MH EDS O₂D1-2G

Single Person
Electronic Digital Pulse-Demand™
Aviation Oxygen Delivery System

INSTRUCTION MANUAL

Thank you for purchasing the MH EDS O_2D1-2G Pulse-Demand Oxygen Controller. The MH EDS O_2D1-2G (O2D1) is patented oxygen control technology that allows you and your co-pilot to fly with safety and comfort, knowing it will automatically give the oxygen required at the various altitudes.

THE EDS O_2D1-2G IS DESIGNED FOR EASY OPERATION, PLEASE CAREFULLY READ THIS INSTRUCTION MANUAL BEFORE USE.

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Aviation Oxygen Systems

MOUNTAIN HIGH
Equipment & Supply Company

Proudly Made in the USA

Patent # 6,220,244
Other Patents Pending

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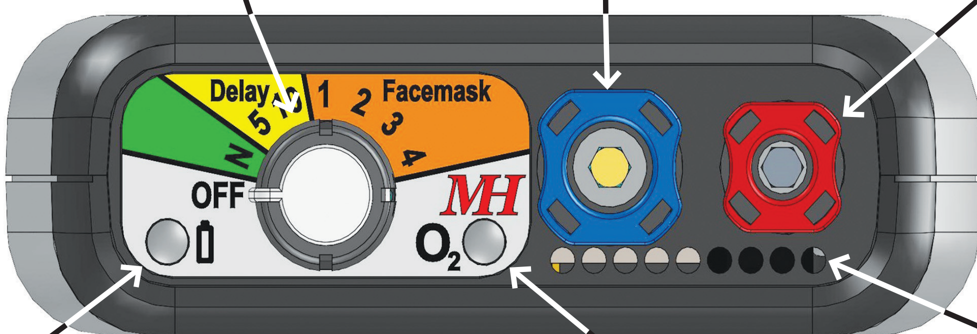
INTRODUCTION

The patented MH EDS-O2D1-2G (O2D1) is an aviation oxygen delivery device for one person. It is designed to deliver aviation oxygen in the most efficient, comfortable and convenient way possible. With its user-selectable settings, apnea alarm and small size, the O2D1 is the most portable and flexible electronic digital oxygen delivery system in the world.

By providing a measured pulse of oxygen at the beginning of each inhalation, the O2D1 automatically supplies the oxygen you need to stay alert and comfortable while flying. In contrast to constant flow systems that waste oxygen by supplying more than your body can use, the O2D1 provides a short pulse of oxygen as you inhale, ensuring that your oxygen is used most efficiently. Efficient oxygen delivery means you can fly farther on a single oxygen refill or save space and weight with a smaller tank. It also makes it more feasible to enjoy the advantages of oxygen while flying below the altitudes where oxygen is mandated--that can mean fewer headaches, increased alertness, and feeling less exhausted when you reach your destination. Your actual oxygen usage will be determined by your breathing rate and physiological needs at altitude.

The programmability of the O2D1 means that, unlike constant-flow oxygen systems, you can "set it and forget it". By automatically detecting your pressure altitude, the O2D1 can be set to start providing oxygen immediately or at a specified altitude and will automatically adjust the oxygen flow as your altitude changes. When you're flying, don't you have more important things to do than adjust your oxygen flow during altitude changes?

FEATURES



- Easy-to-use, small size and light weight.
- Incorporates a MIL spec ruggedized easy-to-grip rotary control switch providing improved reliability, increased ease of function and visibility. This switch also has very positive position detents for excellent tactile feedback making it resistant to changes from causal rubbing or bumping.
- Automatically adjusts oxygen flow for altitude pressure density.
- Provides reduced oxygen consumption through more efficient oxygen delivery than standard constant-flow systems.
- Rotary Mode-Selector Switch allows automatic altitude enable, Night and Day operations and high flow settings.
- Green/Yellow/Red LED's indicate oxygen flow, alarm, and status.
- Audible and visible flow-fault alarm informs user of kinked, pinched, or disconnected oxygen lines, obstructed cannula or mask.
- Reduced dry mouth and sinus discomfort compared to constant-flow oxygen systems.

BASIC SAFETY

Pure oxygen is a highly oxidizing gas and can vigorously accelerate combustion. It can provide a catalyst for spontaneous combustion resulting in personal injury or death if not used properly and with caution.

- ***DO NOT use any type of oil or grease on any of the fittings, valves or cylinders.***
- ***DO NOT smoke while in use.***
- ***DO NOT operate near an open flame.***

The O2D1 is intended to be used with regulators provided by Mountain High. Some third-party oxygen regulators may be used. See "Using a Third-Party Regulator" page 6 for details. Pilots who intend to fly with the O2D1 are advised to familiarize themselves and their passengers with the system prior to using it. Two cannulas and a face mask are included with the O2D1 unit. The cannula may be used for flight operations up to 18,000 ft. Above 18,000 ft., a face mask should be worn. A compatible face mask with a built-in microphone is available from Mountain High.

Face Mask

Instruction Manual

MH EDS-O2D1-2G Unit

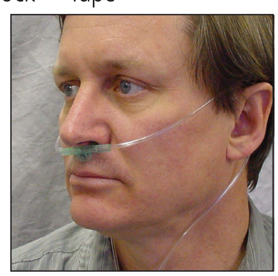
Oxygen Input Tube

Cannulas
1 standard, 1 flared tip

AA Batteries (Qty 2)
3M Dual-Lock™ Tape

Tote Bag

1. **If** you have not already done so, fill your cylinder with Aviation oxygen. (Many FBOs offer this service.)
2. **Inventory** your system *(see photo) and* read the front label on the unit.
3. **Read** the instructions provided with your cylinder and regulator, attach the regulator to the cylinder and **hand tighten only *(DO NOT use a wrench or pliers. The "O" ring seals the regulator to the cylinder, and over-tightening will damage the regulator).***
4. **Open** the battery cover on the back of the O2D1 unit, install the 2 AA batteries (supplied) and replace the battery cover. *(NOTE: Batteries fit tightly, handle with care.) See next page for detailed instructions.*
5. **If** you are using the O2D1 with a Mountain High Four-Port regulator (FPR), locate the oxygen input tube (clear tube with a short red tube on one end) and insert the *Red* tube into the red "Oxygen In" connector on the O2D1 unit until it stops (approx.1/8 inch). Then connect the other end of the tube to your regulator. If you are using a MH single port regulator (XCR), use the red tube that came with the regulator in place of the tube that came with your O2D1.
6. **Insert** the Blue end of the cannula or face mask tubing into the ***blue*** "Out" connector on the unit. ***(CAUTION: DO NOT pinch the cannula or face mask tubing when inserting them into the blue "Out" connectors). Use only the supplied MH EDS cannula or face mask as other cannulas or masks will not work properly with the O2D1. DO NOT lengthen or shorten the cannula tube.***
7. **Turn** the cylinder valve on.
8. **Turn** the Rotary Mode-Selector Switch on the O2D1 unit once clockwise. This will turn the unit on and set it to "N" mode. A start-up pulse of oxygen, LED light and beeper test will verify battery power.
9. **Don** the cannula or face mask (make sure the face mask seals against the skin) and take a breath. The bright green LED should illuminate, and a pulse of oxygen should be delivered. Refer to the card that comes with the cannula or face mask for details on donning.
10. ***You are ready to fly.***



Comfortable cannula position, looped over ears and the tab pointed down.

O2D1 with cannula and AA batteries

INSERTING AND REMOVING THE BATTERIES

Remove the battery door by pressing down gently on the battery cover flange then slide the door out and away from the unit. The O2D1 unit uses two (2) standard AA alkaline batteries. Insert the batteries as shown on the label inside the battery compartment (they will be a tight fit), then replace the door by sliding the door into place until it snaps in place. Take care when removing and replacing the batteries as to not damage the batteries and/or connectors.

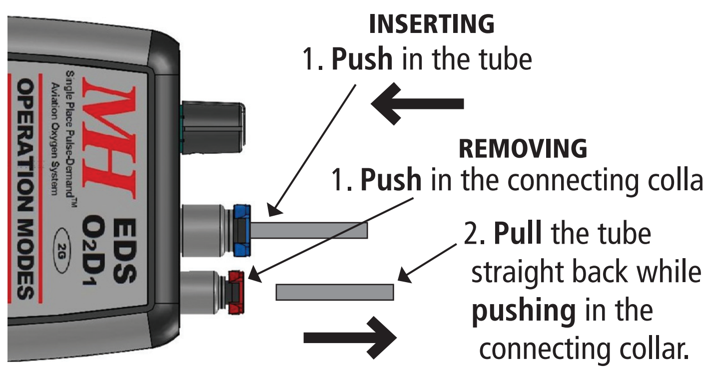
Recommended Batteries: 2 each 1.5 volt DURACELL ULTRA alkaline batteries type 'AA' or equal quality equivalent.
Battery Life: 100 Hrs. @ ~25° C. @ ~25% R.H. Measured from mean, assuming fresh DURACELL ULTRA alkaline batteries operating under normal operating conditions.
NOTE:
Batteries should be replaced annually or when voltage is low.
Lithium batteries are NOT recommended.

INSERTING AND REMOVING THE TUBING

To INSERT the tubing, push tubing in until resistance is felt, then push in a little harder, about another 1/8 inch. Then give it a gentle tug to make sure it has seated properly.

To REMOVE the tubing, push tubing in slightly, then push in the connector collar while you pull gently on the tubing to remove it.

WHEN REMOVING TUBING; *DO NOT* PULL ON THE TUBING WITHOUT PUSHING IN THE COLLAR; IT WILL DAMAGE THE CONNECTOR.



STORING THE O2D1

When not being used, the O2D1 unit, oxygen tubes, cannulas, etc., should be disconnected from the oxygen supply and stored in a secure manner to ensure that dirt and debris do not enter the inlet and outlet tubes. The supplied tote bag or a zip-top plastic bag is a good storage container. ***If the unit is not going to be used for 30 days or more, remove the batteries. When using the unit for the first time after storage, check the batteries to ensure proper operation. A set of fresh spare batteries should be part of your pre-flight inventory.***

DO NOT store the EDS unit while the inlet is under pressure. Remove all sources of oxygen pressure and secure the unit to ensure it will not become damaged. If the lines are disconnected they must be covered so that debris, dust or dirt can't get in. If the supply line is left hooked to the system, make sure that it is first purged with clean dry air or oxygen before the EDS unit is connected. ***If the lines are disconnected they must be covered so that debris, dust or dirt can't get in.***

MOUNTING THE O2D1

You may mount the O2D1 unit to a suitable place using the supplied piece of 3M DUAL LOCK tape. Peel the protective backing off one of the rectangles to expose the adhesive and apply it to the back of the unit above the thumb indent for the battery door. **DO NOT COVER ANY PART OF THE BATTERY DOOR**. When a suitable place to mount the unit has been found, peel off the protective adhesive backing on the other rectangle and press the adhesive side to the chosen mounting area. ***Let the adhesive cure for 12 hours before attempting to remove the two halves of the Dual-Lock from each other, or the adhesive may pull away from the unit or mounting area.***

ROTARY MODE-SELECTOR SWITCH SETTINGS AND MODES OF OPERATION

The O2D1 unit is controlled by a Rotary Mode-Selector Switch.
A stop inside the selector switch prevents inadvertently turning the unit off in flight.

Mode-Selector Switch Settings

The O2D1 has three main modes of user controlled operation:

1. Semi-Automatic (N Mode)
2. Fully-Automatic (D5, D10)
3. Semi-Automatic (F Modes)

Mode-Selector Switch as seen in the "OFF" setting

NOTE: The N and D modes are designed to provide the amount of oxygen needed by an average size healthy person using a cannula at the given altitudes; your needs may be different. To determine whether you are receiving enough oxygen in a particular mode you will need to use a pulse oximeter (available from Mountain High) to determine your blood oxygen saturation (goal is 90-100%) at any given altitude. In all modes, the O2D1 provides a pulse of oxygen which increases with altitude, i.e., it is altitude compensating.

N MODE: "Night" or "Now"

At this setting the O2D1 will immediately start the standard oxygen flow, providing pulses of oxygen appropriate for an average healthy person using a cannula.

Flow start: All altitudes
Use with: Cannula
Flow amount: Standard
Altitude Compensating?: Yes

D MODES: "Day" or "Delayed"

The *D5* setting will cause the O2D1 unit to delay oxygen flow until it senses a pressure altitude of 5,000 ft. and above. The *D10* setting delays oxygen flow until 10,000 ft. and above. NOTE: When the barometric pressure is low, it will start operation at a slightly lower altitude than when the barometric pressure is high.

Flow start: D5--5,000 ft., D10--10,000 ft.
Use with: Cannula
Flow amount: Standard
Altitude Compensating?: Yes

F MODES: "Face Mask"

NOTE: The F settings are used with the Face Mask or when requiring an increased oxygen flow with the cannula.

The F-Mode settings augment the amount of oxygen needed to compensate for the additional dead-space plenum associated with face masks. They also can be used with the MH cannula in situations where more oxygen may be required over the normal 'N' and 'D' settings. Since F-Mode settings are calibrated for use with the MH Alps face masks, only use the approved MH EDS or ALPS face mask.

F settings 1 to 2 are for small Alps face masks.
Settings 2 to 3 are for medium sized Alps face masks.
3 to 4 are for large Alps face masks.

F1= > **Small Mask**
F2= > **Medium Mask**
F3= > **Medium Mask**
F4= > **Large Mask**

Flow start: All altitudes
Use with: Cannula or face mask
Flow amount: Enriched
Altitude Compensating: Yes

The O2D1 is equipped with AUDIO-VISUAL ALARMS and ALERTS designed to bring to the user's attention potential malfunctions of the unit. Read the following for specifics.

POWER UP

POWER-UP: Red Light flashing on and off with audio chime for ~ two (2) seconds with each initial power-up with pulse of O_2 for about 1/2 second.

O_2 DELIVERY or NON-DELIVERY

O2 DELIVERY or NON-DELIVERY: Normally one flash of the LED **Green Light** (~1/4 second minimum) will flash for each pulse of oxygen with a valid inhalation event with properly connected oxygen lines. **NOTE:** The O2D1 **FLOW-FAULT** (see **FLOW-FAULT** below) indicator will not function as an out-of-oxygen warning if the pressure in the oxygen cylinder is 500 psi or less. There may be pressure in the oxygen line but not enough to activate the Pulse-Demand unit, consequently...no FLOW-FAULT warning. Prior to flying, using the cylinder chart, the pilot should estimate his flight altitude and time to determine the amount of oxygen that he or she will need. It is better to have more than your estimated need. If a pilot consistently flies above 18,000 feet, the aircraft should have a supplementary gauge, visible during flight by the pilot, to determine the cylinder oxygen pressure. You should also carry an EOS (Emergency Oxygen System) such as the MH Co-Pilot as a back-up safety feature in case the other system stops working. It is the absolute responsibility of the pilot to determine that there is an adequate amount of oxygen pressure in the oxygen cylinder prior to his flight, as well as an emergency back-up in case of a system failure. The oxygen system must be checked and tested **ON THE GROUND** before the flight.

FLOW FAULT EVENT

FLOW-FAULT EVENT: The O2 LED **Red Light** will flash on and off along with a Hi-Lo audio chime for ~ 2 seconds with every event. **NOTE:** The **FLOW-FAULT** is not intended as a low or out-of-oxygen warning. It is only intended to warn the pilot that there is no oxygen flowing to the EDS O2D1 unit. This typically means that the cylinder valve was not opened, or the supply line has been pinched closed, or is plugged up, or has come off, or the valve in the O2D1 has failed to open.

APNEA EVENT

APNEA EVENT: Flash **Amber Light** four (4) discrete times with audio beeps once every four (4) seconds until unit detects a valid inhalation event. Time before Apnea event is ~30 ~35 seconds. This typically occurs for the following reasons: **(1)** The user has quit breathing for 30 - 45 seconds or the cannula/face mask is improperly worn. **(2)** The outlet tube from the MH EDS-O2D1 to the mask or cannula has become disconnected. **(3)** The outlet tubing has become pinched closed or is plugged off. **The apnea alarm can be used as a "put-your-oxygen-on" alarm once you get to the preset D mode altitude (D5 or D10). In this case, the alarm will not sound if you already have the cannula or face mask on properly.**

LOW BATTERY-1 *(First Warning)*

LOW BATTERY -1: Depending on battery condition, one short flash of the **Red Light** once every second, **no sound**. The unit will continue to operate properly for about six hours @ 77°F (25°C) after the indicator starts to flash. The O2D1 will operate for ~ 100 hours with a fresh set of DURACELL ULTRA alkaline batteries under normal operation.

LOW BATTERY-2 *(Second Warning)*

LOW BATTERY -2: **One short flash of the Red Light once every second, with sound.** When this alarm occurs, the unit may operate for about one hour, then the oxygen flow will then respond with flow-faults or stop and may go into the **Bad Battery Mode**. **BATTERIES SHOULD BE REPLACED IMMEDIATELY.** The O2D1 will operate for ~ 100 hours with a fresh set of quality alkaline

BAD BATTERY MODE

BAD BATTERY MODE: **Alternating Flashing Red Light on and off at a one (1) second rate with unit functions locked out, no sound**. *NOTE: BATTERIES SHOULD BE REPLACED IMMEDIATELY!*

AUTOMATIC SHUT-DOWN

Abandoned unit auto shut off: If you should forget to turn your EDS off after use, it will go into auto shut-down (drawing very little power) after 3 hours of detecting no use, in an attempt to save the batteries. To re-start, turn switch to off then back to desired mode. the O2D1 will restart and resume operation.

USING THE O2D1 WITH A THIRD-PARTY PRESSURE REGULATOR

If the O2D1 will not be used with a MH Pressure Regulator, the alternate regulator must be able to deliver a pressure of between 15 and 20 psi (static) and ~15 psi dynamic (flowing). If the above listed pressure specifications are not met, the O2D21`may not operate correctly. Lower pressures will result in an inadequate volume of oxygen. Higher pressures will result in a too high volume of oxygen. Excessively high pressures will cause the valve to open spontaneously and leak oxygen.

To use the O2D1 with a third-party regulator or built-in oxygen system with a pressure higher than 25 psi, it is mandatory that you use the MH EDS IN-LINE REGULATOR (EDS-ILR) to ensure correct flow pressure. The EDS-ILR goes between the third-party regulator or built in system and the O2D1 to reduce the flow pressure to an appropriate level.

TROUBLE-SHOOTING

- **The O2D1 unit emits no sound or start-up oxygen pulse when turned on:**
  1. Check batteries to make certain they are fresh.
- **Start-up sound is heard, but no start-up oxygen pulse delivered:**
  1. Check oxygen cylinder valve is on.
  2. Check oxygen supply tube for proper connection.
  3. Check oxygen supply tube for obstructions.
  4. Check O2D1 outlet tubing for obstructions.
- **When using the face mask, no oxygen pulse on inhalation:**
  1. Make sure the face mask is sealed against the skin.
  2. Check for obstructions on the **O2D1** outlet tubing.
  3. Use only face masks provided by Mountain High Equipment & Supply.

     NOTE: EDS face masks DO NOT have a plastic dilution bag attached
- **Oxygen pulses are delivered, but an alarm is heard at the same time:**
  1. Check the battery to make certain it is fresh.
  2. Check for obstructions in the cannula/mask and tubing.
  3. Use only masks and cannulas supplied by Mountain High Equipment & Supply.
- **The O2D1 does not trigger at higher altitudes:**
  1. Try using the Flared-Tip cannula included with the kit (MH part number 00EDS-1084-01)

WARNING

DO NOT increase or decrease length of cannula or face mask supply tubing.

NOTICE OF NON-LIABILITY

This device is classified as, and is only suitable for use as, a supplementary breathing apparatus (SBA) for aviation use. It is intended to help supply the needed amount of oxygen for persons during flight altitudes where supplemental oxygen is needed. This device is not suitable for any type of life support operations. This device is not suitable for SCBA (Self Contained Breathing Apparatus), SCUBA (Self Contained Underwater Breathing Apparatus) or any medical operations.

Before it is put to use, it is the responsibility of any user who will use this device to become familiar with the operation and safety aspects of this device. Using the system improperly could cause failure and lead to possible property damage and/or personal injury.

Mountain High Equipment & Supply Company assumes no responsibility for property damage, accidents, injury or death that may result from the misuse of this device/equipment. This includes any use of this device/equipment outside the scope of common sense, the Instruction Manual, inserts and other related documentation.

LIMITED WARRANTY

Mountain High Equipment & Supply Company warrants your MH EDS-O2D1-2G unit against defects in materials and workmanship for two (2) years from date of purchase invoice. The warranty is non-transferable. Should any part of the MH EDS-O2D1-2G become defective within the warranty period, contact our Service Department (service@MHoxygen.com) to request a RMA (Return Materials Authorization). Return the EDS Unit and your cylinder pressure regulator with the RMA, including a description of what/why it is not functioning and we will repair or replace it, at our discretion, free of charge (you pay only shipping to MH).

Return the Unit to:
Mountain High Equipment and Supply Company
Service Department
2244 Airport Way, Suite 100
Redmond OR 97756-8696

This warranty is non-transferable and only valid if Mountain High Equipment & Supply Company determines that the system and its components have not been damaged due to improper use, been submerged in fluids, dismantled or abused. Mountain High Equipment & Supply Company reserves the right to determine if repairs are to be done under warranty or at a nominal charge. **To activate warranty coverage, you must complete and return your enclosed owner's EDS Registration Card.**

Maintenance Questions for MH EDS 0201-2G PULSE DEMAND™ Portable Systems:

Q: I have one of your portable MH-EDS PULSE DEMAND™ units. It seems to be operating just fine, should I send it in for any type of routine service or testing?

Yes. Even though your pulse-demand unit will generally let you know if there is a problem and has been designed to be relatively maintenance free except for batteries, it should be sent in on a regular basis for performance inspection and service. This includes the in-line or screw-on regulator you use with the EDS. Think of it like performing an annual inspection on your aircraft.

Q: Why has this not been mentioned before and how often does MH recommend this be done?

This service program has been derived from usage and servicing data acquired during the last 20 years the technology has been in production and fielded. From this, Mountain High has decided on a routine service program that should be accomplished once every two years, (biennially). This must include the regulator you are currently using with the EDS unit(s).

Q: What is done to my EDS unit and regulator when I send them in for service?

From time to time we make engineering improvements during our production. These improvements may include changes to hardware or firmware or both. This is our way of passing on our latest improvements to you. Also routine service parts such as seals, seats, O-rings and filters are inspected and replaced. Your EDS unit(s) and regulator(s) are then thoroughly inspected and tested on our AIP test set to ensure they are operating to specified standards. This will help to ensure your system is operating properly and upgraded to the latest specifications. Any other parts replaced due to damage or field use would be subject to an additional charge.

Q: How long should I expect this service to take?

Once we receive your unit, in-house turn-around time is generally five to ten working days.

Q: I have sent my EDS unit back once before for a problem of leaking or not responding at certain altitudes, but it came back with the same problem. Why?

Some problems perceived to be with the EDS units have, in fact, turned out to be with the cylinder pressure regulator. This has mostly been the case if you are not using the pressure regulator designed for the EDS or are connecting directly to a built-in system installed in your aircraft. This is why you must include the primary reducing regulator you are using (ours or not) or tell us that you are connecting the EDS unit(s) directly to your aircraft's built-in system without our inline regulator. Many other regulators do not regulate the pressure adequately for the EDS units to operate and deliver the proper amount of oxygen. **Damage can be done to the breathing sensor in the EDS units if the operating pressure is too high.** In addition, we have seen many situations where customers connect the EDS unit to the connectors and tubing that came with their aircraft. Then plug them into the high-pressure outlets in the aircraft. This has caused a lot of confusing problems because these connectors generally have flow restriction orifices. In many cases this has allowed the EDS unit to check out okay at ground level when the pulse response is low, but then complain with flow fault alarms at higher cruising altitudes. Additionally, this problem can be difficult to reproduce because the EDS unit operates with pressure altitude and not barometrical corrected altitude.

Q: How and where do I get service on my EDS unit(s)?

Request a RMA (Return Materials Authorization) by e-mailing: service@MHoxygen.com.

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 argon, carbon dioxide, and traces of rare gases.

What Is Oxygen?
Under normal conditions, pure oxygen is a colorless, tasteless, odorless, 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 also absolutely essential to support the process of "vital combustion" which maintains human life. Although a person can live for weeks without food or for days without water, he or she 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 the air to burn coal, thus 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 oxygen from the lungs to every cell in the body. 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 person walking at a brisk pace will consume about four times as much oxygen as he or she would when sitting quietly. Under severe exertion or stress, he or she 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 a serious hazard especially for flight 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 in all individuals, but are typical in average persons who are 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 in the atmosphere in which we are breathing. A person may have a respiratory or circulatory impairment which reduces the ability of the body to utilize the 21% oxygen in the air. For such a person, supplementary oxygen must be administered by an oxygen tent or by oxygen mask to enrich the inhaled air. 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 therefore 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 the air remains relatively constant at altitudes up to one hundred thousand feet.

Why Must We Use Extra Oxygen When We Ascend In Altitude?
The blanket of air which surrounds our planet is several hundred miles thick, 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, the air is less dense. For example, at 10,000 feet, the atmospheric pressure is only two-thirds of that at ground level. Consequently, the air is less dense, and each lung full 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 of 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 lung full 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 a corresponding 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 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, and 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, the instruments. His or her hearing, perception, judgment, comprehension, and general mental and physical faculties are practically useless.

(continued on next page)

The pilot may be on the verge of complete collapse. Therefore, the availability and use of supplemental oxygen is recommended on night flights where altitudes above 5,000 feet are contemplated, and for altitudes above 8,000 feet on daytime flights.

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, and may be quite proud of his or her proficiency and performance although he or she 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 a pilot can detect his or her need for oxygen by noting an increase in breathing rate, an accelerated heartbeat, and a 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. The person may even decide that he or she has always wanted blue fingernails! Even while "spiraling" out of control, the individual may be convinced (if conscious at all) that he or she 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, some people can tolerate without apparent effect a degree of hypoxia which would have noticeable effects on others who are more susceptible to the 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. The individual who has flown at 14,000, 16,000, or 18,000 feet without oxygen and survived has no idea how close he or she may have been to disaster. The person may believe that all this talk about oxygen need, if true at all, does not apply to him or her. Such a belief may some day be fatal.

Is It True That Oxygen Is Toxic Or Harmful?

Oxygen therapy is often used for prolonged periods in hospitals and homes not with harmful, but 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 hypoxic 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 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, cigarette smoke, apprehension, or other factors. Also, the use of oxygen for five or ten minutes before the termination of a flight (even though the entire flight may have been flown at less than 8,000 feet) can be an excellent tonic to put the pilot in his or her 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 or her own performance will not be affected by hypoxia; he or she 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.

What Types Of Oxygen Equipment Are Available For Private And Executive Aircraft?

There are a variety of types, including portable MH EDS "Pulse-Demand" units which can be carried along when flight at hypoxic altitudes is anticipated. If flights at such altitudes are frequent, then a "built-in" oxygen system offers some advantages, especially in the larger aircraft. For either portable or built-in systems there is a choice between "Pulse-Demand" type and "Continuous Flow" type equipment. "Pulse-Demand" type equipment automatically delivers oxygen to the user during each inhalation in response to his or her own breathing pattern and altitude. The continuous flow type system delivers oxygen at a fixed rate to an accumulator bag which is attached to the mask, and from which the user inhales each breath. The Pulse-Demand is the most efficient.

How Should An Oxygen System Or Equipment Be Selected?

Your MH Sales Engineer can help you at 800-468-8185. He or she can assist the pilot in selecting the system best suited to the specific airplane and the pilot's special needs.

WARNING:

Improper use or improper maintenance of aviation oxygen equipment may result in serious injury or death. Aviation oxygen equipment is intended to be used only for aviation applications and is to be used only by, or under the supervision of, a pilot or crew member trained and qualified in its use. Aviation oxygen equipment is to be serviced only in accordance with the applicable component maintenance manuals from MH Oxygen Systems and only be serviced by technicians trained in the inherent hazards of high pressure aviation oxygen and knowledgeable of this equipment. Aviation oxygen equipment is to be used only with oxygen meeting the requirements of MIL-PRF-27210

EDS O2D1-2G Auto-compensation

Altitude compensated breathing sensor

Because absolute atmospheric pressure lessens as a function of altitude, breathing efforts assert less pressure upon breathing sensors to the point at which they may not properly detect breathing while at higher altitudes. Additionally, as the partial pressure of CO2 drops below a normalized point with altitude, one's breathing efforts also diminish. With these two physical and physiological effects while ascending to higher altitudes, it becomes necessary for the EDS to compensate for this.

The EDS has an active algorithm that constantly and automatically makes breathing sensor sensitivity adjustments based on detected pressure altitude changes and breathing efforts. This helps ensure that all breaths are detected and responded to with the proper amount of oxygen without mis-triggering from artifacts. There are no user settings for this function as it is entirely automatic.

Automatic respire-metric compensation

An adult person of average size (with no compromising pulmonary conditions or illnesses) will have an average respiration rate between 12 and 18 breaths per minute. Persons between 60 and 75 years of age will generally have a rate between 12 and 28 breaths per minute. The respiration effort at rest generally becomes less as the rate increases. Shallow breathing with elevated respiration rates are also typical with exposure to lower partial pressures from altitudes and/or anxiety.

With exposure to lower partial pressures from excursions to higher altitudes, breathing efforts will generally lessen as the partial pressure of CO2 drops along with other atmospheric gases. Respiration is primarily controlled by chemoreceptors that detect dissolved CO2 in the blood. Higher CO2 levels, from physical work, trigger higher respirations until CO2 is re-normalized. Oxygen levels increase from this as well. Therefore, as the amount of dissolved CO2 reduces in the blood so does the need to respirate. Unfortunately, this also exacerbates hypoxia as less oxygen is inhaled and admitted into the blood as the body has no reason to respirate to expel any more CO2.

The EDS has a poly-metric method of dynamically adjusting the amount of oxygen delivered on a breath-by-breath basis as a function of detected pressure altitude, respiration rate and (in some cases) breathing efforts. Without actually complementing respiration with a small amount of CO2 at higher altitudes to encourage respiration, the EDS will dynamically augment the amount of oxygen delivered to help ensure that each individual person's breathing profile is complemented with a 'best-effort' schedule of needed oxygen while at higher altitudes. If the EDS is unable to establish meaningful respiremetrics caused by pneumatic artifacts or mis-fitting cannulas and/or face masks for the current user, it will default to known parameters to cover a known mean pulmonary profile.

Compensating for various plenum volumes associated with face masks

A face mask, unavoidably, has a volume of space (plenum) that does not directly contribute to the admission of oxygen. This plenum can compromise the initial admission of oxygen by allowing the user to re-breathe CO2 rather than oxygen at the most important point of the inhalation phase, displacing some of the pulse of oxygen. While a small amount of re-inhaled CO2 can actually be beneficial at higher altitudes as it encourages respiration, missing the full complement of the prescribed amount of oxygen at altitude is not.

The EDS has four manually operated F-Mode settings, 1 through 4, that provide an additional bolus of oxygen with each breath to help mitigate this. Each setting provides a progressively larger bolus. This is intended to be used to compensate for the plenum volume associated with the use of face masks settings 1-2 for small sized masks, 2-3 for medium sized masks and 3-4 for use with large sized masks. These F-Mode settings can also be used if the user determines that they may need more oxygen than is automatically prescribed.

The O2D1 Specifications, performance standards and limits are derived from actual units tested, characterized or calculated. Specifications are subject to change without notice.

Allowable respiration rates: Adaptive: up to 43 bpm. And down to ~ 5 bpm.

Apnea time-out envelope: Adaptive: ~40 sec Pa. 0-12 K ft., ~30 sec. Pa. 13-18 K ft., 20 Sec. at and above Pa. 18 K ft. Apnea alarm does not respond if in any of the 'D' modes and while below that pressure altitude threshold.

Operating inlet pressures: 15 psig. (1 bar) DYNAMIC (flowing) through cannula and 1.5 meters (5 ft.) of 4 mm. inlet tubing. 25 psig. (1.72 bar) .

Operating & storage temperatures, altitudes, vibration @ humidity, (assumes nominal operating voltage):

Temp range @ ~10% RH: -40° to +60° C. (Storage for complete unit less battery)

Temp range @ ~25% RH: 0° to +60° C. (Operating with std. valve)

Temp range @ ~100% RH NC: +5° to +60° C. (Operating with std. valve) Unit is not water-proof, keep it dry from spray & rain.

Altitudes @ up to ~100% RH: -100 to +30 K ft. Pressure Altitude range @ +5° to +60° C. (Operating with std. valve)

Vibration: Random vibration 5 to 500 Hz, 15 minutes per axis @ 2.5 g. (rms) sin wave.

Physical characteristics (O2D1 unit only):

Width @ widest point: 3.10" (79 mm);
Height, including connectors: 5.23" (130 mm.);
Height, enclosure only: 4.62" (117 mm);
Thickness, front to rear: 0.95" (24.13 mm)
Weight: 7.5 Oz. (0.213 g.) with batteries

Operating Voltage & Current @ 25° C. @ ~25% RH.

(Measured in the 'N' mode setting @ 15 RESP/ typical.):

Battery types: 2 each 1.5 volt alkaline type 'AA' DURACELL ULTRA alkaline batteries or equivalent.

Battery Life: 100 Hrs. @ ~25° C. @ ~25% R.H. Measured from mean, assuming fresh DURACELL ULTRA alkaline batteries operating under normal operating conditions.

NOTE: Make sure alkaline batteries are used and removed during long-term storage.

Nominal battery voltage: ~2.875 VDC ± 40 mv.@ 2.25 ma. Idle. 100 ma. Peak (~50 ms. max), 3.25 ma. Average.

Min. start-up voltage: ~2.5 VDC ± 40 mv.

Low-battery cut-out: < 2.0 VDC ± 40 mv. (Red light on steady unit in non-responsive state 'dead')

Very low battery signal: ~2.25 VDC ± 40 mv. (Red light winking 2/sec.) ~5 Hrs. of service left.

Low battery signal: ~2.4 VDC ± 40 mv. (Red light winking 1/sec.) ~12 Hrs. of service left.

Notes:

The low battery cut-out feature provides a known state of action if the batteries are depleted to the point of inadequate power to operate the unit to any of the declared specifications. In addition, this feature was found to be prudent because, while many of the specifications may stay intact, false triggering of the valve may confuse the operator of a problem other than low batteries. The minimum 'start-up' voltage is where the unit will initiate the built-in test and commence operations. However, it should be noted that during this operation if the batteries are then measured to be too low, the lock-up feature may then shortly ensue. This should help the operator in determining if the unit is bad or if the batteries are too low. A unit that has low batteries that cause 'lock-up' will most likely initially start-up if left off for some time. Alkaline type batteries have so-called self-rejuvenating properties that may cause the user to forestall battery replacement. Obviously, dead batteries will yield no action.