

# factair

F4500 SAFE-AIR TESTER

OPERATING MANUAL





# Contents

	Page No
<b>Introduction</b>	<b>3</b>
<b>Calibration &amp; Warranty</b>	<b>4</b>
<b>Equipment List</b>	<b>4</b>
<b>1 - Pre Use</b>	<b>5</b>
<b>2 - Start-Up</b>	<b>6</b>
<b>3 - Selecting the test standard and configuring the instrument.</b>	<b>7</b>
<b>4 - Initiating a Breathing-Air Test</b>	<b>8</b>
<b>4.1 - Breathing-Air Tests – Airline up to 10 bar</b>	<b>9</b>
<b>4.2 Breathing-Air Tests - HP systems 200 &amp; 300 bar</b>	<b>15</b>
<b>5 - Continuous Oxygen Reading</b>	<b>18</b>
<b>6 - Exporting Test Results and PC Software</b>	<b>19</b>
<b>Appendix 1 - Helpful Tips</b>	<b>21</b>
<b>Appendix 2 - Draeger Tube Tip Cutter</b>	<b>22</b>
<b>Appendix 3 - Reading the Draeger Oil Impactor and Chemical Reagent Tubes</b>	<b>23</b>
<b>Appendix 4 – Breathing Air Standard</b>	<b>27</b>
<b>Appendix 5 – Breathing Air Quality Testing – Why?</b>	<b>28</b>
<b>Frequency of BA Tests / Recording results</b>	<b>29</b>
<b>A.4.5 Compressed Air for Breathing Apparatus from EN529</b>	<b>31</b>
<b>COSHH L5 Sixth Edition</b>	<b>32</b>
<b>Respiratory Protective Equipment at Work</b>	<b>34</b>

## Introduction

Safe-Air Testers are designed to provide a quick and easy method for carrying out accurate periodic testing of breathing-air supplies. The European Standard for breathing-air quality is EN12021, which should be referred to in conjunction with any overriding national standards.

The F4500 is designed primarily for use on airline systems up to 10 bar but can also test high pressure charging systems when used in conjunction with the F3002 High Pressure Regulator.

The instrument has a colour touch screen display and is supplied in a hard weatherproof case with storage provision for a wide range of accessories and equipment. It is primarily designed to be used from within the case; however the tester can also be removed and operated separately where space is at a premium.

The test is carried out using the Draeger Impactor for oil and chemical reagent tubes for carbon monoxide, carbon dioxide and water\*. These are supplied in packs of 10 per type and the chemical reagent tubes show the degree of contaminant present as a colour change to the crystals that they contain. The extent of this is read against the scale on the tube. For the Impactor the degree of oil contamination is displayed on a screen.

## Calibration and Warranty

Safe-Air Testers leave our factory with a 12-month warranty and calibration certificate. Our standard turnaround on annual calibration is 10 working days providing there is no major damage that requires an extensive rebuild. *(Allow an extra 5 working days for calibration of ED versions.)*

*Note:- Please download all stored data before returning the Tester to Factair.*

### Temperature Parameters

Storage: -20/+50°C                      Operating Range: -10/+45°C

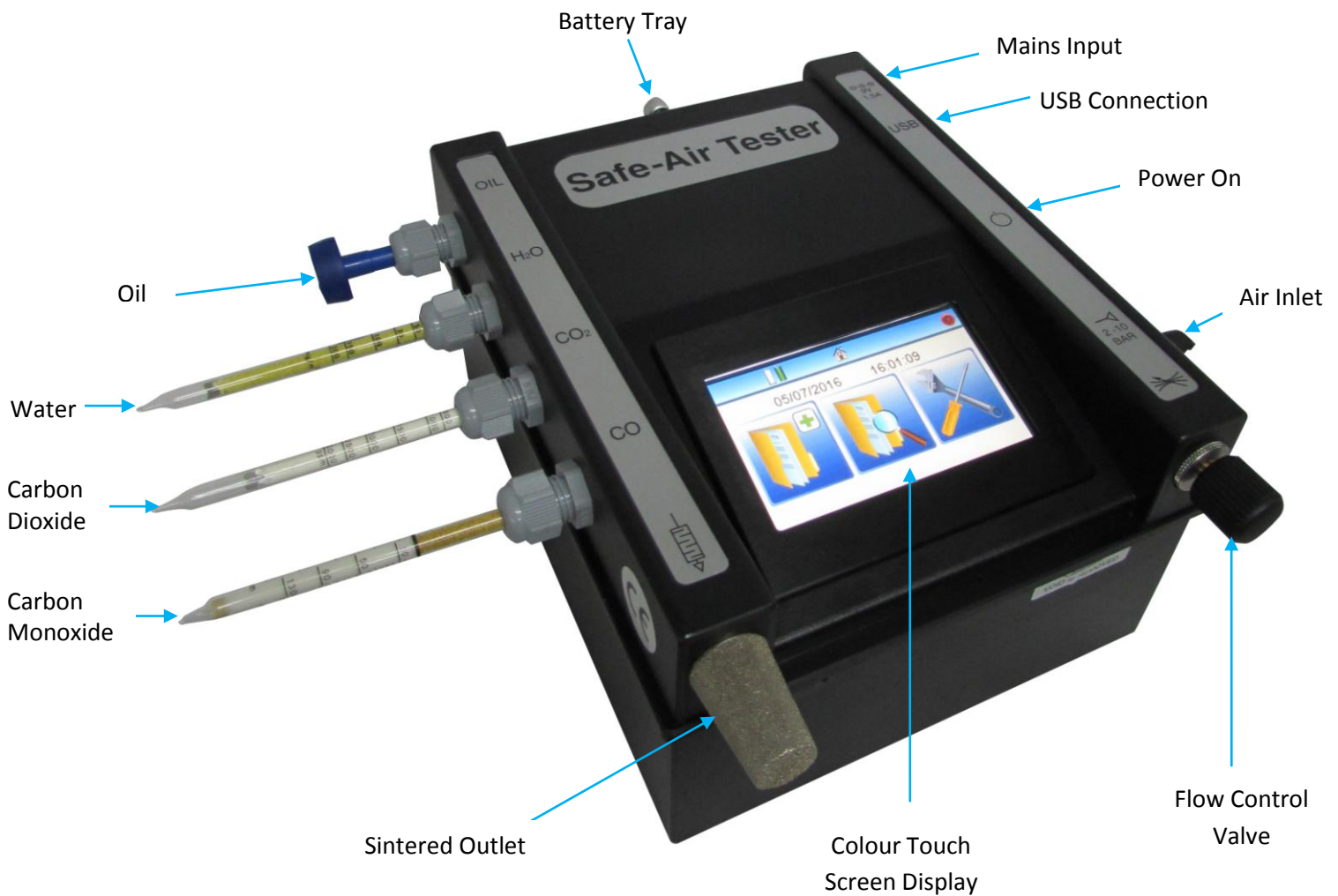
This tester is calibrated for the following approved reagent tubes/Impactor.

H <sub>2</sub> O (Water-reagent tube)*	Draeger ref. 6728531
CO (Carbon monoxide-reagent tube)	Draeger ref. 6728511
CO <sub>2</sub> (Carbon dioxide-reagent tube)	Draeger ref. 6728521
Oil (Impactor) **	Draeger ref. 8103560

*\*Note:- A water reagent tube is not required with the F4500ED which will automatically record the moisture and dewpoint readings*

*\*\*Note:- The tester can also be used with the old type Draeger reagent tube for oil, ref 6728371. (Refer to Appendix 2 at the rear of the manual for instructions.)*

**IMPORTANT – IT IS RECOMMENDED THAT YOUR SAFE-AIR TESTER IS RETURNED FOR RECALIBRATION AND SERVICING WITHIN 12 MONTHS FROM THE ISSUE DATE OF ITS CALIBRATION CERTIFICATE**



**Equipment List:**

- F4500 Multi-Air Tester
- Hard Case
- Mains Power Supply
- USB Memory Cable
- 6 x AA Alkaline Batteries
- Travel Container for used detector tubes
- Tube Tip Cutter
- F2193 Connection adaptor terminating in a CEJN plug
- Stylus Pen

**Optional Extras**

- F3005 20 Bar Regulator
- F3002 200/300 Bar 5/8" DIN thread High-Pressure Regulator

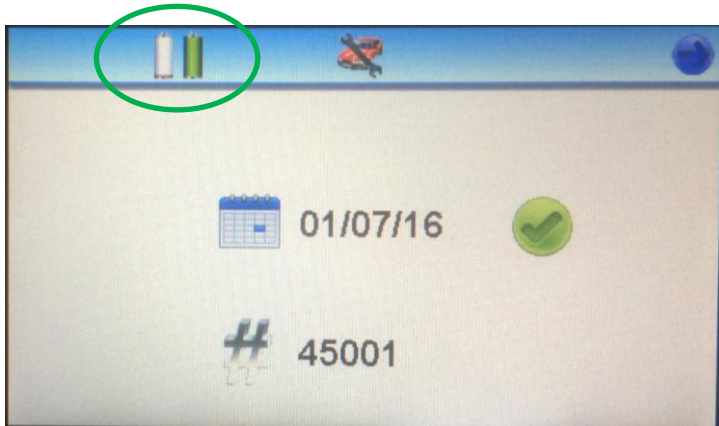
## 1. Pre-Use

F4500 Safe-Air Testers are fitted with internal lithium rechargeable batteries and in addition also have a battery tray which accommodates 6 off size AA alkaline type batteries packed separately and stored underneath the tester within the case. In the event that the rechargeable batteries are not sufficiently recharged then you can continue to use the instrument with either the Alkaline AA batteries or mains power supply.

To install the alkaline AA batteries lift the tester out of its case, open the battery drawer at the rear of the unit and place the batteries inside.

*Note: - It is important to strictly observe polarity when fitting batteries and ensure that they are correctly located.*

During use the battery condition is displayed on the screen as shown below -

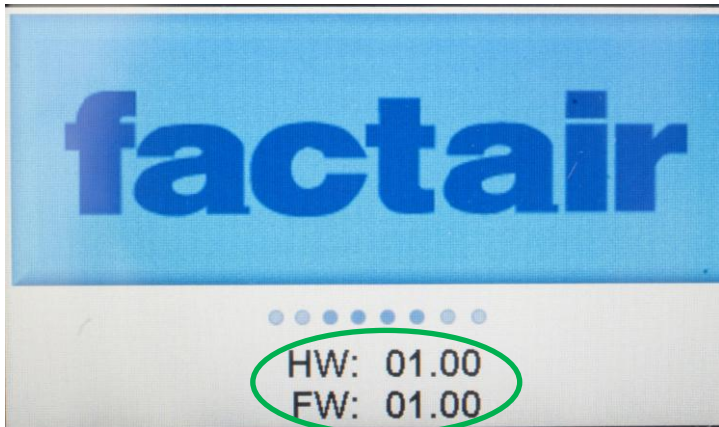


If the tester is to be used adjacent to a power socket, the mains adaptor may be used. Please note the unit should be switched off prior to connection or disconnection of the mains supply.

When connected to a mains power supply the internal lithium batteries will be recharged.

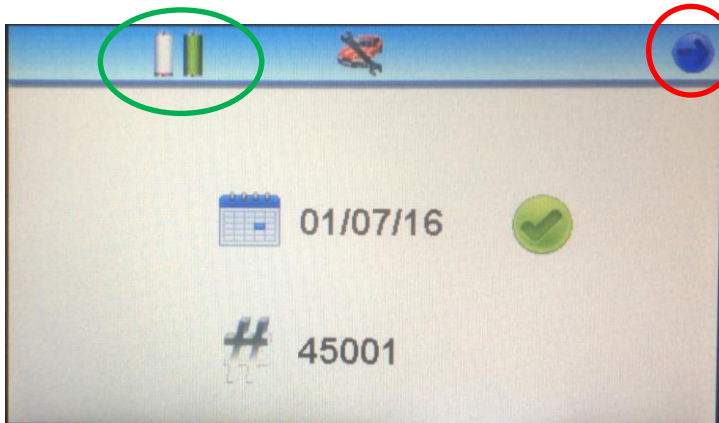
## 2. Start Up

To carry out a test first switch on the machine by pressing and holding the green “on” button, located on the right-hand side of the unit, for approximately 3 seconds.



A splash screen will be displayed which shows the instruments hardware and firmware versions.

Periodically the firmware is upgraded as part of the recalibration process as improvements are identified.

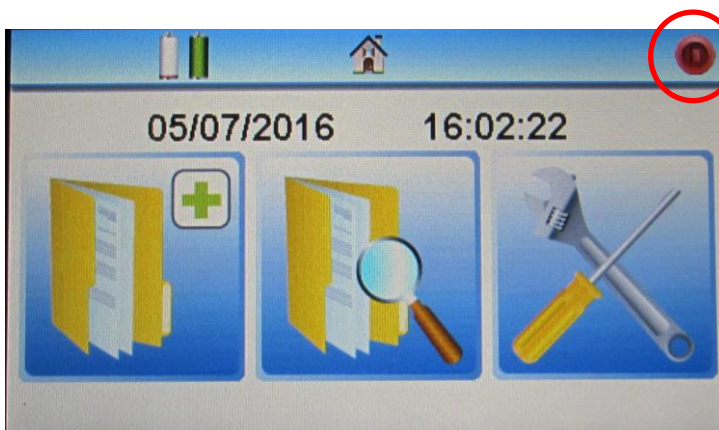


A Stylus pen is provided for use with the touch screen. The display will show the, date last calibrated, serial number and a tick or cross symbol will indicate whether it is within the recommended calibration period.

The F4500 series has 2 battery level displays, the left hand one is for the alkaline AA batteries, if fitted. The right hand one is the rechargeable internal lithium battery. Unless the instrument is connected to a mains power supply the instrument will use the highest of the 2 battery power sources.

Please note if alkaline AAs are inserted whilst the unit is on, their battery level will not be displayed until the unit is turned off and back on again.

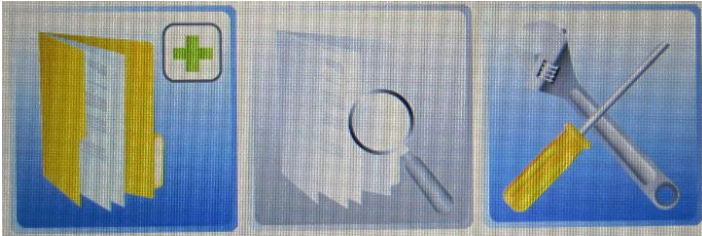
Press the arrow key to progress to the main menu.



The main menu has 3 options available from left to right these are: Begin Test, Review Previous Tests and Set-Up Menu.

Each of these sub-menus are described in further detail below

The instrument can also be turned off from this menu by pressing the red power symbol in the top right hand corner.

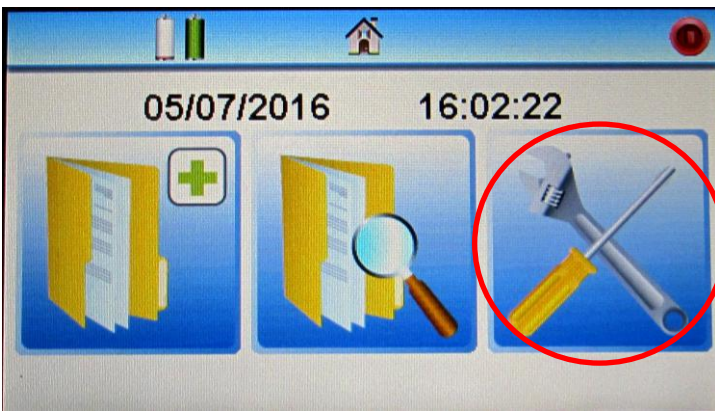


*Note – If the begin test icon is in greyed out this will be because no test results are currently stored on the tester.*

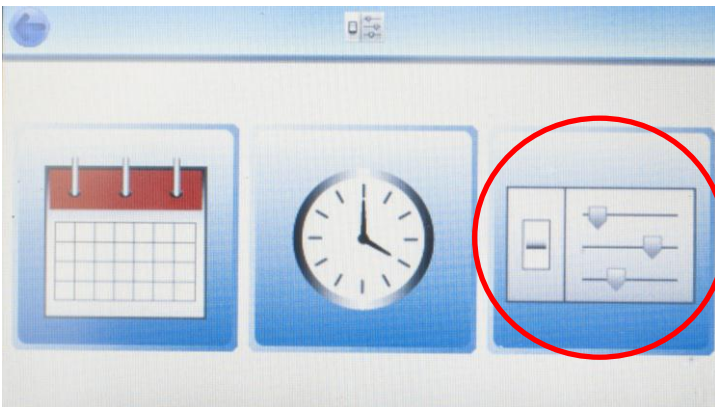


*Note – If the begin test icon is in greyed out this will be because the instrument's memory is full (20 tests maximum) and you need to remove at least 1 test before you can proceed. See Section 4 – Reviewing Test Results for further details.*

### 3. Selecting the test standard and configuring the instrument



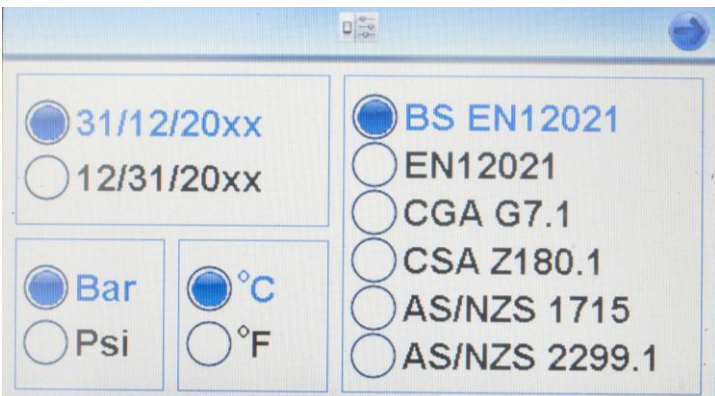
From the main menu press the Configure icon.



In the configuration sub menu there are 3 icons available, from left to right these are:  
 Set Date  
 Set Time (the instrument uses a 24 hour clock)  
 Set units of measure and test standard

The date and time are set prior to the unit being supplied but they can be adjusted as necessary.

To select the test standard or the units of measure press the right hand icon.



In this menu you can then choose date format; pressure and temperature units of measure and the breathing-air test standard.

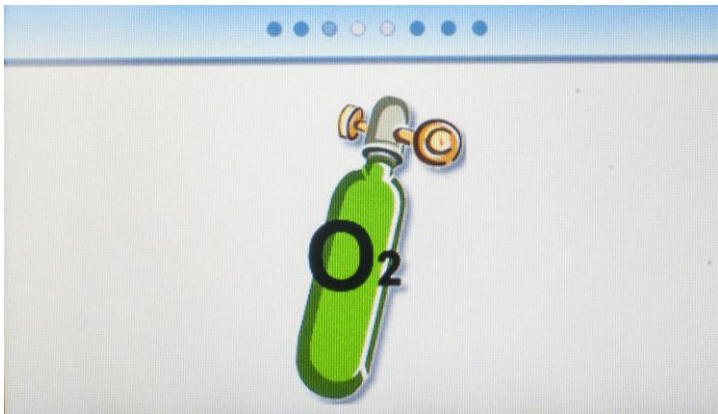
Once you have made your selection press the arrow in the top right corner to exit. To then exit from the configuration sub menu to the main menu press the arrow at the top left of the screen.



#### 4. Initiating a Breathing-Air Test

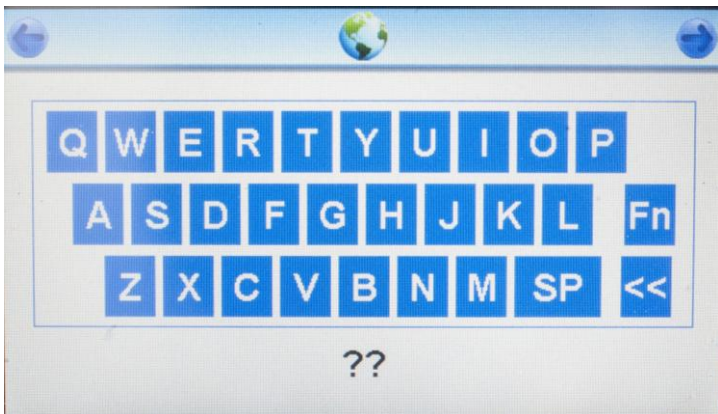


Having selected the breathing-air standard EN12021 in the configuration screen, to carry out a test press the “Begin Test” icon on the main menu

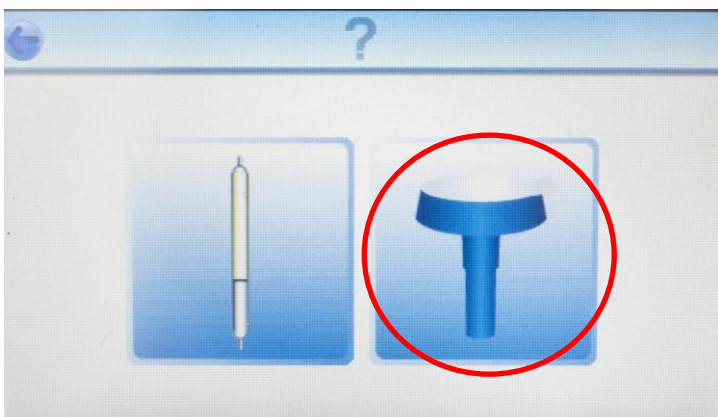


The unit will automatically calibrate the oxygen cell against the surrounding atmosphere; the unit therefore needs to be in a well ventilated area.

*Note:- If the temperature is greater than 40°C inside the instrument the calibration will operate for an extended period to stabilise the Oxygen cell.*



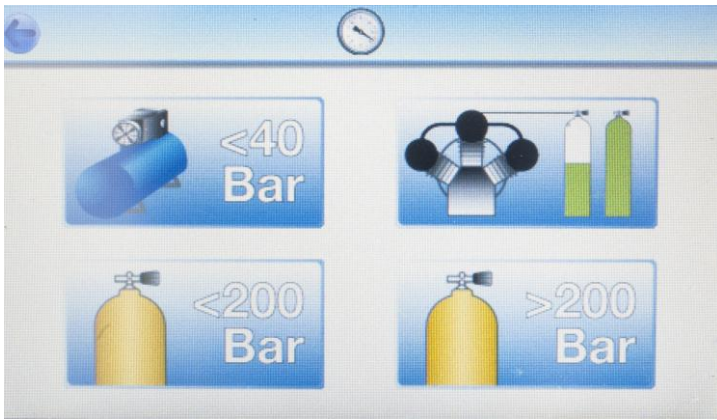
You now have the option of entering a description for the test location, if you wish to use numbers press the “Function” button. Push the right arrow button when you are ready to proceed.



Choose between using a Draeger chemical reagent tube or Draeger Oil Impactor in the test port.

For further details on alternative chemical reagent tubes see appendices 2 and 3.

For breathing-air tests the standard option is to select a Draeger oil Impactor.

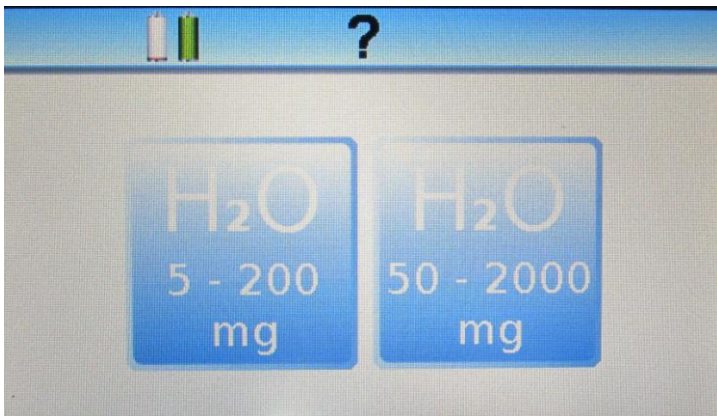


The unit has 4 breathing-air test programmes available: Airline Systems up to 40 bar (top left); High Pressure Charging Compressors (top right) High Pressure Systems up to and including 200bar and High Pressure Cylinders above 200bar. All of the high-pressure tests require the use of the F3002 regulator which has a DIN connector that can accept input pressures up to 300bar.

#### 4.1 Completing an Airline (up to 10 bar) Test



Select (Airline < 40 bar) – note the maximum pressure the instrument is rated to is 10 bar.



The F4500 can be configured with the Draeger 6728531 water tube for 2 different scales. Select the appropriate water range: 5 to 2000 mg/m<sup>3</sup> is for standard airline systems with a fridge dryer or no dryer and 5 to 200 mg/m<sup>3</sup> is for systems incorporating desiccant dryers. Having selected the appropriate range press the arrow key. (This screen will not appear on the F4500ED)



With the flow control valve in the closed position connect to the air supply to be tested. Ideally this should be done by using the hose which normally supplies the breathing apparatus. Fit the appropriate adaptor to the Tester first and then connect the supply hose to the adaptor.

A test can be carried out at any pressure between 2 and 10 bar.

*Note:- If the unit is over-pressurised it will automatically shut down and display an overpressure warning; it will then need to be returned to the manufacturer for checking and resetting.*



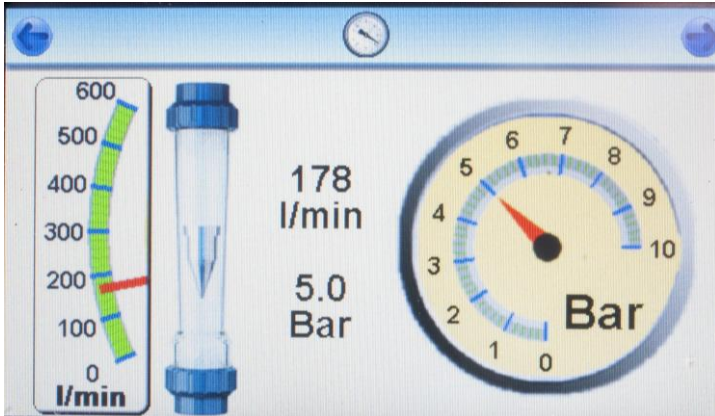
Input pressure will be displayed on the measured pressure bar graph and the adjacent display. System pressure will automatically default to this reading.

*Note:- The pressure dewpoint at the end of the test will be calculated on the recorded system pressure.*

For the majority of applications the system pressure can be left at this default setting, however if the breathing-air system is distributed as breathing air at a different pressure to that being displayed this should be entered at this stage.

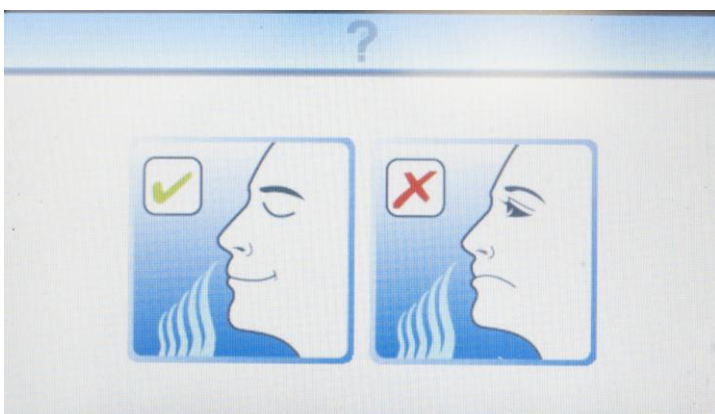
To enter press the right hand side (Set) icon use the keypad to enter the required value, press the right arrow to return. The (Reset) button will automatically reset the system pressure back to the measured pressure.

Press the arrow key to proceed.



We can now confirm the flow and pressure is adequate for your respiratory protective device. Adjust the system's flow control valve so that the flow meter registers the required level\*, check the pressure is sufficient for the breathing-air equipment being used. It is recommended that this flow is left running for the duration of the test to simulate the conditions of use. Press the arrow key to proceed if the flow and pressure meet the minimum requirements for your RPD.

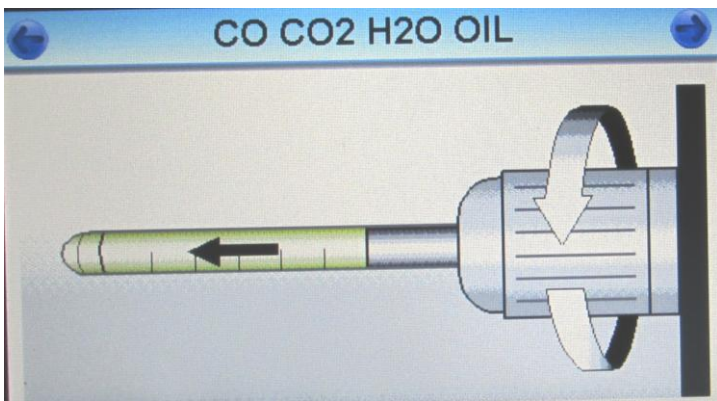
*\*Note:- At high flow rates hearing protection should be considered.*



Carry out the odour test and smell the air exhausted from the sintered outlet. If there is a serious odour problem, fail the sample at this point of the test by pressing the 'fail' button. Initiating flows of seriously contaminated air could result in damage to the instrument. If the odour test is satisfactory, press the 'pass' button.



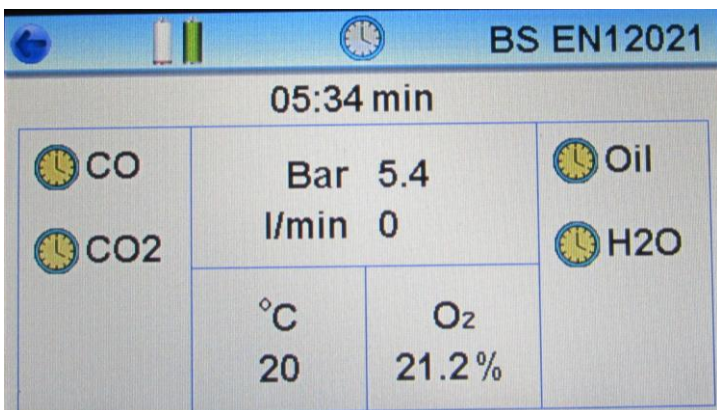
The instrument will now commence a 5-minute purge sequence, during which time an airflow will be passed through the test port and across the electronic cells. This clears contaminants from previous tests and ensures that a representative sample is being tested.



Once the purge has finished, the Water (F4500 only), CO, CO<sub>2</sub> and Draeger Impactor/oil tube should be inserted into the test ports and tightened firmly; ensure the Impactor has an intact protective seal.

This seal must remain in place for the duration of the test.

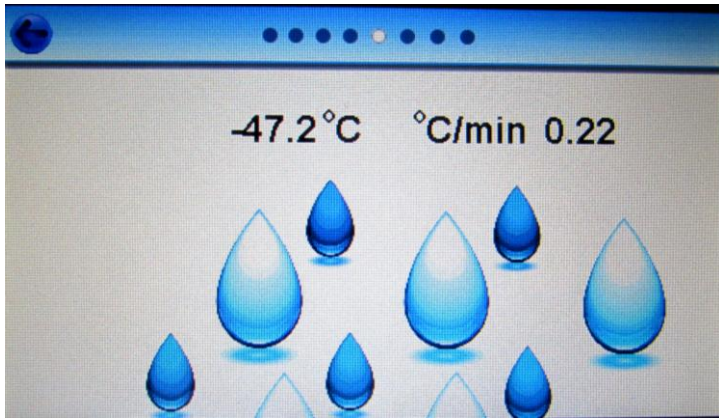
Press the button in top right hand corner to start the test.



The test will now commence and the duration will be displayed as a countdown, together with pressure, flowrate, ambient temperature and oxygen content.

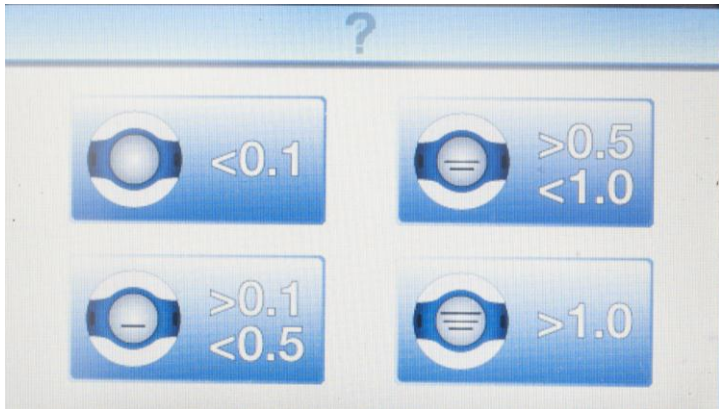
During the test the flowmeter should be set to simulate the requirements of the respiratory protective device RPD.

The unit can be left until the test time has elapsed.



F4500ED only

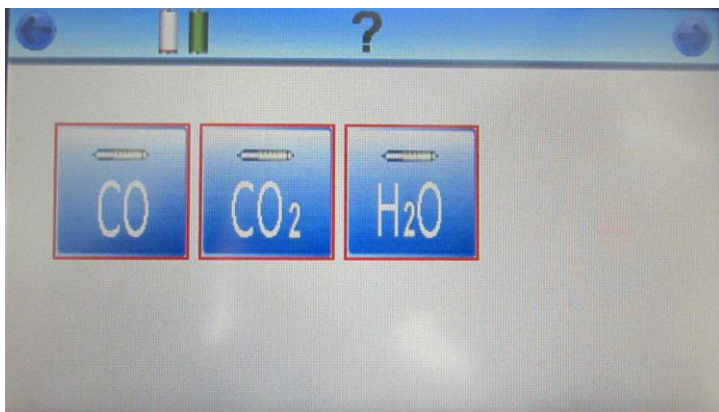
If the instrument detects that the dewpoint meter's rate of change is still too high (>0.2°C per minute) it will automatically continue the test until this stabilises (maximum test time 15 minutes).



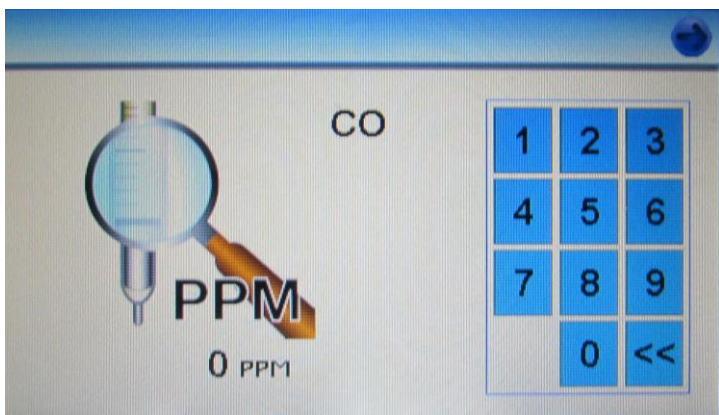
Once the test is complete close the flow control valve, the readings from the Impactor can now be entered.

To enter the results press the corresponding icon on the screen.

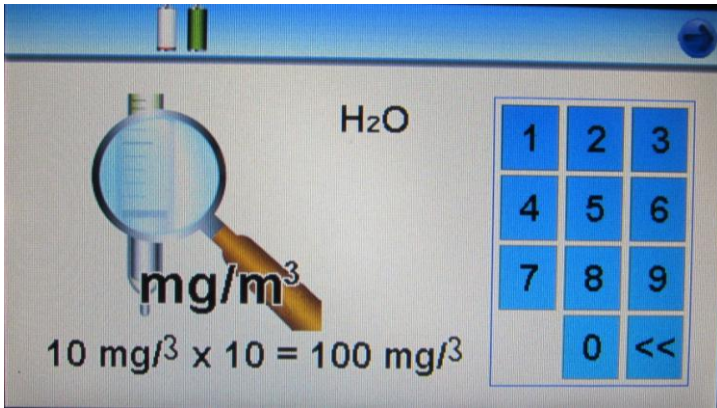
*Note:- Instructions on reading the Impactor can be found in Appendix 3 at the back of the manual.*



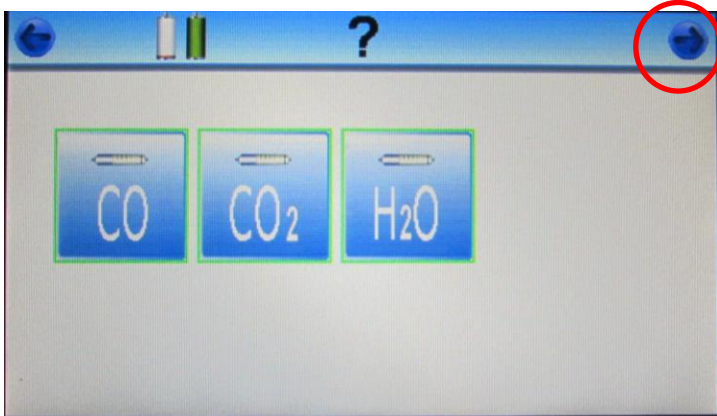
The tube readings should also then be entered, push the button corresponding to each chemical reagent tube.



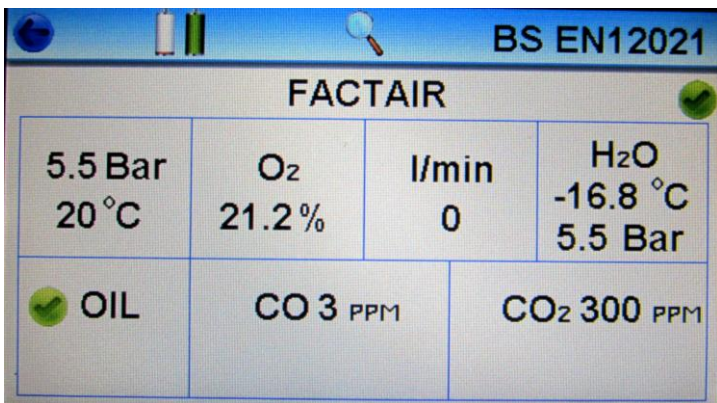
Input the reading from the tube and press the arrow icon in the top right hand corner of the screen.



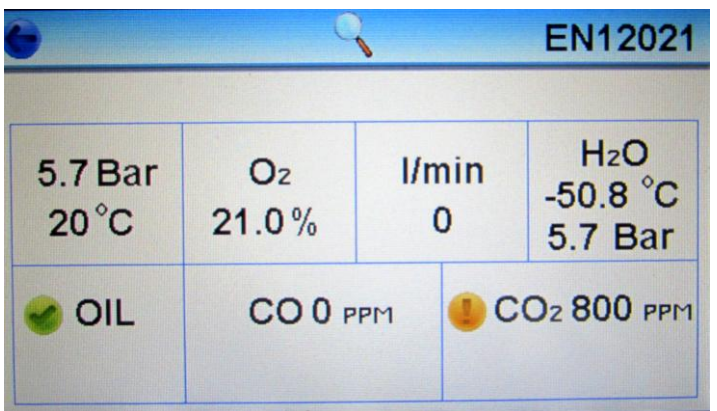
For the water tube reading there is an on-screen prompt if you selected the 50 to 2000mg/m<sup>3</sup> scale to multiply the tube reading by 10 to get the actual result.



As each reading had been entered the input box will turn green, once all the results have been entered press the right had arrow to proceed.



The “test complete” screen displays all the measurements recorded during the test. And automatically determines whether the test was a pass or fail against the standard displayed in the top right corner of the screen. The water content on low pressure tests is displayed as a pressure dewpoint. The test result is recorded in the instrument’s memory, which can store up to 20 previous tests.



If the test was a fail an orange exclamation mark would be indicating those criteria which did not meet the standard. The photograph opposite is an example of a failed test where carbon dioxide failed to meet the requirements of the selected standard.

For airline systems less than 40 bar the pressure dewpoint, i.e. the point at which water will begin to condense into a liquid form in the airline, must be at least 5 degrees centigrade below the lowest temperature at which the system will be used. The F4500 automatically calculates the pressure dewpoint from the measured water content and system pressure, it then compares this to the ambient temperature to determine whether it was a pass or fail.

This test result is automatically recorded in the instrument's memory, which can store up to 20 previous tests. To view these tests return to the main menu and press the "Review Tests" button. Test results are stored accordingly to the date and time they were completed. From this menu previous tests can be viewed or deleted as required.

To disconnect the Tester from the system make sure you leave the inlet adaptor on the instrument and only disconnect at the end of the supply hose. The adaptor can then be disconnected afterwards if required.

To turn off the Tester use the return arrows to return to the main menu screen and press the X in the top right hand corner of the screen.

*Note: - The unit will automatically turn off after a few minutes if left unused at the main menu screen.*

### 3.2 Completing a High Pressure Test

For high pressure tests there are 3 different test options available. All of the high-pressure tests require the use of the F3002 regulator which has a DIN connector which can accept input pressures of up to 300 bar.



High-pressure charging compressors

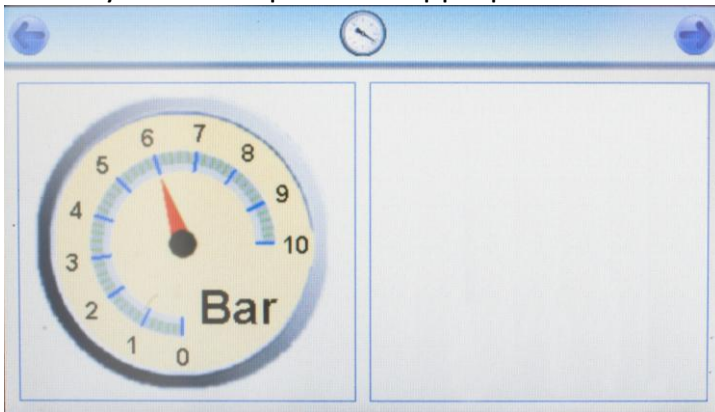
High-pressure cylinder less than 200bar

High-pressure cylinder greater than 200bar

*Note: For cylinder tests please ensure the test is carried out on a recently filled, fully charged cylinder.*

*Note: For the high-pressure charging compressor test a DIN to DIN adaptor ref: F2158 is required to connect the F3002 high-pressure regulator to a charging hose.*

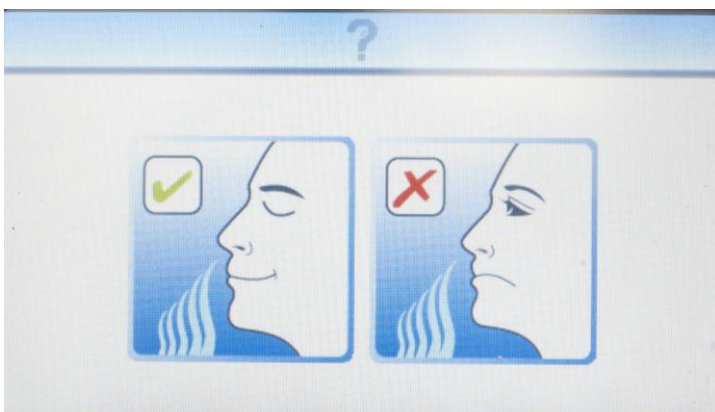
To carry out a test press the appropriate button.



Ensure that the flow control valve is fully closed and then connect the F3002 high-pressure regulator assembly to the cylinder or charging hose to be tested, ensuring that the regulator has the correct type of connector for the cylinder. Connect the regulator hose coupling to both the regulator and the inlet of the Tester.

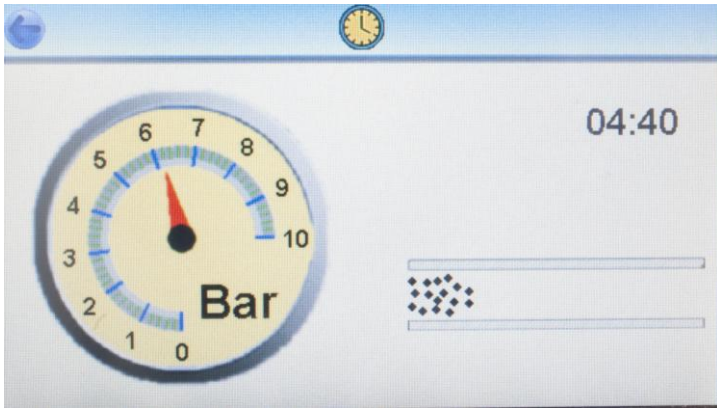
Open the cylinder valve and check that the cylinder is fully charged by reading the contents gauge on the regulator. (A partially discharged cylinder can give an incorrect water result.) The pressure displayed on the tester will be that of the regulated supply from the cylinder and must not exceed 10 bar. Press the button in the top right hand corner to proceed.

*Note:- if the unit is over-pressurised it will automatically shut down and display an overpressure warning; it will then need to be returned to the manufacturer for checking and resetting.*

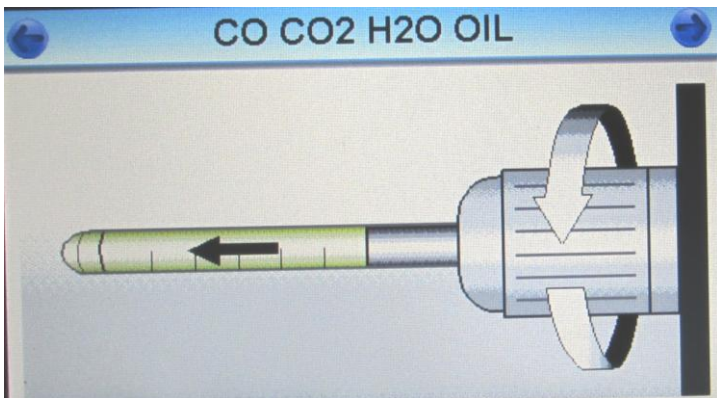


Carry out the odour test by gently opening the flow control valve and smelling the air exhausted from the sintered outlet, then close the valve. If there is a serious odour problem, fail the sample at this point of the test. Initiating flows of seriously contaminated air through the tube ports could result in damage to the unit. If the odour test is satisfactory, press the 'pass' icon.





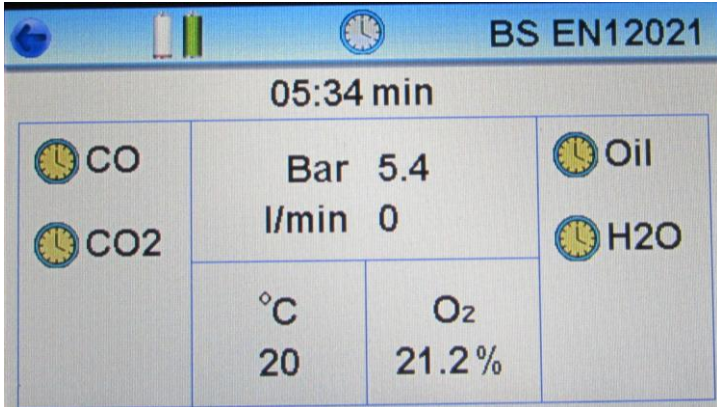
The instrument will now commence a 5-minute purge sequence, during which time an airflow will be passed through the test port and across the electronic cells. This clears contaminants from previous tests and ensures that a representative sample is being tested.



Once the purge has finished, the Water (F4500 only), CO, CO<sub>2</sub> and Draeger Impactor/oil tube should be inserted into the test port and tightened firmly; ensure the Impactor has an intact protective seal.

This seal must remain in place for the duration of the test.

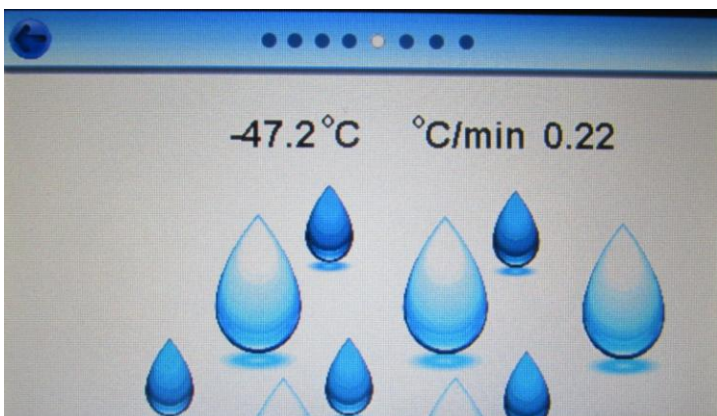
Press the button in top right hand corner to start the test.



The test will now commence and the duration will be displayed as a countdown, together with pressure, flowrate, ambient temperature and oxygen content.

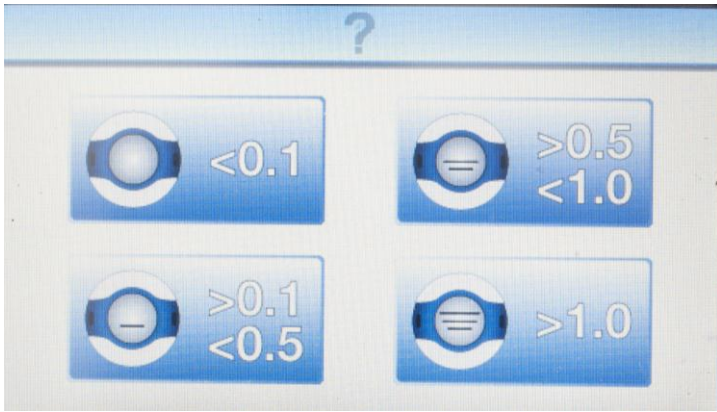
During the test the flowmeter should be set to simulate the requirements of the respiratory protective device RPD.

The unit can be left until the test time has elapsed.



F4500ED only

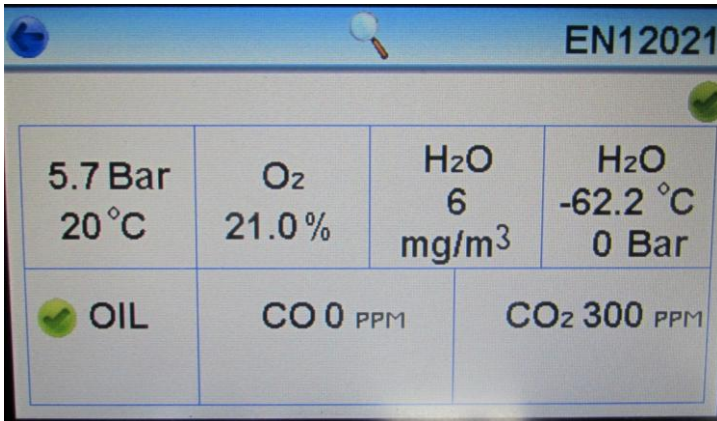
If the instrument detects that the dewpoint meter's rate of change is still too high (>0.2 dec C per minute) it will automatically continue the test until this stabilises (maximum test time 15 minutes).



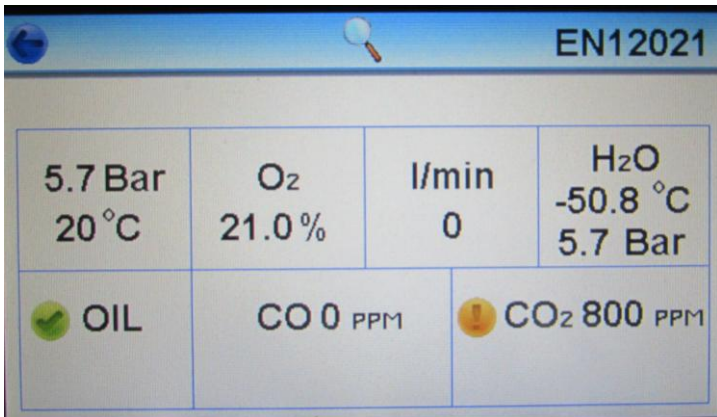
The Impactor can now be removed and evaluated.

To enter the results press the corresponding icon on the screen.

*Note:- Instructions on reading the Impactor can be found in Appendix 3 at the back of the manual.*



The “test complete” screen displays all the measurements recorded during the test. And automatically determines whether the test was a pass or fail against the standard displayed in the top right corner of the screen. For water content on high pressure tests both the measured value in mg/m<sup>3</sup> and the atmospheric dewpoint are provided.

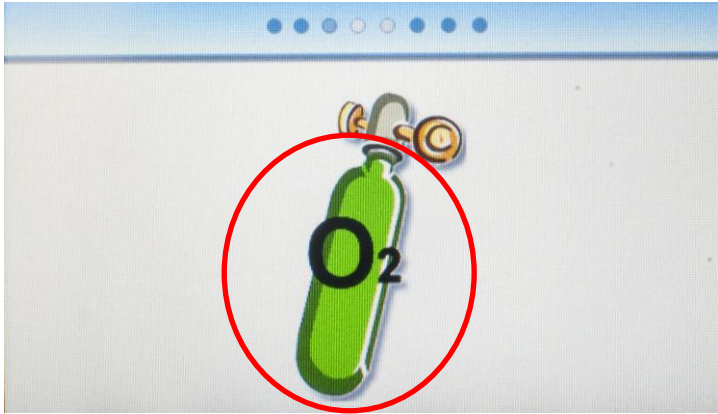


If the test was a fail an orange exclamation mark would be indicating those criteria which did not meet the standard. The photograph opposite is an example of a failed test where carbon dioxide failed to meet the requirements of the selected standard.

The test result is automatically recorded in the instrument’s memory, which can store up to 20 previous tests. To disconnect the Tester from the cylinder firstly turn off the cylinder valve, open the flow control valve until all the air is exhausted then close the valve. It is now safe to disconnect the connection hose and cylinder regulator.

## 5.0 Continuous Oxygen Reading

The F4504 can also provide a continuous oxygen reading.



When you start a test press and hold the O2 cylinder for a few seconds when it is in its self calibration mode.

*Note:- If the temperature is greater than 40°C inside the instrument the calibration will operate for an extended period to stabilise the Oxygen cell.*

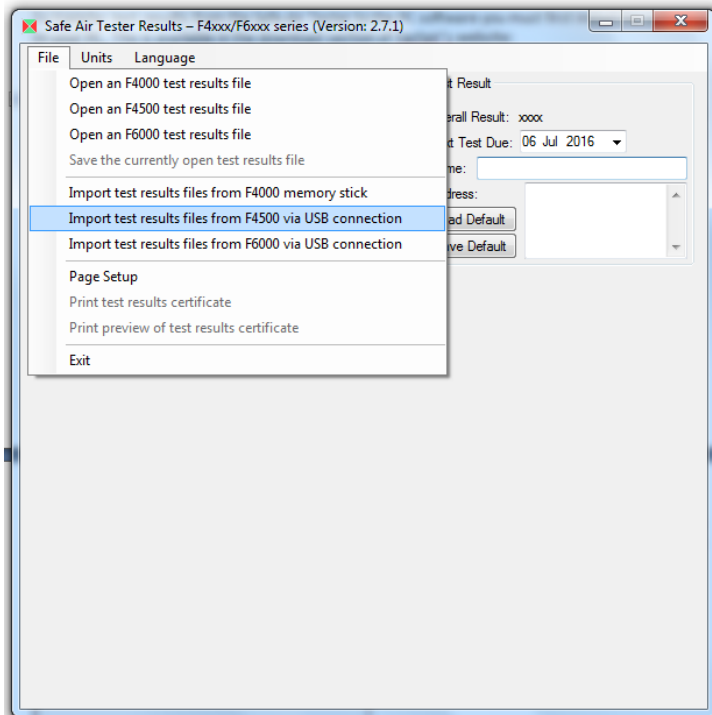


The instrument will then change operating modes to continuously display the oxygen reading, connect your air source and the instrument will continue to provide a reading until you press the arrow key in the top corner.

## 7.0 Exporting test results and PC software

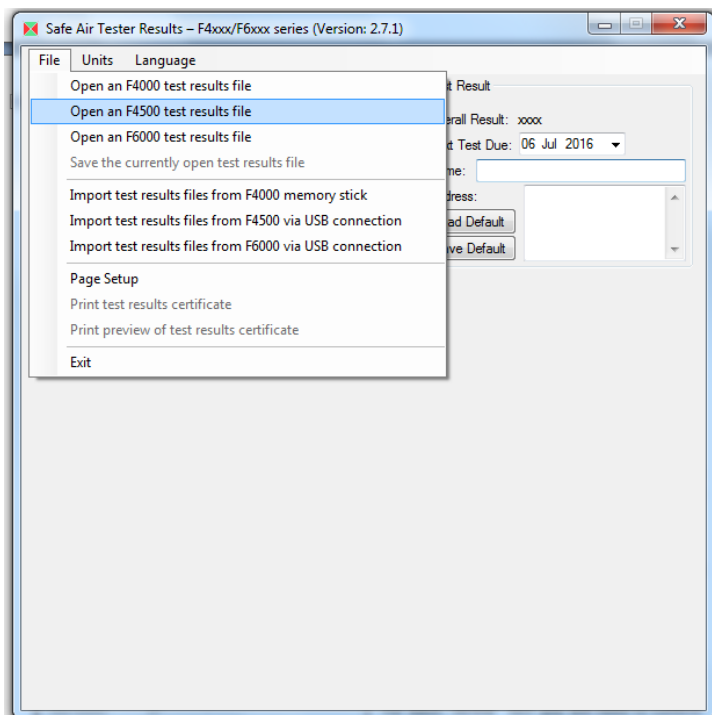
To transfer test results from the Safe-Air Tester to the PC software you must first install the software on your PC. This is available in the download section of Factair's website:

<http://www.factair.co.uk/downloads>



Then click on the File drop down menu and select import test results from F4500 via USB connection.

You will then be able to choose the location where you would like test results to be stored.



Individual test records can be opened from the file drop down menu by selecting "Open an F4500 test results file".

Safe Air Tester - [06-Jul-2016 at 16:54]

File Units Language

Test Info

Test Date: 06 Jul 2016  
 Tester Serial Number: 45001  
 Tester Calibration Date: 01 Jul 2016  
 Tester Model: F4500  
 Test Category: Airline below 40 Bar  
 Location: FACTAIR  
 Oil: Impactor

Test Result

Overall Result: Fail  
 Next Test Due: 06 Jul 2016  
 Name:   
 Address:

Test Measurements

	Reading	Pass/Fail	*Requirements/Notes
Ambient Temperature:	19°C	--	
Test Point Volume:	0 L/min	N/A	** Suitable for RPD
Test Pressure:	5.4 Bar	N/A	** Suitable for RPD
System Pressure:	5.4 Bar	--	
Odour:	OK	Pass	Without significant odour or taste
Oxygen (O2):	20.9 %	Pass	20 - 22% by volume
Carbon Monoxide (CO):	0 ppm	Pass	5ppm (5ml per m3) max
Carbon Dioxide (CO2):	400 ppm	Pass	500ppm (500ml per m3) max
Oil Mist:	0 - 0.1	Pass	Less than 0.5 mg/m3
Water Vapour:	5000 mg/m3	--	
Pressure Dewpoint:	26.5°C	Fail	Must be at least 5°C below ambient

Requirements according to BS EN12021 = \*

\*\* = If not applicable (N/A), then certificate covers air quality only.

Once loaded further information can be added about the following:-

Test location.

Date next test due.

Test engineer and relevant address. *Note:- These details can be saved as default.*

For each "Airline" test you will need to confirm whether the recorded test volume and pressure was sufficient for the RPD by selecting pass or fail as appropriate.

*Note:- In addition there is an option of entering N/A against these categories. In this instance the resultant test certificate will only validate air quality and exclude validation of the pressure and flow.*

When complete you can save the test result file and if required print off a certificate. In the UK, Health and Safety Executive guideline HSG53 recommends test results should be retained for a minimum of 5 years.

## **Appendix 1 - HELPFUL TIPS**

### **With detector tubes**

- Ensure that there are no fragments of glass in the tube glands prior to fitting detector tubes, clean if required.
- Always remove the ends of the detector tubes cleanly using the correct tube tip cutter. Do not use pincers or other devices.
- Always remove both ends of the detector tubes prior to fitting.
- Always fit detector tubes with the arrows facing outwards.
- Never break the glass ampoule in the oil tube before the test.
- Only use the detector tubes that the Tester is calibrated for.
- Once used, be aware that the tube tip cutter contains ground glass and glass fragments. Take appropriate precautions for the disposal of these. Dispose of as sharps.
- When using the tube tip cutter ensure only a light pressure is applied to the tube whilst rotating for scoring.

### **General**

- Make sure the system flow control valve is closed after each test.
- Connecting an air supply to the Tester with the system flow regulator in the open position can damage the unit.
- Never connect to a non-regulated supply from an HP cylinder or compressor.
- Maximum inlet pressure to the Tester is 10 bar. If exposed to an overpressure the Tester will display an overpressure warning necessitating its return to the manufacturer for checking and resetting.
- If the Tester has been used on an excessively wet supply it can be purged dry by running a full test on a known dry source without any detector tubes fitted.
- When using the mains power supply, ensure that the Tester is switched off prior to connection and disconnection.

For any additional advice and information please contact Factair on: +44 (0) 1473 746400.

## Appendix 2

### Draeger Tube Tip Cutter

The F2187 is especially designed to prevent glass from falling out of the opener by accident. The reservoir for the broken-off tips is easy to empty.

#### Instructions

1. Place the end of the tube between the 3 blades, and turn to score the end.



2. Push the tube at an angle to break the tip.



3. Repeat steps 1 and 2 with the other end of the tube



#### **Following information is only for EU-member states:**

The use of the symbol indicates that this product may not be treated as household waste. By ensuring this product is disposed of correctly, you will help prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. For more detailed information about recycling of this product, please contact your local city office, your household waste disposal service or the shop where you purchased the product.

## Appendix 3

### Reading the Draeger Oil Impactor and Chemical Reagent Tubes

#### Oil Impactor

**The Oil Impactor's protective seal must be kept in place for the duration of the test and only removed after the test has been completed.**

With a standard measurement range of 0.1 to 1.0 mg/m<sup>3</sup> the Impactor has a limit of detection of 0.05 mg/m<sup>3</sup>. The Impactor can detect all mineral and synthetic oils, it features a series of 3 horizontal lines, each formed by a series of precision manufactured nozzles. These horizontal lines of nozzles are calibrated to a different concentration of oil. When air is passed through these nozzles any oil present in the air is deposited on the glass plate prior to the air being exhausted by vents around its circumference, this allows the user to easily and quickly identify minute quantities of oil.

For tests that pass with an oil concentration of less than 0.05mg/m<sup>3</sup>, the screen will remain blank. For tests above that read as follows:

The bottom line represents an oil concentration of 0.1 mg/m<sup>3</sup>. When the oil deposited forms a continuous line then the concentration is in excess of 0.1 mg/m<sup>3</sup>. The middle line represents a concentration of 0.5 mg/m<sup>3</sup>, again when the oil deposited forms a continuous line the concentration is in excess of 0.5 mg/m<sup>3</sup>. The top line represents a concentration of 1.0 mg/m<sup>3</sup>, again when this forms a continuous line the concentration is in excess of 1.0 mg/m<sup>3</sup>.



Pass -  
greater  
than  
0.05mg/m<sup>3</sup>  
but less  
than  
0.1mg/m<sup>3</sup>



Pass -  
greater  
than  
0.1mg/m<sup>3</sup>  
but less  
than  
0.5mg/m<sup>3</sup>



Fail - greater  
than  
0.5mg/m<sup>3</sup>  
but less than  
1.0mg/m<sup>3</sup>



Fail -  
greater  
than  
1.0mg/m<sup>3</sup>



Each pack of tubes has its own instruction leaflet but the following notes should help you take readings after the tests have been completed.

Each tube has an expiry date which is located on the back of its storage box.

### Oil (67 28371)

**REQUIREMENT** - THE AIR SHOULD HAVE A MAXIMUM OIL CONTENT OF 0.5 MG/M<sup>3</sup> AND SHOULD BE WITHOUT SIGNIFICANT ODOUR OR TASTE.

1. Using the Tube Tip Cutter, place the ampoule section in the platform at the bottom.

Note: Make sure the tube is against the back wall of the cutter. Line up the black dot nearest the end of the tube with dot on the cutter.



2. With one hand holding the cutter, the other holding the tube and with your thumb against the base of the cutter, apply pressure to the tube, this should break the inner tube.



3. Place your used detector tubes in the F2154 Travel Container, until they can be disposed of properly as "sharps" or glass.



Ensure the oil tube is kept vertical throughout this process.

Satisfactory test: - The white crystals will turn translucent and show at worst a slight discoloration.

Failed test: - (Mineral oil) - The white crystals will show a light brown or darker discoloration.  
- (Synthetic oil) - The white crystals will show a yellow discoloration [Note: best seen by comparing with an unused tube].

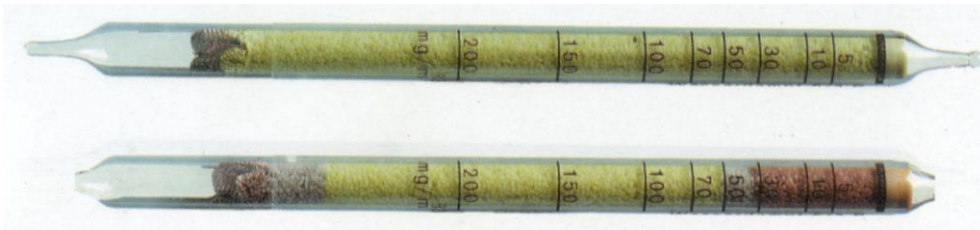


## Water (H<sub>2</sub>O) (67 28531)

- REQUIREMENTS**
- FOR AIRLINES BELOW 40 BAR THE PRESSURE DEWPOINT TO BE 5°C BELOW THE LIKELY LOWEST TEMPERATURE. WHERE THE LIKELY LOWEST TEMPERATURE IS NOT KNOWN THE PRESSURE DEWPOINT SHOULD NOT EXCEED -11°C.
  - FOR HIGH-PRESSURE CYLINDERS THE FOLLOWING UPPER LIMITS APPLY: - 40 TO 200 BAR = 50MG/M<sup>3</sup>, ABOVE 200BAR = 35MG/M<sup>3</sup>
  - FOR HIGH-PRESSURE CYLINDER CHARGING COMPRESSORS THE UPPER LIMIT = 25MG/M<sup>3</sup>

A reddish brown discoloration will show the extent of the water content, which is read from the scale printed on the tube in mg/m<sup>3</sup>.

When using the 50-2000 range setting, the tube reading is multiplied by a factor of 10, i.e. a tube reading of 150mg/m<sup>3</sup> becomes 1500mg/m<sup>3</sup>. To establish the pressure dewpoint refer to the graph on the back of the Safe-Air Tester Result Sheet.



## Carbon Dioxide (CO<sub>2</sub>) (67 28521)

**REQUIREMENT** - MAXIMUM READING OF 500 PPM. (300 PPM EU Pharmacopoeia N<sub>2</sub>/N<sub>2</sub>O)

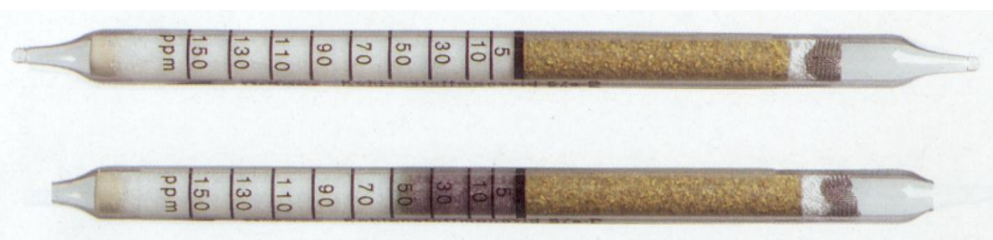
The media in the detector tube will discolour to show the presence of carbon dioxide. The total length of the discoloration read from the printed scale at that point is a measure of the concentration in parts per million.



## Carbon Monoxide (CO) (67 28511)

**REQUIREMENT** - MAXIMUM READING OF 5 PPM.

The media will discolour to show the presence of carbon monoxide in the air sample. The total length of the discoloration is the measure of concentration read directly from the scale in parts per million.



## Disposal of Draeger-Tubes

When Draeger tubes have been used, or unopened tubes have exceeded their expiry date, they should be disposed of using one of the following methods:

### Used Tubes

Submerge the tube(s) in a beaker or metal container filled with water and allow to soak for 24 hours. Treat the residual water in accordance with local authority waste regulations (some tube aqueous waste may require neutralisation prior to disposal). Place the tubes in a “sharps” or glass bin wearing protective gloves and safety spectacles. Dispose of the bin via the company’s normal industrial waste disposal method(s) i.e. landfill or incineration.

*OR*

Place the tubes in a “sharps” or glass bin wearing protective gloves and safety spectacles. Dispose of the bin via the company’s normal hazardous waste disposal method(s) i.e. landfill or incineration.

*OR*

Place the tubes in a “sharps” or glass bin wearing protective gloves and safety spectacles. Dispose of the container via incineration.

### Unused Tubes

Open the Draeger tube at both ends using the special tube opener. Break any ampoules where applicable. Dispose of the tubes as stated above.

**NOTE:** *As an alternative a local authority approved waste disposal contractor can be employed to collect used and unused tubes from site and dispose of them in a safe manner.*

## Appendix 4 Breathing-Air Standard

<b>BS EN12021 &amp; EN12021:2014</b>	
<b>Odour</b>	The gas shall be free from unsatisfactory odour or taste.
<b>Oxygen</b>	(21 ± 1)%
<b>Carbon Dioxide</b>	≤ 500 PPM
<b>Carbon Monoxide</b>	≤ 5 PPM
<b>Oil</b>	≤ 0.5 mg/m <sup>3</sup>
<b>Water Airline &lt;40Bar</b>	Where the apparatus is used and stored at a known temperature the pressure dewpoint shall be at least 5°C below likely lowest temperature. Where the conditions of usage and storage of any compressed air supply is not known the pressure dewpoint shall not exceed -11°C.
<b>Water High Pressure</b>	40 to 200 bar ≤50 mg/m <sup>3</sup> >200 bar ≤35 mg/m <sup>3</sup> HP Charging Comp ≤25 mg/m <sup>3</sup>

Above is an extract only for full details refer to the individual standard.

## **Appendix 5 - Air Quality Testing – Why?**

The required quality of breathing air is stated in EN12021 is to provide information on the safe limits of potential contaminant gases within breathing air and to ensure that the life support gas of oxygen is of an adequate level.

Compressed air for breathing normally originates from a compressor system installed or operating at the place of use and there are various factors that can affect the quality and safety of this air.

- The air intake to the compressor can ingest airborne contamination from local processes and vehicle exhaust fumes which are not removed by standard breathing air filtration. Such air borne contamination may not be continuous but the pollution of the air supply may persist for hours or days.
- Malfunctioning compressors, especially reciprocating type, can produce unsafe levels of both carbon monoxide and carbon dioxide.
- Breathing air filtration has a finite life and can fail causing high levels of oil and water contamination to be present in the air.
- The performance of desiccant filters is dramatically affected by operating temperature. Infrequent validation may result in poor quality air being supplied for an extended period
- Failure of the compressed air aftercooling will result in air entering the filtration at too high a temperature, this will cause the filtration to prematurely fail and pass excess levels of oil and water.
- Malfunctioning dryers can disturb the oxygen concentration to outside safe levels within the breathing air.
- High levels of water in breathing air can freeze within RPD demand valves causing the air supply to fail.
- Insufficient air flow or pressure to the RPD will reduce the protection factor of the RPE and potentially expose the user to ingress of external contaminants.
- The effects of contaminants when breathed at elevated pressure can have a much greater effect on users than it would at normal pressure.
- Changes in the performance of compressor and filtration equipment are usually rapid in nature. Any failure affecting outlet air quality may injure users for an extended period if quality validation is infrequent.
- Odour alone is a poor indicator of air quality, toxic as asphyxiant gasses are often odourless, the limits for oil pollution are lower than the threshold detection level that most people will notice.

All employers have a duty of care to their employees to ensure that the breathing air they are supplied with is adequate for the RPD they are using and safe to breathe. The points raised above may form the basis of the risk assessment called for in the European guidance document for the selection and use of respiratory protective devices EN 529.

## **Frequency of Breathing-Air Tests**

### **Low Pressure Systems**

The purpose of periodically testing air quality is to make sure that the control measures you have put in place are delivering the air quality required.

In the UK national standard EN12021 advises that samples should be taken and analysed at least every three months or more frequently if there has been a change in, or concerns relating to, the production process.

In the HSE guideline document Respiratory Equipment at Work (HSG53) it states you should base the frequency of such tests on a risk assessment, but again they should take place at least every three months, and more often when the quality of air cannot be assured to these levels.

For mobile breathing-air compressors, in the UK, COSHH stipulates that, the employer should ensure that wherever a compressor is located, the quality of air it supplies is not compromised by nearby contaminants. We strongly therefore recommend that for mobile compressors the air quality is tested whenever it is first moved into a new position or prevailing wind conditions change.

The final decision on frequency of test is the responsibility of the Employer and needs to not only reflect local legislation but also the task and frequency of use. It should be incorporated into their risk assessment and updated regularly to reflect results from ongoing breathing-air tests to maintain a robust control system.

### **High Pressure Systems**

Whilst up to a 3 month periodicity for testing may be suitable for low pressure breathing-air systems, further consideration should be given to high pressure compressors where the life of filter elements are normally much shorter, typically 50 hours for a HP filter cartridge and this is reduced further in high ambient temperatures.

Accordingly for these systems we recommend that your risk assessment for testing HP systems should be based on the expected filter life and an air quality test should first be completed when new filter elements are fitted and then again when they reach 50% of their life based on the hours run usage. Subsequent tests would then be dependent on usage with a maximum interval between tests of 3 months.

## Recording Breathing-Air Quality Test Results

When undertaking breathing-air quality tests, results should be retained. In the UK the regulations COSHH stipulates the information retained should include:

- the name and address of the employer responsible for the RPE;
- particulars of the equipment and of the distinguishing number or mark, together with a description sufficient to identify it, and the name of the maker;
- the date of examination and the name and signature or other acceptable means of identifying the person carrying out the examination and test;
- the condition of the equipment and details of any defect found, including for canister or filter respirators, the state of the canister and the condition of the filter;
- for self-contained compressed air/gas breathing apparatus, the pressure of air/gas in the supply cylinder; and
- for powered/power-assisted respirators and breathing apparatus, the volume flow rate to ensure that they can deliver at least the manufacturer's minimum recommended flow rate.

Records can be in paper or electronic format but should be kept readily accessible and retrievable at any reasonable time for examination by safety representatives or inspectors etc.

**In the guideline document Respiratory Protective Equipment, a practical guide (HSG53) it advises results should be kept for 5 years.**

## **A.4.5 Compressed air for breathing apparatus from EN529**

### **A.4.5 Compressed air for breathing apparatus (EN12021)**

#### **A.4.5.1 General**

A compressor system will have produced the compressed air supplied to a breathing apparatus. The compressor system may be used for filling individual high-pressure vessels or those on a mobile trolley or to supply air direct to breathing apparatus and other air-tools used in the workplace.

Contaminants can mix in compressed air at various stages of its production and supply. Any presence of contaminants in acceptable quantities will render the air unsuitable as “breathable air” and can threaten the health and safety of the respiratory protective device wearer. For this reason quality assured compressed air should be supplied to a breathing apparatus. EN12021 stipulates the minimum quality standards for breathable compressed air and includes the levels for oxygen, carbon monoxide, carbon dioxide, lubricants, water and other types of contaminant and odour.

#### **A.4.5.2 Compressor system**

##### **A.4.5.2.1 General**

A competent person should be consulted when planning or installing a compressed air system for producing breathable air. This will help to minimise problems associated with compressors and the down stream effects on the quality of the air supplied. Table A.2 provides a summary of the main elements associated with a compressor system for producing breathable air. In addition to the careful and installation of the system it should be maintained by a competent person to ensure the safe operation of the system.

The compressor should be installed in an area providing sufficient space on all side to ensure good ventilation. The area should be cool as possible but avoid place where freezing is possible. The air intake point should be located in open air and away from potential contaminants (e.g. not close to ventilation outlets or in down stream of the outlets or near vehicle exhaust emission points).

##### **A.4.5.2.2 Air purification elements**

The air purification elements should be placed in the correct sequence to ensure the delivery of acceptable quality breathing air. These purification elements should be replaced in accordance with the advice provided by the competent person and the manufacturers of these elements.

##### **A.4.5.2.3 Testing and inspection**

The volume flow and quality of the supplied air should be thoroughly tested as specified by a competent person after risk assessment.

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**COSHH L5 (Sixth Edition 2013)**  
**EXTRACTS FROM CODE OF PRACTICE RELATING TO**  
**RESPIRATORY PROTECTIVE EQUIPMENT (RPE)**

178. The maintenance, examination and tests should be in accordance with the manufacturer's instructions. Examinations should comprise a thorough visual examination of all parts of the respirator or breathing apparatus, to ensure that all parts are present, correctly fitted, and the equipment is in good working order. In particular, the examination should ensure that the straps, facepieces, filters and

valves are sound and in good working condition. For powered and power-assisted respirators, tests should:

- be made on the condition and efficiency of those parts;
- ensure that the battery pack is in good condition;
- ensure that the respirator delivers at least the manufacturer's recommended minimum volume flow rate.

179. For RPE incorporating compressed gas cylinders, tests should include the condition and efficiency of all parts, the pressure in the cylinders and the volume flow rate. Frequency of examination and tests

180. The quality of the air supplied to a breathing apparatus should be tested at suitable intervals, depending on the task and the frequency of use. When the air supply is from mobile compressors, the employer should ensure that wherever a compressor is located, the quality of air it supplies is not compromised by nearby contaminants. In every case, the air supplied to a breathing apparatus should meet the relevant quality standard. As it is not reasonably practicable to test for all contaminants, the risk assessment made under regulation 6 should guide what other contaminants will require testing.

181. Thorough maintenance examinations and, where appropriate, tests of items of RPE, other than one-shift disposable respirators, should be made at suitable intervals. The frequency should increase where the health risks and conditions of exposure are particularly severe.

182. In situations where respirators are used only occasionally, an examination and test should be made before their next use and maintenance carried out as appropriate. The person who is responsible for managing the maintenance of RPE should determine suitable intervals between examinations. Emergency escape-type RPE should be examined and tested in accordance with the manufacturer's instructions.

183. Suitable arrangements should be made to ensure that no employee uses RPE which has previously been used by another person, unless it has been thoroughly washed and cleaned in accordance with the manufacturer's instructions.

## **Suitable records**

184. The record of each thorough examination and test of RPE carried out should include:

- the name and address of the employer responsible for the RPE;
- particulars of the equipment and of the distinguishing number or mark, together with a description sufficient to identify it, and the name of the maker;
- the date of examination and the name and signature or other acceptable means of identifying the person carrying out the examination and test;
- the condition of the equipment and details of any defect found, including for canister or filter respirators, the state of the canister and the condition of the filter;
- for self-contained compressed air/gas breathing apparatus, the pressure of air/gas in the supply cylinder; and
- for powered/power-assisted respirators and breathing apparatus, the volume flow rate to ensure that they can deliver at least the manufacturer's minimum recommended flow rate.

## **Keeping records**

185. Employers may keep records in any format, eg on paper or electronically. Records should be kept readily accessible and retrievable at any reasonable time for examination by safety representatives or inspectors etc.

## **Accommodation for, and checking of, PPE**

186. Employers should ensure that accommodation is provided for PPE so that it can be safely stored or kept when it is not in use. The adequacy of the accommodation will vary according to the quantity, type and its use, eg pegs, (labelled) lockers, shelves or containers etc. The storage should be adequate to protect the PPE from contamination, loss or damage by, for example, harmful substances, damp or sunlight. Where quantities of PPE are stored, equipment which is ready for use should be clearly segregated from that which is awaiting repair or maintenance. Where PPE becomes contaminated during use, and especially by biological agents, the accommodation should be separate from any the employer provides for ordinary clothing and equipment. Employers may also have duties under the Workplace (Health, Safety and Welfare) Regulations 1992 to provide accommodation for PPE.<sup>14</sup>

187. All PPE should be checked regularly to ensure that it continues to function and provide protection. The types of checks should be suited to that item of PPE and be able to detect significant deterioration. The more likely the performance of a particular item of PPE is to deteriorate, the more often it needs checking. Whoever does this work should be sufficiently knowledgeable and trained to identify deterioration and significant faults. Equipment that has deteriorated significantly or is faulty should be effectively repaired or disposed of safely.

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# Respiratory Protective Equipment at Work

## A practical guide

HSG53 (Fourth edition, published 2013)

### *Dos and don'ts*

#### Do's

Always ensure the breathing apparatus is in good working order before putting it on, even when new.

Always look after your supply hose during use – your life may depend on it.

Always use **all the straps** provided, making sure they are correctly positioned and adjusted. Follow the manufacturer's instructions.

Ensure that an adequate clean air supply is available for all users.

Ensure that the compressed air quality meets the minimum requirements of BS EN 12021.15

Always plan your exit from the contaminated area so you don't run out of air.

Ensure the other PPE you need to wear is compatible with the BA.

#### Don't's

Never place the hose inlet near to potential sources of contamination, eg vehicle exhausts.

Never use the equipment without the waist belt.

Never use a light-duty airline hose where there is any potential for crushing by vehicles or passers-by etc.

Never keep working if the airflow rate drops or any warning devices are activated. Leave the work area immediately.

## Appendix 3 Quality of air for breathing apparatus

### Air quality

1. Air supplied to breathing apparatus (BA) should be clean and safe to breathe, whether it is supplied via a fresh air hose or a source of compressed air.

### Fresh air hose

You should securely anchor the inlet for fresh air hose BA in an area that is free of contaminant. This can usually be achieved by siting the inlet well away from the work area (eg in free air outside the building), and upwind of any local sources of airborne contamination (eg vehicle exhaust).

## Compressed air

2. Compressed air for BA normally originates from a compressor system. The maintenance, examination and testing of compressors should be carried out according to the manufacturer's instructions. The siting of air inlets to compressors should follow the same principles as for fresh air hose. However, because compressors themselves can generate and concentrate a wide range of contaminants, you should take extra care in assuring air quality.
3. As the BA wearer's life and health depend on the air supplied by the compressor, you should ensure that the air supplied meets the quality requirements in British Standard BS EN 12021 *Respiratory protective devices. Compressed air for breathing apparatus*,\* in addition to the pressure and airflow rate requirements of the BA manufacturer.
4. Compressors which are moved from site to site, such as those used by the emergency services or on construction sites, will require a higher standard of maintenance and should be sited so that the quality of air they provide is not compromised by nearby contaminants.

\* BS EN 12021 states: 'Compressed air for breathing apparatus shall not contain any contaminants at a concentration which can cause toxic or harmful effects. In any event all contaminants shall be kept to as low a level as possible and shall be far below the national exposure limit. Combination effects of more than one contaminant shall be taken into account.' (1999) Respiratory protective equipment at work Page 48 of 59

## Periodic testing of air quality

5. The purpose of periodically testing air quality is to make sure that the control measures you have put in place are delivering the air quality required by BS EN 12021. You should base the frequency of such tests on a risk assessment, but they should take place at least every three months, and more often when the quality of air cannot be assured to these levels.
6. As part of the risk assessment, if a mobile compressor is being used consideration should be given as to how often the air supply should be checked when the compressor is moved. Testing for these components may be carried out using any appropriate method, eg:  
simple colour change tubes;  
on-line gas testers;  
sample collection for laboratory analysis elsewhere.
7. The supplier of your compressor or BA should be able to advise you on the best method for you. You should keep records of air quality tests for five years.

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