OXYGEN

PIPER AIRCRAFT CORPORATION

LOCK HAVEN, PENNSYLVANIA, USA

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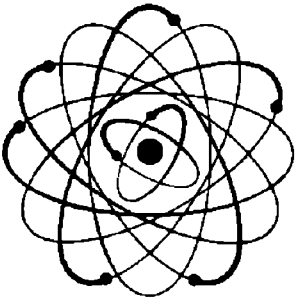

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INTRODUCTION

A NEW ERA

Piper's fleet of turbocharged models have opened a new era of utility for their owners. Now it is possible to cruise above most weather where the air is smoother and greater speeds are attainable.

For owners to achieve maximum utility from their turbocharged aircraft, Piper recommends that they be equipped with oxygen systems. Oxygen systems are also available for non-turbocharged, high performance Piper aircraft.

This booklet contains information on the use of supplemental oxygen, duration tables and formulas for computing duration, check lists, operating and service procedures and optional equipment.

This manual will help obtain maximum utility from the oxygen system and high performance airplane.

WHAT EVERY PILOT SHOULD KNOW ABOUT OXYGEN

by Arthur E. Miller
Director of Research
Scott Aviation Corporation

WHAT IS AIR?

The air surrounding us is a mixture of gases consisting of 78% nitrogen and 21% oxygen. The remaining 1% is made up of minute traces of other rare gases.

WHAT IS OXYGEN?

Under normal conditions, pure oxygen is a colorless, tasteless, ordorless, non-combustible gas. It is the most important single element in our universe.

WHY IS OXYGEN SO IMPORTANT?

Although it will not burn alone, oxygen supports combustion; in fact, without oxygen there can be no fire. Oxygen, therefore, is not only necessary for the burning of combustible materials, but it is absolutely essential to support the process of "vital combustion" which maintains human life. Although man can live for weeks without food or for days without water, he dies in minutes if deprived of oxygen.

The human body is essentially a converter which consumes fuel and produces heat and energy. It is like a furnace which utilizes the oxygen in air to burn coal, producing heat and power. The human body must have oxygen to convert fuel (the carbohydrates, fats, and proteins in our diet) into heat, energy, and life. The conversion of body fuels into life is similar to the process of combustion; fuel and oxygen are consumed, while heat and energy are generated. This process is known as "metabolism".

WHERE AND HOW DO WE NORMALLY OBTAIN OUR OXYGEN?

At each breath we fill our lungs with air containing 21% oxygen. Millions of tiny air sacs (known as "alveoli") in our lungs inflate like tiny balloons. In the minutely thin walls enclosing each sac are microscopic capillaries, through which blood is constantly transporting, from the lungs to every cell in the body, the oxygen extracted from the air in the lungs. Because the body has no way to store oxygen, it leads a breath-to-breath existence.

HOW MUCH OXYGEN DOES THE HUMAN BODY NEED?

The rate of metabolism, which determines the need for and consumption of oxygen, depends on the degree of physical activity or mental stress of the individual. A man walking at a brisk pace will consume about four times as much oxygen as he would when sitting quietly. Under severe exertion or stress, he could be consuming eight times as much oxygen as when resting.

WHAT HAPPENS IF THE BODY DOES NOT RECEIVE ENOUGH OXYGEN?

When the body is deprived of an adequate oxygen supply, even for a short period, various organs and processes in the body begin to suffer impairment from oxygen deficiency. This condition is known as "hypoxia". Hypoxia affects every cell in the body but especially the brain and the body's nervous system. This makes hypoxia extremely insidious, difficult to recognize, and, therefore, a serious hazard, especially to fight personnel.

WHAT ARE THE EFFECTS OF HYPOXIA?

Hypoxia causes impairment of vision (especially at night), lassitude, drowsiness, fatigue, headache, euphoria (a false sense of exhilaration), and temporary psychological disturbance. These effects do not necessarily occur in the same sequence nor to the same extent to all individuals, but are typical in average persons when affected by hypoxia.

WHEN AND WHY MUST WE USE EXTRA OXYGEN?

Supplementary oxygen must be used to enrich the air we breathe to compensate for either a deficiency on the part of the individual or a deficiency of the atmosphere which we are breathing.

A person may have a respiratory or circulatory impairment which reduces the ability of his body to utilize the 21% oxygen in the air around him. For such a person, supplementary oxygen must be administered by oxygen tent or by oxygen mask to enrich the inhaled air by adding oxygen to it. The total volume of oxygen in each inhalation is then so much greater than normal that it compensates for the individual's own physical inability to utilize normal atmospheric oxygen.

When we ascend in altitude, a different condition is encountered, a condition in which the individual may be perfectly normal, but in which there is an oxygen deficiency in the atmosphere and supplementary oxygen must be used.

DOES THE PERCENTAGE OF OXYGEN IN THE AIR CHANGE WITH ALTITUDE?

No; the ratio of oxygen to nitrogen in the composition of air does not change. The 21% of oxygen in air remains constant at altitudes up to several hundred thousand feet.

WHY MUST WE USE EXTRA OXYGEN WHEN WE ASCEND IN ALTITUDE?

The blanket of air, several hundred miles thick, which surrounds our planet is compressible and has weight. The air closest to the earth is supporting the weight of the air above it and, therefore, is more dense; its molecules are packed closer together, As we ascend in altitude, for example, at 10,000 feet, the atmospheric pressure is only two-thirds that at ground level. Consequently, the air is less dense, and each lungful of air contains only two-thirds as many molecules of oxygen as it did at ground level. At 18,000 feet the atmospheric pressure is only one-half that at ground level. Although the percentage of oxygen is still the same as at ground level, the number of molecules of oxygen

in each lungful is reduced by one-half.

As we ascend, there is a progressive reduction in the amount of oxygen taken into the lungs with each breath, and, therefore, there is a decrease in the amount of oxygen available for the bloodstream to pick up and transport to every cell in the body. To compensate for this progressive oxygen deficiency, we must add pure oxygen to the air we breathe in order to maintain in the inspired air enough oxygen molecules to supply the metabolic needs of the body.

AT WHAT ALTITUDES SHOULD OXYGEN BE USED?

In general, it can be assumed that the normal, healthy individual is unlikely to need supplementary oxygen at altitudes below 8,000 feet. One exception is night flying; because the retina of the eye is affected by even extremely mild hypoxia, deterioration of night vision becomes significant above 5,000 feet.

Between 8,000 and 12,000 feet, hypoxia may cause the first signs of fatigue, drowsiness, sluggishness, headache, and slower reaction time. At 15,000 feet, the hypoxic effect becomes increasingly apparent in terms of impaired efficiency, increased drowsiness, errors in judgment, difficulty with simple tasks requiring mental alertness or muscular coordination. These symptoms become more intensified with progressively higher ascent or with prolonged exposure. At 20,000 feet, a pilot may scarcely be able to see -- much less read -- his instruments. His hearing, perception, judgment, comprehension, and general mental and physical faculties are practically useless. He may be on the verge of complete collapse.

Therefore, the availability and use of oxygen from the ground up on night flights where altitudes above 5,000 feet are contemplated, and at altitudes above 8,000 feet on daytime flights, is recommended.

HOW CAN YOU TELL WHEN YOU NEED OXYGEN?

You can't; therefore, oxygen should be used before it is needed. The most dangerous aspect of hypoxia is the insidious, "sneaky" nature of its onset. Because the effects of hypoxia are

primarily on the brain and nervous system, there is a gradual loss of mental faculties, impairment of judgment, coordination, and skill; but these changes are so slow that they are completely unnoticed by the individual who is being affected. Actually, a person suffering from mild or moderate hypoxia is apt to feel a sense of exhilaration or security; he may be quite proud of his proficiency and performance although he may be on the verge of complete incompetence.

Because hypoxia acts upon the brain and nervous system, its effects are very much like those of alcohol or of other drugs which produce a false sense of well-being. There is a complete loss of ability for self-criticism or self-analysis; some people believe that an individual can detect his need for oxygen by noting the increase in his breathing rate, his accelerated heartbeat, and the slight bluish discoloration (cyanosis) of the fingernails. However, by the time these symptoms develop, the individual is more likely to be mentally incapable of recognizing these signs; he may decide that he has always wanted blue fingernails! Even while "spiraling" out of control, he may be convinced (if he is conscious at all) that he is doing this deliberately and enjoying it immensely.

ARE ALL INDIVIDUALS EQUALLY AFFECTED BY HYPOXIA?

No, they are not. Just as there is a variation among individuals in their ability to tolerate heat, cold, or alcohol, so can some people tolerate without apparent effect a degree of hypoxia which would have noticeable effects on others who are more susceptible to oxygen lack. There is no way to measure and predict hypoxia tolerance, because it can be affected by physical condition, fatigue, emotion, tobacco, alcohol, drugs, diet, and other factors.

The individual who has flown at 14,000, 16,000, or 18,000 feet without oxygen and survived has no idea how close he may have been to disaster. He may believe that all this talk about oxygen need, if true at all, does not apply to himself. Such a belief may some day be fatal.

IS IT TRUE THAT OXYGEN IS TOXIC OR HARMFUL?

Oxygen is often used for prolonged periods in hospitals and homes for oxygen therapy with no harmful, and with definitely beneficial, effects. It is most generally agreed that a 60% oxygen concentration on the ground, which is equivalent to a 100% oxygen concentration at approximately 12,000 feet, will not cause any harmful effects.

WHY NOT USE OXYGEN INTERMITTENTLY FOR SHORT PERIODS?

If one is at an altitude where there is an oxygen deficiency, intermittent use of oxygen would only temporarily alleviate the hypoxia effects during the period in which oxygen is being used. Because of the insidious nature of hypoxia, a person already mildly hypoxic is very unlikely to even think of using his oxygen equipment, either intermittently or otherwise.

It is true that occasional use of oxygen for five or ten minutes (even at altitudes below 8,000 feet) can act as a "refresher" to relieve the effects of mild hypoxia, of cigarette smoke, of apprehension, or other factors. Also, the use of oxygen for five or ten minutes before termination of a flight (even though the entire flight may have been at less than 8,000 feet) can be an excellent tonic to put the pilot in his best mental and physical condition for the approach procedures and landing maneuvers.

HOW WILL OXYGEN EQUIPMENT IMPROVE THE UTILITY OF THE AIRPLANE?

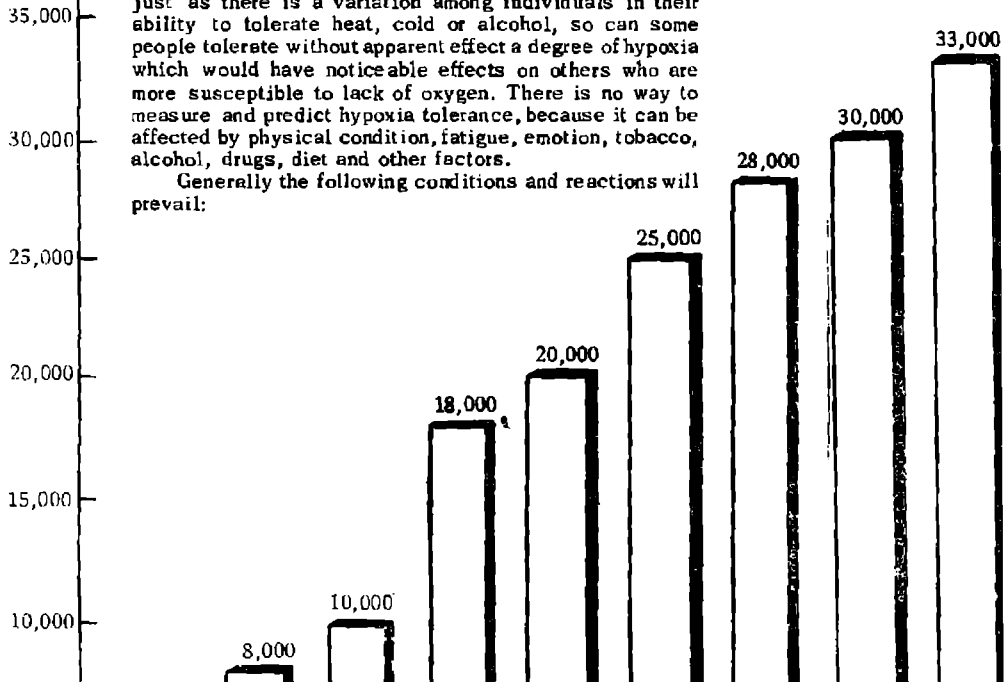
With oxygen equipment aboard, the pilot can choose the higher altitudes which give the smoothest flight, the most favorable winds, the best performance from the Omni and other radio navigation equipment, the highest speed, the longest range, and the best engine performance. The pilot can have these advantages safely with oxygen, because his own performance will not be affected by hypoxia; he will be just as efficient and capable as at lower altitudes or even on the ground. With oxygen equipment in use, pilot and passengers will arrive at their destination fresh and fit, without the headache, lassitude and fatigue which often

result from prolonged exposure to even mild hypoxia.

MAN'S SUPPLEMENTAL OXYGEN REQUIREMENTS VS. ALTITUDE

Individuals are not all equally affected by hypoxia. Just as there is a variation among individuals in their ability to tolerate heat, cold or alcohol, so can some people tolerate without apparent effect a degree of hypoxia which would have noticeable effects on others who are more susceptible to lack of oxygen. There is no way to measure and predict hypoxia tolerance, because it can be affected by physical condition, fatigue, emotion, tobacco, alcohol, drugs, diet and other factors.

Generally the following conditions and reactions will prevail:



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FEET	REACTION
35,000	Pressurized oxygen system required regardless of oxygen flow.
35,000 33,000	Pure oxygen barely adequate. 15 seconds of clear consciousness without supplemental oxygen.
30,000	Unconsciousness in two minutes without supplemental oxygen.
28,000	Immediate 100 percent loss of coordination without supplemental oxygen.
25,000	Hypoxia rate increases rapidly. Usually less than five minutes consciousness without supplemental oxygen.
20,000	Unconsciousness can occur in as little as five to seven minutes at 20,000 feet without supplemental oxygen.
18,000	This is the half-way point in the earth's atmosphere and pressure is reduced to 7.34 PSI and oxygen saturation in the body is only 75%. Without supplemental oxygen, hypoxia is almost immediately apparent and efficiency deteriorates quickly and drastically. Unconsciousness can occur if supplemental oxygen is not used.
10,000	Fatigue, drowsiness and sharp headaches can occur with increasing quickness if flights are made without supplemental oxygen at this and higher altitudes.
8,000	Over prolonged flights there are measurable changes in blood pressure and respiration. Mild hypoxia can result. It is generally assumed that the normal, healthy individual is unlikely to need supplementary oxygen at and below this altitude.
5,000	No supplemental oxygen required below 5,000 feet. Oxygen saturation at this altitude is 95%. Use of supplemental oxygen at and above 5,000 feet for night flying will benefit pilot, particularly towards end of flight. Smoking reduces visual acuity and service altitude of the individual.

SECTION I

DESCRIPTION

PIPER OXYGEN SYSTEMS

Piper provides factory or field installed oxygen systems for turbocharged and high performance model aircraft.

This equipment is manufactured under Piper's name and is engineered for simplicity of operation, maximum efficiency and minimum maintenance.

Piper Oxygen Systems are continuous flow and flow rate is governed by the size of orifice installed in each mask. The flow rate is automatically regulated to remain constant. Masks having a 2 liter per minute flow provide a 5,000 foot altitude equivalent of oxygen at 20,000 feet: Masks with a 1.5 liter per minute flow provide a 10,000 foot altitude equivalent of oxygen at 20,000 feet.

The systems are not designed for use above 30,000 feet.

When masks are not in use they should be disconnected. Oxygen will continue to flow through the mask whether it is worn or not as long as it is connected to the outlet and the system is "On".

Smoking is prohibited while oxygen is in use and for several minutes after the system is turned "Off".

STANDARD SYSTEMS

The standard system for the Comanche series includes four outlets, one 2.0 LPM mask for pilot and three 1.5 LPM masks for passengers. A conversion kit is available for six outlets and additional masks.

The Aztec standard system consists of six outlets, one 2.0 LPM mask for pilot and five 1.5 LPM masks for passengers.

The Navajo system consists of eight outlets, one 2.0 LPM mask for pilot and seven 1.5 LPM masks for passengers.

MASKS

Three different face masks and three connectors with different flow rates are available with Piper Oxygen Systems.

The natural rubber BLB Nasal and Oronasal Microphone Masks are of the constant flow type. They are proven by years of military and civilian use.

Semi-disposable mask assemblies are made of molded, pliable polyetheylene plastic, easily cleaned for re-use.

All masks come with adjustable elastic head band, flow indicator and connector.

Oxygen flow is measured in liters per minute. Connectors to wall outlet are color coded to indicate flow rates.

Masks	Liters Per Minute	Liters Per Hour	Marking
Oronasal Microphone Mask	2.0	120	Red Band
BLB Nasal Mask	2.0	120	Red Band
Semi-Disposable	2.0	120	Red Band
Semi-Disposable	1.5	90	Gold Band
Therapeutic	7.5	450	Therapeutic

OXYGEN CAPACITY

Two sizes of oxygen cylinder are used in Piper Oxygen Systems.

When full, both cylinders will indicate 1,850 PSI.

The Navajo and Aztec systems use a 115 cubic foot capacity cylinder of which 3,092 liters or 95 percent of the 3,255 liter

capacity is usable.

The Comanche and Twin Comanche systems use a 63 cubic foot capacity cylinder of which 1,692 liters or 95 percent of the 1,792 liter capacity is usable.

Because extremely low pressures can make regulation erratic, the last five percent of oxygen in the cylinder is considered unusable. This is a safety factor built into all oxygen systems.

OXYGEN DURATION

Oxygen duration is dependent upon liter flow and number of masks in use during flight.

DURATION FORMULA

To figure duration, divide total liter flow per hour of all masks in use into usable oxygen.

PRESSURE VS. USABLE OXYGEN*

PSI	Navajo/Aztec Usable Liters	Comanche/Twin Comanche Usable Liters
1850	3092	1692
1600	2670	1470
1400	2340	1280
1200	2010	1100
1000	1670	920
800	1330	730
600	1010	550
400	670	370
200	335	185

*Calculated using CAR 4b-21 Oxygen Flow Chart; 70° F., 95% Cylinder Volume. Below 150 PSI flow is unreliable.

DURATION IN HOURS* (Standard Systems, Pilot 2.0 LPM, Passengers, 1.5 LPM)

Persons Using	Navajo Aztec	Comanche Twin Comanche
1	25.76	14.10
2	14.72	8.05
3	10.30	5.64
4	7.93	4.33
5	6.44	3.52
6	5.42	2.96
7 (Navajo)	4.68	
8 (Navajo)	4.12	

EARLIER SYSTEMS

Some earlier Piper oxygen systems installed in production or sold in kit form have a 2.5 liter flow per minute. The only difference in the systems is in the orifice in the wall connector which is not color coded. These 2.5 LPM orifices may be replaced with the 2.0 LPM or 1.5 LPM orifices to obtain the greater duration.

DURATION IN HOURS* (2.5 LPM, All Masks)

Persons Using	Aztec	Comanche Twin Comanche
1	20.61	11.28
2	10.30	5.64
3	6.87	3.76
4	5.15	2.82
5	4.12	
6	3.43	

*Calculated using CAR 4b-21 Oxygen Flow Chart; 70° F., 95% Cylinder Volume.

SECTION II

OPERATION

Piper Oxygen systems are turned "On-Off" by means of a Push/Pull knob.

When the system is "On", each passenger gets oxygen by plugging his individual connector into the wall outlet next to the seat. This outlet has a check valve and oxygen will not flow through it unless the connector is inserted.

Oxygen will flow through the mask at the full breathing rate as long as the system is "On" and the mask is connected to the wall outlet regardless of whether or not it is worn.

CHECK LIST

Cylinder should be checked for sufficient oxygen before all flights. Gauge will read 1850 PSI in all Piper systems when full.

1. Insure that there are no kinks in hose between mask and wall outlet.
2. Check mask for proper attachment to hose.
3. Oxygen ON. Pull knob full out gently.
4. Check mask for proper fit. It should be comfortable. You can breathe normally through Piper masks when oxygen is not on.
5. Insert connector into wall outlet. Push in firmly, turn clockwise approximately 90° against the internal stop.
6. Check flow indicator. Flow indicator is located on hose approximately 12" below mask. Red indicator sleeve will disappear into housing when oxygen is flowing. If indicator does not move, check hose for kinks, connector for proper positioning and if oxygen system is ON.

CAUTION

NO SMOKING WHEN USING OXYGEN

AFTER USE

1. Oxygen OFF. Knob full in.
2. Remove mask and disconnect by turning connector 90° counterclockwise.
3. Coil mask tubing in approximately 4" loops and store in container.

SECTION III

SERVICING

OXYGEN SYSTEM SERVICING

The cylinder is serviced through a filler valve located in a convenient place in each aircraft. There is no need to remove the cylinder from the aircraft for refilling.

Whenever possible, use only aviators breathing oxygen.

IMPORTANT

Oil, grease or any lubricant in contact with oxygen creates a serious fire hazard. Such contact must be avoided.

Only a thread compound approved under MIL-T-5542 can be used safely on oxygen systems. Apply only to the first three threads of male fittings to prevent thread seizure.

While oxygen is non-flammable in its pure state, mixed with other gases or hydrocarbons, it becomes extremely inflammable.

Permit no smoking aboard the aircraft when using oxygen and for a few minutes after the flow has been shut off.

Oil, grease and other fatty materials constitute a fire hazard when in contact with oxygen. Be sure that hands and clothing are free of these when handling oxygen equipment, particularly connecting plugs.

SECTION IV

OPTIONAL EQUIPMENT

Six-place Conversion for Comanche, Twin Comanche	The Comanche and Twin Comanche standard systems are four-place. Six-place may be specified for production installation. A conversion kit is available to increase present four-place to six-place.
Therapeutic Mask	Molded, pliable polyetheylene plastic, easily cleaned for re-use. Delivers 7.5 liters per minute from any wall outlet without extra regulatory adjustment. Ideal for passengers with asthma or known cardiac condition.
Semi-Disposable Masks	Molded, pliable polyetheylene plastic, easily cleaned for re-use. Delivers either 2.0 LPM or 1.5 LPM. Complete with connectors, flow indicator, tubing.
Oronasal Microphone Mask	Proven by years of military and civilian use, finest type constant flow mask available. Natural rubber face piece. Delivers 2.0 LPM. Complete with connectors, flow indicator, tubing, RS-8 Microphone with "Push To Talk" Switch in cable.

BLB Nasal Mask	Finest natural rubber, proven by years of service. Delivers either 2.0 LPM or 1.5 LPM. Complete with connectors, flow indicator, tubing.