BGA AIRWORTHINESS AND MAINTENANCE PROCEDURES

PART 4, LEAFLET 4-11

MAINTENANCE OF GLIDER OXYGEN SYSTEMS

INTRODUCTION

1. General

Oxygen systems in gliders may regarded as installed systems or portable systems. Most are of simple design comprising of a storage cylinder, regulator, piping and mask. Oxygen is used for assisting the pilot to achieve and maintain heights above 8000 ft. Glider oxygen systems are not designed as therapeutic or medical emergency systems.
This leaflet is written with installation and maintenance in mind and not for design of systems. Due to the complexity and diversity of systems, aircraft and equipment manufacturers maintenance instructions should be followed wherever possible. This leaflet is written to give general guidance where specific manufacturers information is not available.

2. Types of systems

There are two types of oxygen system generally installed in gliders:

Demand or Demand diluter systems – Oxygen is mixed with air and is only delivered to the mask as the pilot inhales. This system is the most precise and economical and will be found in most glider installations.

Constant flow systems – Oxygen is delivered to the mask in a constant flow usually with a high/low setting. This system uses more oxygen and to increase endurance larger cylinders tend to be used.

Oxygen generators, automatic emergency systems and portable therapeutic sets are not used in gliders and are not covered by this leaflet

3. Reference Information

Carriage of Dangerous Goods (Classification, Packaging and Labelling) and use of Transportable Pressure Receptacles Regulations 1996. Statutory Instrument number 2092. www.legislation.hmso.gov.uk
Health and Safety at work act 1974 (BGA Site Opps. Manual, Appendix 5)
CAA CAAIP Leaflet 5-9 Oxygen Systems www.caa.co.uk/publications
EASA CS-22 (replacing JAR-22) www.easa.int

SYSTEM REQUIREMENTS

4. Basic requirements

All oxygen systems must have various features including those defined in CS22:

- The Oxygen equipment must be approved for use in aircraft.
- The equipment must be free from hazards in itself, methods of operation and its effect upon other components.
- There must be contents gauge visible to the pilot.
- Cylinders and other equipment must be installed as so not to be hazardous in crash landings.
- There must be a means of shutting off the oxygen supply.
- There must be a flow meter or other means of determining that oxygen is being delivered visible to the pilot.

- All equipment, pipe work, hardware and consumables must be suitable for use with oxygen systems.
- Oxygen supply should work independently of any electrical supply – this may be in a manual reversion or emergency mode.

5. Oxygen

Only Aviators Breathing Oxygen must be used in glider oxygen systems conforming to British Standard 3N3 - 2000 or ISO 2046 or MIL-PRF-27210 or equivalent.
Oxygen not specified for aviation use must not be used e.g. some reports state that medical oxygen must not be used as the moisture content may be too high and could freeze in the regulator and welding oxygen must not be used as the purity cannot be guaranteed. Breathing oxygen for aviation use is 99.99% pure. There is a liability issue if oxygen not specified for aviation use is used.

SAFETY PRECAUTIONS

6. General Safety

Oxygen is non-flammable, non-toxic, clear, no smell or taste and of course, supports life. However, Oxygen also supports oxidation and combustion. Oxygen will turn normally non-flammable and benign products into extremely flammable and hazardous substances.

Warning

Oxygen is very hazardous in contact with any grease, oil, flammable solvents, dust, lint, metal filings or other combustible materials. Ensure that the area, all tools, clothes, hands and equipment or consumables are clean before starting work on an oxygen system. Contact with any of the above may cause spontaneous combustion or explosion.
Grease or Oil will cause an explosion on contact with oxygen.
Keep away from all forms of combustion and naked lights.

Caution

Do not smoke near or whilst working on oxygen systems and for at least 10 minutes after as clothes may be saturated with oxygen.
Do not use any lubricants.
Only use parts, products and consumables approved for use with oxygen.

STORAGE CYLINDERS/BOTTLES

7. Type

Their are various types of cylinder used – Metal (steel or aluminium) and Kevlar or composite material. Steel cylinders are much heavier than the aluminium, Kevlar or composite types but more durable. The max pressure is usually 1800psi but this may vary dependant on type. Do not exceed the stated max pressure.

8. Colour coding and marking

Breathing Oxygen cylinders may be coloured Black with White top (valve end) or Green. All cylinders should be marked with "Use No Oil" and have Name of manufacturer, drawing number, Capacity (Litre), test pressure, working pressure, test date. The latest test date may also be stamped on the neck or metal cylinders.
All black cylinders indicate the oxygen is for welding or industrial use and not for breathing.

9. Mounting

All oxygen cylinders must be secured irrespective if they are regarded as portable or installed systems.

Cylinder mountings must be installed and inspected to ensure security during any eventuality – normal flight or emergency situations and crash landings. The mounting must also be able to release the cylinder for inspection and filling.

During inspection ensure the mounting is suitable for the type and size of cylinder to be installed. Due to the various sizes and types of cylinder it is unlikely that when changing cylinder types the mounting will fit.

10. Testing

Oxygen cylinders must be inspected and hydrostatically tested at the intervals as specified by the cylinder manufacturer. In the absence of any recommendations the following should be used:

- Metal cylinders – every 5 years
- Kevlar or composite cylinders – every 3 years

Reputable gas suppliers have a responsibility for statutory testing and will refuse to refill any cylinder that is out of test date. Some cylinders will have a limited service life, others have unlimited service lives. Due to the complexity of different types the testing inspector or manufacturer will be able to advise on the service life. The test interval makes no differentiation between in-use and storage.

Testing of pressure vessels is very important as a rupture failure could have very serious or fatal results.

There are various testing schedules. UK cylinders manufactured to BS 5045 are tested to BS EN 1968. Other cylinders will have similar testing schedules.

Charged cylinders are subject to special transport regulations. See “Carriage of Dangerous Goods”.

11. Inspection

During the annual inspection or whenever a cylinder is removed for servicing or storage it should be inspected for Test date, external corrosion, damage, leaks, cracks or other sign of un-serviceability. Kevlar cylinders are particularly susceptible to impact damage and if damage is suspected they should be professionally inspected.

Normally oxygen cylinders should not be deflated below approximately 200 psi.

If the cylinder is damaged it should be fully deflated and this should be advised to the inspector.

Retaining some residual pressure in the cylinder will help prevent any moisture present in the oxygen condensating on the inside of the cylinder and prevents air and other contaminates from entering. Completely empty cylinders may require additional inspections and purging before refilling adding to the servicing cost. Internally corroded or damaged cylinders will probably be scrapped.

VALVES & GAUGES

12. Cylinder mounted valves and gauges

Every storage cylinder must have its own shut off valve to isolate it from the aircraft system and for removal from the aircraft. Some cylinders will have a gauge indicating cylinder contents directly some systems will require the shut off valve to be open to indicate the contents. Other systems will have an integral regulator or pressure reducing valve and system pressure gauge mounted on the cylinder. Control knobs must not be wire locked in the ON position as this may hinder the shutting off of the system.

Cylinders and cylinder-mounted equipment must be protected during transit, storage and during installation/removal from accidental damage. Gauges, regulators and valves are especially at risk when attached to a heavy storage cylinder.

13. Over pressure safety valve or disc
Most storage cylinders and some systems will have over pressure relief valves or blow out discs/plugs to relieve the pressure should it become dangerously high. This can be caused by over charging or by extended heat soak from the sun or by other faulty components.

14. Inspection and maintenance
Shut off valves should be checked for smooth operation and leakage. (See general maintenance)
Valve control knobs should have the direction to open/close clearly marked.
Non-return valves flow direction should be checked.
Pressure relief discs/plugs or indicators should be checked
Gauges must be clear and undamaged and accurate.
Check for damage, correct fitment, operation, leaks and any signs of un-serviceability.

PIPE WORK AND HOSES

15. Rigid pipes
In high pressure parts of the system only Stainless Steel or Copper based alloys should be used. In the low pressure part of the system aluminium may also be used. Only pipes approved for use with oxygen systems may be used.
It is preferable to use pre made pipes. If it is necessary to manufacture a new pipe it is preferable to use compression joints.
If soldered joints are required this should be entrusted to specialists as the use of incorrect materials or techniques can have dire consequences.
Soldering of rigid pipes is not covered by this leaflet.

16. Flexible hoses
Depending on the design of the system either made up hoses or cut lengths of hose with push connectors. Only hoses and connectors approved for use with oxygen may be used.
Some systems use small bore flexible hoses throughout. These hoses should be of the type specified for that application. Flexible hose will be non-kink in normal usage and may be colour coded. Do not use general purpose flexible hose purchased from the DIY stores, as this may not be compatible for use with oxygen.

17. Inspection and maintenance
Pipelines and hoses should be inspected for kinking, chafing and damage, correct routing, perishing, age hardening, leaks and any deterioration or un-serviceability.

18. Removed pipes and hoses
New pipes and hoses should be received sealed in polythene bags or fitted with approved blanks. To avoid any contamination do not use any pipe or hose that is supplied open.
When removing oxygen pipes that are to be reused they must be blanked at each end with approved blanks or placed in clean polythene bags to avoid internal contamination.
DO NOT USE TAPE as the adhesive on the tape may contaminate the pipe or fitting, do not use old blanks as these may have been contaminated with oil, grease or other contaminates.

REGULATORS & FLOW METERS

19. Types
The type of regulator will depend on the system installed. Only the type of regulator designed for the particular system must be used. Some regulators will have gauges showing system pressure some will have flow meters or indicators and some multi ported. Regulators will have some form of control, this may be a simple OFF/ON valve, some may have LOW/HIGH or 100% or emergency positions and others may be fully controllable possibly via a remote control unit.

20. Electronic and LCD displays and controllers
Some modern systems will incorporate an LCD type screen displaying oxygen quantity, system information, flow rates and duration. The latest oxygen efficient systems will use a pulse demand system to only deliver the required amount of oxygen to either allow a reduction of cylinder size or increased endurance.

21. Inspection and maintenance
Apart from general inspection, leak checks, operation check and external cleaning there is little maintenance or repair that may be carried out on regulators and flow meters. It is recommended that regulators are serviced and tested at the same interval as the storage cylinder is tested.
If repair or servicing is required the item should be returned to a specialist or the manufacturer.

MASKS

22. Cannula masks
These are the most basic form of mask comprising of a nosepiece and thin tubes that usually pass behind the ears. Cannula are regarded as disposable and should any maintenance be required other than cleaning, they should be replaced.

23. Lightweight mask
A standard, lightweight, usually clear or light green PVC mask that covers mouth and nose. Some will have a small bag attached for oxygen storage. Lightweight masks are regarded as disposable and should any maintenance be required other than cleaning they should be replaced.

24. Heavy duty mask
Sometimes called “Drager masks” these are usually a rubber type material and are far more substantial that the disposable types. Some masks have a facility for an integral microphone.

25. Maintenance of heavy duty masks
Masks should be inspected for perishing, worn or slipping straps, cleanliness, secure hose connections and general condition. The microphone, if fitted, must be inspected for contamination or deterioration caused by moisture from the pilot’s breath as it is inside the mask.

26. Cleaning
Only use sterile wipes approved for use with oxygen systems for cleaning masks.
To avoid cross infection it is recommended that each pilot have his/her own mask. This is especially important with the Cannula type of disposable mask.

27. Storage

When not in use, masks should be stored in special purpose bags or sealed in clean polythene bags ready for use.

FILLING

28. Filling oxygen cylinders

It is strongly recommended that oxygen cylinders are only filled by specialist gas suppliers.

If it is desired to fill cylinders locally then there are a number of precautions that must be observed.

- Follow all the safety precautions above.
- Only trained operators may fill oxygen cylinders.
- Only use Aviators Breathing Oxygen.
- Remove all cylinders to be filled from the aircraft.
- Ensure the test date of the cylinder to be filled has not expired and the cylinder is not damaged.
- Fill cylinders in the open or well a ventilated area free from all forms of contamination, combustion or naked lights.
- Do not smoke during and for at least 10 minutes after completing the recharging process in case your clothes are saturated with oxygen.
- Only use clean tools and equipment, including clothes.
- The main storage cylinders must be controlled via a filling regulator with pressure gauges showing delivery and supply pressures.
- Only use specialist adaptors for connection to cylinders.
- Operate all valves slowly to avoid sudden changes in pressure.
- Fill the receiving cylinder slowly.
- Monitor temperature of the cylinder being filled. If excessively hot, stop filling and wait until cool before continuing
- Do not exceed the stated maximum pressure on the receiving cylinder.
- Regularly maintain the servicing equipment and calibrate the regulator and gauges.

GENERAL MAINTENANCE

29. General maintenance

Other than specific maintenance instructions above, generally working on oxygen systems is safe provided a few general guidelines are followed

- Never work on a pressurised system.
- Use the right tool for the job.
- Always ensure that your tools, clothes and the general area is clean.
- If a leak is suspected use a propriety leak detection fluid approved for use with oxygen or plain water. The use of washing up liquid is forbidden as it may contain ingredients that react with oxygen. Never use a naked flame.
- Use the correct parts and materials.
- Only use PTFE sealing tape on pipe thread joints. Do not use on compression or cone fittings. Ensure tape does not enter the oxygen system.
- Do not use any lubrication or sealing material unless it has been supplied specifically for use on gaseous oxygen systems.
- Operate all valves and controls slowly to avoid rapid pressurisation of pipelines and components.

- Always use clean blanks and never use adhesive tape. If blanks are not available use cling film or clean polyethylene bags.
- Whenever an oxygen system is installed or removed the effect on the weight and balance must be considered. A heavy cylinder may significantly reduce available cockpit load. In gliders cylinders are normally stored at or near the centre of gravity so may have little effect on the C of G position. If necessary the glider must be reweighed and placarded “with” or “without” oxygen installed.

Acknowledgements

The BGA thank the following organisations for direct help and web site information used to assist in the compilation of this leaflet.

British Oxygen Co.
British Compressed Gases Association
CAA publications
CASP Aerospace inc.
Oxygen equipment manufacturers and suppliers.