Oxygen Equipment

Breathless

You are high, very high and the view is spectacular, literally breathtaking. which is why you need oxygen. We take a look at two electronically controlled oxygen systems which supply just the right amount of vital oxygen - with economy.

Stories of high altitude flights for Gold C and Diamond Height badge gains have not always had a happy ending: not infrequently bad luck; and failure resulting from human performance, and pilot error have resulted in catastrophe. These problems are usually related to the supply of oxygen which is vital in the hostile environment of the upper troposphere.

It is really annoying if, as luck would have it, there is no immediate strong lift in the wave and you have to quietly persevere with modest rates of climb and then just before you reach badge height the oxygen runs out and you have to break off the climb tantalisingly close to success. The stark fact that there is insufficient oxygen at high altitudes is not always appreciated. Experience is no safeguard, as many well known pilots have demonstrated, to their cost.

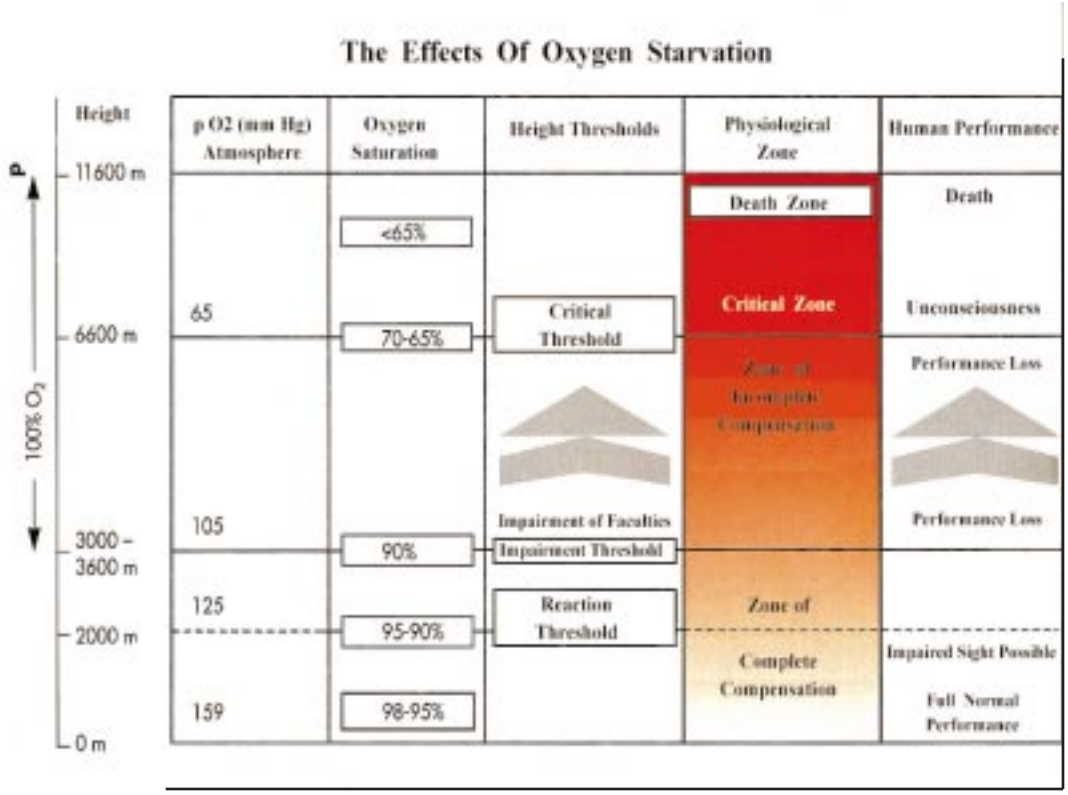
If you climb to a high altitude without oxygen equipment you are risking your life. A single devastating statistic says it all: at 22,000 ft., a pilot without oxygen will not be fully conscious after just five or ten minutes if he is very fit.

Pilots who try to make savings by flying without oxygen at moderate heights are also at risk. And this also applies to pilots who use waves for cross country flights, flying at between 10,000 and 20,000 ft. Of course they cannot afford to waste oxygen, or it will not last long.

There are now two very effective electronically controlled oxygen systems which enable a pilot to make the best use of his oxygen: a fully automatic electronic one from the United States and a German one which you set manually to the pressure altitude. Both adjust automatically to your breathing rhythm at the start of inhalation, supplying exactly the amount of oxygen you need at the specific altitude and that can be drawn into the lungs. Neither system adds oxygen to the air which never reaches your lungs when you take a breath. This is the secret of their economy compared with traditional oxygen systems, and especially the wide-spread continuous flow system.

The American EDS (Electronic Oxygen Delivery System) produced by Mountain High Equipment and Supply Company in Salt Lake City, Utah [now in Redmond, Oregon] is distributed in Germany by Büscher Flugversand. The German Flowtimer is produced by Spiegelberg in Hamburg. The EDS is approved in the United States by the FAA and can be used up to a height of about 20,000 ft. with a cannula and up to 29,500 ft. using an oxygen face mask. The Flowtimer is not certificated. It can provide an adequate supply of oxygen up to about 23,000 ft. The manufacturers give no indication of a recom-

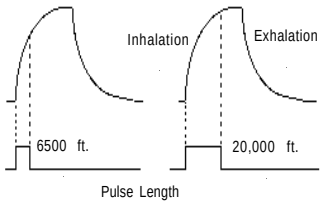
The Flowtimer by Spiegelberg in Hamburg adjusts electronically to the pilot's breathing rhythm. The pilot has to select the oxygen pulse length to suit the specific altitude.



The EDS is a completely automatic oxygen system for pilots. It adjusts to the pilot's breathing rhythm and supplies exactly the right amount of oxygen for the pressure height. Up to 20,000 ft. the pilot wears a nasal cannula, and above 20,000 ft. an oxygen mask instead.

mended maximum height. Using a cannula it could be a good option for cross country pilots flying up to about 20,000 ft.

Jürgen Knüppel, a gliding instructor and aviation doctor from Fürstenfeldbruck, who was advisor to the German National Gliding Team for many years, has taken a



Electronic oxygen supply units just give the pilot short pulses of oxygen sysnchronised with his breathing pattern.

close look at both systems and is impressed with them "though," as he says, "that is no substitute for certification following full testing by aviation authorities." Together with the German National Team, aerokurier had the opportunity to test their functioning and emergency procedures in a pressure chamber test. Members of the DAeC Team will now benefit from using this equipment when they compete in the World Gliding Championships in St Auban, France at the beginning of July. Competition tasks will mean wave flights in the highest mountain areas.

This is not the first time this type of system has been used in the World Gliding Championships: in New Zealand in 1995 Holger Karow and Michael Grund were both very satisfied with the equipment on the high altitude wave days.

There are other advantages too. Miniaturisation and weight savings thanks to micro electronics and oxygen supply via a cannula which is as comfortable to wear as glasses. The cannula can be put on before take-off and forgotten while being used at up to 20,000 ft., and all the time the pilot is completely free to eat, drink and communicate on the radio. Wave flight tests at up to 23,000 ft. over the last two years have confirmed adequate oxygen saturation in the blood at over 90%, measured with a portable pulsoximeter. These values are certainly safe levels.

With this electronic equipment there is no plumbing needed in the cockpit. There is a reduction valve and pressure gauge on the oxygen cylinder, connecting via a tube to the control unit. At this point the two systems differ somewhat. EDS reduces the cylinder pressure to 1.7 bar, the Flowtimer to 3 bar.

The equipment is simple to use. The EDS unit does everything for you. You just switch it on, check the battery life and then choose one of two Modes. If you choose Mode D (D = Day) the system supplies oxygen from 11,500 ft. upwards. The flow rate is matched to the altitude (density altitude) automatically by an integral temperature dependent pressure sensor. Whatever altitude you fly at no adjustment is necessary: the oxygen supply is always ideal. You just need to make sure that the pressure sensor in the unit is not blocked off.

In Mode N (N = Night) the EDS unit provides oxygen at any altitude, even below 11,500 ft. This is useful for power pilots as night vision is impaired by even the slightest reduction of oxygen in the blood. The flow increases from zero at sea level to the Mode D flow rates at 11,500 ft and above. In other respects the two Modes are similar in operation.

When it comes to economy the EDS is a clear winner. At 20,000 ft. a 2 litre cylinder at 200 bar (400 litres) will last eight hours, whereas a traditional continuous flow system will last only 2.16 hours. At 25,000 ft., which is not impossible with a traditional system and a 2 litre cylinder, maximum duration is 1.54 hours, including the climb and descent phases. The EDS pilot enjoys about three times this duration (see table). Expensive professional demand systems are also less wasteful, but they cannot match the EDS for oxygen economy.

The pilot is alerted by acoustic and visual warnings if a connection fails, or if the oxygen has run out, or if he is hyperventilating. With electronic regulation it is important to establish a regular breathing rhythm and not to breathe excessively fast, which in practice means taking not more than about 20 breaths per minute.

The warning to breathe normally is also beneficial in another way. If you breathe too quickly (hyperventilate) when the body does not require extra oxygen, there is a danger of the blood pH value being disturbed, with the result that brain's access to oxygen is considerably reduced. So it is the same story again: lack of oxygen.

The acoustic and visual warning is also triggered if the battery voltage is low.

Oxygen consumption and capacity of a 2 litre cylinder (200 bar) used in different systems

Height	Constant flow			EDS		Flowtimer	
m	1/min	1/h	h	1/h	h	1/h	h
4500	2,5	145	2:44	41	9:45	~90*	4:26
6100	3,0	175	2:16	49	8:00	~140*	2:50
6700	3,2	200	2:00	61	6:33	~140*	2:50
7600	3,5	210	1:54	70	5:42	-	-

When set to manufacturer's recommended settings.

Time Available For Raional Action After Loss Of Oxygen Supply. (Time of useful consciousness) (TUC)

Height (ft.)	Time (mins)
18,000	30
22,000	5 - 10
25,000	3 - 5
28,000	2 - 3

THE STAGES IN OXYGEN STARVATION

INITIAL PHASE
LETHARGY
LIGHT-HEADEDNESS
DIZZINESS
COLDNESS AND FALSE WARM SENSATIONS (SKIN)
SWEATING
A FEELING OF PRESSURE IN THE HEAD
TINGLING (FINGERS, TOES)
IMPAIRED VISION (SHIMMERING)

LATER
EXHAUSTION
SEVERE DIZZINESS
THROBBING HEADACHE
TUNNEL VISION
BLURRED VISION
TINGLING MUSCLES
DIFFICULTY IN CONCENTRATING
LOSS OF RESPONSE
LOSS OF JUDGEMENT
LOSS OF CRITICAL FACULTIES
EUPHORIA

FINAL PHASE
COLLAPSE
UNCONSCIOUSNESS
COMA
DEATH

According to the manufacturer there is time for the pilot to descend to a lower altitude with the EDS fully operational. An external battery can also be hooked up to the EDS so that the battery can be worn next to the body to counteract the low temperatures common at wave heights so it remains effective. At normal temperatures the 9 V battery is said to give 40 hours service.

If the EDS unit should fail, it is bypassed by connecting an oxygen mask directly to the tube from the reduction valve. This is not difficult for the pilot in the cockpit if he has checked out the procedure in advance. If the pilot can reach the valve on the cylinder, he can still regulate the flow slightly by turning it. If the oxygen has not been exhausted, the emergency descent will be safer if the pilot switches to continuous flow.

The Flowtimer by Spiegelberg has even less controls than the EDS, but it does require more attention because it has to be adjusted for altitude. There is an on/off switch and a switch for setting the oxygen pulse lengths. The pilot cycles through four oxygen supply pulse options. An LED confirms the option selected: 60 ml (10,000-13,000 ft), 80 ml (11,500-14,750 ft), 100 ml (13,000-16,500 ft) and 120 ml for higher altitudes. This recommendation has a large safety factor built in, because the values are higher than the EDS values which also include a safety factor. There is room for an experienced pilot using Flowtimer to tease out further oxygen savings.

The power supply to the unit is provided by two 1.5 V mignon cells which, according to the manufacturer, have a 100 hour service life. There is no battery tester. There is an acoustic and LED alarm when the batteries are empty, if there is no oxygen pressure or if you are not breathing through your nose for ten seconds - because breathing through the mouth means no oxygen.

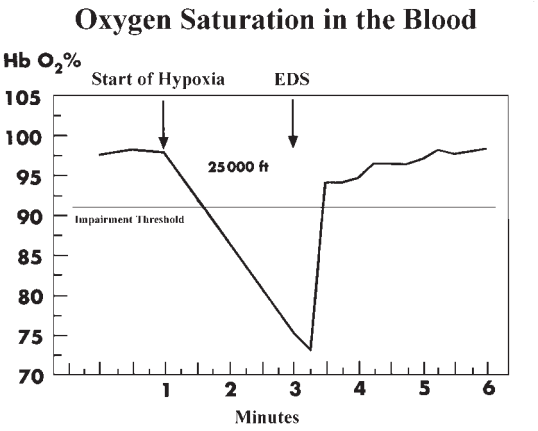
There are no specific emergency procedure recommendations for this equipment. It is not very easy to change over to constant flow to bypass the control unit. The pressure regulator is still supplying oxygen at 3 bar. It should still be possible to descend safely from about 20,000 ft. without changing over. At 20,000 ft. the pilot will probably be conscious and fairly coherent for up to about 30 minutes.

Bundeswehr glider pilots take additional oxygen cylinders for emergencies - an example worth following. Neither of the units is yet certificated by the German aviation authorities, though the EDS already has FAA approval in the United States.

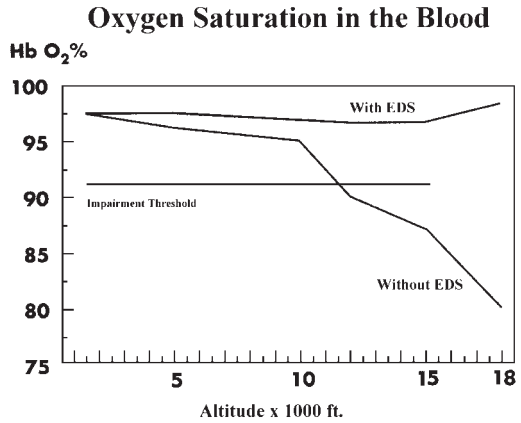
But even without official certification these units do represent good value compared with the alternatives in any case, and are definitely an extra safety benefit. In addition they offer enhanced mental performance at medium altitudes between 10,000 and 20,000 ft. Their sheer economy of operation means a pilot can start using oxygen at a lower altitude. At heights in excess of 20,000 ft. a closed system with oxygen mask should be used.
Gerhard Marzinzik

Specifications EDS and Flowtimer

Type	EDS	Flowtime
Dimensions	8.2 x 14.3 x 4 cm	6.7 x 13.5 x 3.6 cm
Weight	374 g	300 g
Battery	9 V	2 x 1.5 V
External battery	Possible	No
Battery tester	Yes	No
Battery life in use	40 hrs.	100 hrs.
Operation temperature	-55 ^{o} to 50 ^{o}C	-5 ^{o} to 50 ^{o}C
Automatic adjustment		
To breathing	Yes	Yes
To pressure height	Yes	No/Manual
Automatic start	11,500ft./0ft.	--
Warning-acoustic & visual		
Empty battery	Yes	Yes
No oxygen supply	Yes	Yes
If hyperventilating	Yes	No
Not breathing through nose	No	Yes
Equipment		
Pressure regulator	Yes	Yes
Nasal cannula	Yes	Yes
Oxygen mask	Yes	No
Drager mask	150 DM	No
Connections	Yes	Yes
Batteries	Yes	Yes
Price	1780 DM	1199 DM
Supplier	Buscher	Spiegelberg
	Hohler Weg 6	Tempowerkring
	34466 Wolfhagen	21079 Hamnburg
	Germany	Germany
	+49 5692 2363	+49 40 7901 2220



At high altitudes loss of oxyen supply is immediately critical. EDS provides rapid relief.



Oxygen equipment is a mondatory requirement for non-commercial fligh above 12,000 ft. The diagram shows why.