SF$_6$ 6100 Pump Back Analyser

Instruction Manual

SMC
5840 S. Memorial Drive
Suite 208
Tulsa, Oklahoma
74145

Tel. 918-622-5725
Fax. 918-664-2073
sales@noramsmc.com

Warnings

⚠️	• Electrical Shock Hazard • Do NOT remove internal metal panel • There are no user-serviceable parts in this unit • Do not attempt to repair the analyser yourself • Refer all servicing to <u>qualified</u> personnel
⚠️	• The unit should not be exposed to extreme temperatures < -5°C or > +50°C (< +23°F or > +122°F) • Normal operating temperature is +5°C to +35°C (+41°F or +95°F) • Do not operate the unit with the carry case lid closed • Avoid direct sunlight exposure • Do not use liquid cleaners, aerosols or solvents to clean the case • Use a damp cloth for cleaning with the power cable disconnected • Do not use this equipment near water • Only use fingers to touch and operate the display panel • Make sure any ventilation slots and the fan on the side panel are free of obstruction
⚠️	• This unit is NOT designed for use in life support situations or any use that is not specified by the manufacturer. • No responsibility can be held for injury or loss of life caused by inappropriate use of this equipment. • Always use a tube connected to the gas outlet (4) which is vented to atmosphere when working with gases that may by toxic or injurious.

Warnings

T+ (skull and crossbones symbol)	• HF & SO$_2$ are toxic and can be fatal if inhaled • HF & SO$_2$ cause severe skin burns • HF causes severe damage to the eyes • H$_2$S & CO are toxic and can be fatal if inhaled • Read the MSDS sheets carefully before working with these toxic gases
(corrosive symbol)	• HF and SO$_2$ are extremely corrosive to the respiratory tract • Read the MSDS sheets carefully before working with these corrosive gases
(X harmful symbol)	• H$_2$S and CO are extremely flammable in high concentrations • Long term exposure to CO causes organ damage • SO$_2$, HF and H$_2$S are harmful irritants to the eyes, skin and respiratory tract even in small doses • Very toxic to aquatic life

Contents

1   Introduction

The Rapidox SF_6 6100 Pump Back is a battery-powered "zero emission" SF_6 multigas analyser capable of measuring multiple gases simultaneously in a rugged and portable case. Depending on the configuration the analyser can measure up to eight parameters including sulphur hexafluoride (0-100% SF_6), sulfur dioxide (0-100ppm* SO_2), dew-point (-60/20°Cdp H_2O), carbon tetrafluomethane (20-80% CF_4), hydrogen fluoride (0-10ppm HF), air (0-100%), carbon monoxide (0-100ppm) and hydrogen sulphide (0-100ppm). In addition, the SF_6 compartment gas pressure is displayed on-screen as well as some other selectable parameters.

* 0-500ppm is available on request

The sample gas can be used if the inlet pressure is between 0.3 bar and 10.0 bar.

The analyser has a full pump back facility allowing any gas stored inside the analyser to be re-pressurised and returned to the SF_6 compartment. The sample hose and storage bag can be vacuum purged before testing to ensure no mixing of contaminated gas occurs. During the testing cycle no SF_6 can escape into the atmosphere.

The sampled gas is stored inside a special flexible bag held within the analyser. This bag inflates and deflates during the testing cycle and can be used to store any SF_6 that is not to be pumped back afterwards. The bag is constructed from a material that is highly resistant to moisture or air penetration. Various safety features are in place to prevent the bag from over-filling during use.

The analyser has a built-in PC and all functions are accessed via a 7" touch screen panel. The analyser is fully automatic and will run in various sampling modes where sample gas is drawn into the analyser via a special FEP-lined sample hose and DILO couplings. The gases pass through the various sensors and data is processed and displayed on the screen. The analyser is fitted with a printer, alarms, data-logging functions and USB output.

The portability of the analyser is achieved by means of two lithium battery packs (one for the main operation and one for the pump back) which can be charged on any worldwide mains power. The unit will run for up to eight hours on the battery before recharging is required. The unit will also run directly on mains power while the battery is recharging. Up to twenty pump back cycles can be performed on a single charge.

2   Technical Specification

Rapidox SF_6 6100 Pump Back Analyser	
Mains Voltage for charging	90-260Vac 50/60 Hz
Main Lithium Battery Operation	Up to 8 hours on a single charge 5-7 hours to fully charge from flat
Pump back Lithium Battery Operation	Up to 20 pump back cycles on a single charge (depending on the final gas pressure) 5-7 hours to fully charge from flat
Analyser dimension	570mm (w) X 470mm (d) X 280mm (h)
Weight	21 kg without accessories
Gas Storage Bag	5 Litres capacity at sea level
Sample Time	8 minutes
Display	7" full colour PC touch screen

Warm up time	15 minutes at 20°C
Normal operating conditions	Temperature -10°C to 40°C Humidity 10 to 90% RH Pressure 800 to 1100 mbar absolute.
Minimum Gas Inlet Pressure	0.3 bar
Maximum Gas Inlet Pressure	10 bar
Maximum Pump Back Pressure	10.5 bar
Data Output	Via USB memory stick or thermal printer
Sampling	Timed or Continuous modes
SF_6 Sensor (infra red)	0-100% scale +/- 0.5% full scale accuracy
SO_2 Sensor (electrochemical)	0-100ppm (or 0-500ppm) scale +/- 2% full scale accuracy
H_2O Sensor (polymer)	-60 to +20°Cdp +/- 2°Cdp of reading accuracy Optional display corrected to 20°C available
CF_4 Sensor (balance)	>20 <80% scale calculated as a balance gas
HF Sensor (electrochemical)	0-10ppm scale +/-2% full scale accuracy
Air (electrochemical O_2 sensor) or N_2 (balance)	0-100% scale +/-2% full scale accuracy
CO & H_2S Sensor (electrochemical)	0-1000ppm scale +/- 2% full scale accuracy
Calibration	Calibration by the user using zero and span gases. Not H_2O sensor*
Data-logging	Continuous on-board data-logging downloadable via USB
Fuse 1 (main PC)	T3.15A H250V 20mm anti surge
Fuse 2 (compressor)	T16A H250V 20mm anti surge

3   Analyser Description

Figure1: Layout of the SF$_6$ 6100 Pump Back Analyser

1. Main display and touch screen menu system
2. Thermal printer
3. Sample gas inlet (via closed coupled fitting)
4. Earth fixing point
5. Gas flow indicator on the display
6. Power on/off switch
7. LED battery charging lights
8. USB memory stick port
9. Fuse holders (see Table 1)
10. Mains inlet
11. 18V charging point (using special vehicle charging adapter)
12. Service Connection Point
13. Ventilation Slot
14. Cooling Fan
15. Bypass Port

4   Getting Started

The two labelled fuses will be removed for transportation safety reasons. There are two fuses located in fuse holders labelled with the values listed in Table 1. This completely isolates the lithium batteries. These fuses are different and must not be mixed up. The fuses should be inserted into the correct holders (9) and fixed into position before first use. Remove the fuses temporarily if you are transporting the analyser by air. If you require the analyser to be earthed during operation, please connect your earth lead to the earth fixing point (4).

Open the Peli-case fully and switch on the Rapidox using the switch (6). The analyser screen will boot up and the display will show readings from the sensors after approximately sixty seconds.

Note that if the analyser was previously being used in "Continuous" mode, then the warning picture shown in Figure 2 number 5 will be displayed on the screen during boot up. This is to remind you that the gas is free flowing out of the bypass port, and a separate gas recovery system should be attached.

4.1   Battery Charging

The analyser can run on battery OR mains power. When on mains power and the battery is charging the LEDs (7) will show a red colour. This will eventually turn orange and finally green when the unit is fully charged. There is an on-screen battery life meter which shows the remaining battery life and indicates if the unit is charging or not. It takes between five and seven hours to fully charge a flat battery depending on operational circumstances.

To charge the battery, attach the IEC mains lead to the mains socket on the side of the analyser (10). Alternatively, an optional vehicle charger can be used with the 18V charging point (11). Note that you must leave the lid open when on charge as the cooling fan will operate to vent the battery compartment.

Lithium batteries need to be charged carefully and the analyser is fitted with various safety features to make sure the batteries do not over heat during a charge. The temperature of the batteries is measured and should it exceed safe limits the charger circuit will disable itself. The LED will flash slowly to indicate it is too hot to charge. This may occur if the unit is used in very hot countries. Please place the unit in a cool location such as an air conditioned office to charge correctly.

When the unit is running on battery power the LCD indicators (7) remain switched off until the mains lead is re-connected.

4.2 Advisory Screens

During sampling, line purge and pump back the analyser checks to see if the sample line hose is correctly fitted to ensure that the cycle works correctly and doesn't allow any contamination of the compartment gas with air, or any SF_6 is allowed to escape into the atmosphere. Various simple instructions are displayed on-screen to make it easy to follow the correct sequence. These are as follows:
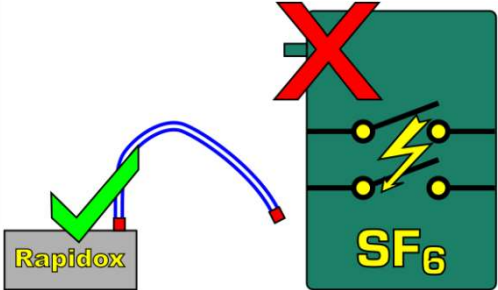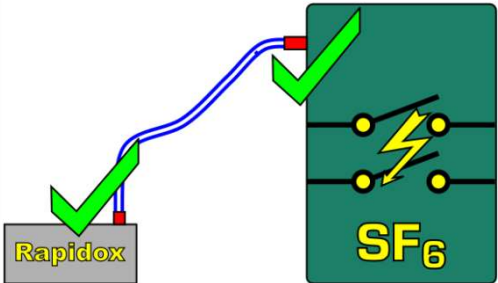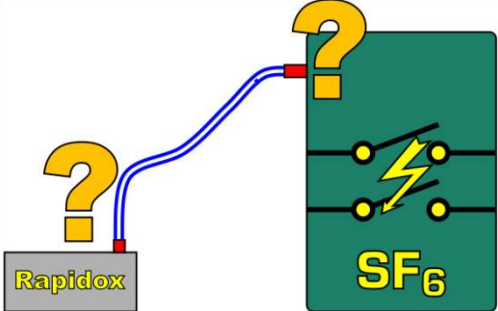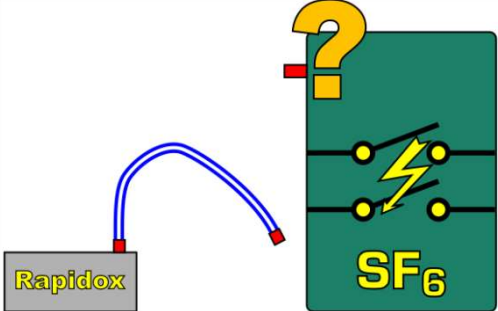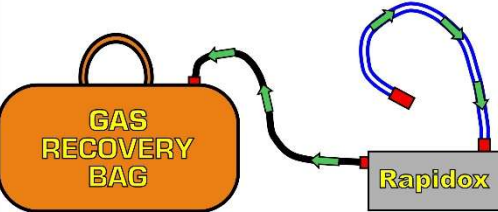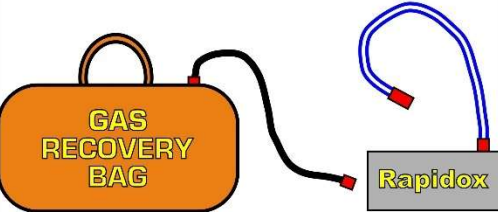
1) Shows how to correctly set up the analyser for a line purge (line must be connected to the Rapidox but NOT to the gas compartment)	2) Shows that the Rapidox sample line should be connected to the pressurised gas compartment ready to take a sample
3) Questions if the sample line doesn't appear to be connected to anything that has gas pressure i.e. the sample line has become detached	4) Questions if the operator has disconnected the sample hose from the gas compartment before attempting a line purge
5) Analyser is running in continuous mode so the bypass outlet should be connected to a separate gas recovery system	6) Asks for the external gas recovery system to be disconnected once continuous mode is deactivated

Figure 2: Examples of different on-screen help messages you may encounter during operation. The screen
message includes text prompts explaining what action to perform.

5   Performing a Test

With the analyser switched on and ready, use this guide to prepare the machine for testing
and complete an analysis. All screens and menus are soft keys so to change or access
anything you gently press the screen with your fingertips. Pressing over the name of a gas
will open a live graph screen (see 6.2) showing the progress of the sample over time.

5.1   Main Screen Display
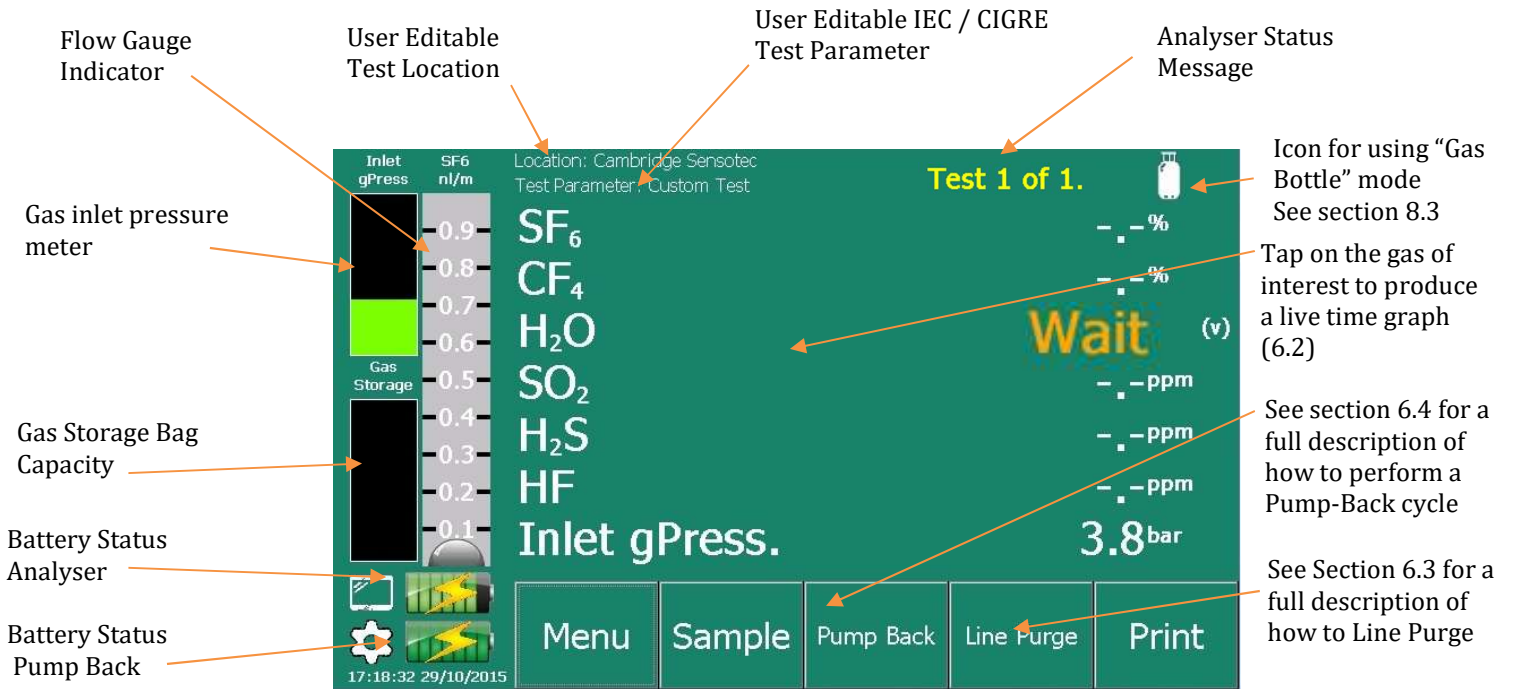
Figure 3: Main screen just after boot up. The H_2O sensor is still warming up which takes approximately 60
seconds. Note that not all sensors may be present in your equipment

5.2   Setting the Test Parameters

Timed tests are fixed at 8 minutes long to complete the testing correctly without filling the
bag to capacity. To set this option press MENU – SAMPLING and enter these parameters as
shown in Figure 4. Full details of this menu option are in section 7.4.
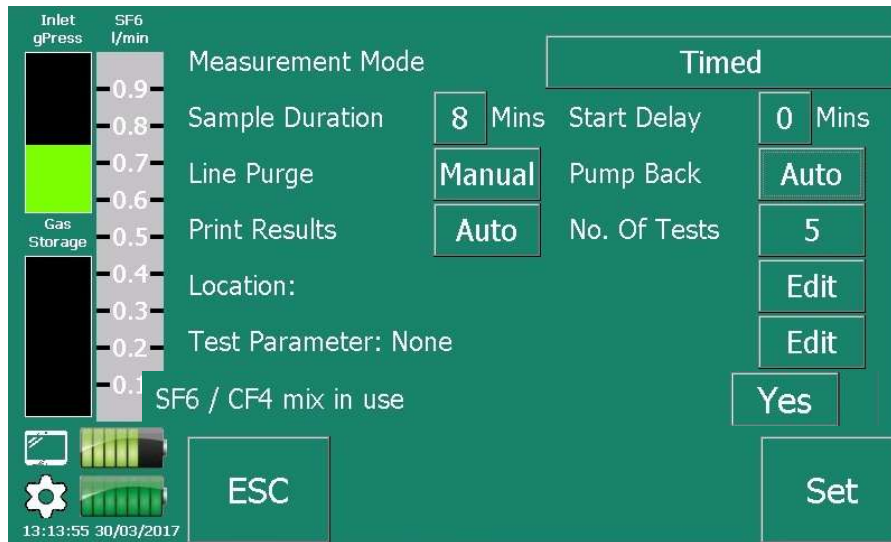
Figure 4: Use this option to change the sampling method to "Timed" or "continuous" and set the sampling duration and other options.

An initial set up is recommended as follows (see 7.4 for full details):

1) Measurement Mode: Set this to TIMED.
2) Sample Duration: This is fixed to 8 minutes and the option is greyed out
3) Start Delay: Set this to 0 unless you must walk away from the equipment before a test starts. Please see section 6.5 for details on this function.
4) Line Purge: Set this to MANUAL.
5) Pump Back: Set this to AUTO if you are measuring gas from an in-service switchgear or circuit breaker.
6) Print Results: Set this to AUTO so the printer will produce a report at the end of the test.
7) Number of Tests: Set this to 1.
8) Location: If you want to name the location EDIT it now and it will be saved with the results.
9) Test Parameter: Please refer to section 6.6 for details on this feature.
10) SF_6 / CF_4 mix in use: Only change this to YES if you are working with CF_4 blends otherwise leave it as NO. Selecting the wrong option will make the results inaccurate. Please see section 6.9 for details on this function*
11) Make sure you press SET to save your choices.

*note that this feature will only be visible if it was specified at the time of order.

5.3 Preparing the Analyser

Make sure that the sample line hose is clean and dry. A brand new 2m long sample hose is supplied pre-pressurised with dry SF$_6$ at 5bar pressure. Take the male end of the hose and insert it into the Sample Gas Inlet as shown in Figure 5. Do NOT attach the other end to anything yet. Use both hands to pull the knurled collar of the inlet coupling downwards as you push the male fitting into place.

Release the collar to lock in position. To release the coupling simply pull down on the knurled collar and the hose will self-eject.

Pull the knurled collar down with your finger tips before trying to attach the male hose fitting. Line up the hose fitting before attempting to connect	Push male coupling into the female firmly whilst holding the collar down. Release the collar only when fully engaged
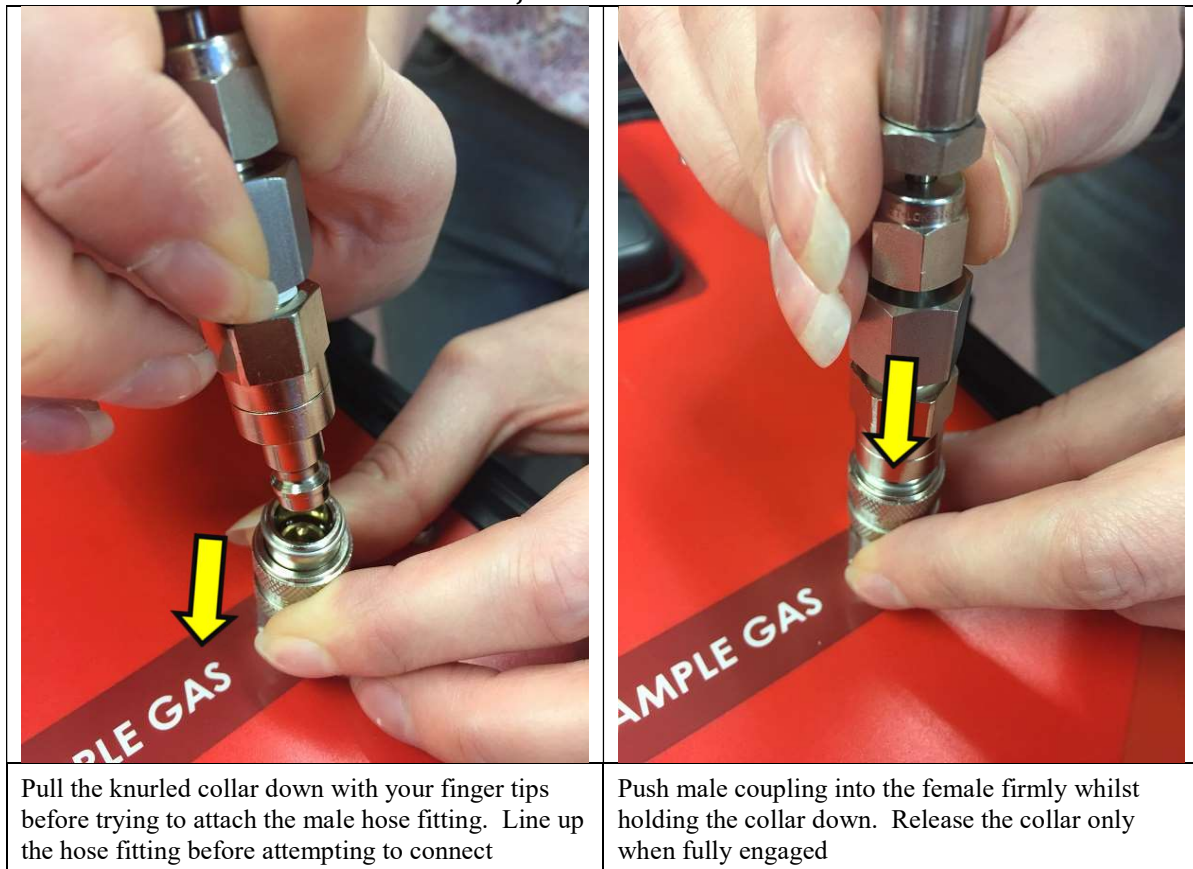
Figure 5: Correct procedure for attaching the sampling hose to the analyser.

As this is the first test it is recommended to perform a vacuum purge of the sample hose by pressing the button labelled "Line Purge". This will vacuum out any unwanted air from the system and takes approximately 45 seconds to complete. You will see on-screen message (see Figure 6) to remind you NOT to connect to the gas compartment. Once completed the following message will show:

| | Connect the Rapidox sample hose to the analyser but NOT the gas compartment |
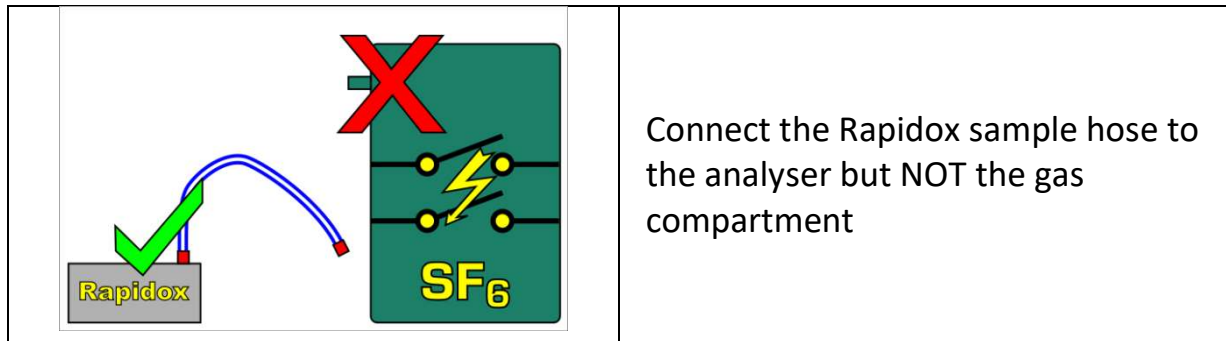
Figure 6: Screen message displayed when attempting a line purge.

5.4 Sampling

Once the line purge is completed press SAMPLE to begin the test. You will be instructed (see Figure 7) to connect the female coupling on the end of the hose to the gas compartment using a DILO male coupling adapter (supplied).

| | Connect the Rapidox sample hose to the gas compartment to pressurise the analyser with sample gas |
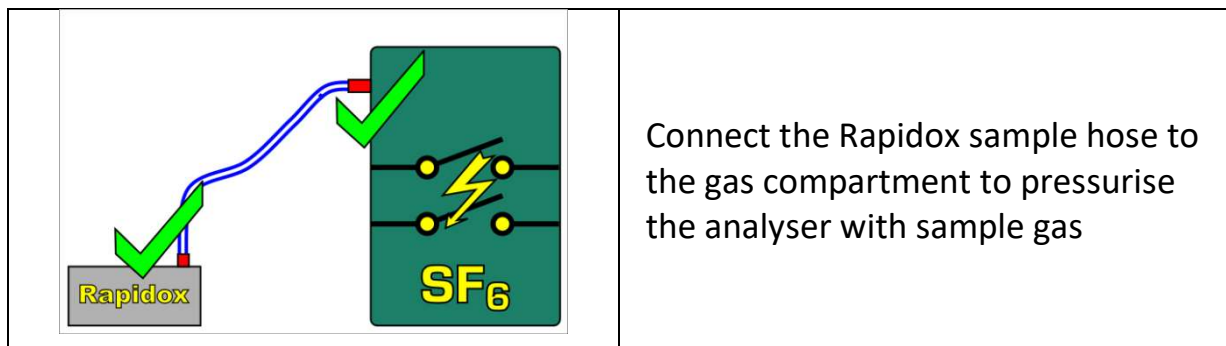
Figure 7: Screen message displayed when performing a sample analysis.

Gas compartment pressure is OK

Location:
Test Parameter: IEC 60480 > 200 kPa   Testing

Time before result

7   Mins   58 Secs

Graph   ABORT
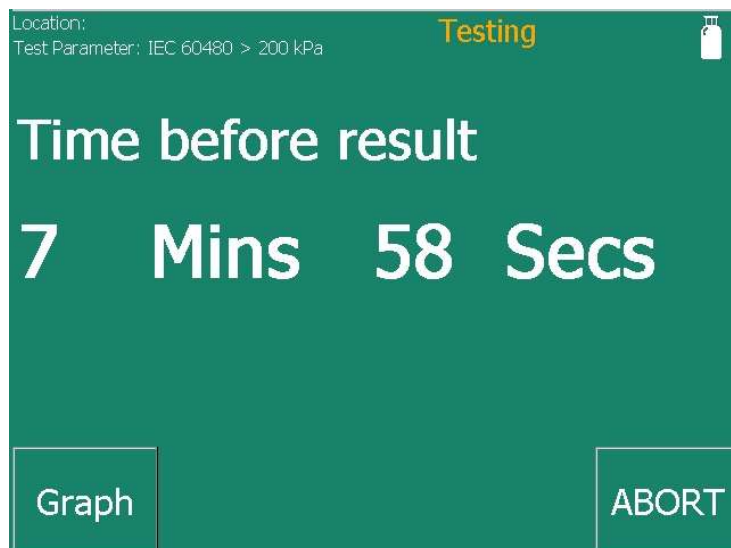
Figure 8: Screen message displayed when performing a Timed analysis. The test will take eight minutes to complete.

Once the hose is correctly connected you will see the Gas Inlet Pressure Meter (see Figure 8) rise and the pressure display will indicate the gas compartment pressure. Note that there must be a minimum pressure of 0.5bar to proceed. If the pressure is acceptable the gauge will appear green. Press OK to continue.
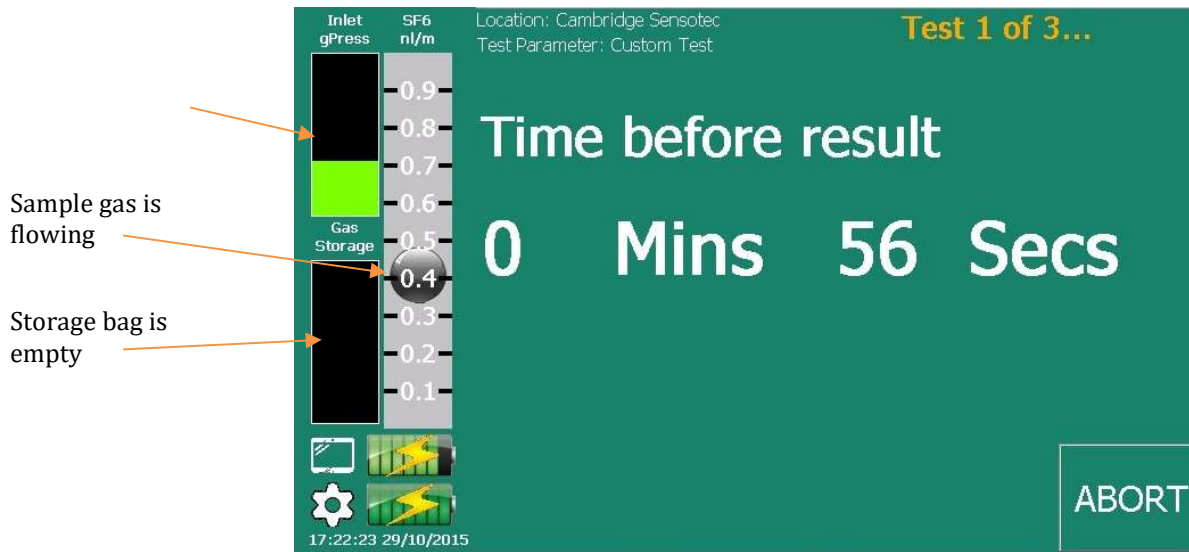
A timer will appear on the screen and count down eight minutes. During this period the SF_6 gas will flow into the analyser at a rate of 0.5L.min-1. The black ball on the electronic flow gauge will rise and settle in the mid-point (see Figure 8). Press "Graph" to see a live display of the readings and "Abort" to cancel the test.

If at any time during the test, large amounts of toxic gases are detected and "Auto Abort" is enabled then the test will stop mid-way with an advisory warning.
When the test is completed the results of the analysis will display on the screen and the printer will produce a short summary report. If pump back is set to "Auto" the unit will immediately begin pumping the gas back to the compartment.

5.5 Results and Finishing

With the test completed and all the gas pumped back the analyser storage bag will be empty and the machine is ready for the next test. If multiple tests were selected, then the cycle will repeat itself until everything is completed. Finally, the screen will indicate to the user that it is safe to disconnect the hose from the gas compartment and then from the Rapidox before moving on to the next location.

Note that if a sequence of repeated tests is performed it is not usually necessary to do a line purge each time, as the hose is full of dry SF_6 from the previous test.

Note that if you are testing very small volume circuit breakers at low pressures then it is NOT recommended to do repeated testing as continual sampling and pumping back can eventually make a noticeable change in the gas quality; particularly the overall moisture content.

The following flow chart in Figure 9 shows the complete operational sequence for performing a gas sample test with the Rapidox Pump Back Analyser.

5.6   Notes about Dewpoint Measurements

The dewpoint sensor fitted to this equipment is a special high speed polymeric type designed for use in SF_6. For optimal readings dewpoint is measured at compartment pressure and the readings are then pressure corrected to atmospheric pressure 1013mbara.

The sensor itself is electronically "cleaned" regularly by the analyser to prevent contamination building up and causing a drift of readings. At the start of each timed test the sensor is cleaned. This takes approximately two minutes to complete and an additional four minutes is then required to allow the readings to settle. In exceptional circumstances the sensor will perform an advanced clean which takes up to six minutes to complete. During this time no readings are visible on the plot or recorded in the data logger. The logger will record the words "Clean" or "Adv. Clean" instead.

If the analyser is operated in continuous mode, then the cleaning will happen automatically every thirty minutes. The initial clean cycle will begin five minutes after the analyser is powered on. During any clean cycle the continuous mode will display "Please Wait" on the main screen which will disappear once the cleaning is complete.
The dewpoint reading displayed on the screen shows the units as °Cdp but this is calculated as frost point when readings are below 0°C. Although there is no actual frost generated on a capacitive sensor surface, the readings are calculated as frost point so direct comparisons can be made with a chilled mirror analyser. This is important because the difference between "over ice" and "over water" calculations become significant in very dry measurements. All CIGRE and IEC test standards are in terms of frost point "over ice" regardless of the measurement method.

As well as recording the absolute dewpoint at room temperature it is possible to display an equivalent dewpoint corrected for temperature at 20°C This options features in the Units menu and the unit can be accessed by tapping on the main screen over the displayed unit. Tap the screen with your finger to change from "°Cdp@RT" to "°Cdp@20°C".
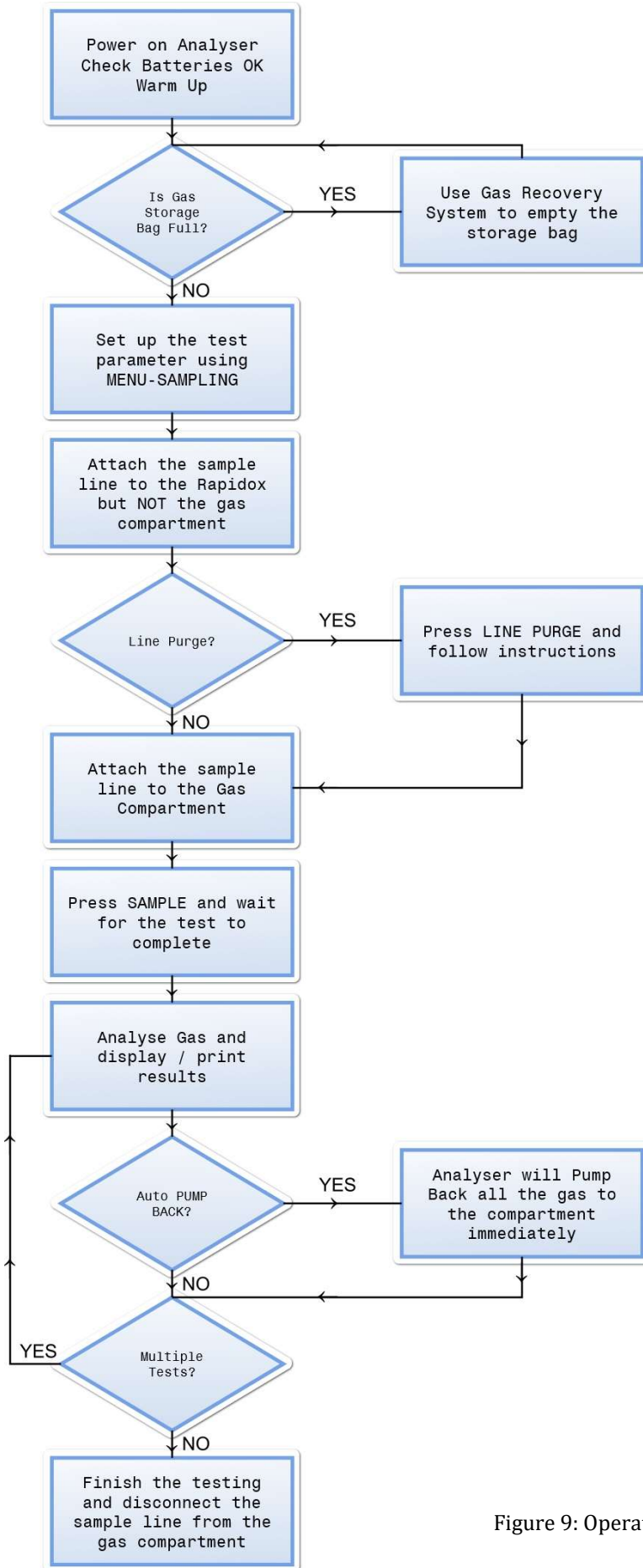
Figure 9: Operational Flow Chart

6 Operational Description
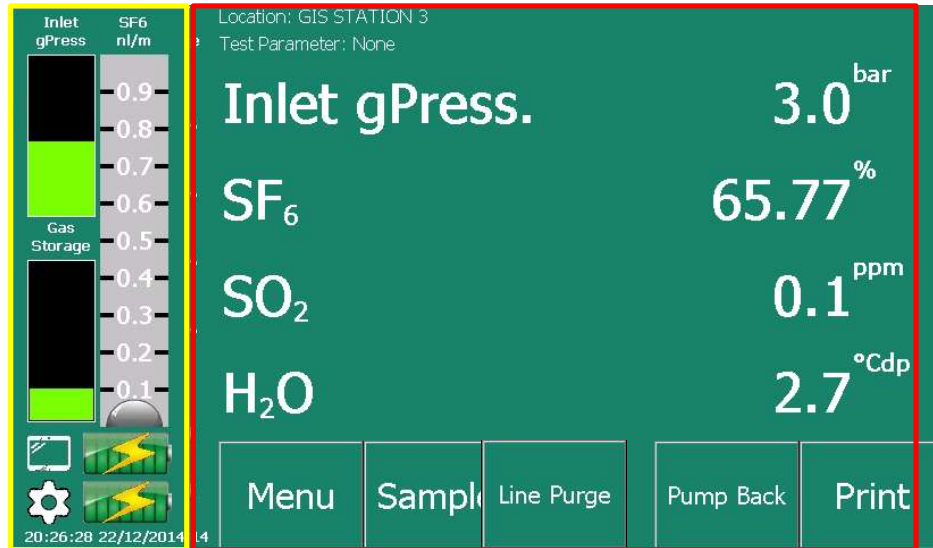
6.1 Main Screen

Figure 10: Main operation screen (RED) configured with just three sensors, showing sensor readings with side panel (YELLOW) indicating the gas flow, bag, battery and pressure status

During sampling the target gas flow is factory set to 0.5L.min^{-1} and this is displayed on the side panel using the electronic gauge (Figure 10 – YELLOW) . The inlet gas pressure and the gas analysis readings are also displayed on the side panel. At the top of the main screen (Figure 10 – RED) is information about the name of the test location and the type of standard test being performed. These can be edited and selected in the menu system (section 7.4). Press "Sample" to begin a test. Press "Menu" to enter the analyser menu screen and "Print" to produce a printout of the data as seen on the display.

Press "Line Purge" to vacuum purge the sample hose. This removes any air already inside the hose before a test is performed. You will be prompted to attach the hose before proceeding. A full description of this feature is in section 6.3.

Pressing "Pump Back" will allow you to return the gas inside the analyser to the gas compartment. On pressing this button you will be prompted what to do before pump back commences. See section 6.4 for a more detailed description of the pump back feature.

A status message will display in the top right hand corner to indicate what the machine is doing. For example, the display might show "Testing Sample 1 of 3……" if multiple cycles have been selected.

During a test, a button labelled "Abort" appears instead of "Print". This can be pressed at any time to stop the cycle.

The gas storage gauge will give you an indication of how full the internal storage bag is. The bag will hold up to five litres of gas at standard temperature and pressure. This is more than sufficient capacity to complete a single eight-minute timed test in normal atmospheric conditions including at high altitude. In exceptional atmospheric conditions or during calibration the bag may become full prematurely and testing will stop. The gauge will change red to indicate "Bag Full" and no further testing will be allowed until a pump back cycle has been performed. To empty the bag, press the "Pump Back" button and you will be prompted to make the correct connections before pump back commences. Note that if there is any residual gas inside the bag and you attempt to perform a timed test, the unit will show a message indicating that a pump back is required before proceeding.

If you want to see a live chart of any of the channels finger tap over the live reading display of the gas / measurement of interest and the display will change:

6.2   Live Graph Display

To view a live graph recording of the gas values or compartment pressure, press on the appropriate label on the main display and the graph function will open. The main panel shows a live display graph of the reading from the sensor. Use the "Esc" button to return to the main display screen and the "Prev" & "Next" buttons to change the sensor you are viewing. Each gas type is assigned a colour and this is shown in Figure 35 below.

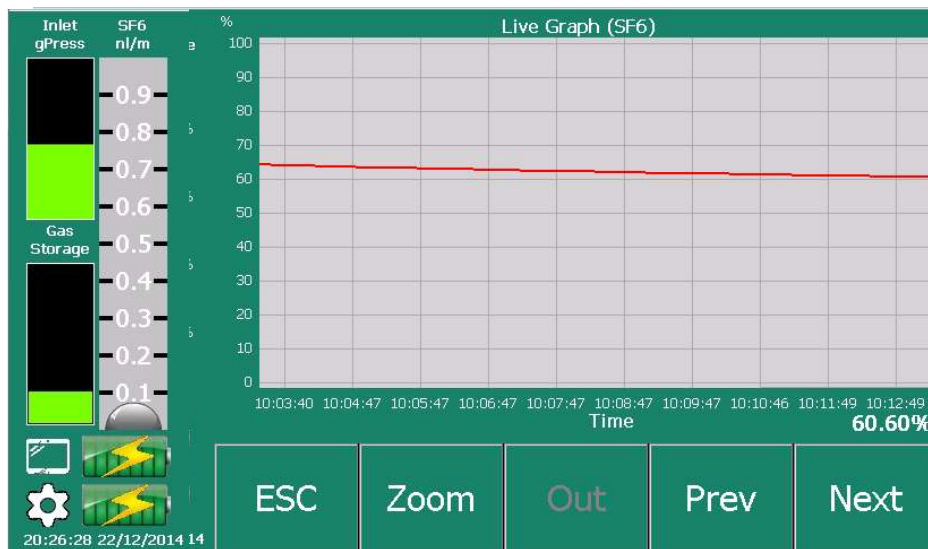Figure 11: Pressing on any gas name on the main screen will display a live graph of that measurement.

6.3   Line Purge Option

Pressing this button will activate the line purge feature. This uses a vacuum to remove all the air from the special sample hose that is supplied with the analyser. It is recommended to do a line purge of your hose at the start of a day's testing to ensure no air gets mixed in

with the SF_6. If you are doing a series of tests it is not necessary to line purge every time as the hose will be full of SF_6 from the previous test.

The small volume of residual gas in the sample hose that is removed during the line purge operation is vented to the "Bypass Port" (Figure 1-15). As there is a possibility that this may contain SF_6, the gas may be collected using an optional gas recovery bag. Connect the recovery bag using a 4mm OD tube to the bypass port (Figure1-15). There are screen shots to remind you to do this should it be deemed necessary (see Figure 6).

Only use the sample hose that is supplied with this equipment to do your testing. This hose has closed couplings that are gas and vacuum tight. The inside of the hose is lined with FEP to make sure moisture and other gases don't stick to the lining.

Connect the sample hose to the Gas Inlet socket (Figure 5) but DO NOT connect the other end to the gas compartment. You will get a prompt and a diagram on screen to assist you (Figure 6). Once you confirm that the hose is correctly in position the pump will run for approximately 45 seconds to extract all the gas from the line. Afterwards you will receive a prompt stating the line purge is complete. The sample line is now ready to be connected to the gas compartment for testing.
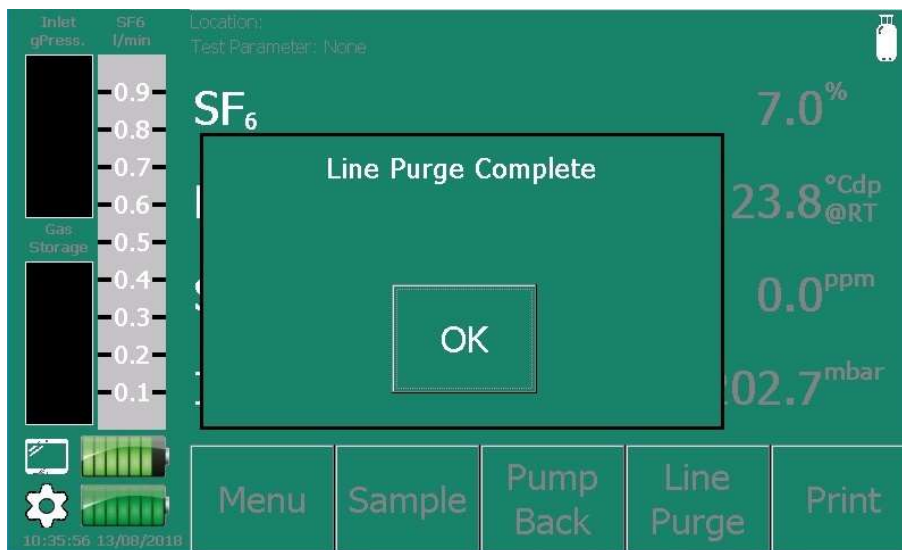
Figure 12: Line Purge takes 45 seconds to complete and finishes with the above message

If you have the line attached to the gas compartment so there is pressurised gas present then the pump will stop after a few seconds and question if the hose is still connected (see Figure 2 - 4). This is a safety feature.

Note that occasionally the H_2O sensor will display "U/Range" after a line purge because the vacuum causes the moisture to drop below the minimum reading. This is not a problem and the sensor will recover itself as soon as the analyser is pressurised with new SF_6.

6.4   Pump Back Option

If you have completed a test, or have gas in the storage bag, or have a bag that is full then you can pump the gas back in to the gas compartment or gas recovery unit with this option. You will receive a screen message and a diagram asking you to check and confirm the sample hose is connected to the gas compartment (Figure 2 – 2). After confirmation, the internal compressor will activate to pump all the SF_6 back into the gas compartment. Depending on how full the bag is and the pressure of the gas in the compartment this can take up to five minutes to complete but is typically much faster than this. Once all the SF_6 has been removed from the analyser the compressor will switch off and a message will display confirming you can now remove the sample line again.

6.5 Start Delay

In certain test environments, you are required to walk away from the equipment while the test is being performed. The Rapidox allows the user to enter a start delay time in the Sampling Menu. When enabled, the unit will count down the delay time before starting a test. The feature works in both Timed and Continuous modes. To enable or edit this function press "Menu" followed by "Sampling" to display the following screen. Press on the button labelled "Start Delay" and enter a delay time in minutes. Set zero for no delay. The minimum time delay is 0.1 mins (6 seconds) and the maximum time delay is 10 minutes. Press "Set" to store the new value.
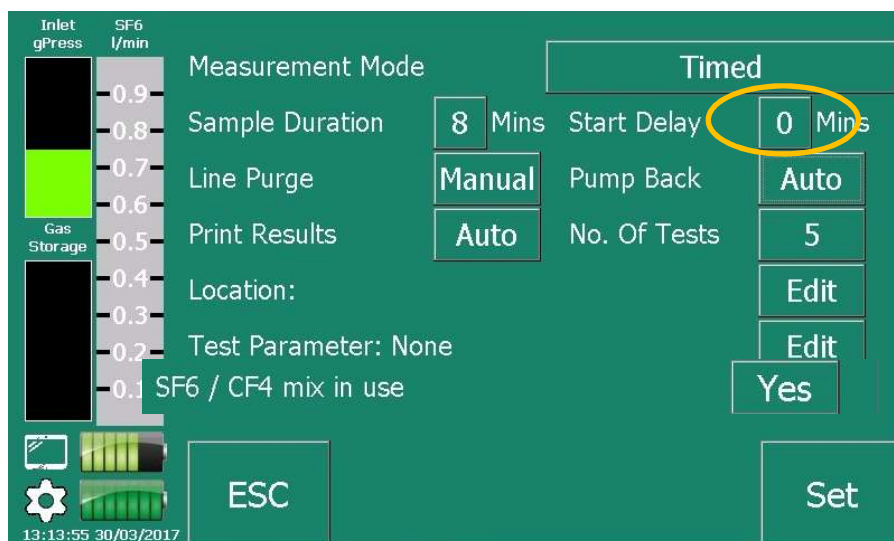

Figure 13: Use this feature to set a Start Delay time before a test begins

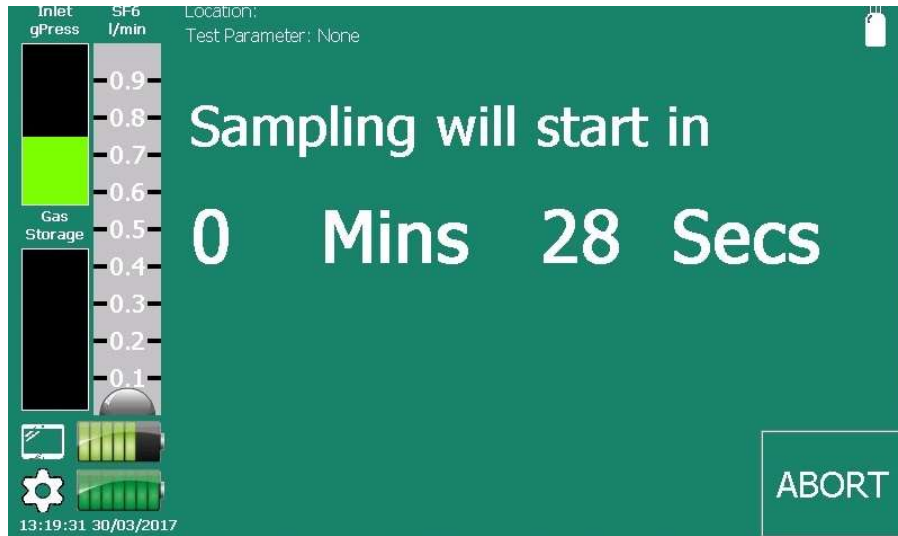Figure 14: Enter a time up to ten minutes to use a delayed start

Figure 15: The delayed start is shown on the screen before a sample commences

6.6   Working with Pre-Loaded Test Parameters

The Rapidox has several commonly used SF_6 test parameters pre-loaded for quick and easy selection. The list includes CIGRE and IEC international test standards as well as the option to create and name your own custom test. Note that the dewpoint values used in these standards are "Over Ice" i.e. frost point. To set up this function press "Menu" and then "Sampling". The pre-loaded tests are accessed by pressing the "Edit" button alongside the label "Test Parameter":

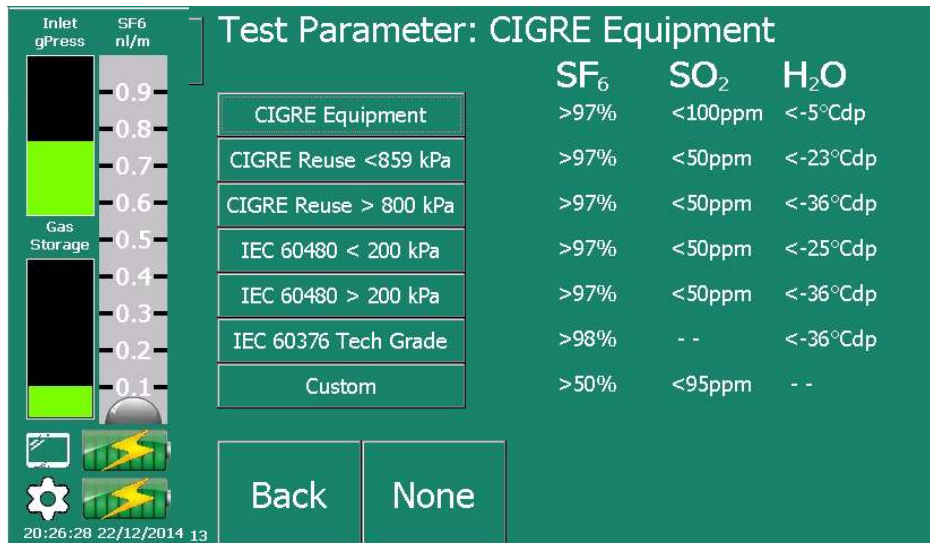|	SF_6	SO_2	H_2O
CIGRE Equipment	>97%	<100ppm	<-5°Cdp
CIGRE Reuse <859 kPa	>97%	<50ppm	<-23°Cdp
CIGRE Reuse > 800 kPa	>97%	<50ppm	<-36°Cdp
IEC 60480 < 200 kPa	>97%	<50ppm	<-25°Cdp
IEC 60480 > 200 kPa	>97%	<50ppm	<-36°Cdp
IEC 60376 Tech Grade	>98%	- -	<-36°Cdp
Custom	>50%	<95ppm	- -

Figure 16: Pre-loaded test parameter screen. Press the "None" button to remove any tests that have been selected.

On this screen the user can remove any tests by pressing "None". This will clear all previous selections. To select the relevant test simply press on the labelled button of choice and the pass/fail alarm settings will be loaded as displayed. Or if the user wants to create a new bespoke test click on the button labelled "Custom" to access the editing screen.
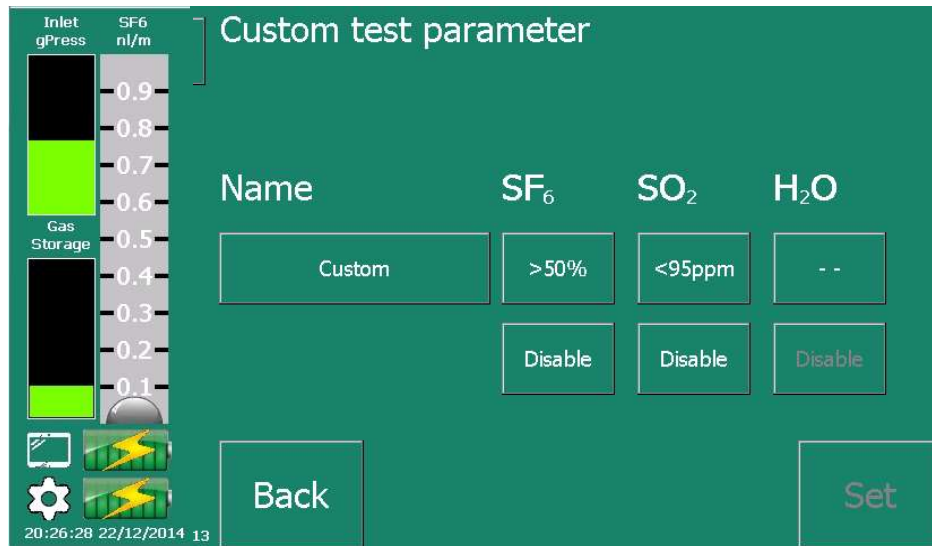

Figure 17: Custom test parameter edit screen

By clicking on the button below "Name" the user can re-name the test e.g. "Taiwan GIS recycle". Next the three gas parameters can be edited in turn. For each gas a pass/fail set point can be entered as well as > and <. Or alternatively the test can be disabled for the gas in question. Once the custom test parameters are set up press "Set" to store them. Pressing "Back" returns you to the Sampling screen where you will see that the test name has changed to your custom name. This new test can be selected and used in the same way as the standard tests until it is edited and modified again.

With the test of choice selected the user can return to the main screen and begin sampling gas. If the readings are outside the test parameter, the screen will display "FAIL" in red alongside the gas symbol. Or if the sample is within the test parameter the word "PASS" in green will be displayed. This information is logged and printed as a permanent record.

6.7 Working with SF_6 and N_2 mixtures

In certain countries SF_6 is mixed with dry nitrogen in gas compartments. In this case it is possible to reconfigure the analyser, so the balance gas analysis is displayed as the nitrogen content. This option is not factory enabled and requires a re-boot to operate if selected.

To enable the N_2 Balance option press "Menu" and "Options" followed by "System Control". Enter the admin password (default it 8888) to continue.

Figure 18: Use the System Control Menu to switch on / off the Balance Gas option

Select YES and press SET. The analyser will respond by asking to re-boot to enable this function. Once restarted the main screen will now display N_2 as the balance gas.
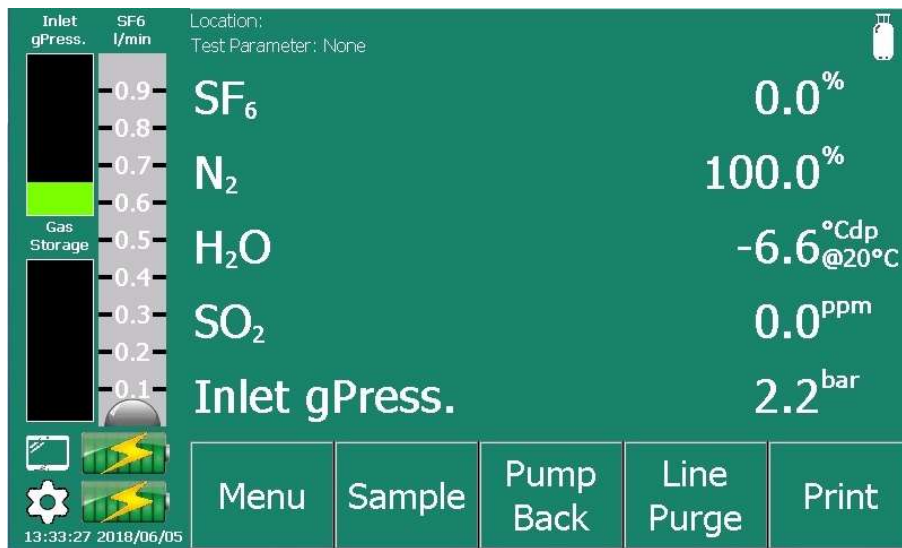

Figure 19: Main screen with N_2 mode enabled.

6.8 Working with SF_6 and Air mixtures

With the N_2 balance mode enabled as described above in section 6.7, it is possible to change the display to indicate "Air" instead of "N_2". This option is enabled in the "Set Units" menu as described in section 7.7 below. In this case the Set Units menu is modified as shown in Figure 20 below.
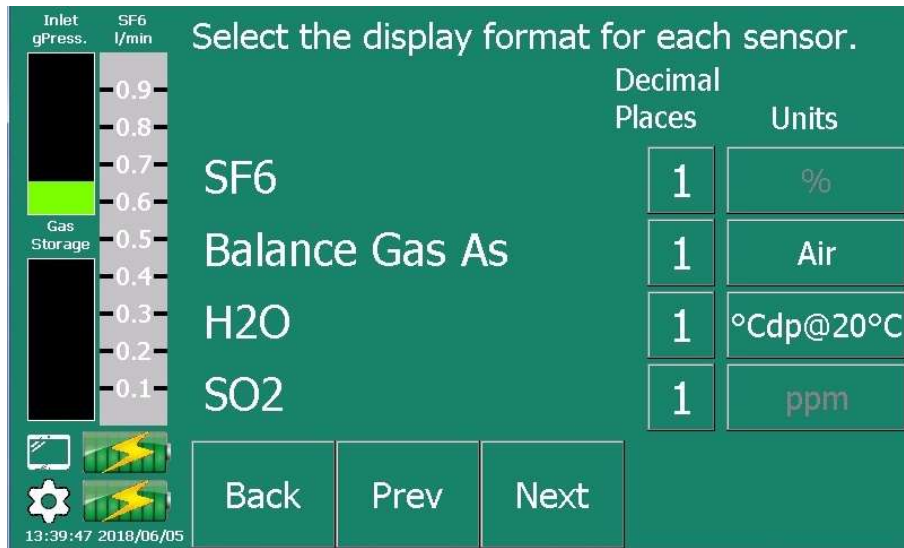
Figure 20: With the balance gas option enabled it is possible to change the display units from "N$_2$" to "Air" if required.

Figure 21: With Air selected as the unit for the balance gas, the display now looks like this.

The balance mode can be enabled or disabled ay time by the use by accessing the System Control Menu. A reboot is required to complete the task.

6.9   Working with SF$_6$ and CF$_4$ mixtures

This feature is specified on ordering and may not be available on your instrument

In certain cold countries SF_6 is blended with carbon tetrafluoromethane (CF_4) normally in a 50:50 mix. This is used as an anti-freeze to prevent the SF_6 from becoming liquid at extreme cold temperatures.

This Rapidox will correctly measure the SF_6 and CF_4 content of your gas mixture in the range specified using a combination of sensor readings and mathematics. To enable the CF_4 reading option press "Menu" followed by "Options" and "System Control". Enter the admin password to enter this menu (default is 8888) Here is an option "SF_6 / CF_4 mix in use". Please select Yes if you are using CF_4 mixtures or No if you are using SF_6 only. It is important the CORRECT option is selected to ensure accurate readings are maintained! Please see section 7.4 for full details. Note that the analyser must be re-booted if this option is required.
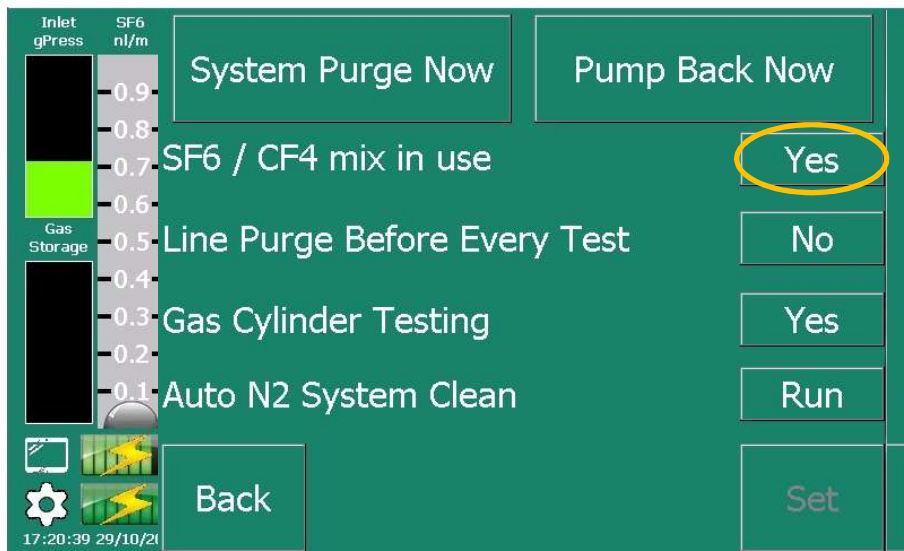

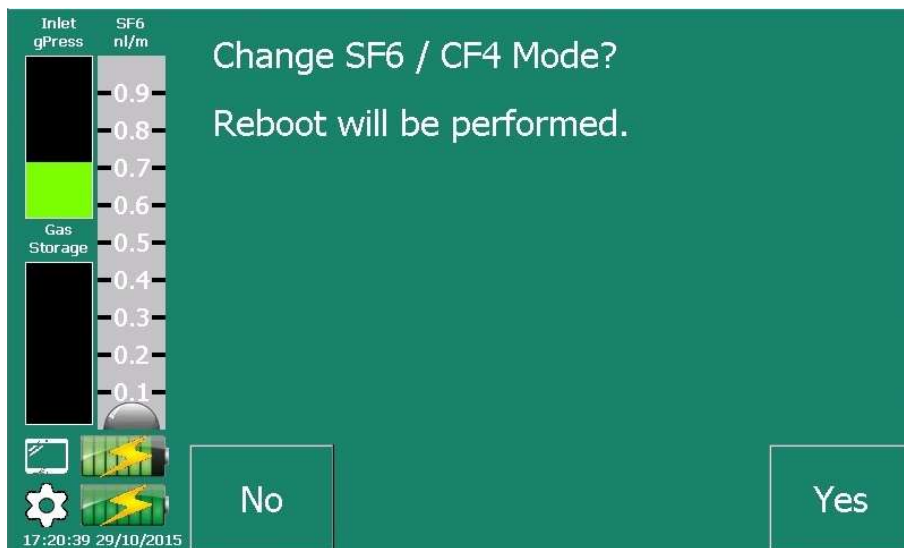Figure 22: To select CF4 mix operation use the menu option "Sampling" to select "YES"

Figure 23: When working with CF_4/SF_6 blended mixtures select this option and re-boot the analyser

7   Rapidox Menu System

Pressing "Menu" enters the main Rapidox Menu system as seen below. Press "Back" to return to the main analyser screen. If padlocks are displayed then these options are password protected. See 7.9 for more information on passwords.
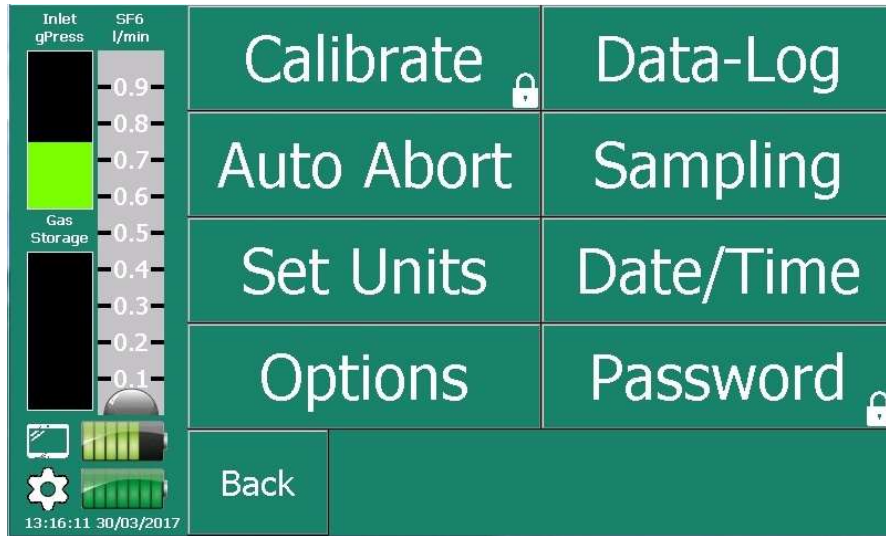
Figure 24: Rapidox Main Menu Screen. Note that on the pump back versions of this analyser the alarms are disabled

7.1   Calibrate

Use this screen to calibrate the gas sensors should they require updating. Note that it is not possible to field calibrate the H$_2$O sensor because it has a special factory calibration over many measurement points. Should the H$_2$O sensor need re-calibrating please contact SMC Sensotec for advice.
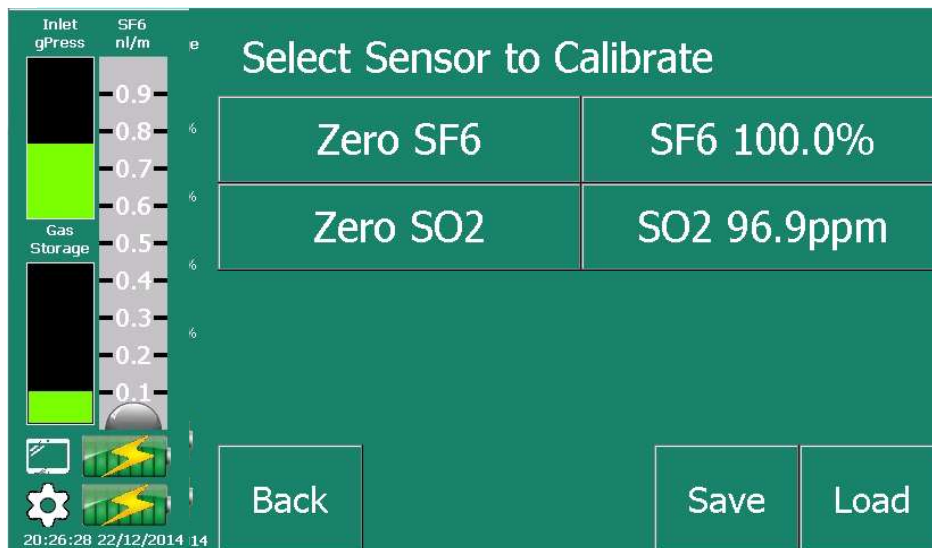
During calibration, the cal gases are either diverted through the analyser and ejected via the Bypass Port (Figure 1-15) so no gas enters the storage bag (set unit to CONTINUOUS mode) or the cal gases enter the internal storage bag so no gas escapes intro the atmosphere (set unit to TIMED mode). For the latter the calibration time is restricted to around eight minutes until the storage bag is full. At this point the calibration will stop and warn you to pump back. It is recommended that timed mode is selected when calibrating with SF_6 gases and continuous mode is selected when calibrating or zeroing with nitrogen gases (eg toxic gases).

If calibrating with the bypass port, either connect a suitable gas recovery bag to this port or ensure that a tube is connected to vent the gas to the outside air, subject to local laws and regulations. After calibration the analyser sample hose must be line purged before further sampling of SF_6 is performed. This will ensure that no residual calibration gas gets mixed with the sample gas and inadvertently pumped back into a gas compartment. Various simple diagrams are displayed on-screen to make it easy to follow the correct sequence. These are as follows:

1) Attach a pressurised nitrogen gas bottle to the Rapidox using the sample hose	2) Disconnect the nitrogen gas source
3) Attach a pressurised SF_6 gas bottle to the Rapidox using the sample hose	4) Attach a suitable gas recovery bag to the Rapidox to purge the cal gas from the system
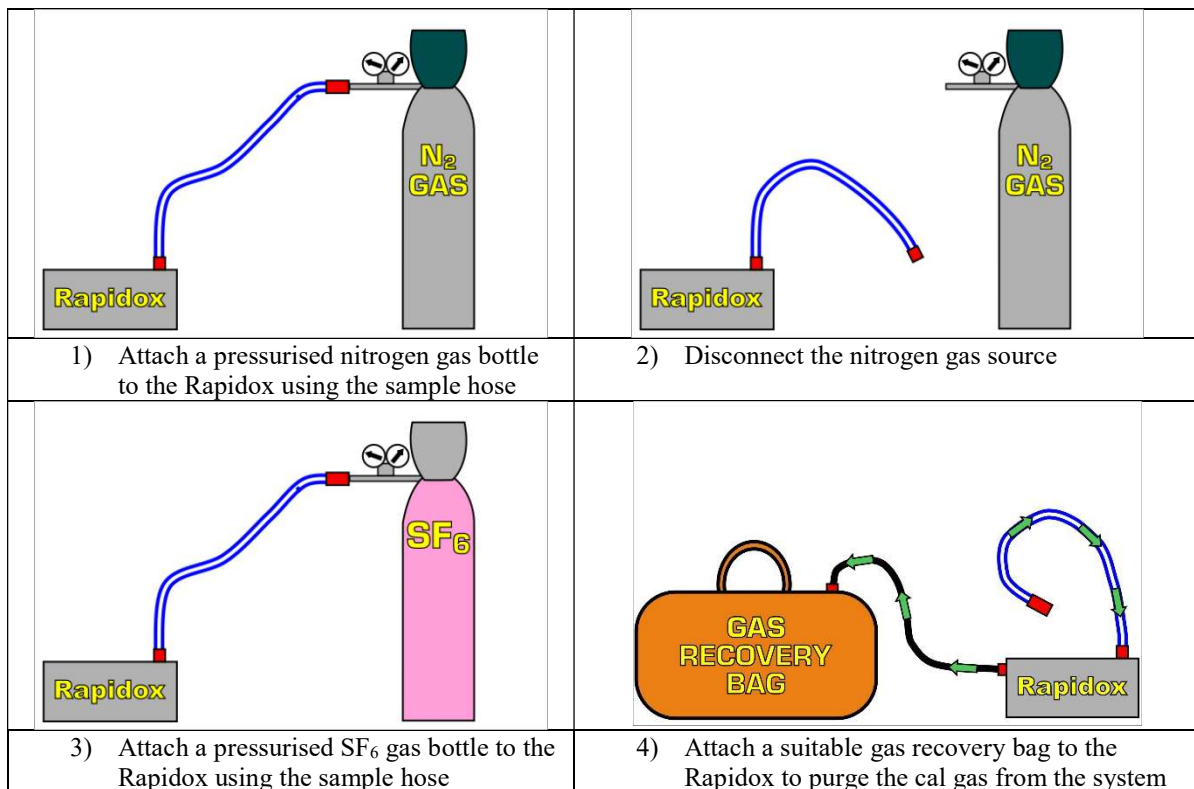
Figure 26: Various prompts are displayed on the screen to assist you in performing a calibration

Press on the option you have chosen to either zero or span calibrate the sensor of choice. To zero the sensors first make sure that you have fresh air or nitrogen flowing through the analyser. To calibrate the span of the sensor you will need a gas bottle of known concentration gas (normally 100% SF_6 and 100ppm SO_2). The current calibration values

are displayed on the calibrate screen as seen in Figure 25 above but these can be changed if they do not match the value of your gas bottle.

You can load a previous calibration by pressing "Load" and you can save the calibration you have just performed by pressing "Save". All calibrations including the initial factory one are stored on the hard drive of the analyser.

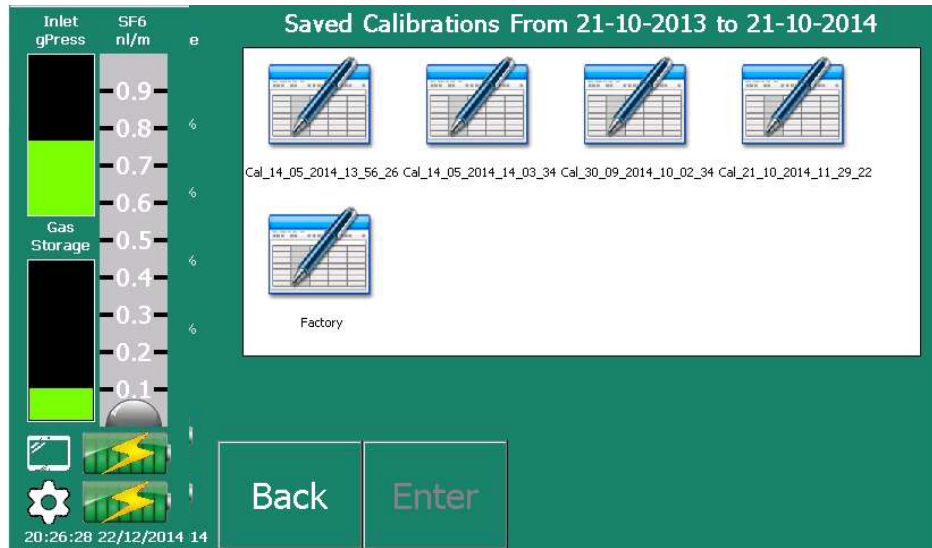Figure 27: Historical calibrations can be re-loaded and new ones saved using the "Load" and "Save" buttons.
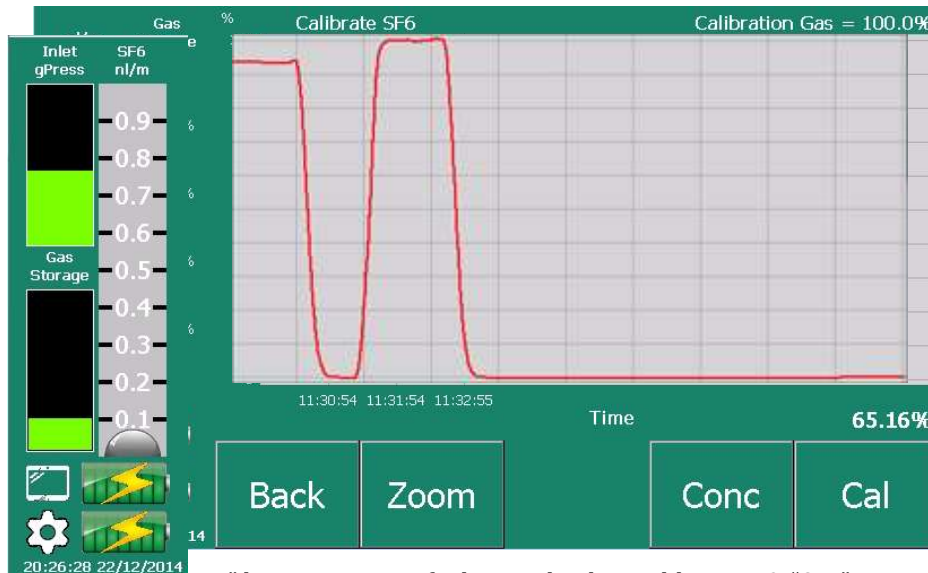

Figure 28: Use the "Zoom" button to magnify the graph when calibrating & "Out" to return to full

The current calibration gas concentration is shown in the top right hand corner of the main screen. To change this value press "Conc" and enter a new value using the number pad. This will be remembered for next time.
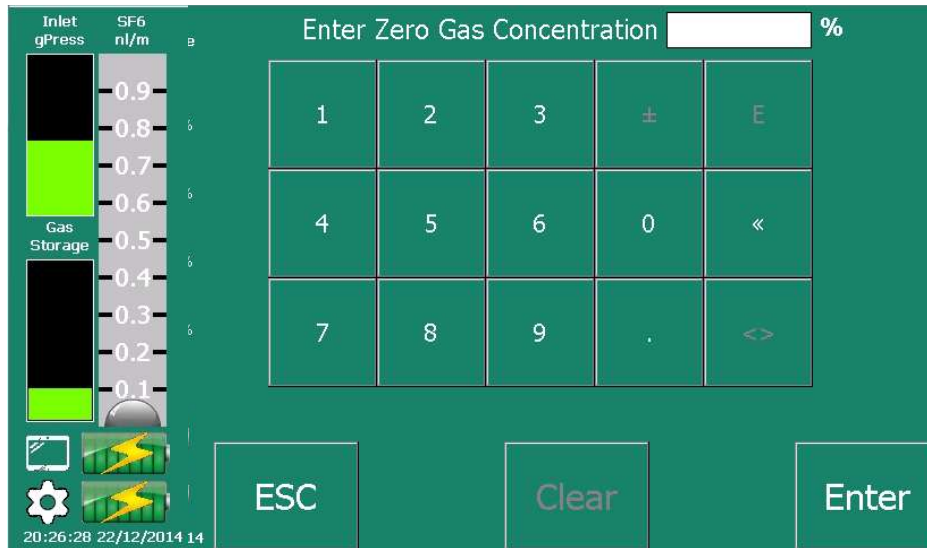
Figure 29: The zero and span calibration gas concentrations can be modified by the user

Once you are happy that the reading is stable press "Cal" to save the new calibration. Use the "Out" button to redraw the graph full scale. Use the "Back" button to return to the main calibration screen. Repeat the process for any other sensors that you want to calibrate. Note that if you calibrate with the wrong gas or try to calibrate 'back to front' the analyser will give you a warning to check before proceeding.

Figure 30: To complete the calibration press "Cal". Note that the analyser will warn you if the expected value is out of range.

7.2 Data-Logging

The test set data-logs all parameters and test results constantly whilst the machine is operating. The data is stored indefinitely until the hard drive is full and then data will be overwrit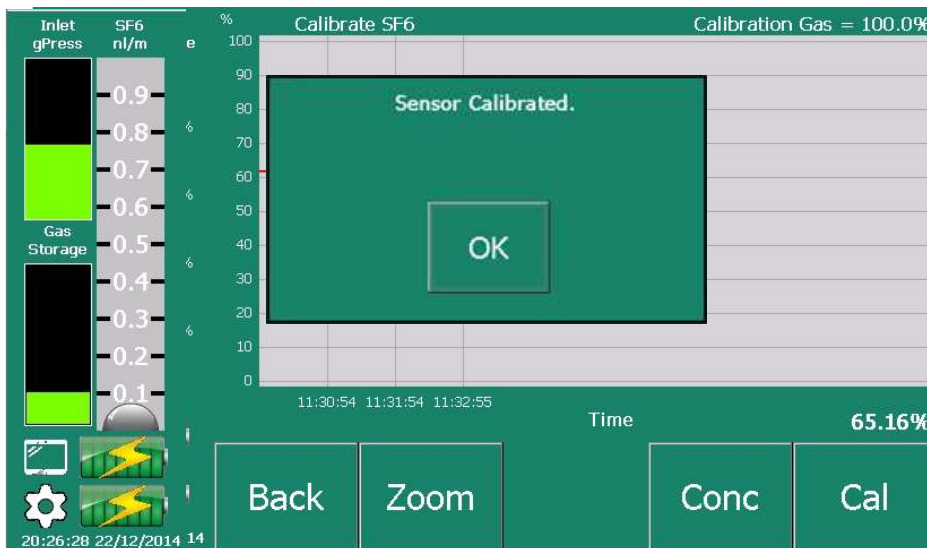ten oldest first. There is sufficient space on the hard drive for a minimum of twelve months of continuous data storage based on how the unit is used. You can use this option to search, review and re-graph historical data.
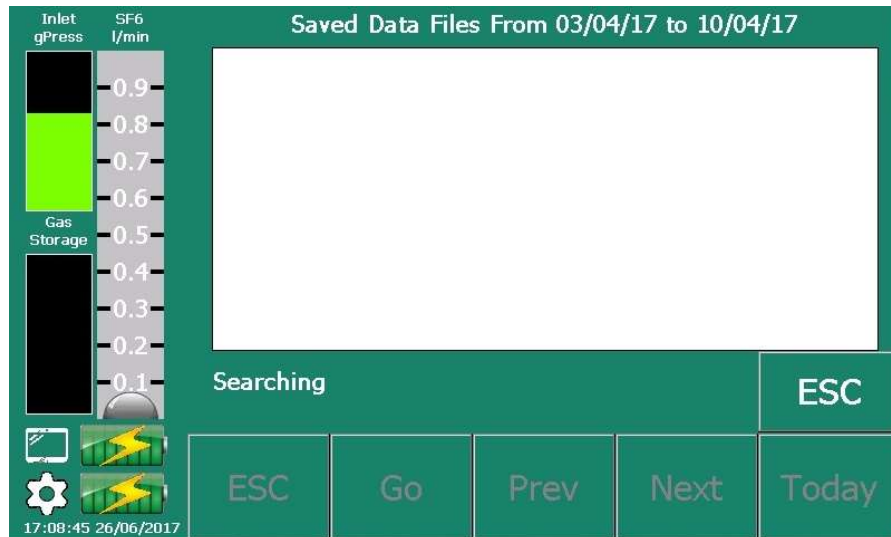
Figure 31: Use this screen to select data-files stored in date blocks and view them in graph form.

Use the "Prev" and "Next" buttons to search though the history of data files. Press the "Esc" to stop searching. Each session is recorded as a separate file on the hard drive. To return to the current set press "Today". To view the data as a graph press on the file icon of interest and press "Go".

A list of separate files representing sessions for the selected day are now displayed. Use the "Up" and "Down" buttons to scroll the list and select the session of interest. Note that if the test was timed then the end result can be displayed and reprinted, as well as graphed. If the test was continuous then some viewing options will be disabled. If the test has a "*" alongside it then this indicates the data are a complete test, as opposed to un-starred tests which are either continuous measurements or a test where the user aborted before the timer reached zero.

Figure 32: The Data is loaded from the hard disc drive and displayed on the screen

To display the basic test result press "Show Results". The result information will be displayed as follows:
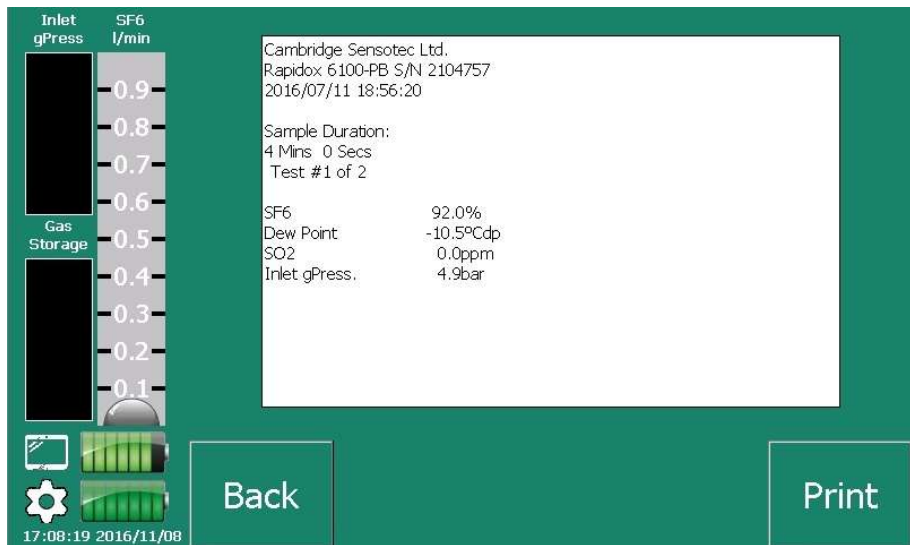
Figure 33: The Data is loaded from the hard disc drive and displayed on the screen. Here it can be printed out.

To show a full graphical reporesentation of the sample test press "Graph Sample". A full colour graph of the test will be displayed as shown in Figure 34. Note that if the data is from a large continuous test that it may take up to a minute to load and graph the results.

The graph Y axis is set to display the percent scale of the sensor so that all types of sensor reading can be shown on a single graph. Press Next and Back to display individual gas charts.
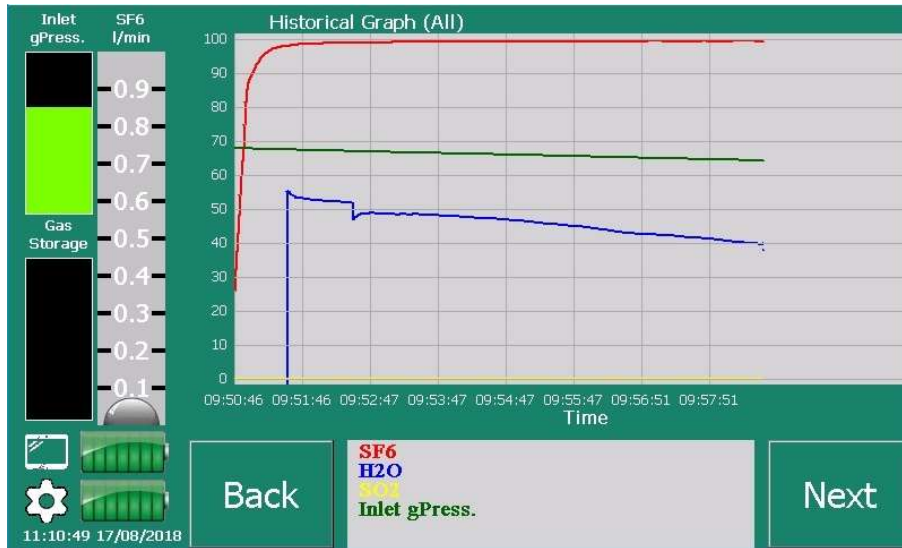
Figure 34: Historical data-log graph with colour coded key

255 0 0	SF$_6$		0 200 200	H$_2$S
70 255 68	CF$_4$		183 132 0	HF
0 0 255	H$_2$O		255 0 255	AIR
255 255 0	SO$_2$		0 100 0	Pressure
176 68 255	CO		255 255 255	Flow

Figure 35: RGB Colours used for each gas type shown on a graph. Not all gas types are fitted to Rapidox machines.

Pressing "Back" and "Next" will redraw the graph with a single gas or parameter to aid with clarity. Using the "Options" button seen on Figure 32 the user can set a default choice for what sensors are displayed on the historical graph:
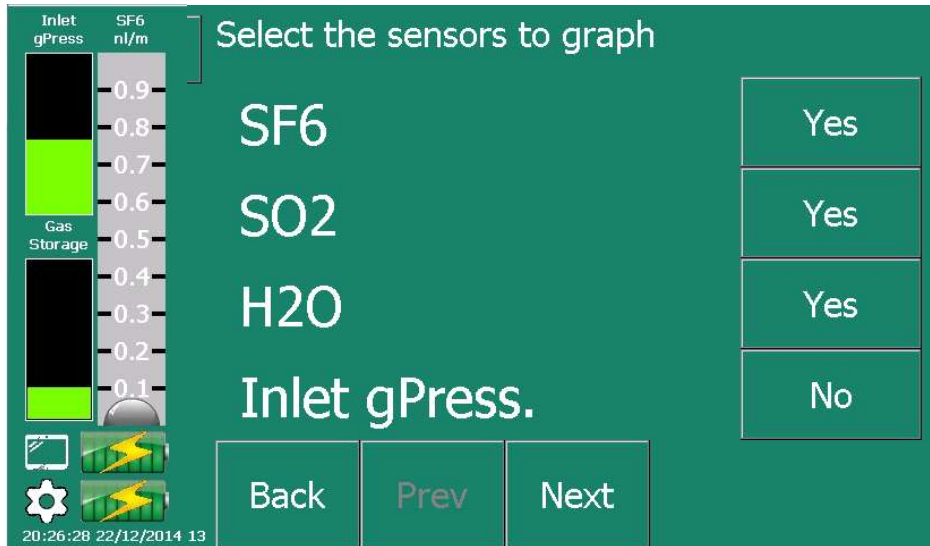
Figure 36: The user can customise the historical graphs using the "Options" button and selecting which sensors to display and which to hide.

7.3 Auto Abort

The Auto Abort function allows users to set limits for toxic gases entering the analyser. This helps to prevent damage to the equipment if excessive amounts of harmful gases such as SO_2, H_2S, CO and HF enter the pipework. With the function set and enabled as soon as any toxic gas level rises beyond the limit set, the test will abort, and the gas will be returned to the compartment if auto-pumpback is enabled. To enter this function press "Menu" followed by "Auto Abort" to see the following screen:

Figure 37: Auto Abort function. Depending on what toxic gas sensors are fitted a list of gases will be present here.

Note that you cannot set over-gas limits for SF_6 CF_4 and H_2O. Only the toxic gas sensors fitted to your machine will be listed here. Toggle the Enable/Disable button to switch on the over-gas protection. Press on the gas value to edit the over-gas set point. Toggle the pumpback switch to "Auto" or "Manual". Once all the settings have been configured press "Set" to store permanently.
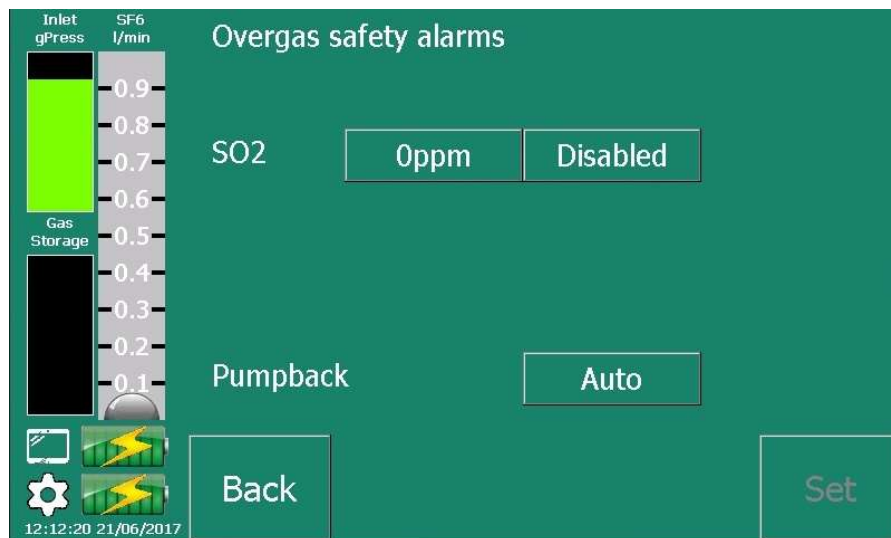
If a gas reading exceeds an over-gas limit, then the analyser will report this as shown below:
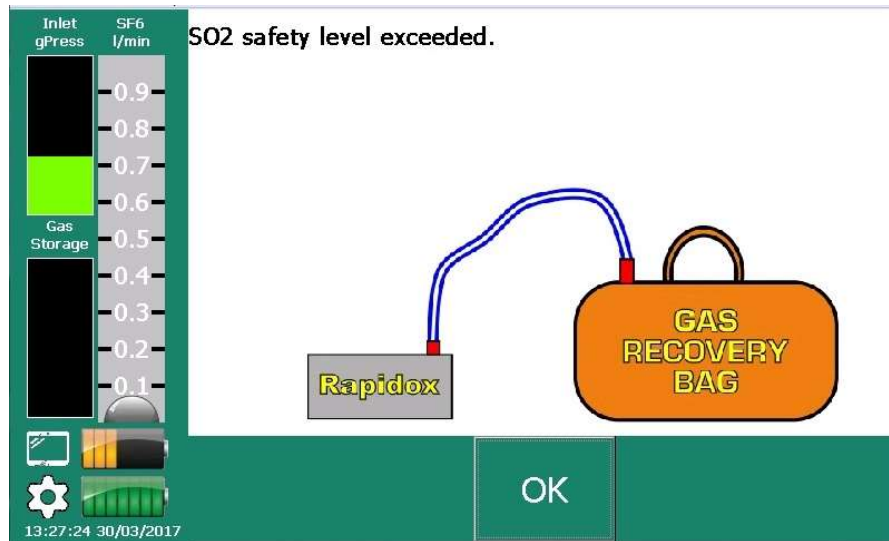
Figure 38: Message indicating that the SO_2 over-gas limit has been exceeded. The test has been aborted and the gas needs to be returned to the compartment.

7.4   Sampling Modes

You can choose the method of gas analysis as "Timed" or "Continuous" mode. For normal testing Timed mode should be used in this mode the user selects a fixed time to sample gas of eight minutes. The analyser then samples for this period and then displays the result on the screen until the next sample is required. Multiple repeat tests are allowed, and the testing can be aborted at any time. You can choose if the gas is automatically pumped back after each test is completed and select if you would like an automatic print out of the results at the end. During the test it is also possible to enter the live graph viewing mode.

In "Continuous" mode the analyser will sample gas permanently and pass the waste gas out through the bypass port. A separate SF_6 gas recovery system is required to prevent the gas entering the atmosphere. This mode is used exclusively for calibration, validation and service purposes.

For both modes There is an option to identify the sample with a name (e.g. "GIS Station 3") that is displayed on the main screen. This name is also recorded on the data log file and on the print out.
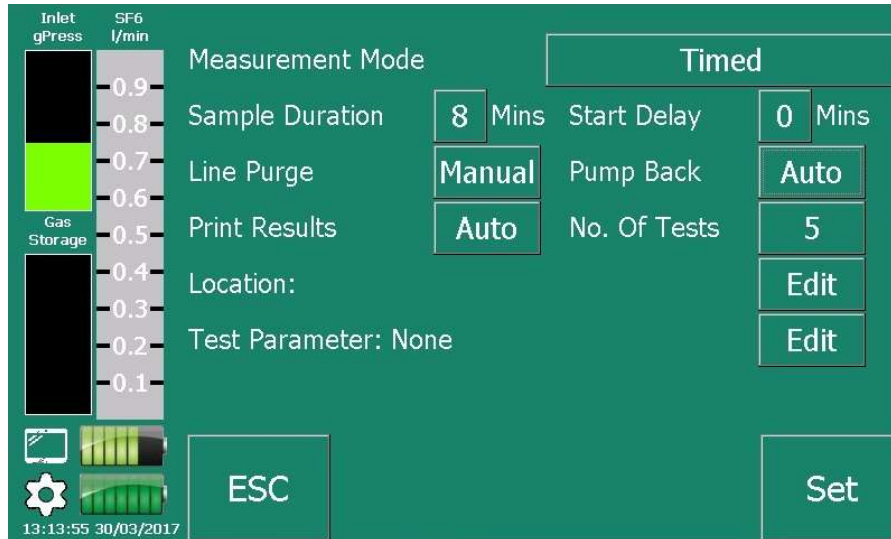
7.5   Timed Mode

Figure 39: Use this option to change the sampling method from "Timed" to "Continuous" and set the sampling duration and other options.

The sample duration is fixed at eight minutes in this mode. For accurate dewpoint readings the H_2O sensor is cleaned every cycle which takes just under four minutes to complete, and a further four minutes are required to get a stable reading.

If desired, a start delay can be incorporated to allow the user to walk away from the equipment during testing. See 6.5 for a full description of this feature. It is recommended that three repeat tests are performed to make sure that the sample line and equipment has fully dried down and the dewpoint reading is accurate. If the dewpoint measurement is still falling, then repeat the test again until a stable and consistent measurement is obtained.

Note that the unit waits thirty seconds in between each test before starting the next one. This allows all the sample gas to re-disperse inside the gas compartment prior to new sampling.

Tap on the buttons labelled "Line Purge", "Pump Back" and "Print Results" to toggle these options on or off during a test. Setting "Line Purge" to "Auto" will cause the analyser to ask you to do a vacuum purge of the sample line prior to each sample. This is important to do on first use but may not be necessary each time so it is suggested this is left on "None" until you are more familiar with your testing regime. Setting the "Pump Back" option to Auto

will force the analyser to pump back the gas into the compartment after each set of tests is completed. This is a normal procedure, so it is suggested to leave this set to "Auto". Both these options can also be manually commanded from the main display screen as well. Note that if you choose multiple tests using the "Number of Tests" button then the "Auto" mode will pump back after each to prevent the storage bag from over filling. Setting the printer option to Auto will produce a print out of every test result if required. It is normal to have this option set to "Auto".

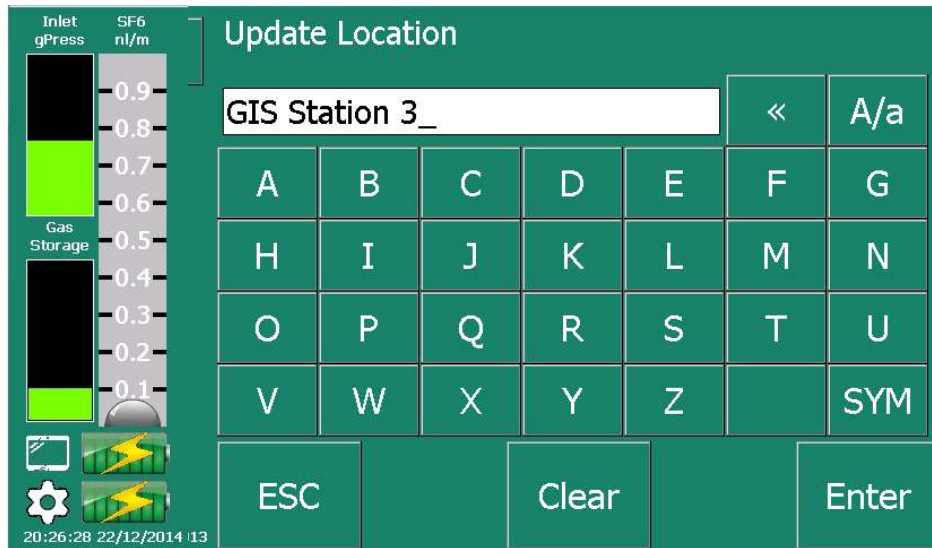Figure 40: The Location name can be edited here using the alphabet keypad. Names are displayed on the main screen and are printed and saved with the data.
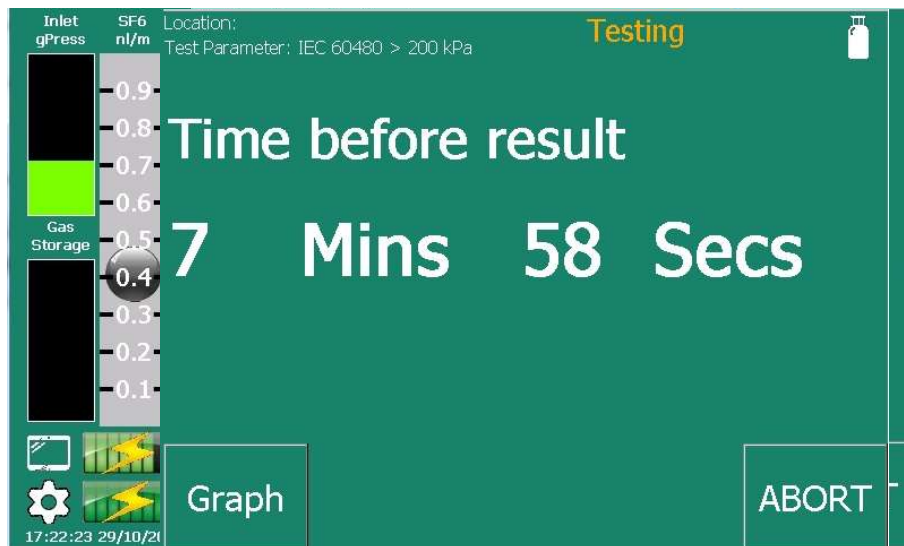
Figure 41: During a "Timed" test the main screen displays a count down while the sample is being taken. The results are displayed after the clock reaches zero. Press "Graph" to review the live data and "Abort" to abort the sample mid-run.

Figure 42: If during sampling the user wants to escape, pressing the "Abort" button will stop the sample and the screen will show -.- to indicate that the sample was incomplete.

7.6 Continuous Mode
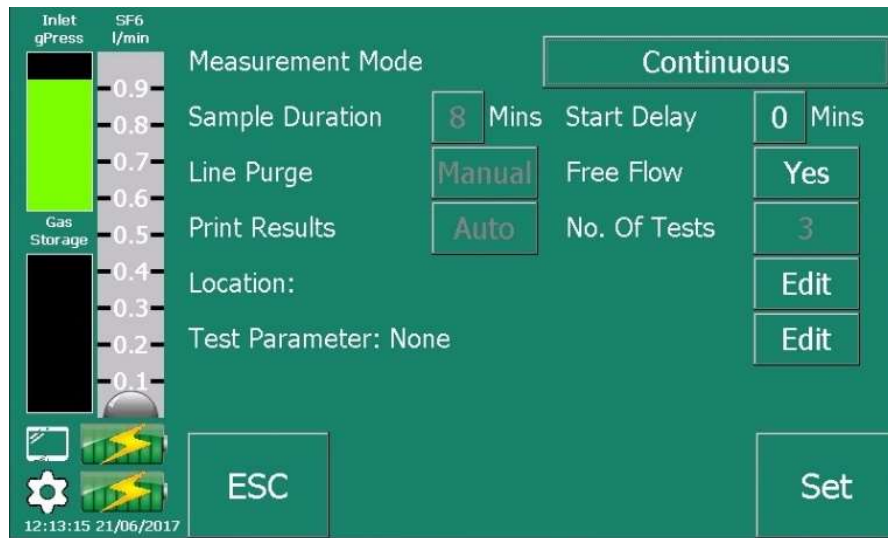
Figure 43: Continuous Mode set up page

This mode is used only when calibrating, validating or servicing the analyser. When this mode is set, the test gas is diverted through the analyser and sent to the Bypass Port (Figure 1-15). No gas enters the storage bag in this mode. Consequently, several of the options are greyed out as they are not applicable in this mode.

The gas leaving the bypass port may be either collected for recycling using an optional gas recovery bag or vented in accordance with local regulations, using a length of tube

connected to the port. Note that each time the analyser is started, a reminder screen will be displayed as shown in Figure 2 number 5).

In this mode the start delay option is still available. See 6.5 for a full description of this feature. An additional option is available called "Free Flow". This option is only used when connecting external calibration equipment such as mass flow controllers dewpoint generators. Selecting yes will disable all the flow control on the analyser which may otherwise interfere with external flow control equipment. Leave this option set to "No" unless you are working with such equipment.

Note that in continuous mode the dewpoint sensor will clean itself five minutes after powering on and then every thirty minutes afterwards. During the two minute clean period the display will indicate "Wait" while the sensor is off-line. Occasionally the dewpoint sensor will perform a more advanced clean cycle which lasts slightly longer and repeats itself up tot six times. If you observe this please leave the analyser running until the cycle is complete and readings settle down again.

7.7   Set Units

Use this menu to change the units displayed by the analyser for the different measurement parameters. The number of decimal places displayed can also be set here. Use the "Back" button to return to the main menu. Note that you can also change the units directly from the main display screen by tapping on them with your finger.
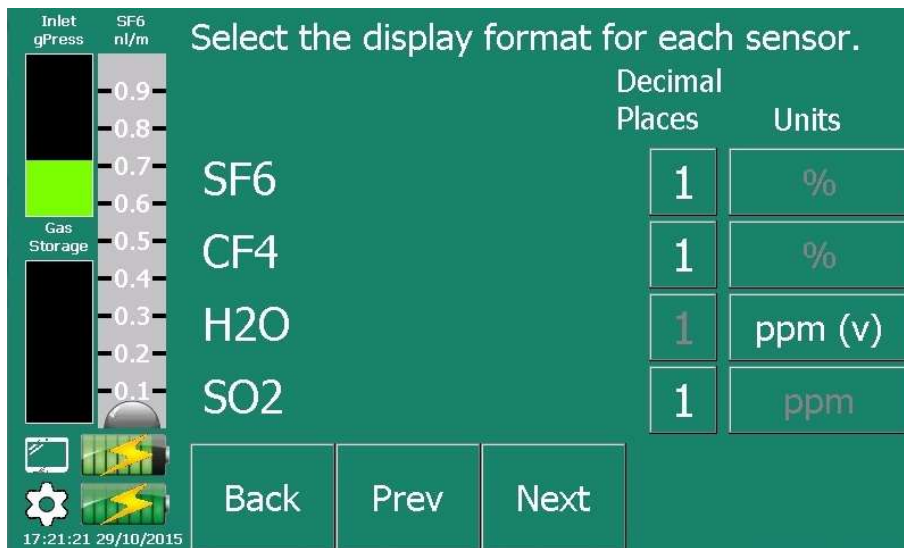
Figure 44: Setting the display units for the different sensors. T. Once selected the choice will be saved as the default until changed again.

7.8   Date & Time

There are various options for setting the analyser date and time and how it is displayed. This information appears in the bottom left-hand corner of the display and is used for data-logging and record keeping.
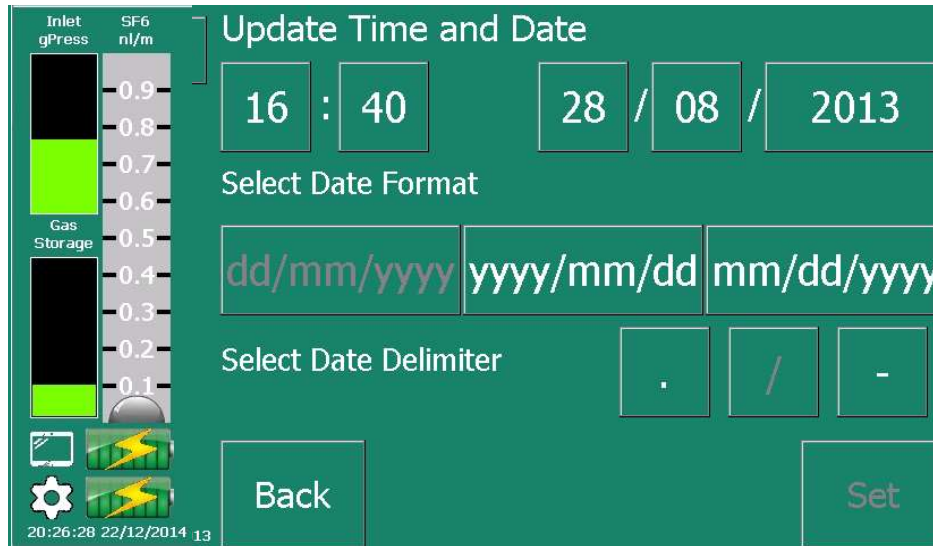
Figure 45: Use this screen to set the date and time and how it should be displayed on the main screen.

7.9 Passwords

Default password USER = 2222
Default password ADMIN = 8888

Various levels of password protection can be set allowing access to selected menus and options. This gives the user full flexibility to set the analyser up in a way that restricts access only to sensitive screens and settings if desired. A four digit numerical administrator password is required to enter the password screen. The default admin password is 8888 but this can be changed later:
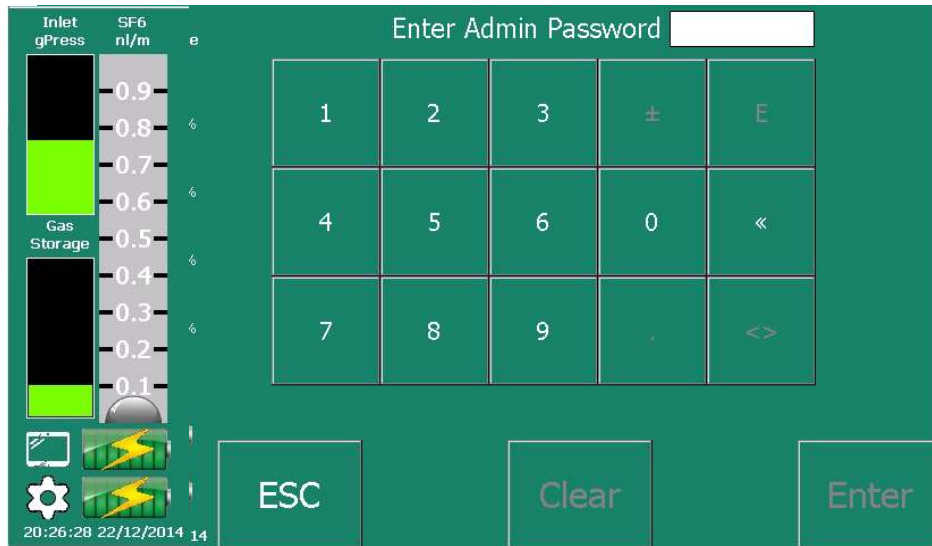
Figure 46: To enter the password menu the user must enter the Admin password. The factory default is 8888.

Once you have entered the password menu as the Administrator then you can set the restrictions and change the passwords as you so desire. There is an Admin password (used to enter only the password screens) and a user password (used to access menus and options on the analyser). The default factory user password is 2222. Once a menu is set to "User" a padlock symbol will appear on the button and to continue the user password will need to be entered to gain access.
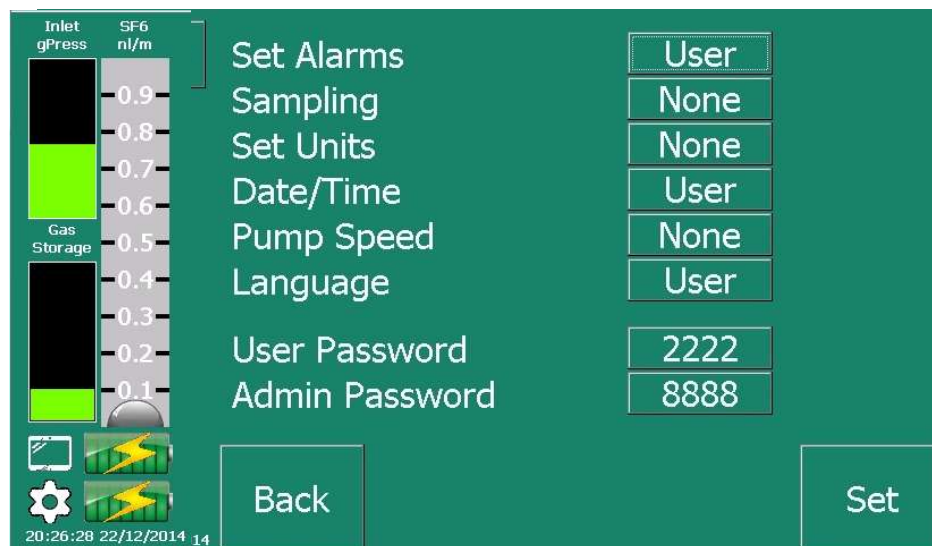
Figure 47: The password administration screen allows sensitive menus to be locked with a user password.

Figure 48: Once a password is enabled the user password will have to be entered to gain access to the menu button that is locked.

Press "Set" to store the new settings. Please contact SMC for advice about how to recover a lost Administrator password.

8 Options Menu System

The Options Menu displays various settings that the user may use to set the analyser up initially. Also included here are some diagnostics and other system tools. The "Data Transfer" button remains grey until you insert a memory stick into the socket (8) as shown in Figure 49. If padlocks are displayed then these options are password protected. See 7.9 for more information on passwords.
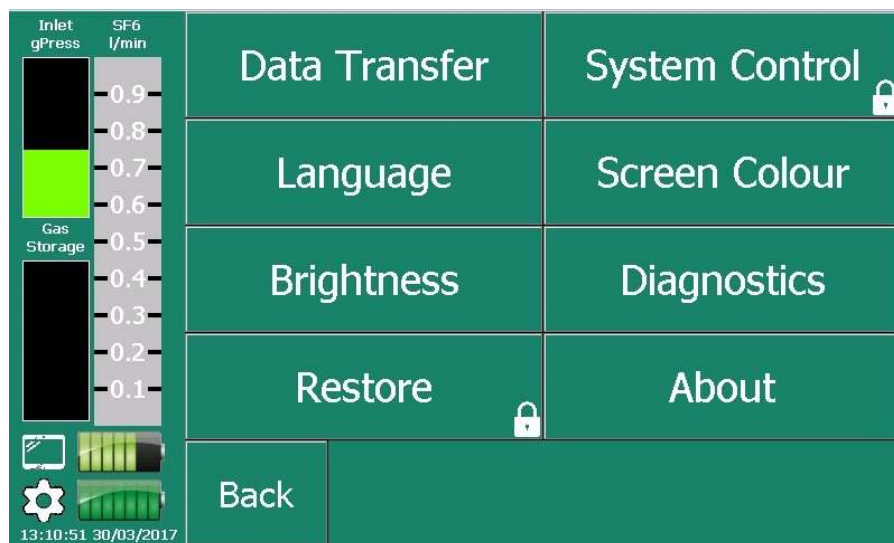
Figure 49: List of options Menu. The "Data Transfer" option remains grey until a suitable USB memory stick is attached.

8.1 Data Transfer

Use this function to transfer results and sample data onto a memory stick and view with Excel or similar programs. The memory stick should have sufficient space available to transfer the files selected. A warning is given if there is insufficient space.

Select a start data and end date of interest and the size of the files to be transferred will display. Press "Copy Results" to transfer just the basic results of each test (as printed) or "Copy Data" to transfer the complete data log file.
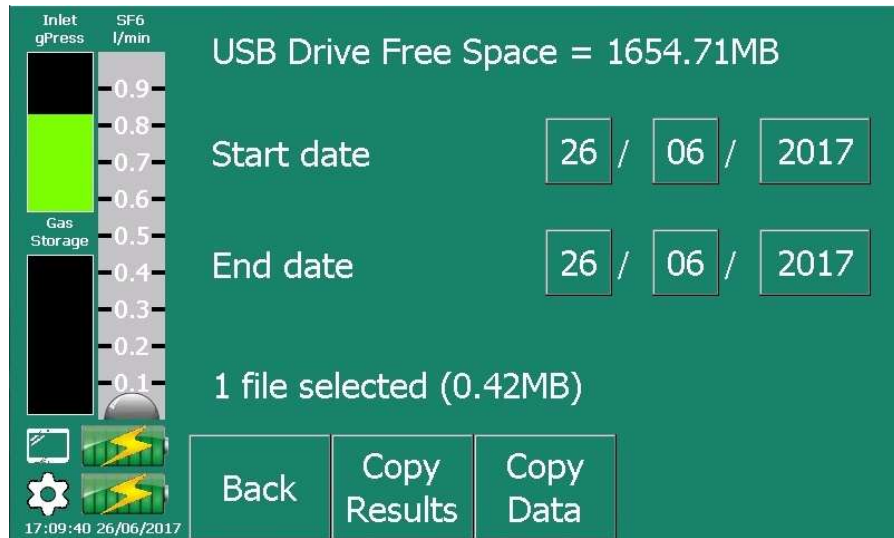
Figure 50: Use this screen to select the range of data to transfer onto your memory stick

Figure 51: Press "Copy" to begin the transfer. Do not remove the memory stick until told to do so.

Figure 52: It is now safe to remove the USB memory stick.

The individual results file is in csv format that can be opened directly into Excel. Each test is listed in order of date and time and each sensor result is placed on an individual row:

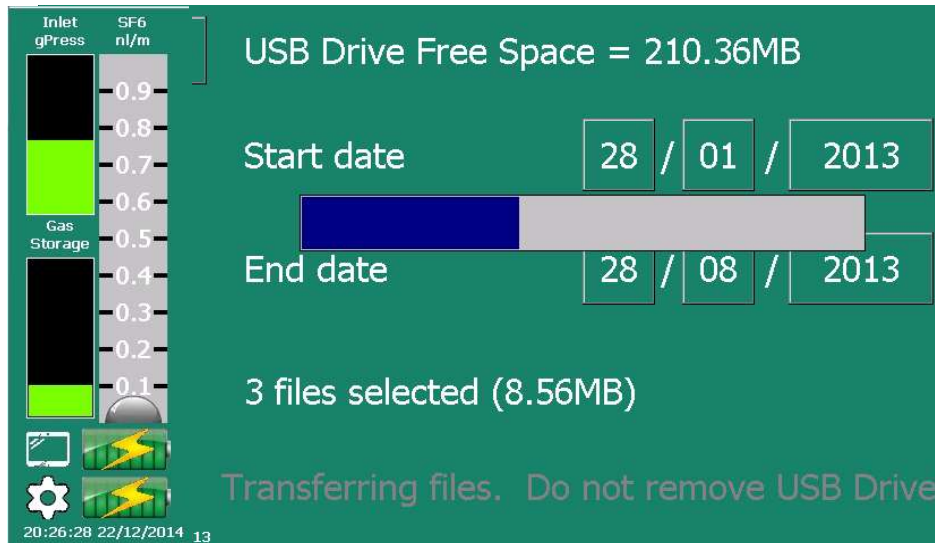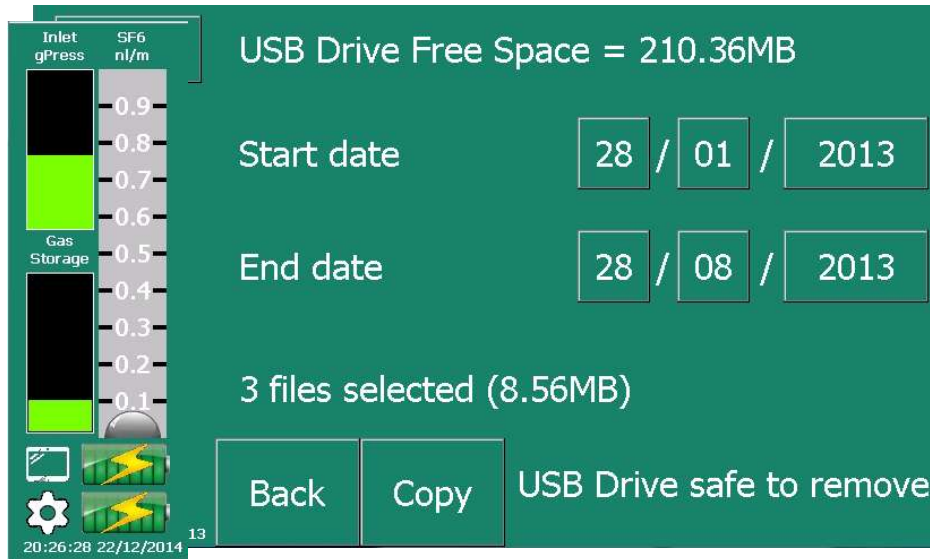|	A	B	C	D	E	F	G	H	I	J	K
1	Date	Time	SF6(%)	H2O(Deg.Cdp)	SO2(ppm)	H2S(ppm)	HF(ppm)	Inlet gPress.(mbar)			
227	08/04/2018	13:19:44	96.3	16.2	0	0	0	6909.08			
228	08/04/2018	13:19:46	96.32	16.2	0	0	0	6909.87			
229	08/04/2018	13:19:47	96.35	13.02	0	0	0	6910.67			
230	08/04/2018	13:19:47	96.37	13.02	0	0	0	6911.46			
231	08/04/2018	13:19:49	96.4	12.55	0	0	0	6911.46			
232	08/04/2018	13:19:50	96.42	12.55	0	0	0	6910.67			
233	08/04/2018	13:19:50	96.44	12.55	0	0	0	6909.87			
234	08/04/2018	13:19:51	96.46	12.55	0	0	0	6909.87			
235	08/04/2018	13:19:53	96.47	12.55	0	0	0	6909.87			
236	08/04/2018	13:19:53	96.49	12.55	0	0	0	6909.87			
237	08/04/2018	13:19:54	96.52	11.33	0	0	0	6909.87			
238	08/04/2018	13:19:56	96.54	11.33	0	0	0	6909.08			
239	08/04/2018	13:19:57	96.56	11.33	0	0	0	6909.87			
240	08/04/2018	13:19:58	96.57	11.33	0	0	0	6909.87			
241	08/04/2018	13:19:58	96.59	11.33	0	0	0	6909.87			
242	08/04/2018	13:19:59	96.61	10.25	0	0	0	6909.87			
243	08/04/2018	13:20:01	96.63	10.25	0	0	0	6909.08			
244	08/04/2018	13:20:02	96.65	10.25	0	0	0	6909.08			
245	08/04/2018	13:20:03	96.66	10.25	0	0	0	6909.08			
246	08/04/2018	13:20:04	96.68	9.35	0	0	0	6909.08			
247	08/04/2018	13:20:04	96.7	9.35	0	0	0	6909.08			
248	08/04/2018	13:20:05	96.72	8.96	0	0	0	6909.08			
249	08/04/2018	13:20:07	96.74	8.96	0	0	0	6909.87			
250	08/04/2018	13:20:08	96.76	8.96	0	1.04	0	6909.87			
251	08/04/2018	13:20:09	96.78	8.42	0	1.04	0	6909.87			
252	08/04/2018	13:20:09	96.79	8.18	0	1.04	0	6909.87			
253	08/04/2018	13:20:10	96.81	8.02	0	1.04	0	6909.08			
254	08/04/2018	13:20:11	96.82	-16.06	0	1.07	0	6909.08			
255	08/04/2018	13:20:13	96.84	-14.05	0	1.07	0	6909.08			
256	08/04/2018	13:20:14	96.85	-14.61	0	1.07	0	6909.08			
257	08/04/2018	13:20:15	96.86	-15.35	0	1.07	0	6909.08			
258	08/04/2018	13:20:16	96.88	-16.07	0	1	0	6909.08			
259	08/04/2018	13:20:17	96.89	-16.79	0	0	0	6909.08			
260	08/04/2018	13:20:17	96.9	-17.49	0	0	0	6909.08			
261	08/04/2018	13:20:18	96.92	-18.19	0	0	0	6909.08			
262	08/04/2018	13:20:19	96.93	-18.9	0	0	0	6909.08			
263	08/04/2018	13:20:21	96.94	-19.55	0	0	0	6909.08			
264	08/04/2018	13:20:22	96.96	-20.16	0	0	0	6909.87			
265	08/04/2018	13:20:23	96.97	-20.72	0	0	0	6909.87			

Figure 53: Basic test results downloaded from the Rapidox are easily imported into an Excel spread sheet.

The complete data log files are also in csv format and can be opened directly into Excel. This time the tests can be re-graphed as shown in Figure 54 using the functions available in Excel.
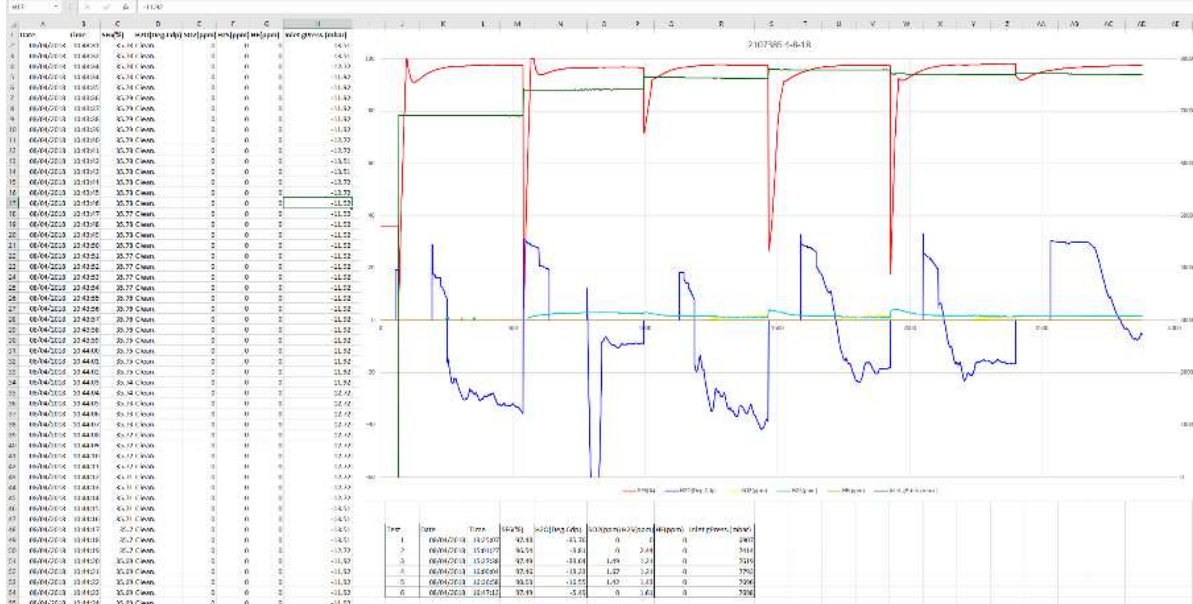
Figure 54: Data from the Rapidox is easily imported into an Excel spread sheet.

8.2 System Control

This options menu is used to set how the line purge and pump back operates and to manually allow a purge of the complete system. As a complete system purge can involve releasing small amounts of SF_6 into the atmosphere if precautions have been ignored it is generally a password controlled menu option.

Figure 55: For analysers with CF_4 option enabled this is what is displayed

Figure 56: For analysers NOT fitted with CF4 option this is what is displayed.

Pressing "System Purge Now" will perform a complete vacuum purge of the analyser including all pipework, sample hose and gas storage bag. This is normally only required if the analyser has just been calibrated and the user needs to purge the system of calibratio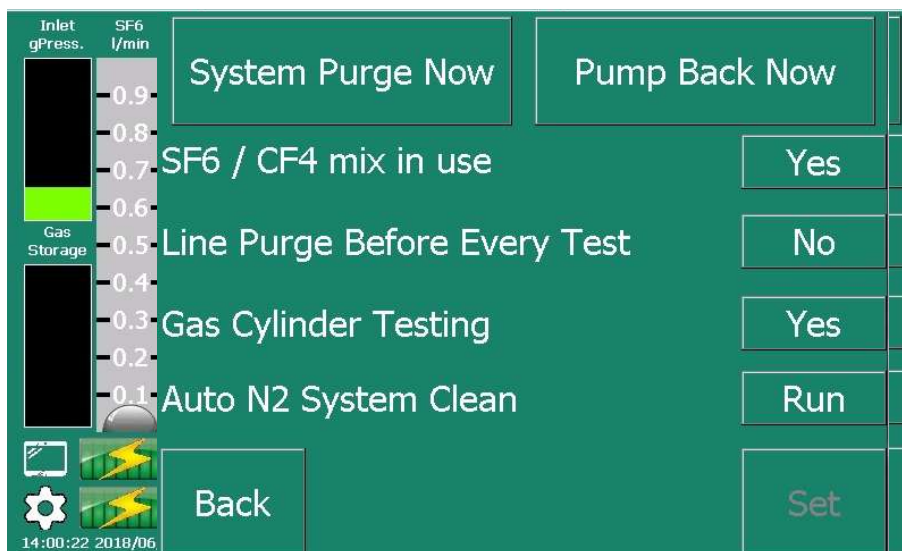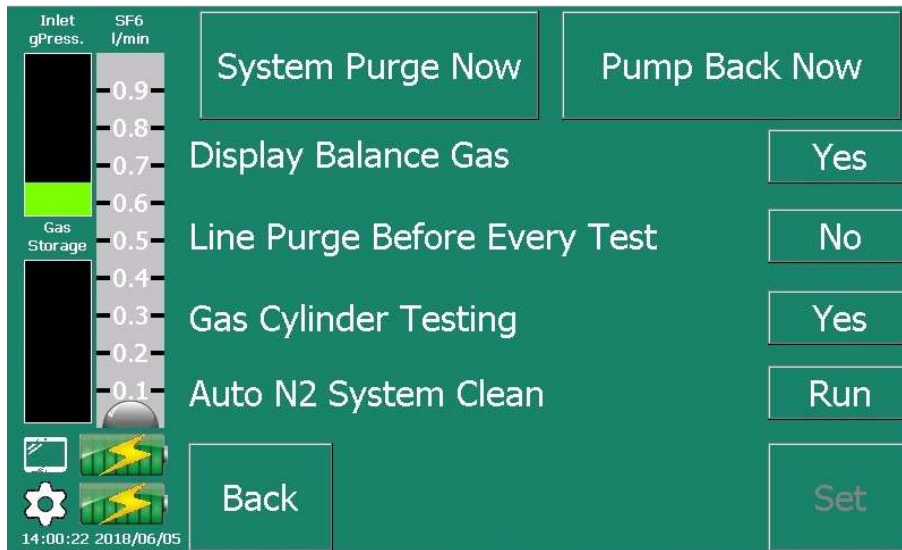n gas, or contaminated gas has been allowed to enter the machine. Once purged the analyser is ready to take gas samples again.

Pressing "Pump back now" manually operates a pump back cycle. This option is also available from the main display window. Once pressed the analyser will prompt you to connect the sample line to the gas compartment and begin pumping back. Depending on the pressure in the gas compartment and the volume of gas in the bag the pump back cycle can take up to five minutes to complete.

"SF6 / CF4 mix in use" enables or disables the CF_4 measurement mode. This function requires a system reboot and is described in detail in section 6.9 above.

"Display Balance Gas" changes the main display so that the missing balance is shown as either nitrogen or air. This function requires a system reboot and is described in detail in sections 6.7 & 6.8 above.

The option to set a line purge before every test should be set to "no" unless instructed otherwise by SMC.

8.3   Gas Cylinder Testing

The "Gas Cylinder Testing" option is used when you want to use the analyser with a gas bottle of SF_6 rather than a switch gear or circuit breaker. With this option set to "Yes" the

analyser will accept gas directly from a gas bottle fitted with a regulator. A small gas cylinder icon ![cylinder] is displayed on the main screen to indicate this mode is in operation.

When sampling directly from gas bottles, it is normal for the regulator pressure to drop momentarily when the test begins and in "normal" mode this can cause the Rapidox to stop the test. In this cylinder mode, pressure drop monitoring is suspended making it easier to sample directly from a bottle.

Note that in normal circumstances you cannot pump back directly into a gas cylinder unless the internal cylinder pressure is below 10 bars. Auto pump back should normally be disabled in this case.

8.4   Auto N_2 System Clean

On occasions where the gas analyse has become contaminated with toxic gases such as SO_2, H_2S, CO or HF, or the sample was excessively wet, this N_2 System Clean mode allows the entire analyser to be purged with bottled nitrogen to clean and dry it. Using this mode the user is instructed to attach a cylinder of nitrogen and the unit will then run automatically until all readings on the toxic gas sensors have reached zero once again. Nitrogen is fed into the storage bag until it is full and then the gas is purged out of the instrument via the bypass port using the pump. The auto clean mode will repeat itself up to a maximum of XXX times if necessary.

8.5   Language

The default language is set to English but the user can change the screen language to Spanish, French, German, Chinese (Simple or Traditional), Korean, Turkish or Portuguese. Note that the analyser will request a system reboot if a different language is selected.

Figure 57: Use this option to change the language setting of the analyser. Requires a system re-boot. Not all options are shown on this screen

Figure 58: The analyser will ask you to confirm you really want to change the language before performing a re-boot.

8.6 Screen Colour

There are several choices of screen colour and two choices of text colour (black or white). Use the menu below to change the colours to your preference.
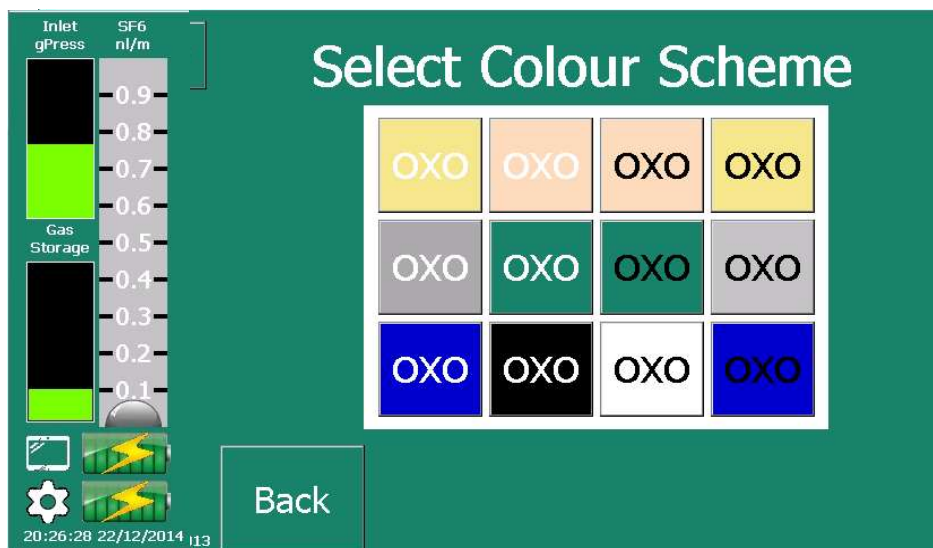

Figure 59: Use this option to change the colour scheme of the display

8.7 Screen Brightness

The brightness of the screen can be increased or decreased using this menu option. The screen brightness does have a significant impact on the battery life of the instrument.

There is also a screen saver option that can be enabled or disabled to help increase battery life. The screen will darken when the saver is active. The user can select a delay time in minutes before the screen saver switches on. The minimum time that can be set is one minute.

Use this screen to change the brightness level. The value will be stored until changed again.
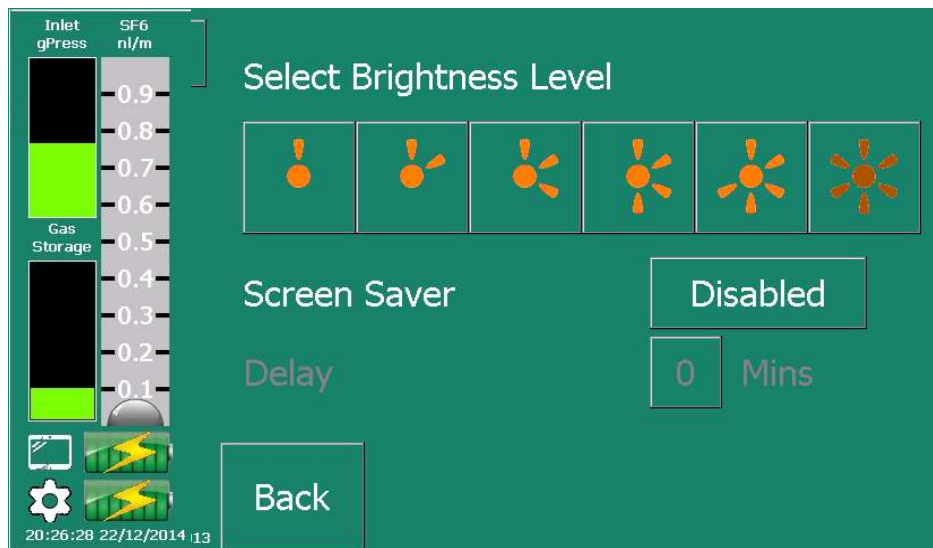

Figure 60: Use this option to adjust the screen brightness and screen saving feature.

8.8 Diagnostics

The diagnostics page provides information that is useful to SMC when diagnosing problems with sensors or calibrations. The screen also displays readings from internal pressure sensors and the battery. Please note that the screen is provided for information purposes only.
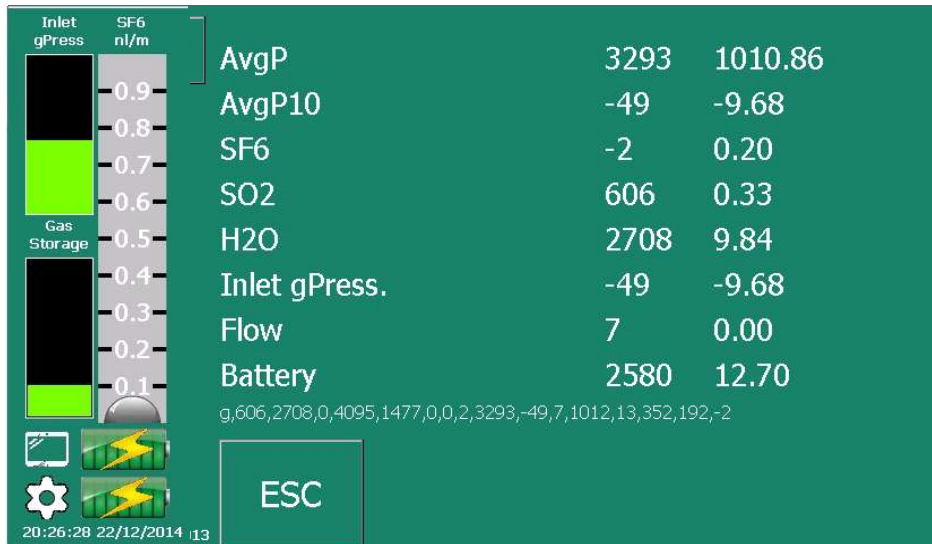
Figure 61: Diagnostics Page

8.9 Restore

This screen can be accessed and used to perform a factory restore of the analyser. In normal circumstances this would only be required is the user is experiencing difficulties with a calibration. Note that all data is lost during a factory restore and the sensors will require a fresh calibration afterwards as only a basic calibration is loaded. The analyser will ask you to confirm that you really do want to restore the machine and will reboot once this has been completed.

Figure 62: Use this option to perform a system restore.

8.10 About

This screen is for information purposes only and shows the configuration of the analyser including sensors and their ranges.

Figure 63: This screen shows important system information about the analyser and sensors connected.

9 Troubleshooting

Q: When I switch on the unit the SF_6 sensor display says "Wait".
A: The infra-red SF_6 sensor needs a bit of extra time to warm up before it can give readings. The Rapidox waits for an internal signal coming from the sensor to say it is ready before 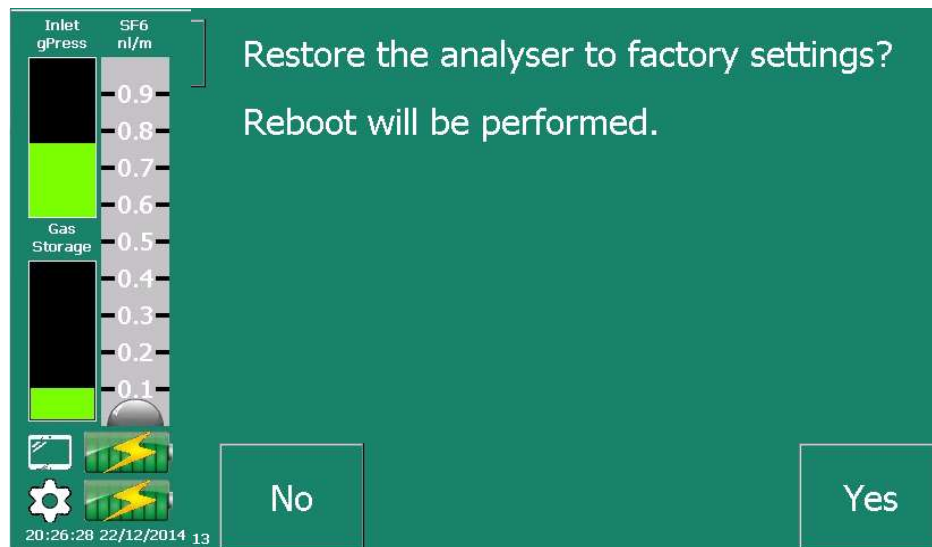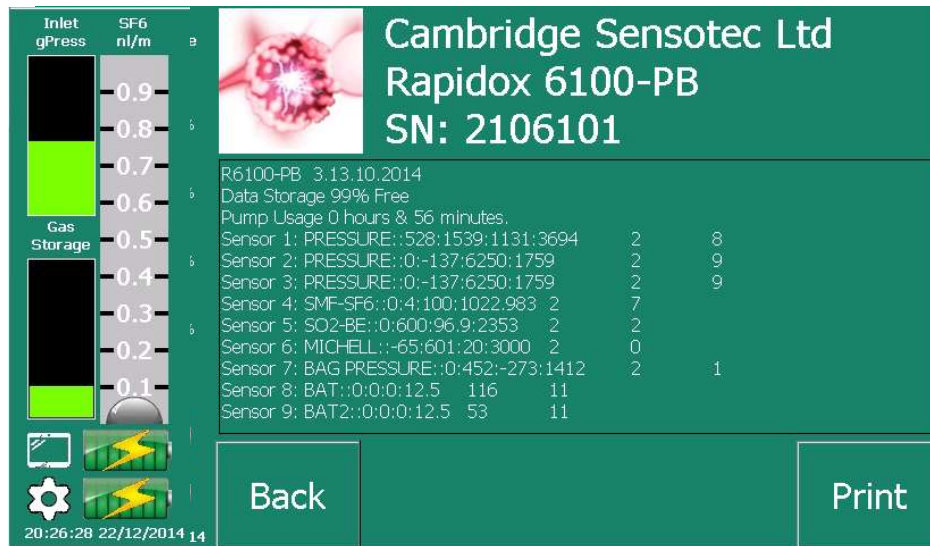displaying readings. This should take around sixty seconds to complete. If the "Wait" message does not clear please contact us for advice.

Q: When I start the machine I get a "Hardware Error Fault" message.
A: Very occasionally when the battery has been allowed to run very flat the start up voltage isn't quite enough to get the sensors re-started and this message can display. To fix the problem try switching the unit off and removing the fuses for ten seconds and refitting. Restart the analyser and in nearly all cases it will reboot correctly.

Q: One or more of the sensor readings is flashing.
A: The reading flashes if the value has gone above 101% of full scale and is to warn you that the reading / calibration is just out of calibration spec. Please contact us for advice

Q: I see other messages such as "O/Range" or "U/Range" instead of the gas reading.
A: This message displays if the reading goes above 102% or below 0%. This is usually caused by a bad calibration Try recalibrating the sensor in question once more, making sure that a sensible flow and pressure are being used. If all else fails try restoring the analyser back to factory setting (see 8.9 for details). Contact SMC if the message refuses to clear.

Q: The H_2O sensor reading shows "U/Range" right after I perform a line purge.

A: This is quite normal and caused by the fact the dewpoint sensor is sitting in a vacuum. Because of the pressure compensation maths the reading can be pushed below its minimum for a moment but this will fully recover once pressurised compartment gas is applied.

Q: After a few minutes of testing the unit stops with question marks displayed.

A: Are you testing gas from a bottle? If you are, please check to see if you are using "Gas Cylinder Mode". The pressure in certain gas cylinders can drop a little during testing and normal mode is very sensitive to this for safety reasons. Gas Cylinder mode should be used in this case and the warnings should stop.

Q: One or both of the red charging lights is flashing on the top of the unit

A: If this happens then it means that the battery is too hot to charge. It is a safety feature to make sure the lithium batteries don't get damaged. If you are in a hot location >30C then move the unit to somewhere cooler to charge – e.g. an air conditioned office.

Q: One or more of the sensor readings says "Fault"

A: Please contact SMC for further advice.

Q: The Rapidox won't power up at all.

A: If the battery is flat then please connect the mains IEC cable and leave the unit to charge for five to six hours. Note that you can use the analyser whilst it is charging. The red LED should change to orange (almost fully charged) to green (fully charged).

Q: The Rapidox still won't power up at all.

A: Please check that the two fuses located on the side are fitted and not blown. This fuses are different and must not be installed the wrong way around. See **Error! Reference source not found.** for correct fuse values.

Q: I get a "Sensor out of Range" warning when I try to calibrate

A: Check that the calibration gas value on the bottle matches the value you have programmed into the Rapidox. If they are different then the Rapidox will get a signal it is not expecting and try to warn you with this message. Check that you are not trying to calibrate the sensor 'backwards' by applying span gas when you are setting the zero point.

Q: I messed up the calibration procedure and the analyser is not working properly.

A: Return the box to the factory defaults using the instructions given in section 8.9 and try again.

Q: I'm working in a location that has CF_4 but can't get the CF_4 to display.

A: This option must be enabled by the user and the machine re-booted. Please make sure that the gas does indeed have a blend of SF_6 & CF_4 before enabling. If you use

this mode without CF_4 present, then the results will be inaccurate.

Q: The SF_6 reading seems very inaccurate

A: Please check the settings MENU – SAMPLING and check to see if the CF_4 option is set to yes or no. If it is set to yes and there is no CF_4 in the gas then the SF_6 reading will be inaccurate. If everything seems normal, then please contact SMC for advice.

Q: The cooling fan seems to operate even though it is cold?

A: The cooling fan is set to operate each time a sample is taken to make sure no SF_6 gas leaks into the peli-case. Any build-up of SF6 inside the peli-case from external sources can cause errors on the measurements. The fan also runs for five minutes each time the unit is powered on.

Q: My storage bag says it is full before the 8 minutes are up!

A: The storage bag is five litres in capacity so at normal atmospheric temperature and pressure there is at least ten minutes of storage space in the bag. So, in normal circumstances you should never see a "Bag Full" message. However, since the flow rate is based on gas density in exceptional circumstances it may be possible to fill the bag too quickly: eg if the gas changes from SF6 to N2 very quickly during the test. Also, in extreme weather conditions the volume of gas in the bag may be too big even if the gas flow was correct. And the gas bag full may appear if calibration takes longer than eight minutes. If the problem persists there may be an issue with the calculated flow rate so please contact SMC for advice.

Q: Why does the sampling need to take eight minutes?

A: The Rapidox uses a special polymer dewpoint sensor to give high speed and reliable dewpoint measurements. Normally these take hours to stabilise, but this sensor is exceptionally fast. However, all dewpoint sensors are susceptible to drift so this unit re-calibrates itself at the start of every test. This takes four to six minutes to complete and we then need another two minutes to get a settle reading from it. So it really has to be eight minutes to get a decent dewpoint measurement.

Q: Why do the dewpoint graph traces have such strange patterns?

A: The dewpoint sensor takes 4-6 minutes to clean and is off-line during this time. So part of the trace of the H_2O sensor is zero. After this both pressure correcting maths and a regression algorithm kick in and these both take about thirty seconds of readings before they become stable as they are both rolling averages. The result is that only the last minute or so is a true reflection of the correct dewpoint.

Q: What is this 20°Cdp corrected function? Surely dewpoint is absolute?

A: Temperature corrected dewpoint seems to be a nonsense because it is an absolute measurement unaffected by the temperature. However, most SF_6 measurements of dewpoint are performed using readings that are corrected somehow to 20°C. In fact, what is happening is that the H_2O is being measured in terms of relative humidity (%RH), which is indeed temperature dependent. The Rapidox dewpoint sensor measures humidity and temperature and then works out the equivalent

dewpoint both at actual temperature (RT) and at the corrected point (@20°Cdp). In hot countries this produces a drier reading and in colder countries this produces a wetter reading. And of course if the ambient temperature is 20°C then the readings are both identical.

Q:	Why does it take several tests before the dewpoint falls to an acceptable level?
A:	This question is the one we get asked about the most. Fundamentally water is a very difficult gas to measure because it absorbs onto every surface and takes ages to completely dry. And all the materials in contact with the gas including the bottle regulators need to be high quality stainless steel or FEP. If you are in a hot and humid country trying to run some tests then you have to accept that the hoses and couplings will be covered in water and this will take a while to dry off completely. If the first one or two tests are too wet but the readings are falling then please repeat the testing a few times to observe a trend of dryness.

10   Warranty

The Rapidox analyser and the sensors have been carefully tested and inspected before shipment and are guaranteed to be free from defective materials and workmanship for a period of twelve months from date of purchase and delivery.   However, if the analysis gas contains corrosive gases or large quantities of particulates, sensor life may be shortened. In the case of the latter, it is normally possible to insert a filter prior to the sensor head to remove the particulate material. Damage caused to the sensors by contamination, chemical attack or water ingress will not be covered by this warranty.

10.1   Conditions of Warranty:

1) This warranty is in addition to and does not affect any statutory rights of consumer purchasers. This warranty is valid worldwide on a "back to base basis".

2) This warranty covers breakdowns due to design or manufacturing faults; it does not apply to damage, however caused, wear and tear, neglect, unauthorised adjustment or repair, or any items of limited natural life.

3) In the event of failure, please take the following action:

a] Refer to the "Troubleshooting" section of your instruction manual to identify and possibly correct the problem.

b] If the fault cannot be resolved, please contact the SMC service and repair centre at the address given on the cover of the manual.

4) The warranty period applicable shall be 12 months from the date of delivery provided that:

a] Notice in writing of the defects complained of shall be given to SMC (The Seller) upon their appearance, and

b] such defects shall be found to have arisen from the Seller's faulty design, workmanship or materials, and

c] The defective goods shall be returned to the Seller's premises at the Purchaser's expense if so requested by the Seller.

d] Any repaired or replaced goods shall be redelivered by the Seller free of charge to the original point of delivery but otherwise in accordance with and subject to these Conditions of Sale.

e] Alternatively the Seller shall be entitled at its absolute discretion to refund the price of the defective goods in the event that such price shall already have been paid by the Purchaser to the Seller, or, if such price has not been so paid, to relieve the Purchaser of all obligation to pay the same by the issue of a credit note in favour of the Purchaser in the amount of such price.