Breathing-Air Quality Testing
Regulations, Standards and Guidance

Regulations, Standards and Advisory Documents

Guidance on using Draeger tubes

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.

International Breathing-Air Standards

	Europe	US	Australia and New Zealand
	BS EN12021 & EN12021:2014	CGA G-7.1-2011 Grade D	AS-NZS 1715: 2009*
Odour	The gas shall be free from unsatisfactory odour or taste.	None (No pronounced odour)	No objectionable or nauseous odour
Oxygen	(21 ± 1)%	19.5% - 23.5%	19.5% - 22%
Carbon Dioxide	≤ 500 PPM	≤ 1000 PPM	≤ 800 PPM
Carbon Monoxide	≤ 5 PPM	≤ 10 PPM	≤ 10 PPM
Oil	≤ 0.5 mg/m^3	≤ 5 mg/m^3	≤ 1 mg/m^3
Water Airline <40Bar	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.	Dewpoint ≤50°F (67 PPM v/v), for SCBA use in extreme cold a dew point not to exceed -65°F (24 ppm v/v) or the dewpoint must be 10°F lower than the coldest temperature where the respirator is worn.	
Water High Pressure	40 to 200 bar ≤50 mg/m^3 >200 bar ≤35 mg/m^3 HP Charging Comp ≤25 mg/m^3		Contain not more than 100 mg/m^3 for cylinders initially filled to pressure of at least 120 bar.

Note – Also ensure that the test point volume and pressure is sufficient for the RPD being used. For AS-NZS 1715 the minimum requirement is 170 l/min continuous flow for each person, measured at the respirator.

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

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 forward to 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 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.

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 fltted, 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.14.

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.

Respiratory Protective Equipment at Work
A practical guide
HSG53 (Fourth edition, published 2013)

Dos and don’ts

Table 6 Breathing apparatus

Do’s	Don’t’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.	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

2. 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

3. 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.

4. 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.

5. 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

6. 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.

7. 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.

8. 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.

Material:
Excerpt from Table 6 Dos and Don'ts and Appendix 3 Respiratory Protective Equipment at Work. A practical guide.
Health and Safety Executive (ISBN 071762904)

Source Acknowledgement:
HSG53 Respiratory Protective Equipment at Work ISBN 978 0717 6454 2 Health and Safety Executive 2013

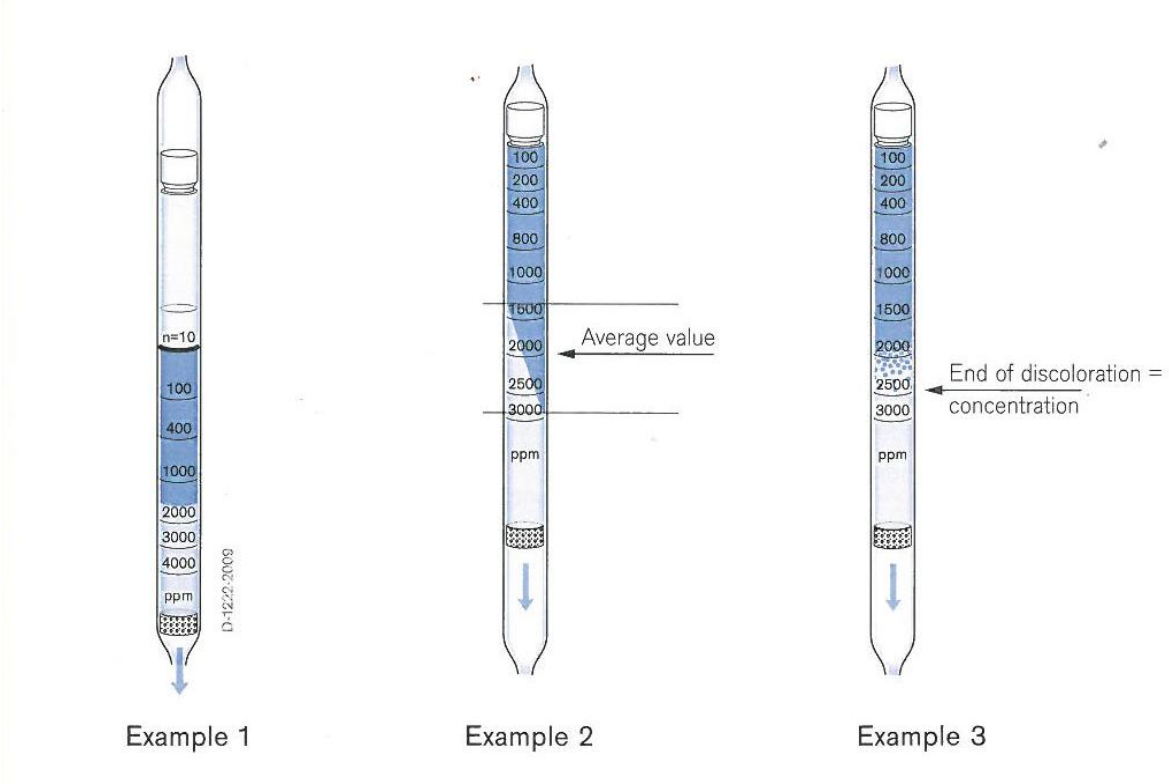
Evaluation of Draeger Tubes

The reading of the tube must be done immediately following the measurement.

When reading the concentration on a scaled tube three different situations can be encountered:

- The colour indication ends at right angle to the tube's longitudinal axis
- The colour indication is oblique to the tube's longitudinal axis
- The end of the colour indication become very diffuse

When the colour indication is at a right angle to the tube's longitudinal axis the concentration can be read directly against the scale (see example 1). If the colour indication is oblique i.e. runs in a slanting direction to the tube's longitudinal axis), then the average reading indicates the concentration (see example 2). If the colour indication becomes progressively diffuse the end of the discolouration may be difficult to evaluate. In this case the final edge of the discolouration is just visible (see example 3).



The UK national forward to EN12021:2014 requires the user to also add the maximum error for the testing system, to the reading obtained, and then use this combined total to determine if the test is a pass or fail.

Therefore for BS EN12021:2014 only the following percentages should be added to the actual reading.

CO_2	6728521	+15%
CO	6728511	+15%
H_2O	6728531	+22%

F2187 Draeger Deluxe Tube Tip Cutter

Opening the Draeger Detector Tubes by breaking off both ends has become safer and simpler than before. A slight turn of the tube is all that is needed in order to score the tip against three metal discs in the upper opening and then to break off the tip.

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 three 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

For Oil (6728371) Tubes only

4. Once the air quality test is complete, 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.

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

6. Place your used detector tubes in the F2154 Travel Container, until they can be disposed off properly as “sharps” or glass.

Ensure the oil tube is kept vertical throughout this process

Note: This booklet is for guidance purposes only. Whilst every care has been taken with the preparation of this document Factair does not accept any responsibility for any loss occasioned by reliance on the contents.

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