of time set in this option (only relevant if E.G.A. is operational on system). This allows for the combustion to stabilise before sampling commences. The timing starts at the ignition point.
		0 - 250	Period (seconds) after ignition no sampling takes place.
36	**0**		**E.G.A. Sensor Selection:** Available when using an E.G.A. System fitted with NO_2 and SO_2 cells. The following option selects the type of additional cells used.
		0	Neither
		1	NO_2 only
		2	SO_2 only
		3	NO_2 and SO_2
56	**1**		**Operation of alarm output for all M.M. and E.G.A. errors/lockouts on Terminal 79:**
		1	Relay normally off, on when alarm.
		2	Relay normally on, off when alarm.
			Note: *This is a switched neutral and not an output terminal.*
76	**0**		**Trim channel:** If an E.G.A. is optioned, the trim can be applied to either Channel 2 (servomotor) or channel 5 (VSD). If trim on channel 5 is used, Options 91 to 97 must be entered correctly.
		0	Trim on channel 2.
		1	Trim on channel 5.

3.2.2 Relevant M.M. Parameters

The following table shows the relevant parameters for the Mk7 E.G.A. operation on the Mk7 M.M. It is important to remember that changing these parameters will dramatically change the trim operation. The majority of these parameters can be left with the default settings in most applications; any adjustments to these parameters should be made one at a time.

Parameter No.	Factory Setting	Parameter Value	Description
4	**45**		**E.G.A. -** Number of seconds 'ENTER' button is disabled after 'E.G.A.' button is pressed during commissioning and single point change.
		5 - 100	Seconds.
8	**30**		**E.G.A. -** Delay after draining before trim cycle starts (washout period). When the E.G.A. drainings and the cells are cleaned with air this value maintains the E.G.A. readings from before the drain period for 'n' seconds to allow the air to clear from the E.G.A.
		5 - 240	Seconds.
9	**60**		**E.G.A. -** Auto commission time (seconds). How long the air rich and fuel rich positions are held during commissioning.
		5 - 240	Seconds.
10	**1**		**E.G.A. -** Version
		0	Mk6 E.G.A.
		1	Mk7 E.G.A.
		2	Mk8 E.G.A.
11	**15**		**E.G.A. -** Air flush time, the flush out period between going air rich and fuel rich during commissioning.
		5 - 60	Seconds.
12	**0**		**E.G.A. -** CO included in trim calculation on fuel 2 & 3 (see option 17). Required when using natural gas on fuel 2 & 3.
		0	No.
		1	Yes.
13	**20**		**E.G.A. -** ÷4 = % of air damper movement. Amount of auto commission trim. Applies only to fuel rich cycle.
		5 - 30	Degrees.
14	**20**		**E.G.A. -** Number of degrees the fuel valve moves bebfore fuel rich trim is reset.
		1 - 200	Degrees
16	**12**		**E.G.A. -** ÷2 = time between calibrations if burner does not switch off.
		1 - 50	Hours.
17	**3**		**E.G.A. -** Number of trims before an E.G.A. error is flagged when combustion limits are exceeded. Each trim is equal to Parameter 25 (seconds).
		0 - 10	Number of trims.
18	**20**		**E.G.A. -** ÷2 = % of trim, trim amount during run. This value cannot be set above 20 (10%) or an error 25 occcu
		5 - 60	Amount of trim.
19	**5.00**		**E.G.A. -** ÷4 = % ofr air damper movement. Amount of auto commission trim. Applies only to air rich cycle.
		0 - 20	Air damper movement. (20 = 5.00%)
23	**0**		**E.G.A. -** Trim to add air when CO is present. When trim is taking place, if the O_2 and CO_2 appear on the air rich side but the CO appears on the fuel rich side then the air damper will open further to remove CO.
		0	Enabled.
		1	Disabled.
24	**120**		**E.G.A. -** Calibration time.
		20 - 360	Seconds.
25	**30**		**E.G.A. -** Time between each sample (trim).
		5 - 100	Seconds.
26	**8**		**E.G.A. -** Number of samples (trims) between each trim cycle.
		1 - 50	Number of trims.

Parameter No.	Factory Setting	Parameter Value	Description
27	**25**		**E.G.A. -** Minimum operating temperature (÷5 = degC)
		0 - 255	Temperature
28	**200**		**E.G.A. -** Maximum operating temperature (÷5 = degC)
		0 - 255	
31	**0**		**Selects efficiency to be displayed:**
		0	English (USA/ Canada - incorporates hydrogen & moisture loss).
		1	European.
35	**2**		**O_2 change to detect residence time:** Default is set at 2 for 0.2% O_2 change to detect residence time.
		0 - 10	%
44	**4**		**O_2 window inside which no trim takes place:** ÷10 = O_2 %
		0 - 40	%
45	**2**		**CO_2 window inside which no trim takes place:** ÷10 = CO_2 %
		0 - 20	%
58	**0**		**E.G.A. -** Air Calibrations
		0	Enabled
		1	Disabled
60	**0**		**E.G.A. or O_2 trim interface module**
		0	Normal E.G.A. operation.
		1	O_2 trim interface module operation.
74	**0**		**Trim method:** Changes the method of trim from the normal angular degrees trim to area trim, where the trim works on the area that is open on the damper blades to allow the air through.
		0	Angular degrees trim.
		1	Area trim (quick commission).
79	**0**		**E.G.A. Splitter for twin burner application:** When using twin burners its is possible to use the E.G.A. data from the master M.M. module for the slave M.M. module, so only one E.G.A. is required. Set parameter 79 to 1 on the slave and parameter 79 to 0 on the master.
94	**0**		**Upper offset limit ppm NO:** This is an offset limit from the commissioned values.
		0 - 999	ppm No
96	**0**		**Upper offset limit exhaust temperature:** This is an offset limit from the commissioned values.
		0 - 999	deg C/ deg F
97	**0**		**Absolute limit exhaust temperature:** System checks for exhaust temperature readings higher than this value
		0 - 999	deg C/ deg F

3.2.3 Commissioning Procedure

Commissioning with the E.G.A. is an extension to commissioning with the M.M. and is required if the trim function is to be used. The factory trained technician must be completely familiar with the commissioning of the M.M. unit before commissioning with the E.G.A. The Mk7 M.M. commissioning procedure is shown in Mk7 Manual: M.M. Installation and Commissioning Guide.

The commissioning procedure as described must be strictly adhered to. Anybody commissioning an M.M./E.G.A. system must have an adequate understanding of combustion plants and be officially certified by Autoflame Engineering.

In the wrong hands, hazardous conditions could be made to exist that could lead to product damage, critical injury or death.

The fundamental idea of the system is to set a fuel valve position and then set a corresponding air valve position. Care must be taken when adjusting the fuel and air positions so as not to create any unstable or dangerous combustion conditions, e.g. moving the fuel valve to the open position without increasing the air valve correspondingly.

Commissioning a system with an E.G.A. does not require a combustion monitor as the E.G.A. performs all normal exhaust gas measurements. When burning oil, a smoke detection device is required to check that the smoke generated is within government guidelines.

Ideally, to implement commissioning as quickly as possible arrange for a substantial load on the boiler. The commissioning procedure can be interrupted due to excess temperature or pressure, causing the burner to turn off. In these instances the commissioning data accumulated so far is not lost. When the burner is called back on, the system starts up automatically and commissioning can proceed from where it left off.

Once the burner has been fired the maximum fuel position is entered first then descending fuel positions are entered consecutively until finally a minimum fuel position is entered. The CH1 and CH2 positions must always be less than the ones previously entered. However with CH3 – CH7 it is possible to move the position above or below the previously entered points. This is important if these channels are used to control FGR (Flue Gas Recirculation) or atomisation of oil.

On a newly installed system the following procedures should be carried out as listed:

1. Check all interconnecting wiring between the M.M. and external components are correct.
2. Set the Options and Parameters required (Section 3.1.1 and 3.1.2).
3. Set up positioning motors.
4. Programme fuel/air positions.

Note: For the safety and operational checks, and the full commissioning procedure of the Mk7 M.M., please refer to section 3 in Mk7 Manual: M.M. Installation and Commissioning Guide.

3.3 Mk7 E.G.A. Trim

3.3.1 Trim Operation

With the E.G.A. trim facility it is possible to expand the M.M. so it will measure and display O_2, CO, CO_2 and exhaust gas temperature, together with boiler temperature or pressure. It is also possible to use these O_2, CO and CO_2 values for 3 parameter trim in order to optimise the burner combustion throughout the firing range of the burner in a safe manner. This means that the safety is never compromised by efficiency, but the best burner/boiler efficiency is maintained. Correct set-up of the 3 parameter trim will maintain optimum combustion efficiency, whilst never compromising safety.

During commissioning, for every paired value of fuel and air, the corresponding values of O_2, CO and CO_2 are stored. The system will then automatically induce an 'autotrim' cycle in which the air damper will close 5% (parameter 13) of the entered air damper position and then hold its position for 60 seconds (parameter 9). This is known as the fuel rich part of the autotrim cycle. After 60 seconds the values of O_2, CO, and CO_2 are stored. The 60 seconds allows the combustion gases to move through the E.G.A. in order to obtain new combustion values.

After these values have been stored then the E.G.A. will stop sampling from the stack for 15 (parameter 11) seconds and sample from atmosphere (through the solenoid valve) in order to clear any CO residue that may have been produced during this fuel rich autotrim. During this time the air damper will now open 5% of (parameter 5)the commissioned air damper position and following the air flush time the air damper will be held in this position for 60 seconds (parameter 9). This is known as the air rich part of the autotrim cycle. After the 60 seconds the values of O_2, CO, and CO_2 are stored. It is now possible to move to the next position in the fuel and air curve to be entered. This same process will occur for every fuel and air position entered. This builds up a complete map of the burner's combustion performances (see graphs in Section 3.3.4).

During the normal run mode, the on-line sample at any position within the burner's firing rate is compared to the commissioned values. There are 3 individually sampled parameters (O_2, CO, CO_2) in order to verify the combustion performance either side of the commissioned value. The software within the M.M. unit will inflict minute corrections to the channel 2 air damper positions or the channel 5 variable speed drive in order to maintain the commissioned values. These small changes ensure that the originally entered commissioning data is adhered to, irrespective of variations in stack pressure, ambient temperature/pressure fluctuations, barometric conditions or fuel pressure changes.

The system trim function is achieved by every paired value for air and fuel having stored values for O_2, CO_2, and CO at the commissioned value. Deviations from these ideal values are held and accessible via the Combustion Map button the Mk7 M.M. This data shows the commissioned values of the emissions, the current values of the emissions and the amount of trim that is being used.

<u>Importance of Measuring 3 Parameters</u>
The Autoflame system trims on O_2, CO_2 and CO, and so is not simply an O_2 trim system. If only O_2 is measured and trimmed on then there is no cross reference to CO, CO_2 or NOx Therefore, even if the O_2 readings are correct, changes in ambient conditions can cause the CO to rise significantly (>>100ppm). Another, more dangerous problem that can occur is oxygen being induced into the boiler through gaskets and small gaps in the boiler flue ways. As the flue gas is measured at the exit of the boiler, this could lead to higher O_2 readings even if the combustion is good, i.e. high CO levels (>>100ppm), low O_2 levels. With a simple O_2 trim system, this potentially dangerous problem would not be accounted for. With the Autoflame E.G.A., O_2, CO_2 and CO are constantly measured and any changes to these 3 parameters, will result in a trim taking place on the air damper to return the combustion level back to the original commissioned values. Therefore, even if both the O_2 and CO_2 are reading correctly the system will still trim due to changes in the amount of CO produced.

The following table shows a potential problem with using the O_2 analyser.

	O_2 Analyser			**3 Parameter Trim (Autoflame)**			
State	**O_2**	**CO**		**O_2**	**CO_2**	**CO**	
1	3	0		3	10	0	Commissioned
2	4	0		4	10	0	Trim
3	4.5	100		4.5	10.5	100	Increased Trim
4	5	200		5	10.5	100	No trim
5	4	500		5.5	10	0	Commission position
6	3	1000+		5.5	10.5	50	Trim

Values in red are ones that are not viewable using an O_2 trim system.

State 1 – The burner is operating under normal conditions.

State 2 – Over a period of time, boilers are susceptible to leaks occurring. One of the most likely places that this will occur is on the stack, near to the point where the analyser is measuring the exhaust gases. As a leak occurs at this point, the analyser is not measuring solely the exhaust gases, but is in fact contaminated with 20.9% O_2 from atmosphere. Therefore, the oxygen reading starts to increase.

State 3 – As the amount of oxygen increases so too does the reading. At this point the controller closes the air damper in order to react to the increase in oxygen. The CO begins to rise since the combustion is now not correct.

State 4 – Both analysers still see an increase in the oxygen reading. The O_2 analyser continues to close the air damper in order to reduce the excess air through the system, and so producing CO. The Autoflame analyser measures the increasing CO value and ensures that the air damper does not continue to close.

State 5 – The O_2 analyser continues to trim based on the oxygen readings and so excess CO is produced. The Autoflame analyser has seen this ambiguous case and returns the air damper back to the commissioned value in order to ensure that the O_2, CO_2 and CO levels are returned to the commissioned values (or close to) before further trimming occurs. This, potentially dangerous anomaly has been corrected for.

State 6 – Dangerous combustion occurs on the O_2 analyser, whereas the Autoflame E.G.A. system has taken this ambiguous case into account.

3.3.2 Quick Commission

Quick Commission allows the engineer to commission the burner separately to add the trim values later. This allows the engineer to enter a full combustion curve in situations where there is a low demand for heat or steam. Entering the fuel rich and air rich data for the combustion map can sometimes take too long. Single point change can be accessed at a later time at load to add the trim curve. (See Mk7 Manual: M.M. Installation and Commissioning Guide).

The amount of trim is proportional to the area that the damper is open. During normal commissioning with E.G.A., the air damper is opened and closed (during air rich and fuel rich) based on 5% of the angular position. With quick trim it is based on 5% (parameter 13) of the dampers open area, allowing for more precise trimming.

During normal commissioning with E.G.A. the 'auto commission time' is set to 60seconds (parameter 9). This is the time at which the air damper is held at the air rich or fuel rich phase of commissioning. With quick commission the commission time is based on the residence time of the combustion gas. This is the time from the time the gas leaves the burner, to the time it exits the boiler into the flue. This time will vary depending on how the burner is firing and the burner turn down ratios. The residence time is measured by looking for a change in the O_2 reading from when the air damper is moved, to a change in combustion of >0.2% O_2. This residence time is displayed in the combustion map screen. The residence time is typically longer at low fire that at high fire due to the volume of the gases passing through the boiler.

When selecting a line of combustion in the combustion map screen, the trim values for the air rich and the fuel rich will be displayed below the main table to indicate the trim either side of the commissioned combustion curve.

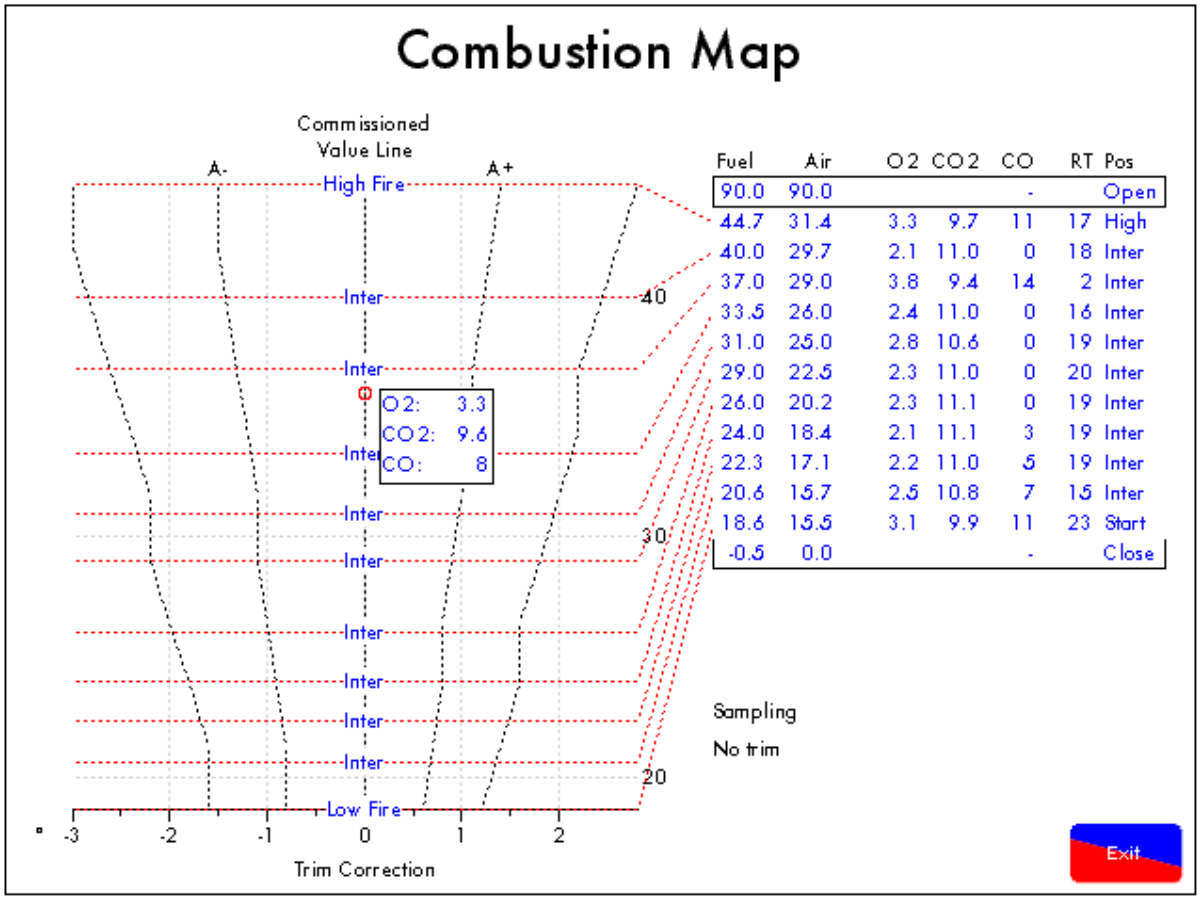


Figure 3.3.2.i Combustion Map Screen

The combustion map screen is enabled by setting Parameter 74 to 1 prior to commissioning the Mk7 M.M. and also requires an E.G.A. to be optioned.

The combustion map (see Figure 3.3.2.i) shows how the trim function works on the system. The combustion map screen can be accessed by pressing the 'combustion map' button on the M.M home screen. The combustion map clearly shows the commissioned E.G.A. values for O_2, CO_2 and CO. The graph on the left of the screen shows the amount of trim being added by the M.M. to control these emissions values so that they are as close to their commissioned values as possible. The red circle indicates the current position of the trim being applied and the current combustion values are displayed at this point as well.

3.3.3 Trim Timing Operation

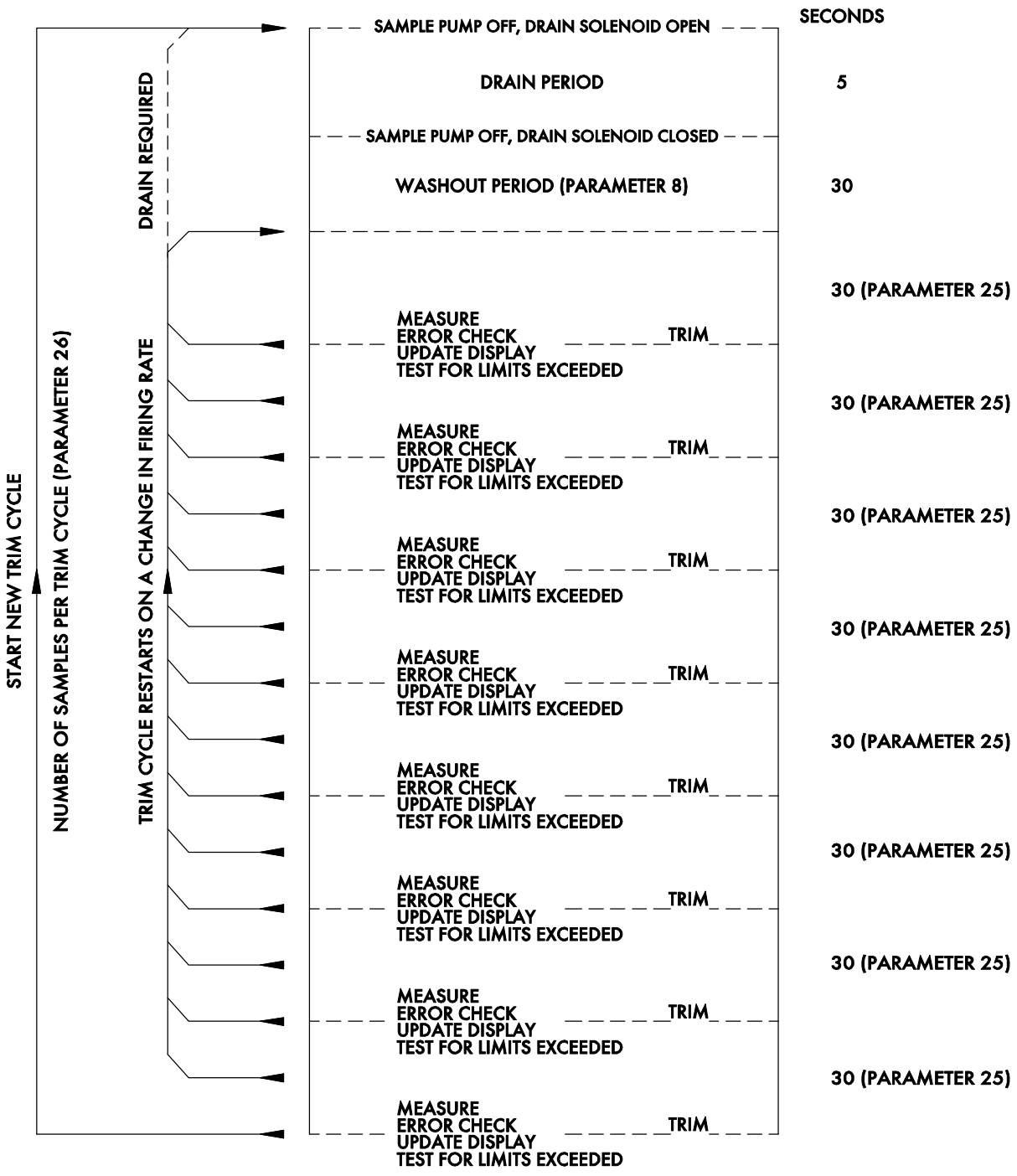


Figure 3.3.3.i Trim Timing Operation

If an air calibration is due during the trim cycle, the M.M. will delay the calibration until the cycle has completed.

3.3.4 Graphical Trim Operation

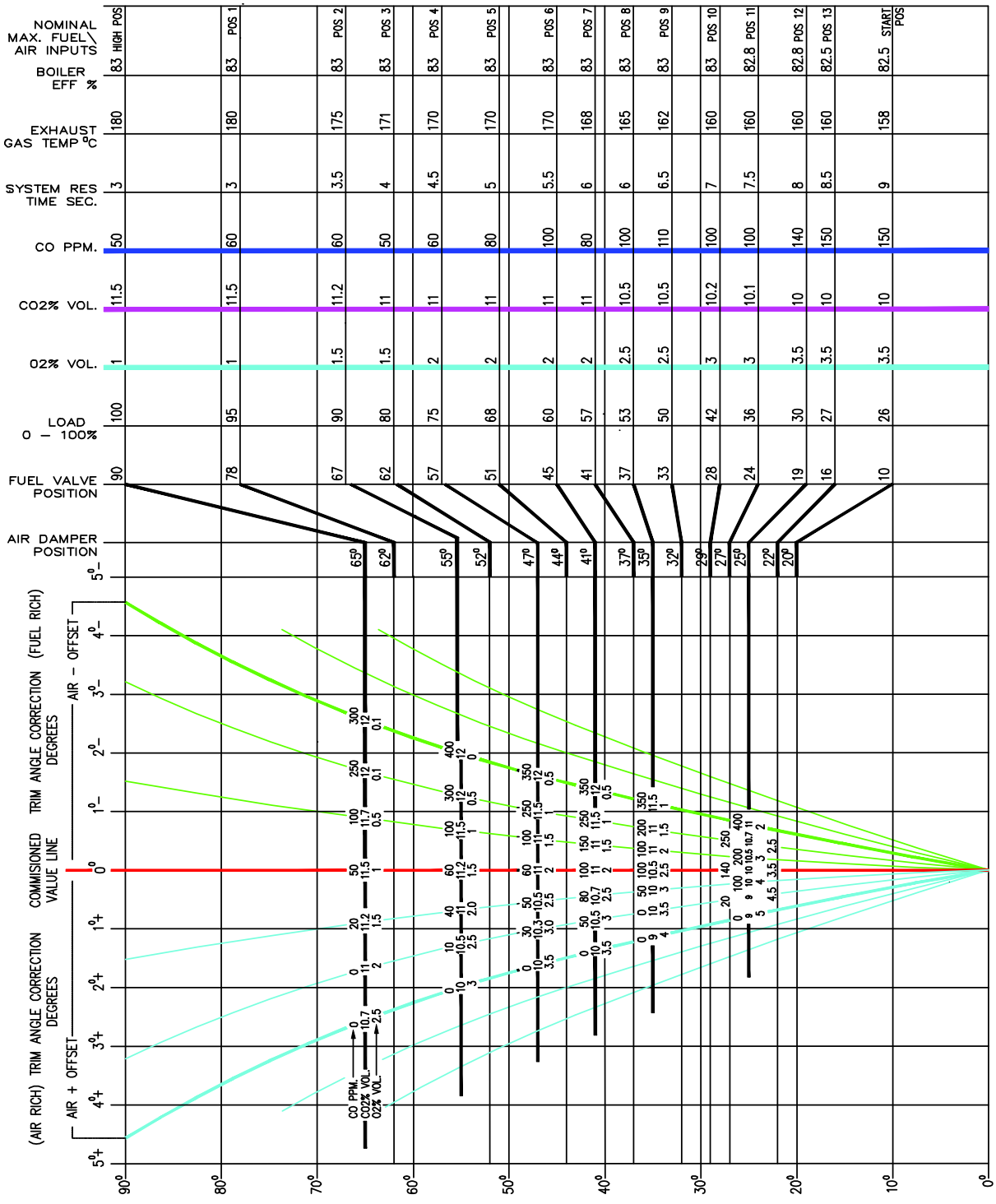


Figure 3.3.4.i Graphical Trim Operation

3.3.5 Channel 5 Trim

When trim is set on channel 5, changing the M.M. options will make a difference between errors occurring or not. For the purposes of trim, the Mk7 M.M. needs to know how the VSD will behave, in terms of a change in the VSD input and its effect on the feedback (output) signal, which is why the VSD Options (90 – 97) must be set exactly – i.e. input/output voltage/current ranges and input/output min/max Hertz. If the system is already commissioned and if any of the VSD drive input/output voltage/current ranges or input/output min/max Hertz are altered then re-commissioning will be necessary as the stored feedback values for each M.M. entered point will now be incorrect. These stored feedback values are used by the M.M. as the starting point for working out the expected feedback signal – whether trim on channel 5 is optioned or not.

3.3.5 Combustion Efficiency Calculations

Based on dry gas.

<u>English Calculation:</u>

$$\%\ Combustion\ Efficiency = 100 - (sensible\ heat\ loss + hydrogen\ and\ moisture\ loss)$$

$$\%Combustion\ Efficiency = 100 - \left(\frac{K1(TG - TA)}{\%CO_2} + \left(K2\left(1121.4 + (TG - TA)\right)\right)\right)$$

$K1 = 0.38$	Natural Gas (F1/F4)
$K1 = 0.56$	Fuel Oil (F2/F3)
$K2 = 0.0083$	Natural Gas (F1/F4)
$K2 = 0.0051$	Fuel Oil (F2/F3)
TG	Flue Gas Temperature
TA	Ambient Air Temperature in Boiler House

Note: To use these equations temperatures must be converted to °C.

<u>European Calculation:</u>

$$\%Combustion\ Efficiency = 100 - sensible\ heat\ loss$$

$$\%Combustion\ Efficiency = 100 - \left((TG - TA) \times \left(\frac{A}{20.9\% - O_2\%} + B\right)\right)$$

$A = 0.66$	Natural Gas (F1/4)
$A = 0.68$	Fuel Oil (F2/F3)
$B = 0.009$	Natural Gas (F1/F4)
$B = 0.007$	Fuel Oil (F2/F3)

3.4 Combustion Limits

3.4.1 Overview of Combustion Limits

The combustion limits are only available when the E.G.A. system is used in conjunction with a M.M. control module. The system will have improved safety from using the combustion limits, as these ensure that the combustion exhaust gases do not reach dangerous levels for health and safety, and also environmental regulations. The engineer can set limits as an offset value of the commissioned exhaust gases value, or as an absolute value. These can be upper or lower limits, depending on the exhaust gas variable and the application; the combustion limits can be set on 5 combustion variables: O_2, CO_2, CO, NO and exhaust gas temperature.

The limits of combustion can be adjusted through options 19 – 27 and parameters 94 – 97 on the M.M. module. Before the burner is commissioned, option 12 must be set correctly so that the limits of combustion are checked.

3.4.2 Standard Limits

Standard (offset) limits are a set percentage volume above and below for O_2 and CO_2, ppm above for CO and NO, and temperature above for exhaust gas temperature, for all the commissioned values. If the online exhaust gas values go above this offset of the commissioned value for that point in the firing curve, the burner will lockout or an error will be displayed, depending on how option 12 has been set on the M.M. These are values are entered after the commissioning of the E.G.A. system has been completed throughout the firing range of the burner, according to health and safety requirements or environmental regulations.

3.4.3 Absolute Limits

Absolute limits are a specific percentage volume, ppm or temperature. In this form only an ultimate low value may be put on O_2 and exhaust gas temperature in percentage volume and temperature respectively. In the case of CO_2 only an ultimate high value may be entered in percentage volume. For CO and NO an ultimate high in ppm may be entered. These values are entered when commissioning of the E.G.A. system has been completed throughout the load index of the burner to avoid the burner locking out when commissioning.

3.4.4 Combustion Limits Control Functions

Using Option 12 on the M.M. module it is possible to have two distinct control functions on how the system will react when the limits of combustion are exceeded.

<u>Control Function 1</u>
Once the combustion limits are exceeded the trim function is disabled automatically and the system runs on the fuel-air ratio positions that the M.M. module was commissioned on. An error will also appear on the M.M. module, and until the error is reset on the M.M., the trim function will remain disabled, even if the combustion limits are no longer exceeded.

<u>Control Function 2</u>
Once the combustion limits are exceed the M.M. module will lockout the burner. The M.M. module will also display an error message, and until the lockout is reset on the M.M. module, the system will remain in a lockout condition.

The following figures give a graphical presentation of how the standard limits of combustion works.

3.4.5 O_2 Limits Example

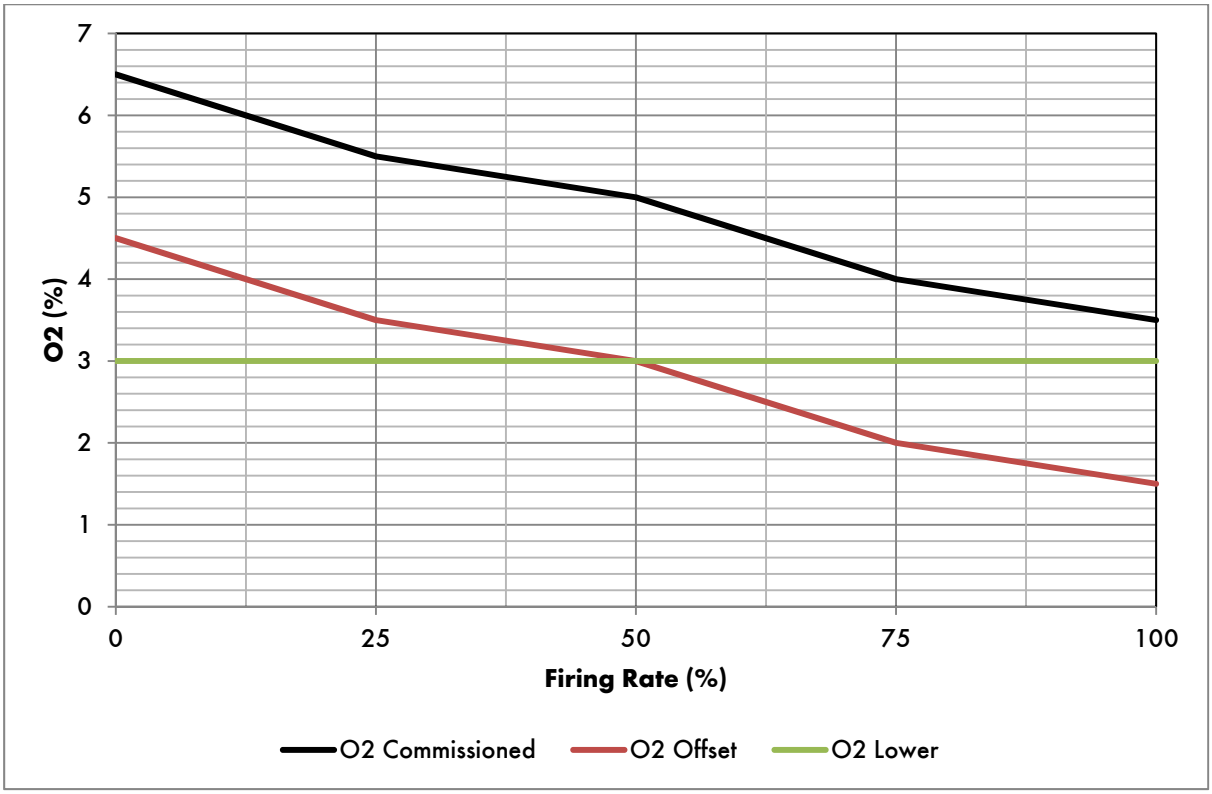


Figure 3.4.5.i O_2 Limits Example

Figure 3.4.5.i shows an example of the O_2 limits. If the offset limit was set to 2%, than the burner would alarm (depending on the terminal 79 operation) when the actual O_2 value dropped below 2% offset from the commissioned value. If the absolute lower limit was set to 3%, the burner would alarm when the actual O_2 value dropped below 3%.

3.4.6 NO Limits Example

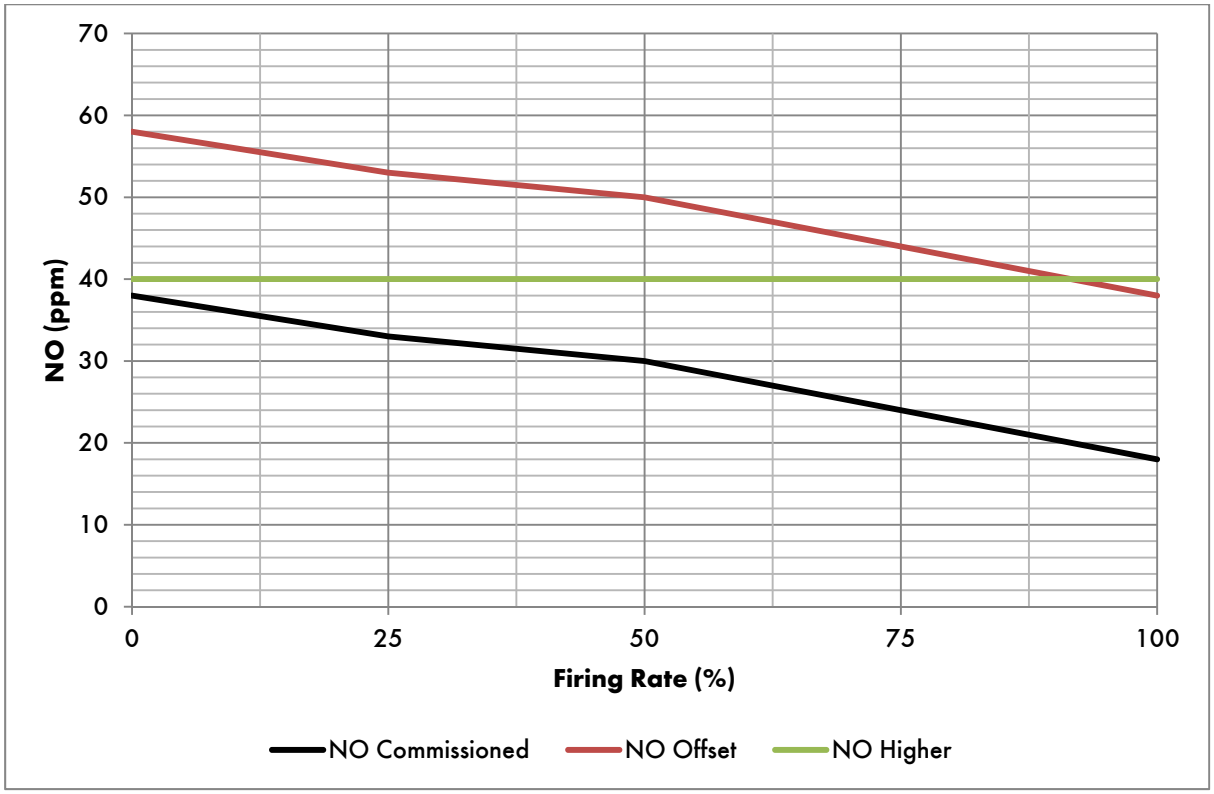


Figure 3.4.6.i NO Limits Example

Figure 3.4.6.i shows an example of the NO limits. If the offset limit was set to 20ppm, than the burner would alarm (depending on the terminal 79 operation) when the actual NO value rose above 20ppm offset from the commissioned value. If the absolute higher limit was set to 40ppm, the burner would alarm when the actual NO value rose above 40ppm.

3.4.7 CO Limit Example

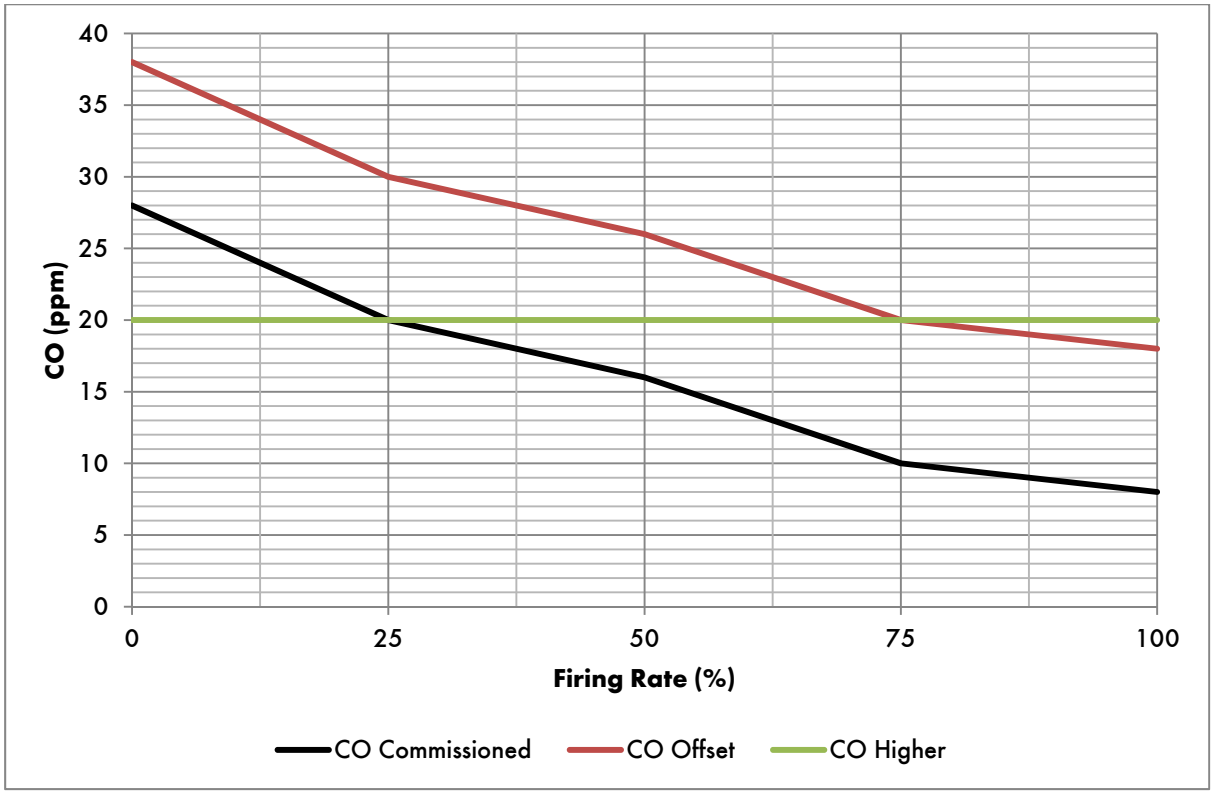


Figure 3.4.7.i CO Limit

Figure 3.4.7.i shows an example of the CO limits. If the offset limit was set to 20ppm, than the burner would alarm (depending on the terminal 79 operation) when the actual CO value rose above 20ppm offset from the commissioned value. If the absolute higher limit was set to 20ppm, the burner would alarm when the actual CO value rose above 20ppm.

3.4.8 Temperature Limits Example

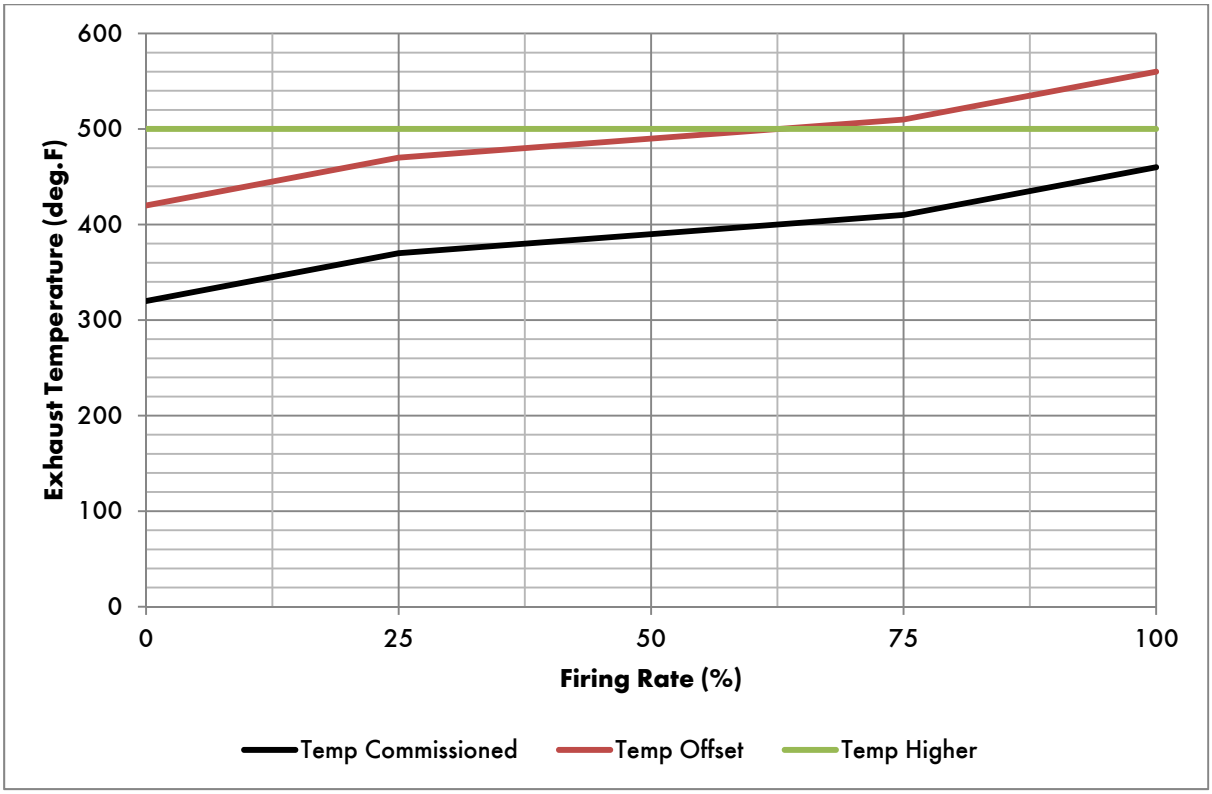


Figure 3.4.8.i Temperature Limits Example

Figure 3.4.8.i shows an example of the exhaust temperature limits. If the offset limit was set to 100deg.F, than the burner would alarm (depending on the terminal 79 operation) when the actual exhaust temperature value rose above 100deg.F offset from the commissioned value. If the absolute higher limit was set to 500deg.F, the burner would alarm when the actual exhaust temperature value rose above 500deg.F.

4 DIMENSIONS AND EQUIPMENT

4.1 Mk7 E.G.A. Dimensions

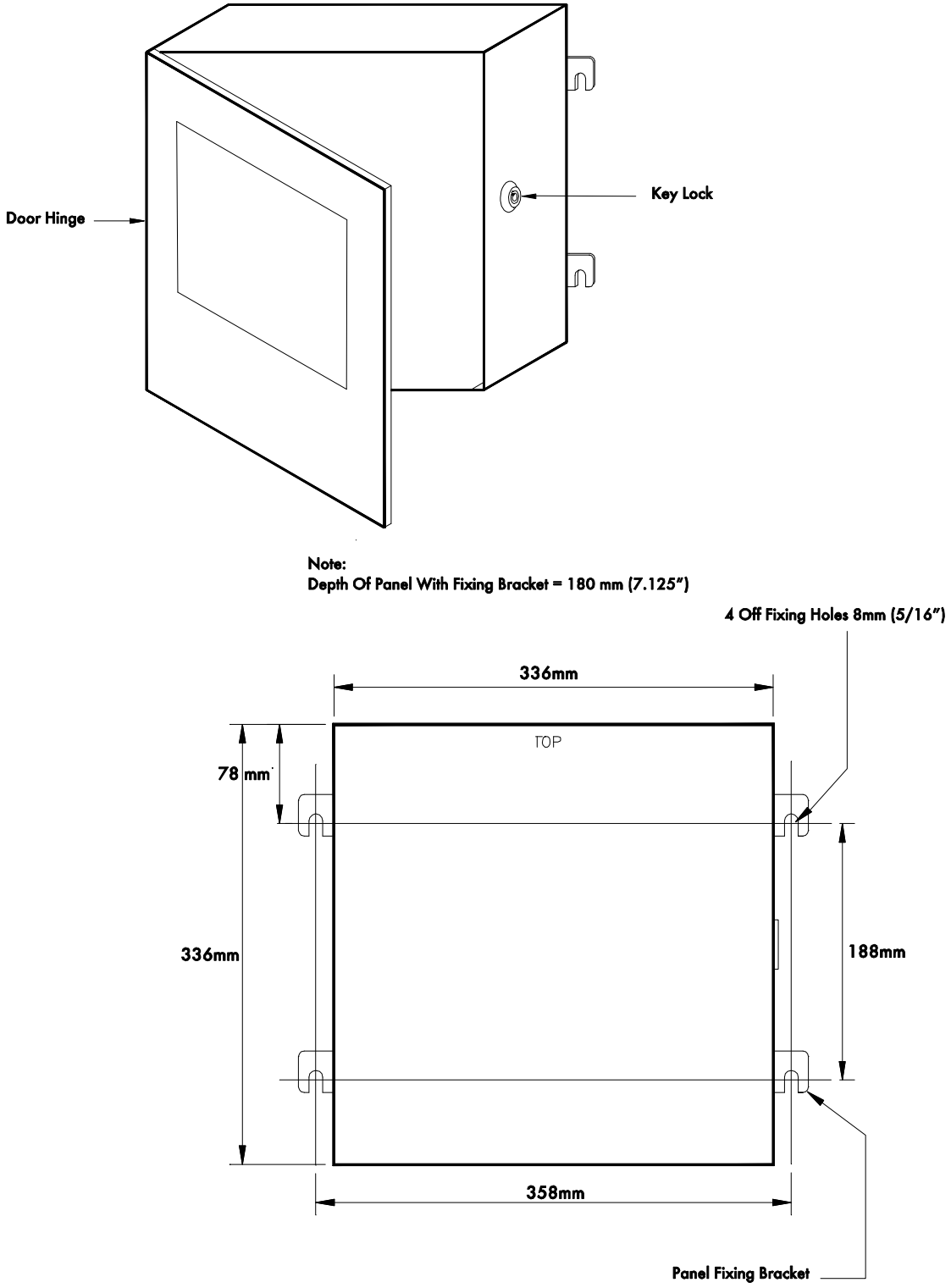


Figure 4.1.i Mk7 E.G.A. Dimensions

4.2 Technical Specifications

Electrical

Electrical Supply	230/110V 50/60 Hz
Power	160W
Max Power Consumption	225W
Pump Flow	110 – 120 mBar 600ml/min
Environmental Rating	IP20 NEMA 1

Temperature Range

E.G.A	Min : 5°C (40°F) Max: 40°C (104°F)

4.3 Sampling Probe

4.3.1 Installation and Maintenance

E.G.A. Sampling Probe Installation

1. Mount the sampling probe at an angle of approximately 45 degrees into the stack.
2. Install a 1.5" BSP socket on the flue or other point that the sampling probe is to be positioned.
3. Mount the main body of the probe as far in as possible; adjustment is made by loosening the grub screws in the flats of the 1.5" BSP bush supplied on the probe.
4. Keep the thermocouple cable and sample tube away from hot surfaces.

Note: For correct E.G.A. operation the probe must be positioned without air leaks as this will give incorrect readings on all sensors.

E.G.A. Sampling System Unit Installation

1. Push the sample tube onto the inlet tube. Plug the thermocouple connector into the socket and tighten the screw.
2. To obtain optimum performance and reliability do not mount the unit in ambient temperatures above 40°C (104°F) or areas of direct heat radiation. Ensure that the air flow to the intake in the bottom of the E.G.A. unit is not impeded and the air temperature is less than 40°C (104°F).
3. Do not mount the units where excessive vibration occurs.
4. Position the sample tube so that the sample slopes down to the E.G.A. unit at all times. The E.G.A. unit must always be mounted lower than the E.G.A. probe. This helps drain excessive condensate from the flue gases, which may cause blockages in the sample tube.

Figure 4.3.1.i Incorrect and Correct Installation of an E.G.A. Unit.

4.3.2 Sampling Probe Assembly

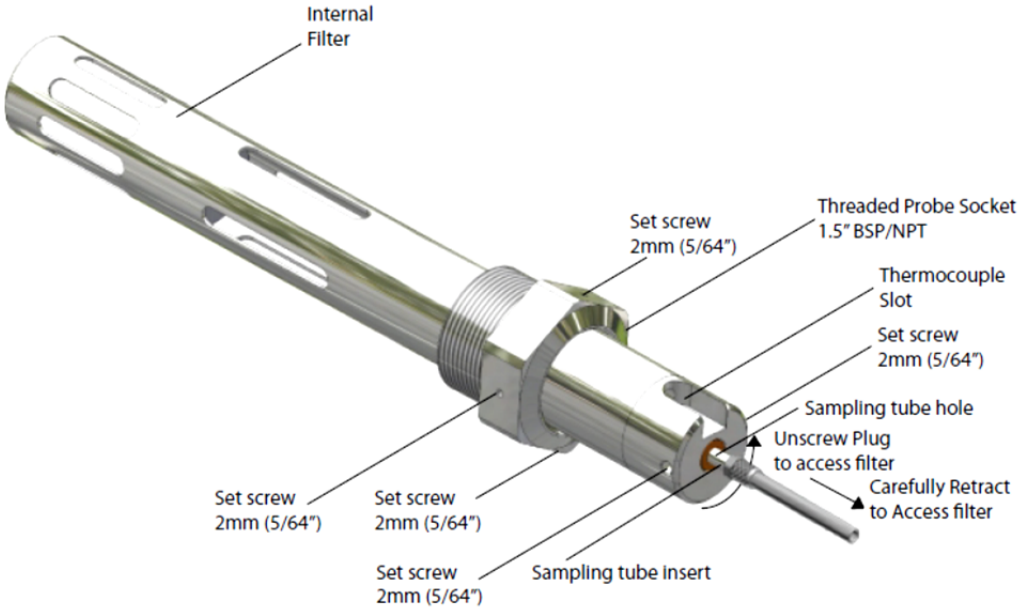


Figure 4.3.2.i Sampling Probe Assembly

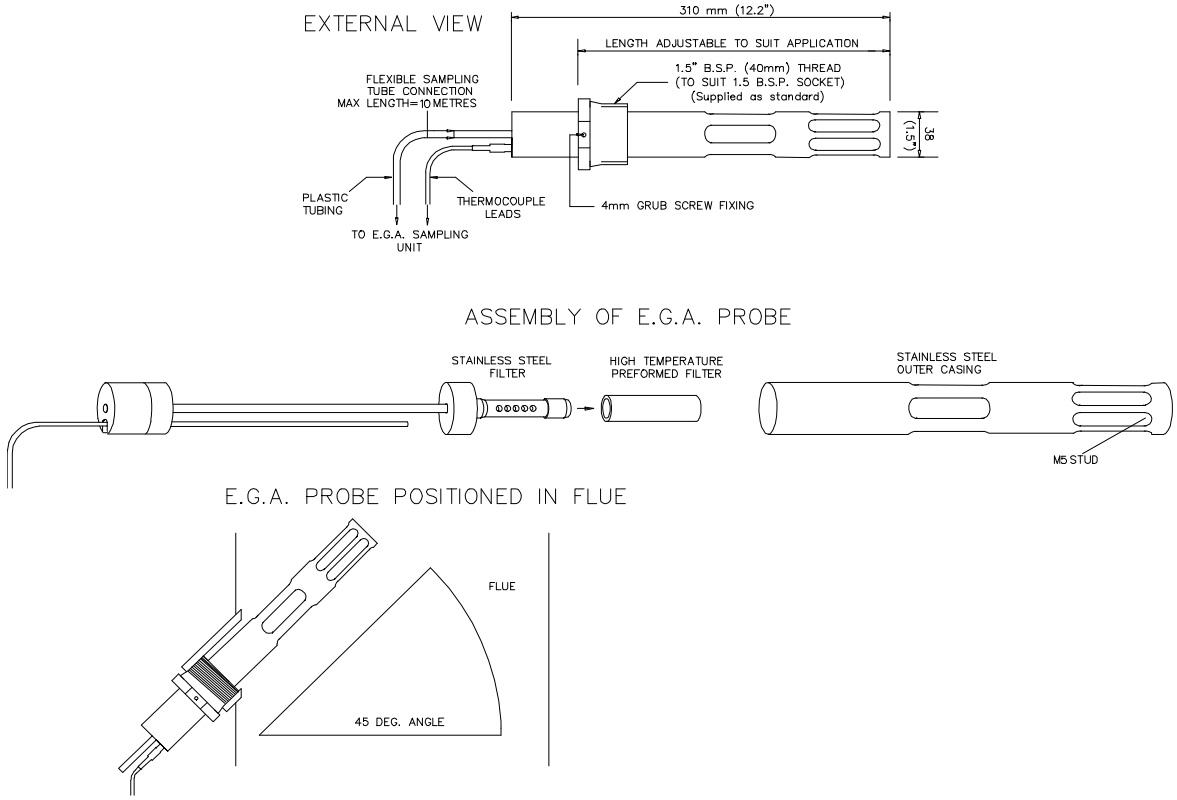


Figure 4.3.2.ii Sampling Probe Dimensions

4.3.3 Sampling Probe Internal Filter

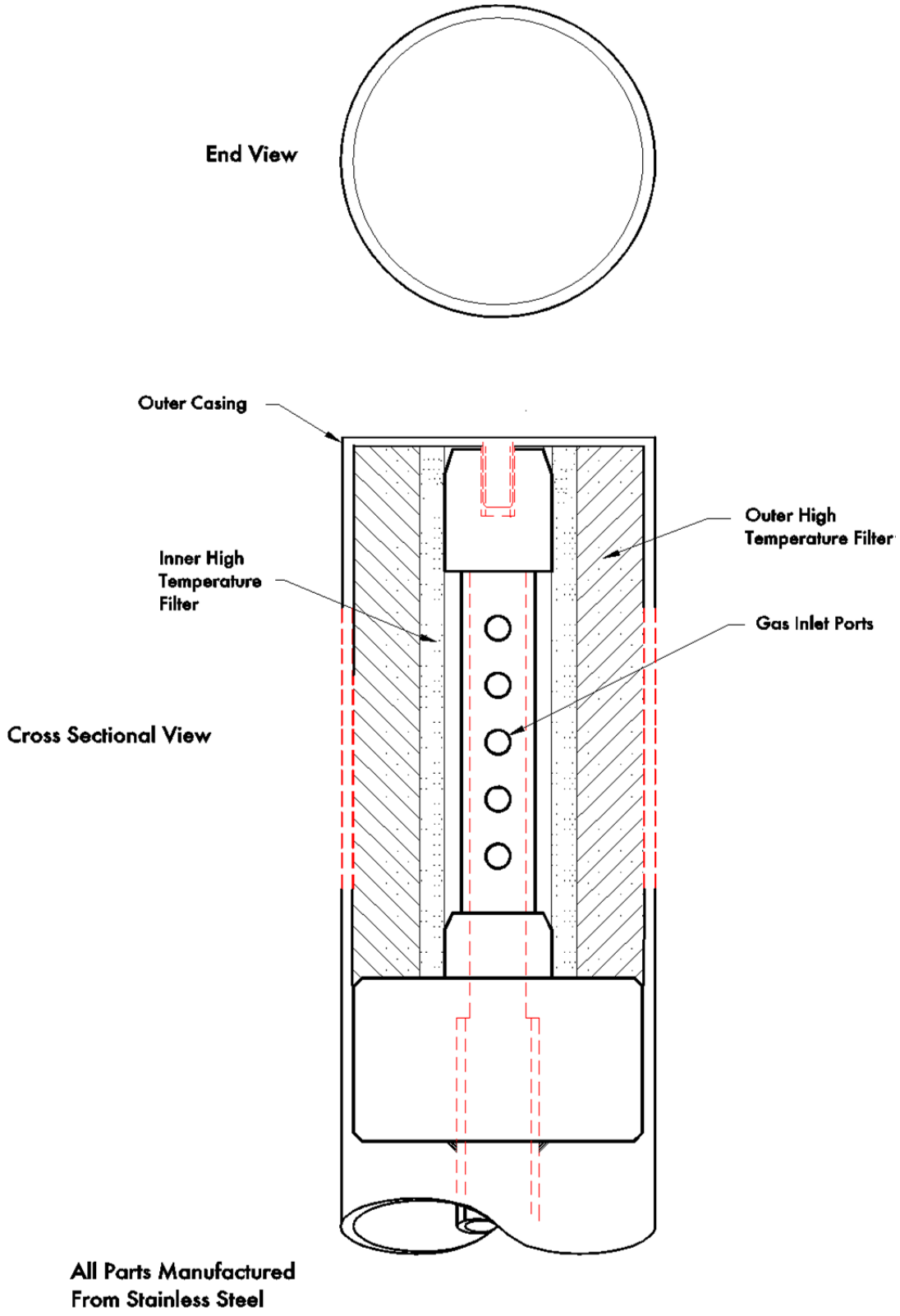


Figure 4.3.3.i Sampling Probe Internal Filter

4.3.4 Sampling Probe Maintenance

On gas only applications it is unlikely that there should be continual maintenance required on the stack mounted probe. It is advised that the probe is checked annually on the gas firing applications in order to ensure that the probe is free of any blockages. On heavy or solid fuel applications, deposits may build up in the outlet part of the tube. If a blockage in the tube occurs a 'O_2 pump fault' will appear on the E.G.A. (See Section 5).

The deposits can be cleared by running a long drill (7mm/0.275") up into the outlet tube by hand. Twist and withdraw the drill often so as to pull out the deposits, otherwise the deposits will be pushed further into the probe assembly.

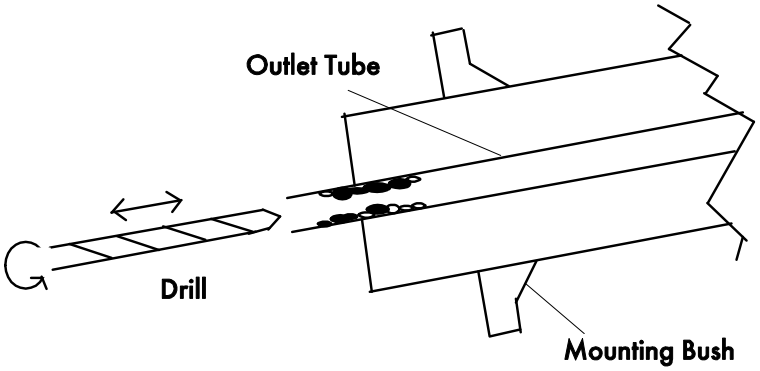


Figure 4.3.4.i Diagram to Show Method of Cleaning a Blocked Outlet Tube

4.3.5 Servicing E.G.A. Sampling Probe

If the filter assembly in the E.G.A. sampling probe is blocked then it is necessary to disassemble the probe and fit a new pre-formed fine filter and coarse filter (Part Number SP70012). To check if the probe is blocked connect the probe to the E.G.A. and allow the E.G.A. to sample. If the pump pressure or flow rate drops below 110mBar or 550 ml/min respectively then the filtering material should be replaced.

To disassemble the probe, unscrew the casing from the base of the probe. See diagram in section 4.3.2. The whole of the internal assembly can now be withdrawn from the sample connection end.

1. Remove the sampling tube and thermocouple from the E.G.A. and unscrew the end cap.
2. Retract the filter and thermocouple from inside the probe at the same angle.
3. Replace the filter on the end of the thermocouple; the thermocouple can also be replaced.
4. Loose the 2mm set screw located above the cap extract the thermocouple.
5. Replace the thermocouple and retighten the set screw.
6. Remove all traces of the filtering materials from the stainless steel filter.
7. Check that the stainless steel filter and inner sample tube are clear inside.
8. Very carefully push the delicate pre-formed filter onto the stainless steel filter.
9. Slide the inner assembly back into the stainless steel outer casing.
10. Pack the void between the fine filter and the outer casing with coarse filtering material.
11. Use a small rod to pack the material down a little at a time.
12. Reassemble by sliding the assembly into the casing and screw together.
13. After reassembly connect the probe to the E.G.A. and check the pump pressure and flow.

4.4 Ancillary Equipment

4.4.1 External Particulate Filter

The external particulate filter (part no. EGA20103/D) is designed to be used when there is excessive moisture from the flue gases, or if there is excess particulates in the flue gases which may cause damage to the E.G.A. The external particulate filter stops excessive moisture from getting into the E.G.A. as it has its own drain solenoid to remove any excess moisture. This drain occurs at the same time intervals as the normal drain solenoid on the E.G.A. The external particulate filter has its own filter, capable of filtering excess particulates from the flue gases. We recommend that this external particulate filter be used for any heavy oil applications. Due to the nature of this product it can only be installed by Autoflame and cannot be fitted on site.

The external particulate filter can be ordered with a new E.G.A. or retrofitted onto an existing E.G.A at our Autoflame London office.

Figure 4.4.1.i External Particulate Filter

Note: For applications firing on heavy or dirty oil, an external particulate filter is highly recommended to be fitted with the Mk7 E.G.A.

The external particulate filter will need to be changed depending on the amount of particulate carried over from the combustion process. This could be a month or as little as once every 6 months, once the filter starts to discolour. Use the Bacharach scale of 5 as an indication as to when the filters need to be changed.

The filter material is fluorocarbon resin bonded, borosilicate glass microfibre designed to coalesce liquid particles through a two layer construction. The inner layer forms the main filtration and the coarser layer provides drainage. It is a type MCE 95% 25micron high efficiency filter.

Figure 4.4.1.ii External Particulate Filter on E.G.A.

The filter should be fitted as in the Figure 4.4.1.ii ensuring that the filter operates correctly. Please note that there may be a discharge of liquid from the filter when in use. This is a design feature to drain any excess moisture from the flue before it reaches the E.G.A. The external particulate filter drain will operate in the same manner and at the same time as the E.G.A. drain solenoid.

4.4.2 Air Inlet Filter

The Mk7 E.G.A. air inlet filter (part no. EGA70106) is designed to protect the E.G.A. from dust and other particles that may cause damage or reduce the performance of the E.G.A. over time. The air inlet filter will fit over the fan that cools the E.G.A. and stop dust and particles from getting inside the E.G.A. The air inlet filter is easy to maintain with only the air filter material needing replacing once it has become saturated. The time between each change of air filter will depend on the site conditions.

Figure 4.4.2.i Air Inlet Filter

While the E.G.A. can successfully be used to measure combustion exhaust gases when burning HFO, it is very important that the fuel is carefully maintained at a constant and known composition. The fuel temperature and pressure play a major role in the amount of particulate carry-over sampled, before combustion even takes place.

The burner must be regularly maintained to ensure complete combustion of the hydrocarbons. Failure to do so will result in premature failure of the E.G.A. Ensure the oil filter is regularly maintained and the oil nozzle is regularly inspected for fatigue.

It is recommended that when the E.G.A. is used on a dual fuel application where natural gas is the primary fuel and HFO is the secondary fuel, the E.G.A. should not be monitoring the HFO exhaust. This can be achieved by simply isolating the E.G.A. when the HFO fuel is selected to be fired.

4.4.3 Chilled Environmental Enclosure

The exhaust gas is vented into the air stream leaving the E.G.A. unit. This is located on the outside of the E.G.A. enclosure next to the drain solenoid outlet. It is extremely important that the exhaust gas is vented into atmosphere; **do not install an E.G.A. within a sealed enclosure**. Installing the E.G.A. in a sealed enclosure will cause the E.G.A. to calibrate on contaminated gases. The E.G.A. will self-calibrate every 12 hours of running or when the burner starts and stops.

In areas of harsh ambient conditions, or excessive heat, it is necessary to use an environmental enclosure with the E.G.A. module. This protects the E.G.A. from dust and ensures that the E.G.A. is well protected. Using the enclosures allows the E.G.A. to operate under optimal operating conditions.

Autoflame manufacture a chilled environmental enclosure that uses a chiller module and control panel in order to maintain the E.G.A. installed within the enclosure at a set temperature to protect itself from excessive heat. The temperature is user adjustable by means of a thermostat counted on the unit but is nominally set for 35°C (95°F), which ensures ideal operating conditions for the E.G.A. Autoflame also manufacture a heated enclosure for low temperature and for anti-condensing sites.

If you require further information please contact Autoflame Technical Support.

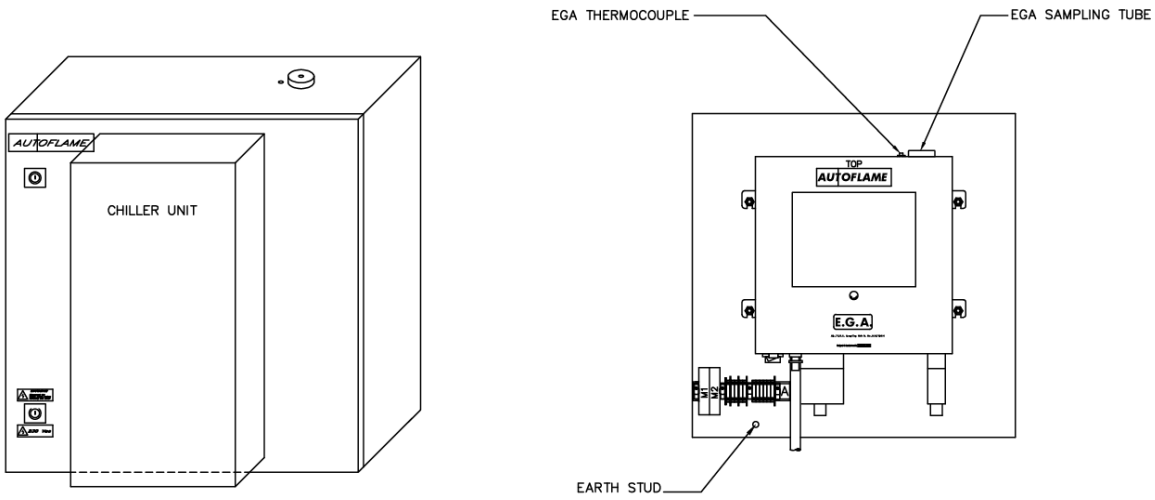


Figure 4.4.3.i Schematic of Chilled Environmental Enclosure

5 ERROR CHECKING AND SELF-DIAGNOSTICS

5.1 Key to Errors

Errors detected in the E.G.A. part of the system are indicated on the home screen of the E.G.A. and on the M.M. screen. In the event of an E.G.A. failure, an error will appear on the E.G.A. screen of the M.M. All other screens on the M.M. are still viewable whilst there is an E.G.A. error. The switched neutral alarm output Terminal 79 can be set to become active or remain inactive in the event of an E.G.A. error (see M.M. Option 12). Depending on the setting of M.M. Option 12, this will determine how the burner will operate, i.e. continue to run based on the original commissioned values (trim and limits testing disabled) or become disabled until the E.G.A. error is reset and becomes fully operational once again.

Error Number	Fault Description
01	No Communications to E.G.A. Check communications between Terminals 23/31 on the E.G.A. and Terminals 25/26 on the M.M. module. Ensure that the E.G.A. is earthed (grounded)
08	O2 Upper Limit Exceeded Check Option 19 and Section 3.4
09	CO2 Upper Limit Exceeded Check Option 20 and Section 3.4
10	CO Upper Limit Exceeded Check Option 21 and Section 3.4
11	O2 Lower Limit Exceeded Check Option 22 and Section 3.4
12	CO2 Lower Limit Exceeded Check Option 23 and Section 3.4
14	O2 Absolute Value Exceeded Check Option 25 and Section 3.4
15	CO2 Absolute Limit Exceeded Check Option 26 and Section 3.4
16	CO Absolute Limit Exceeded Check Option 27 and Section 3.4
20	Pump Fault – Pump Failed/Sample System Blocked Check that the sampling probe is not blocked (filter in probe). Remove sample inlet tubing and press Open/Close buttons on the M.M. in Mk6 mode via the E.G.A. screen in order to force the unit into a re-calibration. If the error is cleared then the blockage is in the probe/sampling tube. If the error persists check the flow through the E.G.A. module. Isolate each section and test the flow (this should be 550 – 650 mL/min at 120mBar). If error still persists then remove the inlet to the pump (lower pipe connection). If the error is resolved then check the filter (Section 5.2.4) and sampling line with the E.G.A. If error persists replace the pump.

Only with M.M.

21	O_2 Cell Failure Check terminal voltage on the wires from the cell
22	CO_2 Cell Failure Check terminal connections on the wires from the cell Ensure the temperature sensor is plugged in (right side of the cell)
23	CO Cell Failure Check Terminal connections on the wires from the cell

Only with M.M.

30	NO Upper Limit Exceeded Check Parameter 94 and Section 3.4
33	Exhaust Temperature Upper Limit Exceeded Check Parameter 96 and Section 3.4
35	Exhaust Temperature Absolute Limit Exceeded Check Parameter 97 and Section 3.4

Should the fault require the E.G.A. to be returned to Autoflame ensure the E.G.A. sampling system should be carefully packed into the carton in which it was supplied and marked "Fragile – Scientific Instruments" and "Do Not Drop".

It is possible to remove and re-install the E.G.A. at a later date without the burner needing to be re-commissioned if using the trim function with an M.M. module. After removing the E.G.A. set Option 12 on the M.M. module to 0. Once the E.G.A. module is ready to be re-installed reset Option 12 back to the required setting, provided the combustion has not been changed either through commissioning mode or single point change the M.M. module will load up as normal and will not be required to be re-commissioned.

When an E.G.A. error appears on an M.M. module it is required that the error is reset on the E.G.A

When first going into commissioning mode, the M.M. invokes an E.G.A. calibration. If an error occurs at this stage it will be necessary to fix the error and restart the commissioning procedure.

<u>O_2 Pump Failure and Blockage</u>

The O2 pump is designed to operate at around 600mL/min at around 120mBar during normal operation, if the pressure drops this can cause an O2 pump fault. Please check the following:

- Check that the pump is operating at around 600mL/min at 120mBar and is displayed on the Mk7 E.G.A. sampling screen
- Check the correct pressure on the E.G.A. by using a follow gauge connected to the outlet piping at the bottom of the E.G.A.
- Ensure that the internal filters are changed at least once a year for gas fired burners (site specific), or when necessary
- Ensure that the internal filters are changed more regularly for oil fired burner (site specific), once every 6 months or when necessary
- Ensure that there are no kinks or loops in the sample line from the probe to the E.G.A.
- Ensure that the sample line does not draw excessive amounts of moisture which could cause a blockage
- Ensure that the sampling probe is fitted at 45° into the stack
- An external filter should be fitted if excessive moisture is being drawn from the sample line
- Check that the O_2 pump is working correctly and is powered, check the voltage on the terminals near the pump – this should read around 20V AC

5.2 Troubleshooting

5.2.1 Ambient Conditions

1. Ambient Temperature – This will read Ok, High or Low. This must be between 5 – 40degC (40 – 140 degF) or the settings of Parameters 27/28. The temperature is measured by a sensor on the electronics PCB and is cross referenced with the sensor on the side of the CO_2 cell.

2. E.G.A. Trim Threshold – This will be Ok or Low and is looking at the setting of Option 28. This value is an offset from the set point, before which the E.G.A. will not operate. This ensures that the E.G.A. does not pull in high amounts of condensation.

3. Chiller – This will be Ready or Not Ready. There is a temperature sensor on the chiller unit and this chiller must get down to a set temperature before the pump will start to draw a sample from the stack. If the chiller is not decreasing its temperature then check the operation of the fan. When the E.G.A. is powered the fan is the first component to start-up and the purpose of this is to cool the chiller unit. Ensure that the door of the E.G.A. is closed and that the 24V DC is present on the fan. If the ambient air in the boiler house is high, it may be necessary to draw cooler air into the E.G.A. Check that the cable to the right in the chiller is connected and all pins follow through. Check the voltage selector switch is set to the correct voltage, i.e. if set for 230V and the mains input is 120V, the fan will run slowly and not cool the unit.

4. Comms – This can read Ok or Not Ok and this is checking for continuity between the E.G.A. and M.M. Check the wiring between the M.M. and E.G.A. modules.

5.2.2 Fuses

If the E.G.A. is mounted in an excessively dusty environment a build-up of particles on the terminals can cause arcing. If the particles are corrosive then any attack to the conformal coating on the printed circuit boards can cause tracks to arc and component failure. Any sign of this activity and the unit should be returned to the supplier.

5.2.3 O_2 Reading

If you get a continuous O_2 reading of 20%, this tells you that the Mk7 E.G.A. is sampling fresh air. To troubleshoot this:

- Check all piping is airtight
- Check sample tube is not blocked
- Check that there are no leaks on the flue
- Check the pinch valve tubing for leaks

5.2.4 Filter Fault

If the E.G.A has a filter fault, please check the following:

- Make sure the fibreglass is pushed up in the internal filter, leaving a space for air flow inside
- Check for any blockages in the tubing connected to the internal filter
- Check the E.G.A. reads 120mBar, 600mL/min at the pump, if not there may be a pump fault

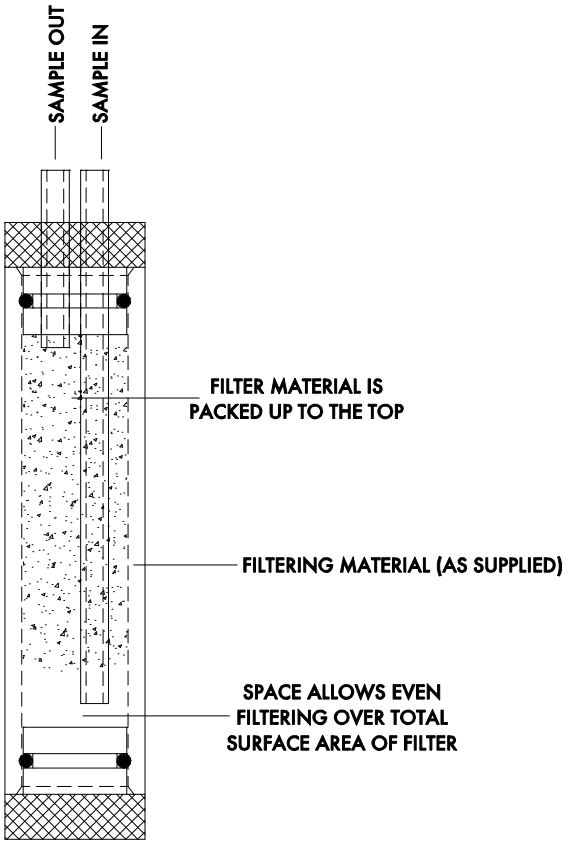
5.2.5 Trim Delay

On burner start-up without calibration the E.G.A. performs a drain and starts sampling at 20.9% O_2 (fresh air), which then reduces to the commissioned value. Enough time must be given before the E.G.A. commences trim, to ensure that it is not correcting the air damper at high O2 values. The total time delay before the E.G.A. starts to trim is based on the boiler's residence time. If the total time delay before trim starts it too short, then a scenario could arise where the E.G.A. reads 5%O2 and over-trims on air damper, reducing the O2 too far.

If calibration on start-up is active, option 32 (trim delay) must be greater than the calibration time (parameter 24). A minimum of 40 seconds should be added. Parameter 24 is set as default to 120 seconds, so option 32 should be set to a minimum time of 160 seconds. The total time before trim is applied is 200 seconds (option 32 + parameter 8); this will also depend on the boilers residence time.

5.2.6 Assembly of Dry Filter

If pump faults are occurring on the E.G.A. it is advised to check the dry filter in the E.G.A. and check for any blockages and make sure that the filter material has not become saturated.



N.B. FREE SPACE MUST BE LEFT AT BOTTOM TO STOP ANY PREMATURE BLOCKAGE
THE SAMPLE IN & OUT PIPES MUST BE CONNECTED CORRECTLY OR BLOCKAGE
WILL OCCUR WITHIN A FEW HOURS.

This filter is specifically used as a dry filter to remove and dust particulate before the dry gas passed into the cells. The filter is carefully packed as a complete replacement part and should be repacked or the filter material changed in the field, as the filter is critically calibrated for a specific pressure drop. The filter should always be dry, if any carryover of liquid or moisture is sent in the filter, please isolate the E.G.A. and contact Autoflame Technical Support.

5.3 E.G.A. Best Practice

The E.G.A. is a sensitive instrument used to analyse the exhaust gases in the flue, so it needs to be serviced regularly to ensure accurate readings are taken for the trim function to maintain safe operation. The following guidelines should be applied to all E.G.A. applications:

- The E.G.A. should be checked before installing it on site. It is advisory that E.G.A. remains upright during any tests and checks. Thereafter the E.G.A should be turned off for a period (couple of hours), and turned back on again to drain out any excess moisture remaining in the E.G.A.

- The Autoflame E.G.A. sampling probe thermocouple is rated at a max temperature of 400°C (752°F). We would recommend the E.G.A. to be fitted into a chilled enclosure when being used in high temperature condition. For environments with high humidity, a chilled enclosure is recommended to avoid corrosion on the board.
- The E.G.A. sample line length is recommended to be 3m.
- Pump Failure
  - A build-up of condensation in the E.G.A could result from incorrect installation installed correctly. Make sure the probe is located at 45° to the stack, and the sampling tube is not wound up.
  - Condensation could also occur from the load demand not being so high at certain times, so it may mean that the back end temperature of the boiler is not high enough. Therefore it will not be warm enough to evaporate the condensation quick enough, causing a large build-up of moisture.
- Cooler not ready
  - There is a temperature sensor in the chiller block and this must read below 12°C(55°F) before the E.G.A, is ready to sample
  - If the unit is started up for the first time, this could take a while for the unit to cool down.
  - If the fan is not working, this could cause the problem. The fan may be running slow or the peltier devices may have failed.
- If extension tubing is attached to the drain solenoid, ensure the end of the tubing is clear of any obstructions or contaminants. When the E.G.A. performs an air calibration, the air is sucked into the E.G.A. through the solenoid.
- If the E.G.A. is placed in an enclosure or cabinet, to avoid the E.G.A. being recalibrated on contaminated gases, ensure that the drain solenoid is taking in fresh air during calibration.
- The E.G.A. O_2, CO, NO, SO_2 and NO_2 cells have a 6 month shelf-life. If ordering an E.G.A. for project that will be installed later we would advise to purchase an E.G.A. without these cells, and then purchase the cells when they are due to be installed. This E.G.A. will come with the CO_2 cell only (patent no: MM72004/NC) as this can only be fitted at Autoflame office. We recommend that the cells are replaced 12-18months for gas firing from manufacturing date and 6-12 months for heavy oil firing applications.
- An external particulate filter should be used for applications:
  - Firing on heavy or dirty oil
  - Environments with dust and particulate
  - Extremely cold conditions
  - High humidity environments
- During commissioning and single point change, the E.G.A. must be given enough time to read an accurate sample of the exhaust gases. This set at 45 seconds to default (parameter 4). Also the time for which the fuel rich and air rich positions are held during commissioning should be set correctly so that the E.G.A. has enough time for the readings to stabilise. This is set to 60s as default on the M.M. (Parameter 9).

5.3.1 Servicing the E.G.A.

Due to the technology used within the Autoflame E.G.A, to ensure accurate and reliable operation the E.G.A. requires annual servicing. Servicing the E.G.A. and sampling probe is a crucial to maintaining the correct operation of the E.G.A. must be done regularly. For firing on natural gas, the E.G.A. must be sent back every 12-18 months depending on the boiler room conditions. For firing on oil, this would be shortened to 6-12 months. Failure to send back the E.G.A. when it is due for a service will cause the operation and life of the E.G.A. to deteriorate. The cells will need to be replaced as they are calibrated instruments which lose accuracy over time and use. The probe is constantly sampling the gases and can become easily clogged with debris and dirt picked up from the burner, without a service this can result in incorrect readings which affect the reliability of the E.G.A. Further issues such as pump problems, chiller faults and inaccurate trim operation will occur.

5.3.2 Shipping the E.G.A.

The E.G.A. is a scientific instrument with delicate components. Whenever the E.G.A. is shipped it is essential that the E.G.A. is returned using its original packaging.

To avoid any potential damage to the E.G.A. during transit and to stop the PCBs from flexing there are pads between the two PCBs of the Mk7 E.G.A., and the casing of the E.G.A. and the PCBs. This extra support stops flexing of the PCBs during transit. The top of the cells will be covered in bubble wrap to protect them from damage during transit. Before powering up the E.G.A., the bubble wrap must be removed from the E.G.A., however the pads can remain between the PCBS. The pads will affect the operation of the E.G.A. and will help protect the E.G.A. from damage when it is shipped back to Autoflame for its annual service.

Ensure that couriers treat the package appropriately and labelled as containing a delicate scientific instrument. If the E.G.A. is damaged in transit, repair costs will be incurred.

Please contact Autoflame or your local Tech Centre to obtain new Autoflame E.G.A. packaging.

6 MK7 CEMS E.G.A.

6.1 Overview of the Mk7 CEMS E.G.A.

The Mk7 CEMS (Continuous Emissions Monitoring System) E.G.A. has been developed from the standard Mk7 E.G.A. In addition to the features of the standard Mk7 E.G.A., the Mk7 CEMS E.G.A. has following features:

2 years of data logging for the following information:

- O_2, CO_2, CO, NO, NO_2, SO_2 weights, volumes and readings at current firing rate, and totalised (scalable)
- Temperatures, pressures, efficiencies
- Fuel consumed (based on M.M. fuel flow metering, or a fuel flow meter) at current firing rate and totalised value (scalable)
- Provides ability to totalise emissions histories across multiple E.G.A.'s through the Mk7 D.T.I.
- 'This Period Last Year' (TPLY) comparison of data for weights, volumes and average readings

6.1.1 C.E.M.S. Upgrade

It is possible to upgrade an existing standard Mk7 E.G.A. that has already been purchased. The E.G.A is required to be returned to the Autoflame UK Office, so that it can re-configured for the CEMS E.G.A. features. Please note that this process will include the service and re-calibration of the E.G.A. incurring additional costs.

6.2 CEMS Set-Up

6.2.1 Fuel Selection

To access the fuel setup screens, press the 'Set-up' button at the top left of the E.G.A. screen, go to the 'Factory Settings'; you will be required to enter the password. Press on the 'Fuel Set-Up' button in the bottom left corner of the screen.

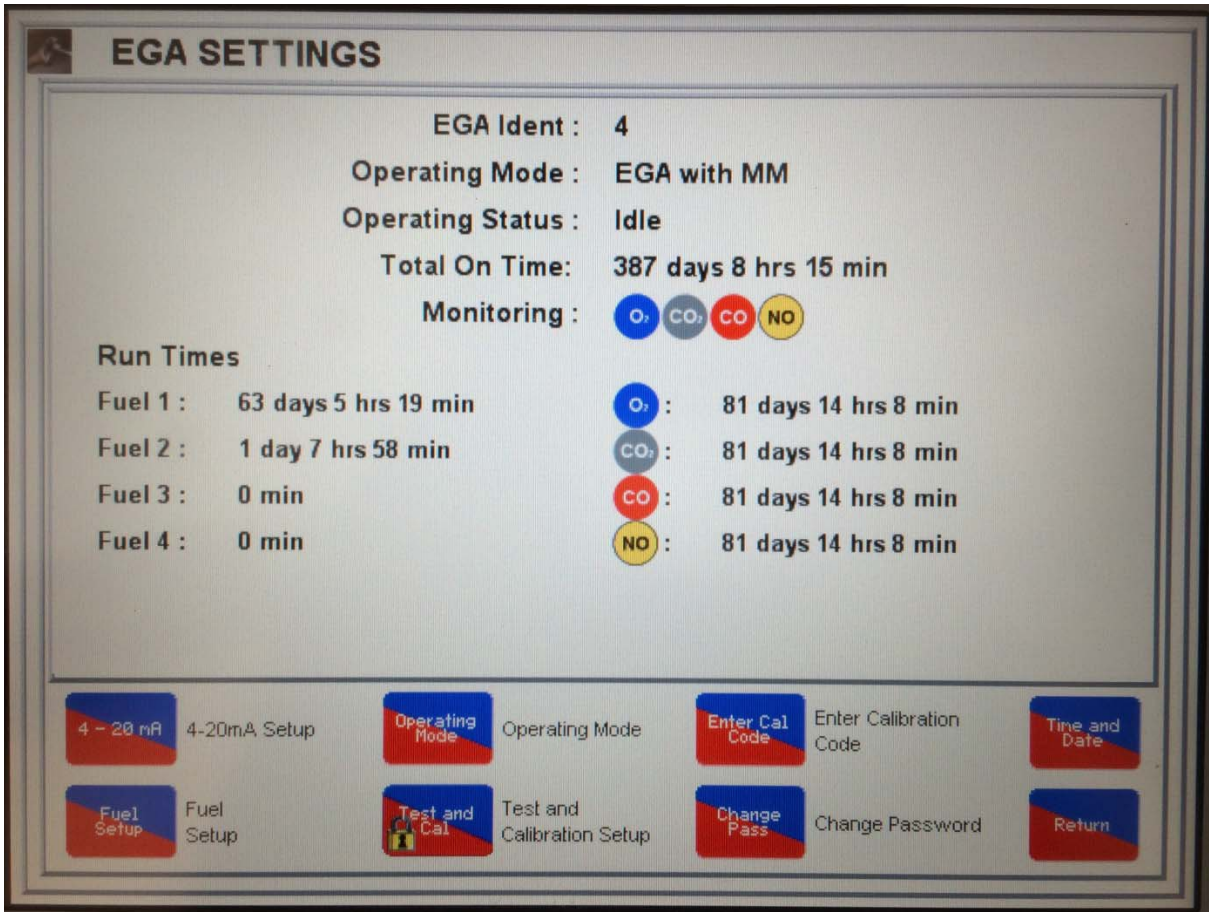
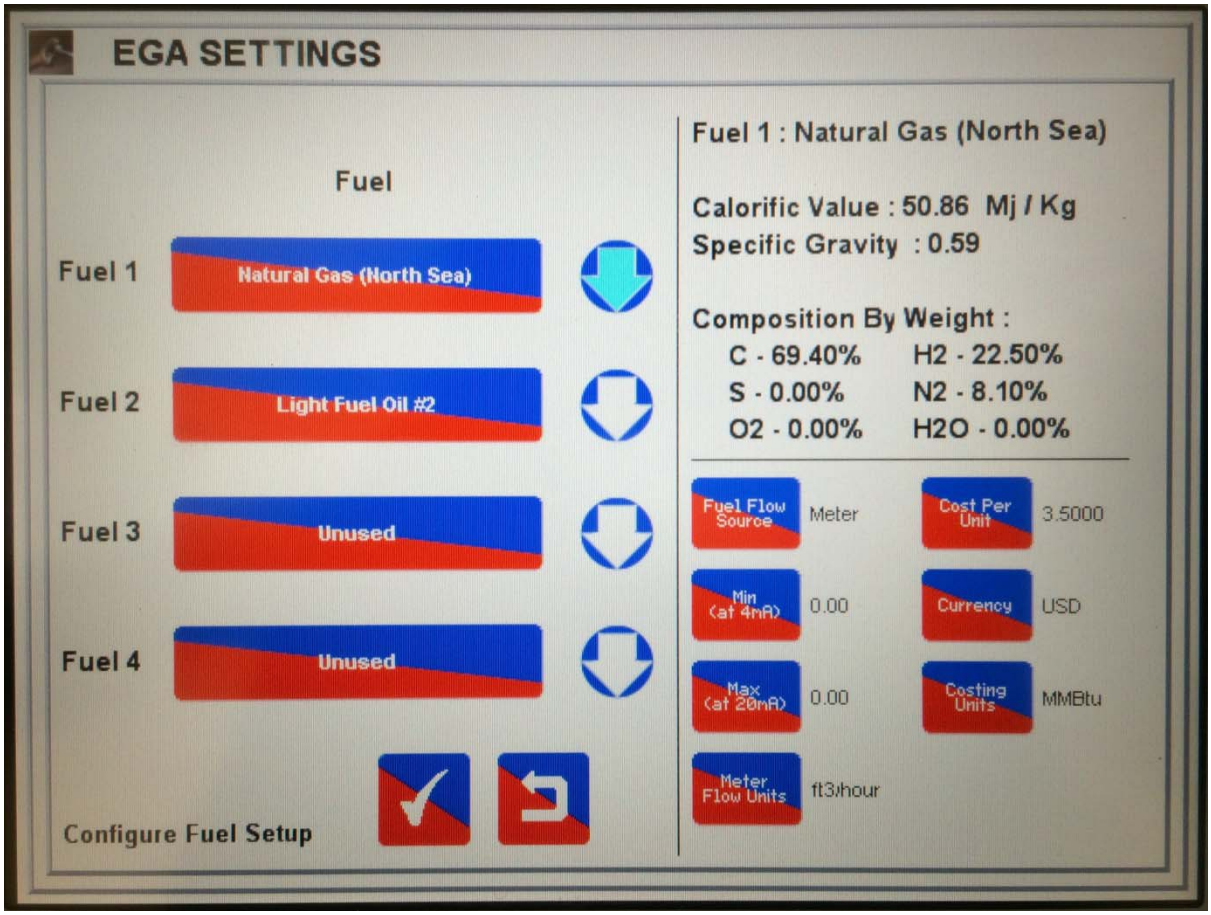


Figure 6.2.1.i EGA Settings – CEMS E.G.A.

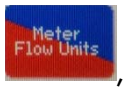
Note: Fuel setup is required for CEMS recording on the EGA and DTI.



6.2.1.ii Fuel Set-up

CEMS fuel data can be entered for up to 4 fuels. There are several pre-set fuels that can be used for each. The calorific values for each are not configurable. If a fuel cannot be found that has similar properties to what is required for accurate CEMS data analysis, please contact Autoflame Technical Support.

For each fuel used in that burner application, the fuel flow source 

, meter units 

, cost per unit 

, currency 

and costing units 

must be set.

6.2.2 Fuel Flow Source

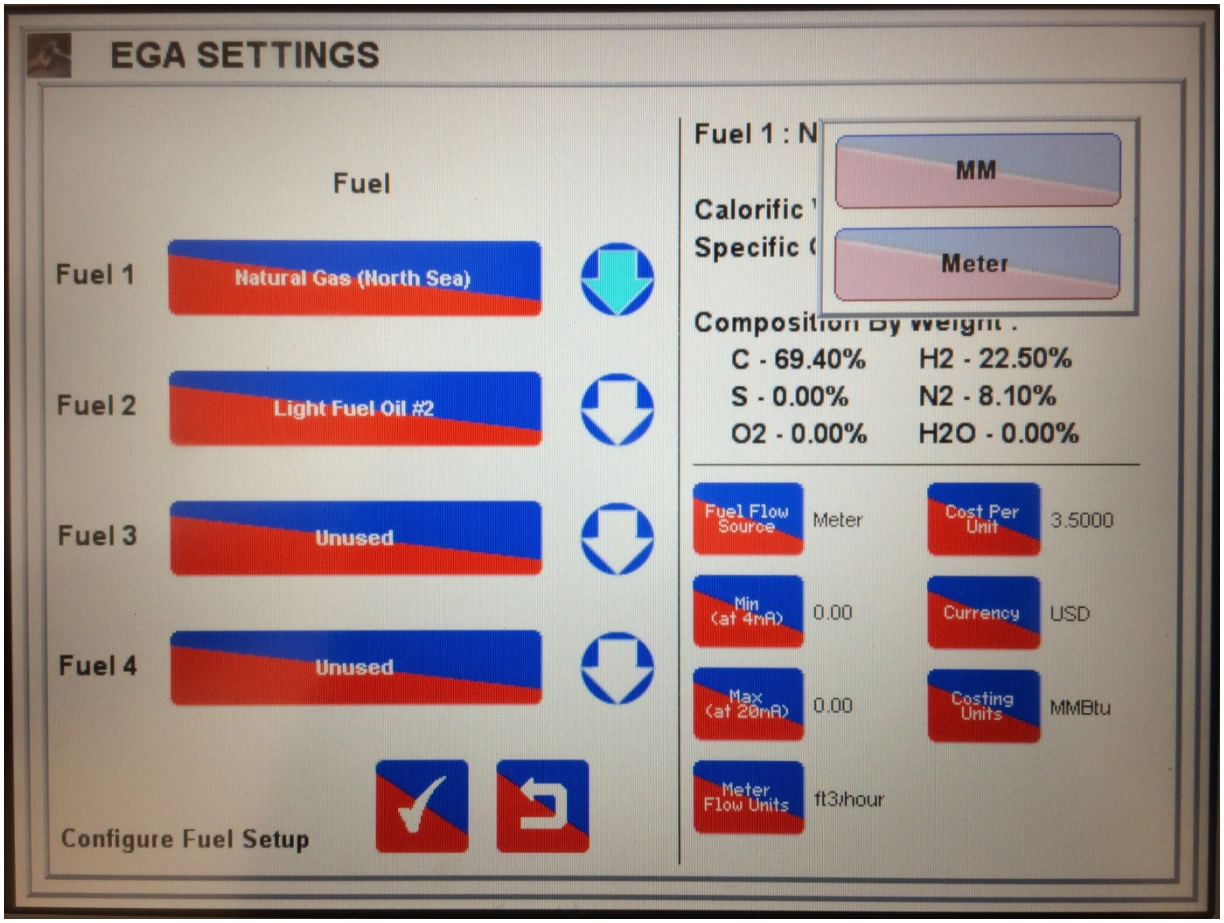


Figure 6.2.2.i Fuel Flow Source

Press 

to enter whether the fuel flow metering data is taken from the M.M. or a fuel flow meter. If the Mk7 CEMS E.G.A. is being used in conjunction with an M.M., then the fuel consumption can be determined based on the M.M. fuel flow metering which is entered through option 57 on the M.M. For the M.M. fuel flow metering based audits, press the 'Fuel Flow Source' button and select M.M.

A fuel flow meter can also be used to calculate the fuel consumption. This is done via a fuel flow meter connected to the 4-20mA analogue signals, the minimum flow at 4mA 

and maximum 20mA 

. Units for the flow meter can be changed using the flow units button 

.

6.2.3 Unit Measurement

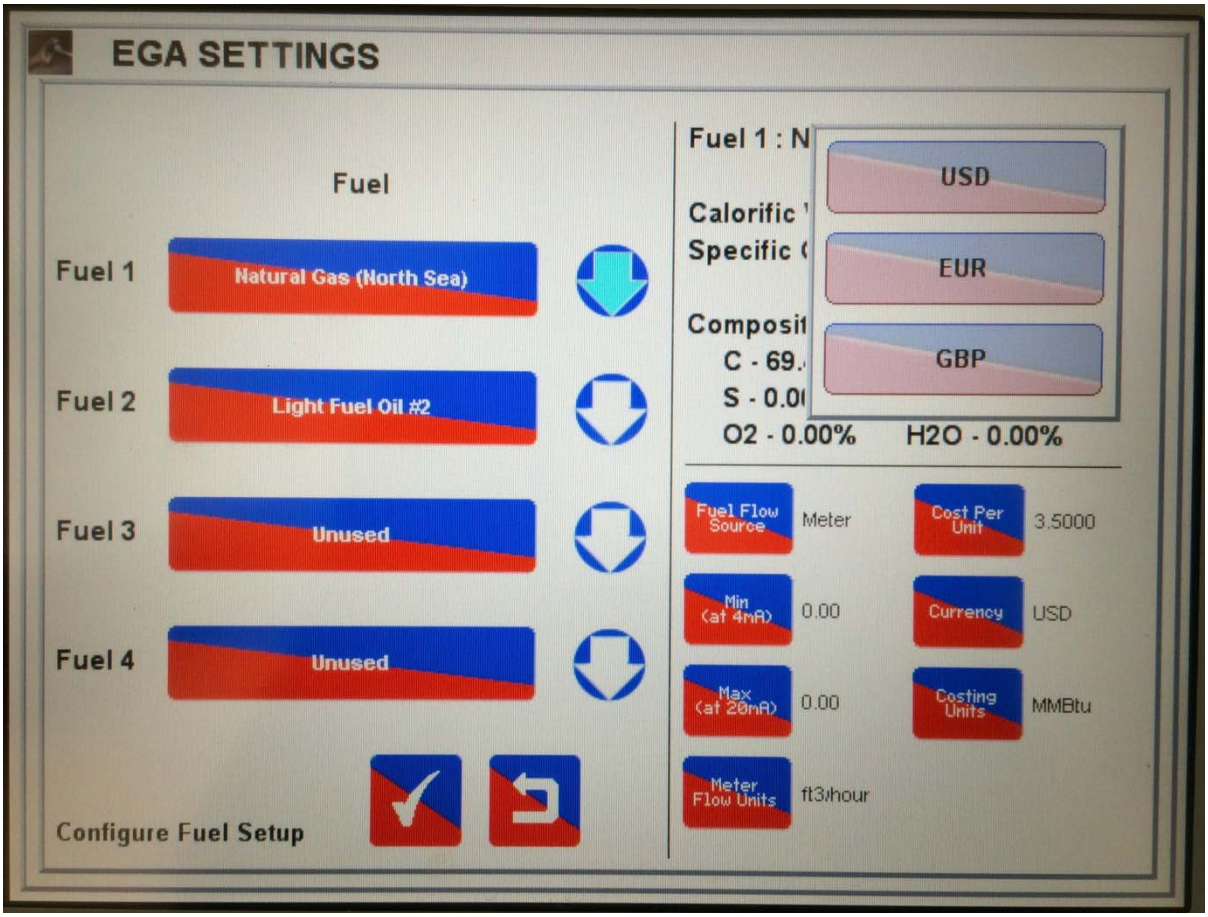


Figure 6.2.3.i Unit Measurement

Press 

, 

and 

to enter the details for the fuel cost and currency.

Once a fuel has been set, accurate CEMS data can be obtained by entering an accurate cost per unit of fuel fired. This is done using the 'Cost per Unit', 'Currency' and 'Costing Units' buttons on the right hand side of the Fuel Set-up screen. If further currencies or unit measurements are required, please contact Autoflame Technical Support.

6.3 CEMS Data Screens

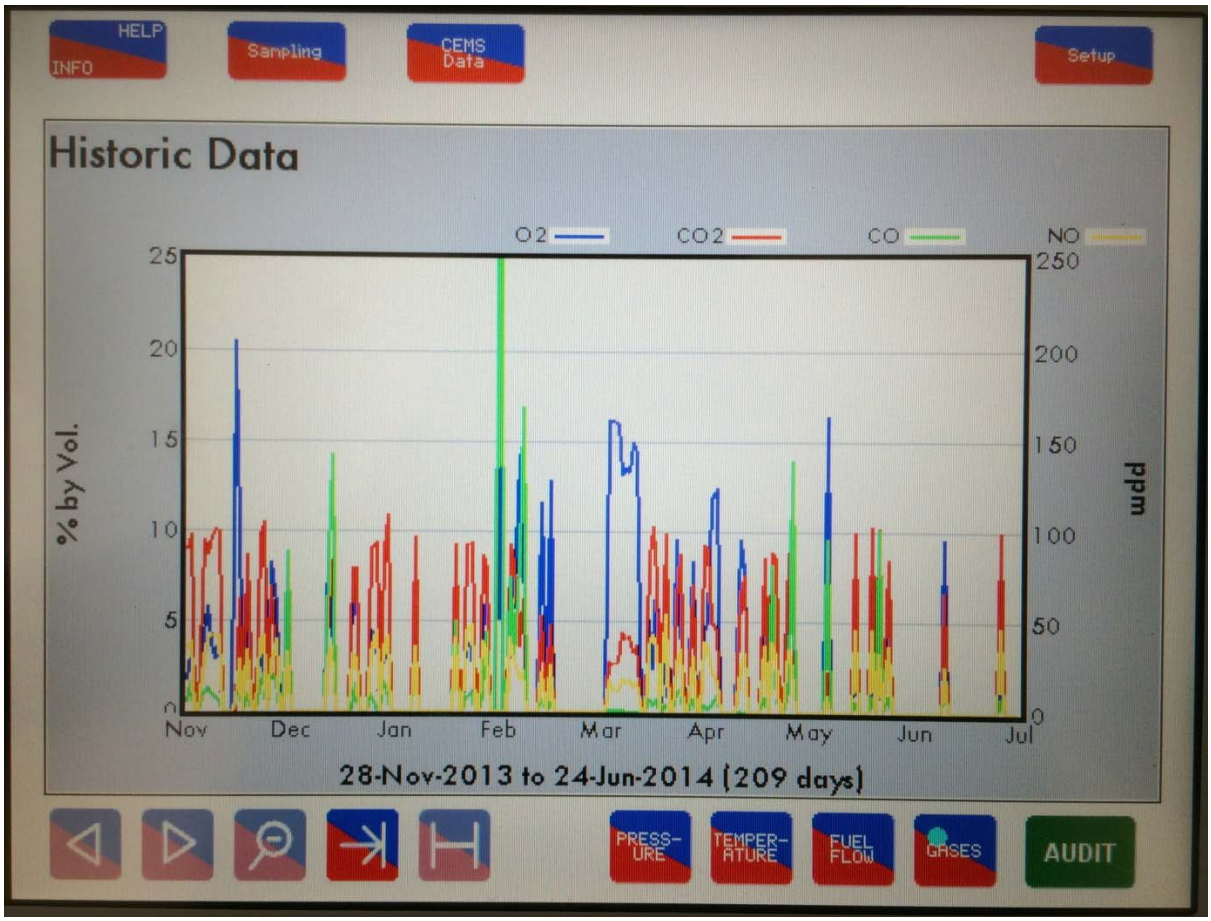


Figure 6.3.i Gas History

Press the CEMS Data button to view the emissions data logging for up to 2 years.

Press GASES to view the gas history. The graph can be zoomed in by pressing 2 points on the axis. To view one gas at a time, deselect the other gases above the graph.

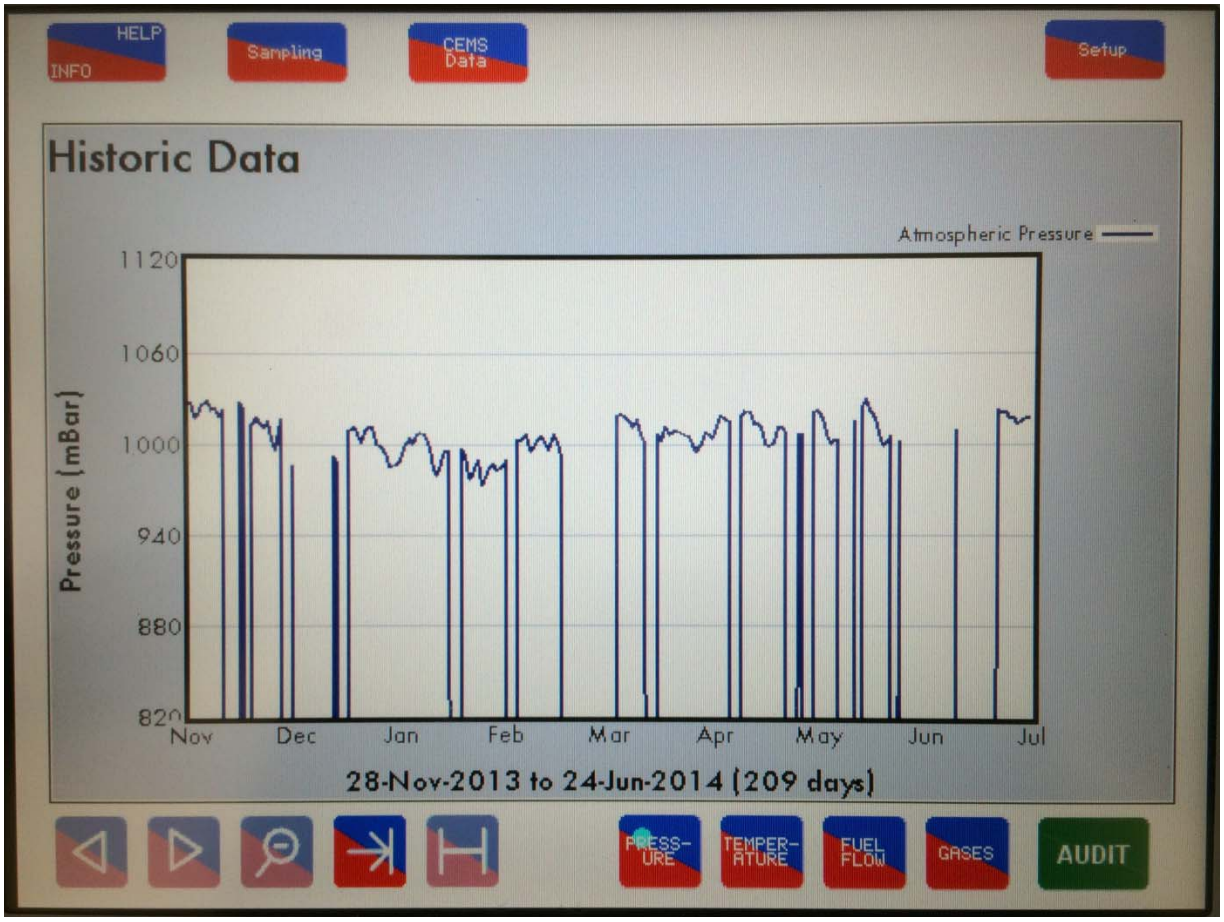


Figure 6.3.ii Pressure History

Press 

to view the atmospheric (ambient) pressure history for up to 2 years. The graph can be zommed by pressing 2 points on the axis.

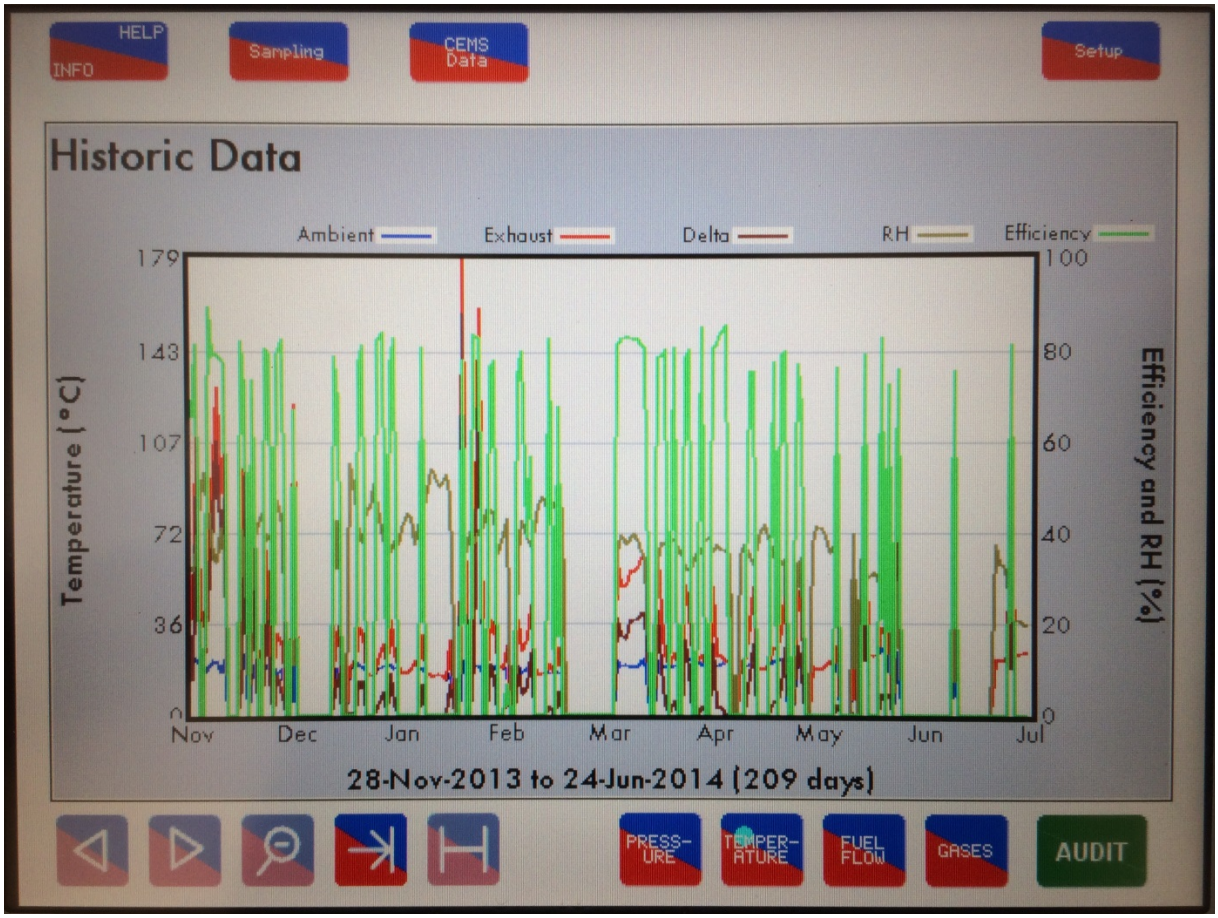
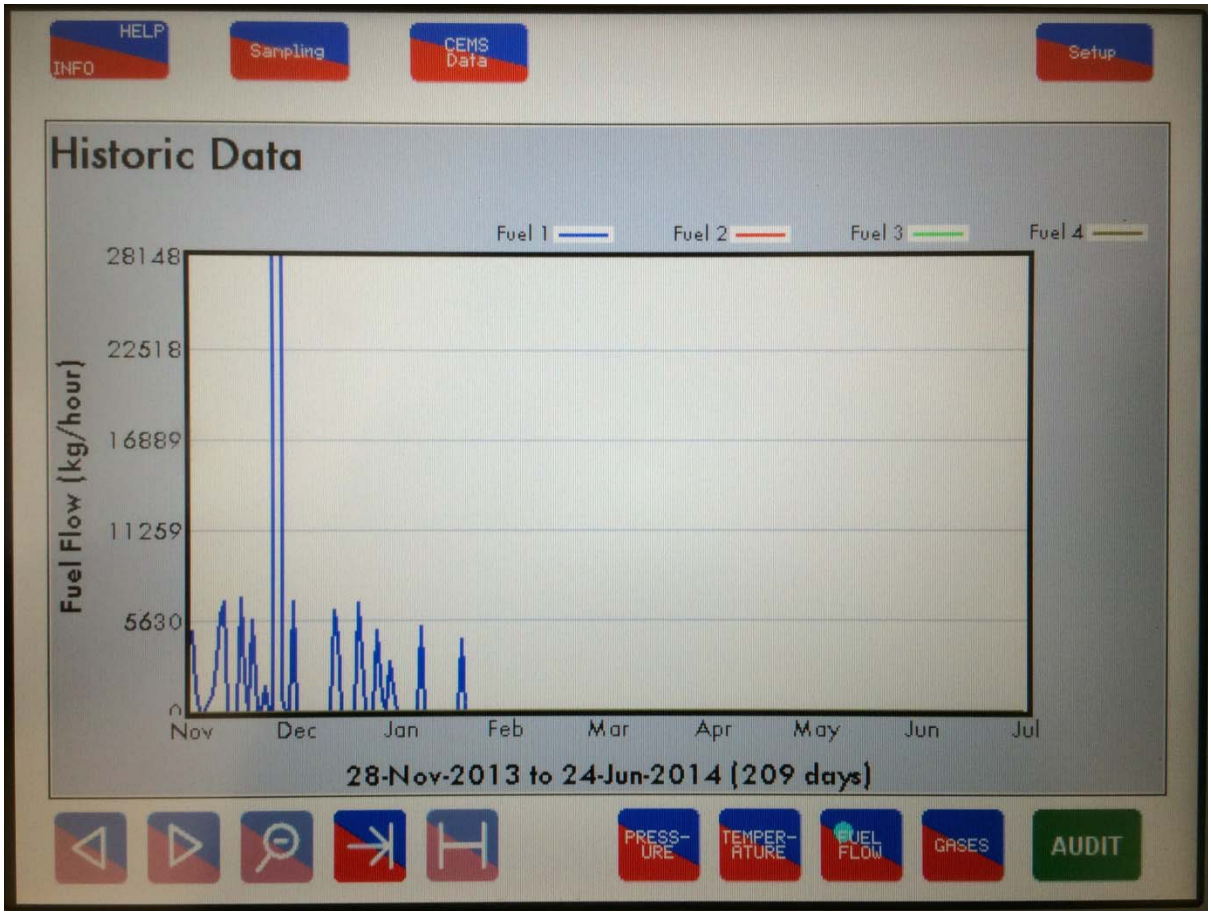


Figure 6.3.iii Temperature History

Press 

to view the temperature history for up to 2 years, for the ambient temperature, exhaust temperature, delta temperature, relative humidity percentage and efficiency percentage. The graph can be zoomed in by pressing 2 points on the axis. To view one temperature graph at a time, deselect the other temperatures above the graph.



6.3.iv Fuel Flow History

Press 

to view fuel flow history. The fuel flow data is taken from the M.M.'s fuel flow metering or from a 4-20mA analogue signal. The graph can be zoomed in by pressing 2 points on the axis. To view one fuel graph at a time, deselect the other fuels above the graph.

The left  and right  arrows are used to change the data range (hours, days, months) to the next available one.

The zoom out button  is used to go back to the next available data range.ie from hourly data to daily data.

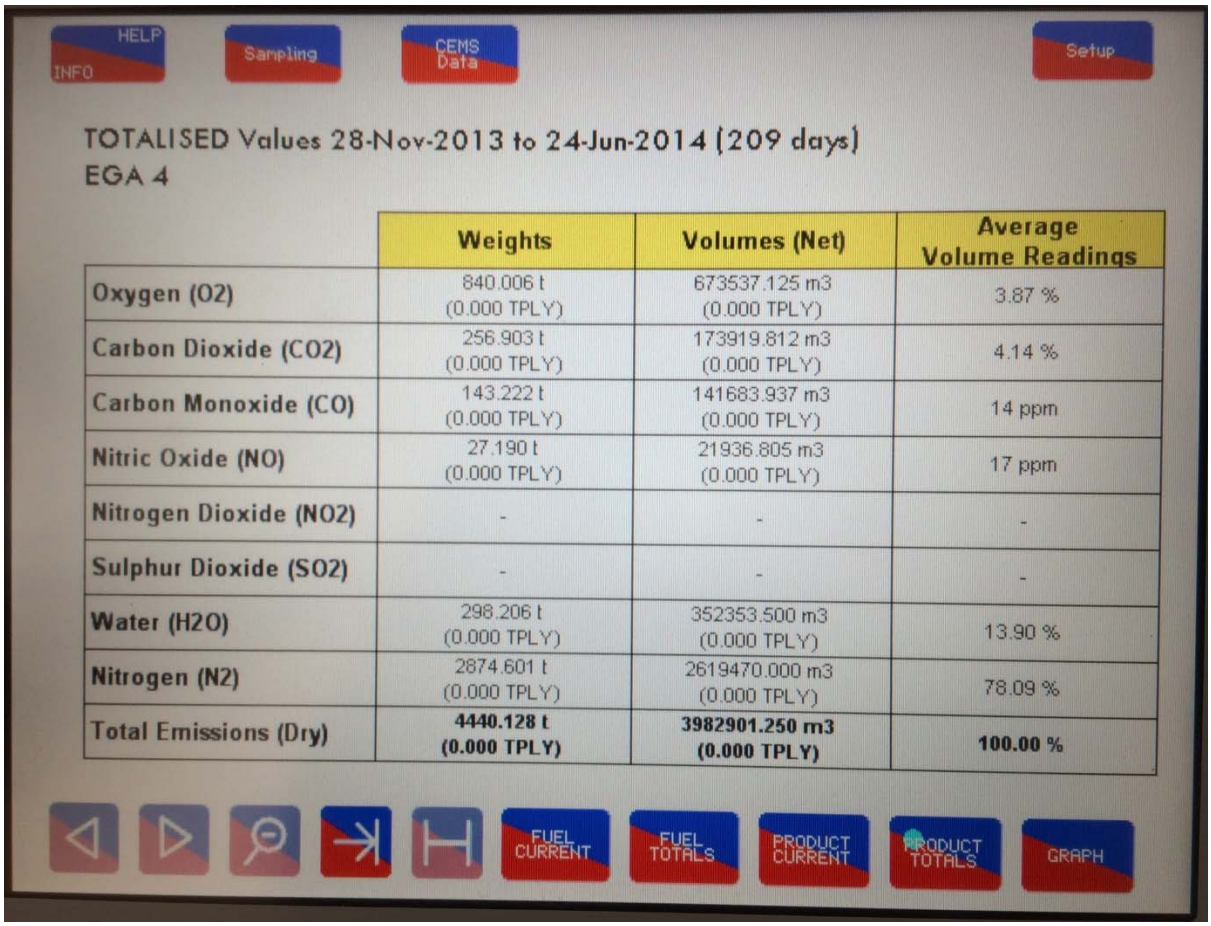
To view the last available data press  .

The full range of data can be seen by pressing  .

To view overnight data, a two day view is required (e.g. From 20:00 on day 1 to 08:00 on day 2). The hourly data for each day is displayed from 00:00 to 24:00.

6.4 CEMS Energy Audits

Once the fuel set-ups have been entered, it is possible on the Mk7 CEMS E.G.A. to take fuel consumption audits. Select a time period using the arrow section on the CEMS data for which the fuel consumption will be calculated for.



	Weights	Volumes (Net)	Average Volume Readings
Oxygen (O2)	840.006 t (0.000 TPLY)	673537.125 m3 (0.000 TPLY)	3.87 %
Carbon Dioxide (CO2)	256.903 t (0.000 TPLY)	173919.812 m3 (0.000 TPLY)	4.14 %
Carbon Monoxide (CO)	143.222 t (0.000 TPLY)	141683.937 m3 (0.000 TPLY)	14 ppm
Nitric Oxide (NO)	27.190 t (0.000 TPLY)	21936.805 m3 (0.000 TPLY)	17 ppm
Nitrogen Dioxide (NO2)	-	-	-
Sulphur Dioxide (SO2)	-	-	-
Water (H2O)	298.206 t (0.000 TPLY)	352353.500 m3 (0.000 TPLY)	13.90 %
Nitrogen (N2)	2874.601 t (0.000 TPLY)	2619470.000 m3 (0.000 TPLY)	78.09 %
Total Emissions (Dry)	**4440.128 t (0.000 TPLY)**	**3982901.250 m3 (0.000 TPLY)**	**100.00 %**

Figure 6.4.i Product Totals

Press AUDIT to view the product and fuel totals. The FUEL CURRENT and PRODUCT CURRENT buttons allow you to view the consumption at present.

Press PRODUCT TOTALS to view information on the exhaust gas weights, volumes and average volume readings for that time period.

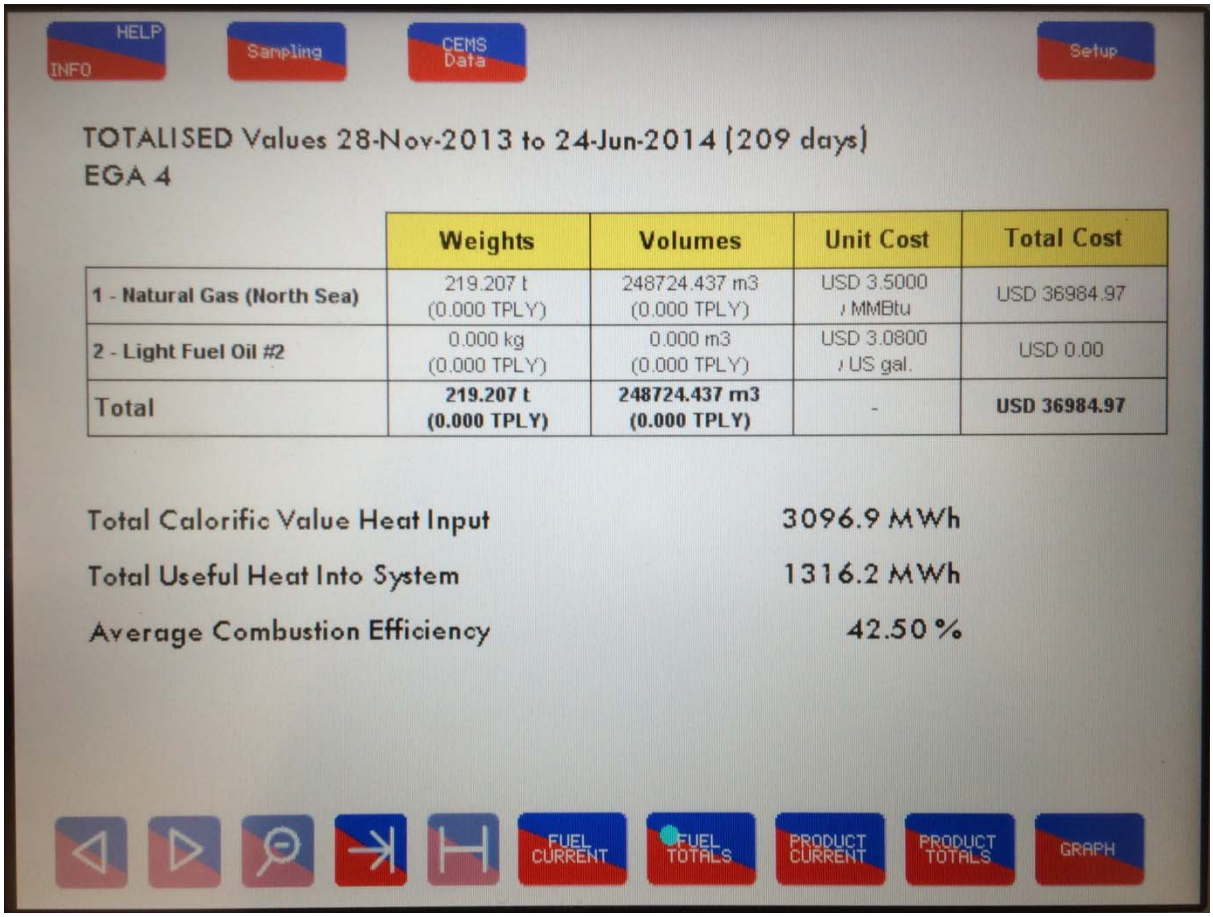


Figure 6.4.ii Fuel Totals

Press 

to view information on the fuel weights, volumes and total costs, as well as the total calorific value heat input, total useful heat into the system and the average combustion efficiency.

As detailed in this section (6.4) the totalised values can be viewed for a particular time period if required.

Notes

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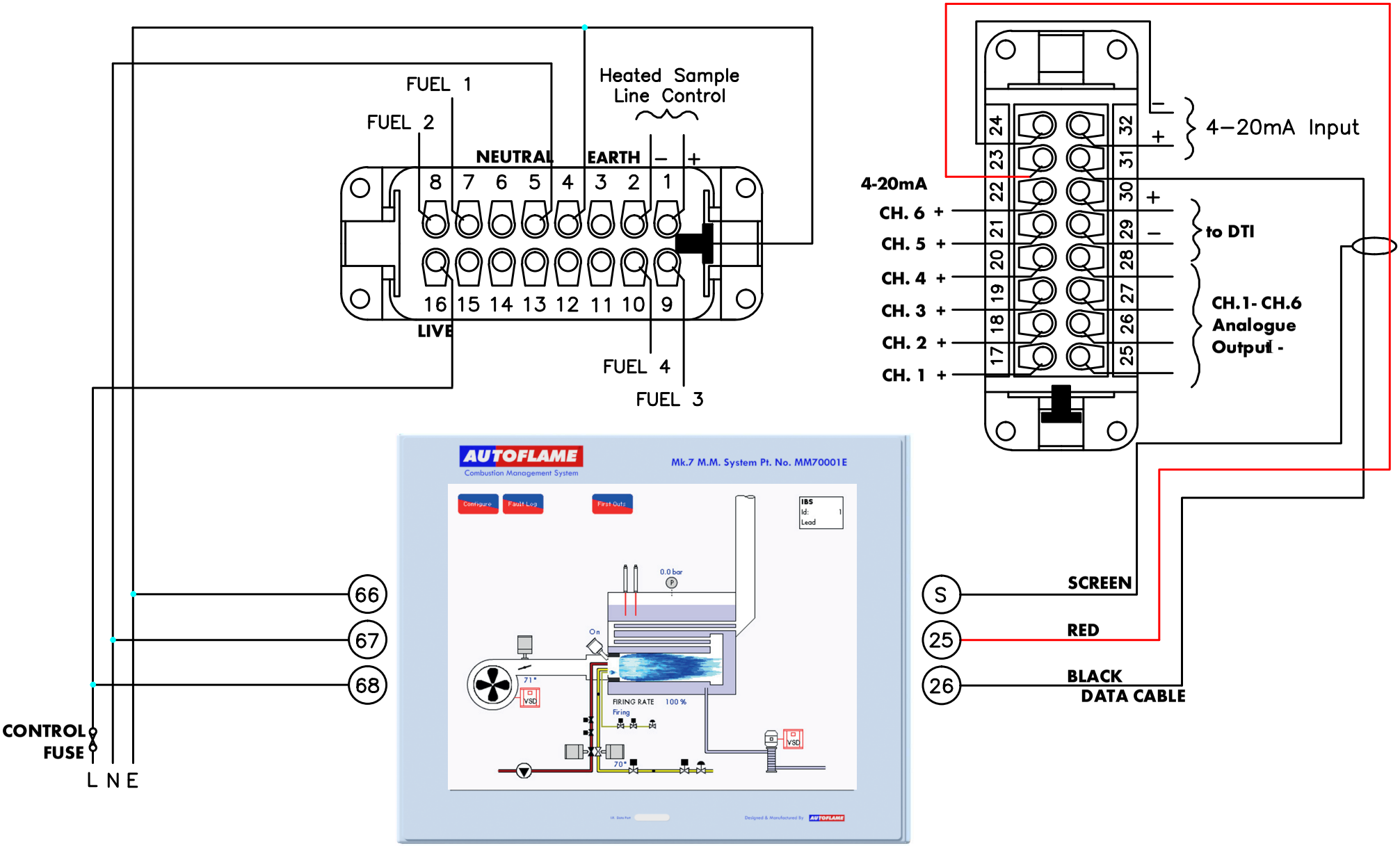
FUEL 1
FUEL 2
Heated Sample
Line Control
NEUTRAL
EARTH
–
+
8 7 6 5 4 3 2 1
16 15 14 13 12 11 10 9
LIVE
FUEL 4
FUEL 3
4-20mA
CH. 6 +
CH. 5 +
CH. 4 +
CH. 3 +
CH. 2 +
CH. 1 +
24 23 22 21 20 19 18 17
32 31 30 29 28 27 26 25
4–20mA Input
to DTI
CH.1- CH.6
Analogue
Output -
AUTOFLAME
Combustion Management System
Mk.7 M.M. System Pt. No. MM70001E
Configure
Fault Log
First Outs
IBS
Id: 1
Lead
0.0 bar
On
71°
VSD
FIRING RATE 100 %
Firing
70°
VSD
66
67
68
CONTROL
FUSE
L N E
S
SCREEN
25
RED
26
BLACK
DATA CABLE