

ESH

Environment,
Safety & Health
SECTION



Oxygen Deficiency Hazard

Safety Booklet

Introduction

The uses of compressed gases, liquefied gases, and volatile liquids are commonplace at Fermilab. The introduction of these materials to the atmosphere can reduce the amount of available oxygen and present a hazard to personnel. Persons exposed to reduced-oxygen atmospheres may experience reduced abilities, unconsciousness, or death.

This booklet provides background information on the hazards associated with potential oxygen deficiencies. It also contains expanded information on ODH control measures and proper operation and use of personal protective equipment used in ODH areas at Fermilab. Keep this booklet in a convenient location for future reference.



Normal vs. Oxygen Deficient Atmosphere

The gases that make up our **normal breathing atmosphere** are listed in the chart below.

NORMAL ATMOSPHERE		
	Volume %	Sea Level Partial Pressure (mmHg)
	78	590
	21	160
	1	7
TOTAL	100	757

(N_2 = nitrogen gas, O_2 = oxygen gas, Ar= Argon gas)

ODH Atmosphere

An ODH atmosphere is defined as any time the oxygen concentration drops from 21% to 18% or less. Area oxygen monitors will alarm at 18% oxygen, while personal oxygen monitors alarm at 19.5%.

Effects of Reduced Oxygen

As you will remember from the video presentation, there are subtle changes that occur as the human body is exposed to reduced oxygen concentrations. The following chart details those changes with regard to the available percentage of oxygen. You will notice that the

effects begin around 17%. This is one of the reasons that the personal oxygen monitors at Fermilab are set to alarm at 19.5%. This advanced warning should give any qualified individual ample time to escape the hazard area and summon help by dialing 3131.



Effect Thresholds for Exposure to Reduce Oxygen (Healthy Individual)

17%



*Night vision reduced
Increased breathing volume
Accelerated heartbeat*

16%



*Dizziness
Reaction time doubled
for novel tasks*

12 %



*Very faulty judgement
Very poor muscular coordination
Loss of consciousness
Permanent brain damage*

10%



*Inability to move
Nausea
Vomiting*

6%



*Spasmodic breathing
Convulsive movements
Death in 5-8 minutes*

Oxygen Deficiency Hazard Area Classifications

The goal of ODH risk assessment is to estimate the probability that a fatality will occur in an area and to design protective measures to prevent those fatalities. The level of risk is tied to the operations in a given area as well as expected component failure rates for the equipment. For a given area, several events may cause an oxygen deficiency. Each event has an expected rate of occurrence and each occurrence has an expected probability of resulting in a fatality. The calculation is then made and an area classification is assigned. The following table lists the ODH classifications and the **hours worked per expected fatality** based on little or no precautionary measures taken in advance.

ODH CLASSIFICATIONS		
ODH Hazard Class		Hrs. of System Operation
0	>	10,000,000
1	≧	10,000,000 - 100,000
2	≧	100,000 - 1,000
3	≧	1,000 - 10
4	≧	10

ODH Control Measures

Once the hazard classification has been assigned to an area, there are specific control measures that must be followed to enter that area. These controls are designed to reduce the fatality risk for each area if properly followed. This is calculated to be one estimated death for > 10,000,000 hours of operation. The chart

below outlines the minimum precautions that shall be observed for each hazard class. If at any time, you are unsure of the classification of your work area, contact your supervisor, the Crew Chief or the Division/Section Safety Officer before you enter and begin work.

ODH CONTROL MEASURES

Environmental Controls	ODH Hazard Class			
	1	2	3	4
WARNING SIGNS	✓	✓	✓	✓
VENTILATION	✓	✓	✓	

ODH Qualified Personnel Controls Requirements

Environmental Controls	ODH Hazard Class			
	1	2	3	4
MEDICALLY APPROVED AS ODH QUALIFIED	✓	✓	✓	✓
ODH TRAINING	✓	✓	✓	✓
PERSONAL O ₂ MONITOR	✓	✓	✓	
SELF-RESCUE SUPPLIED ATMOSPHERE RESPIRATOR	✓	✓	✓	
MULTIPLE PERSONNEL IN COMMUNICATION		✓		
UNEXPOSED OBSERVER			✓	
SELF-CONTAINED BREATHING APPARATUS				✓

ODH Restricted Personnel Controls Requirements

Environmental Controls	ODH Hazard Class			
	1	2	3	4
MUST NOT BE ODH EXCLUDED	✓	✓	N/A	N/A
ODH BRIEFING	✓	✓	N/A	N/A
SELF-RESCUE SUPPLIED ATMOSPHERE RESPIRATOR	✓	✓	N/A	N/A
ONE-TO-ONE ESCORT BY ODH QUALIFIED PERSONNEL	✓	✓	N/A	N/A
AT LEAST TWO ODH QUALIFIED PERSONNEL		✓	N/A	N/A

KEY:  = required N/A = not applicable

**ODH restricted personnel shall not be exposed to ODH classes 3 or 4 operations.*

NOTE: Visitors whom have not had the required training and/or medical evaluation are allowed to enter ODH Class 1 and 2 areas under certain circumstances. They must first obtain authorization from Div/Sec SSO and be properly escorted by ODH Qualified personnel. The Div/Sec Senior Safety Officer may refer the request to the Director's Office prior to granting permission.

Properties of Helium, Nitrogen, & Argon

These are the three gases used in the cryogenic system at Fermilab. Since these gases may not be familiar to you, this page will give you basic information about the properties of the gases as they change from a liquid state to a gaseous state, as in a leak or rupture situation.

Helium



Colorless / Odorless / Tasteless
Liquid @ 5°K, gas above 40°K - lighter than air, one liquid liter of helium will expand to 769 liters of gas at Standard Temperature and Pressure (STP).

Argon



Colorless / Odorless / Tasteless
Liquid @ 88°K, heavier than air, one liquid liter of argon will expand to 859 liters of gas at STP.

Nitrogen



Colorless / Odorless / Tasteless
Liquid @ 77°K, cold nitrogen gas heavier than air, mixes readily with air and displaces oxygen as it warms up, one liquid liter of nitrogen will expand to 687 liters of gas at STP.

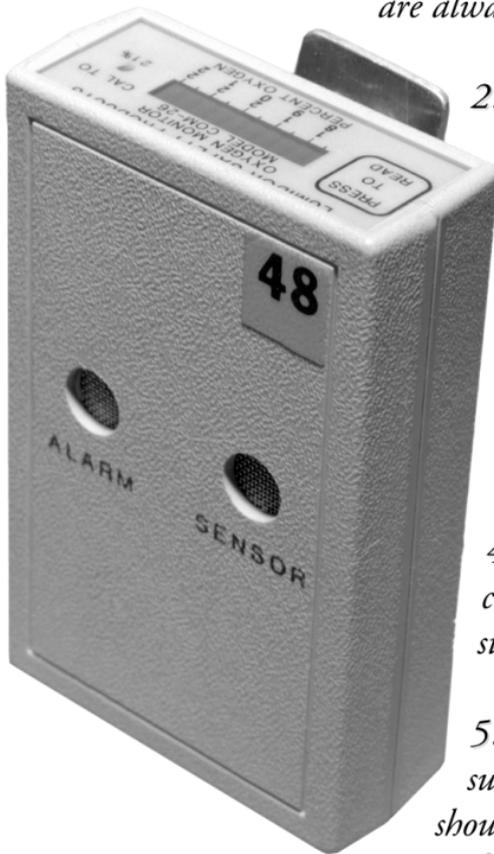
Personal Protective Equipment

All personnel entering a posted ODH area are required to carry personal protective equipment. The requirements are outlined in the ODH Control Measures section of this handout.

Personal Oxygen Monitors

Monitors may be found at the Main Control Room (Beams Division).

1.) Monitors are battery powered and are always energized.



2.) Indicate from 17.5% to 22% oxygen and will sound a slow pulsating alarm when oxygen level drops below 19.5%.

3.) A low battery indicator is a rapid pulsating alarm and indicates the battery needs to be replaced.

4.) Monitors should be within calibration date indicated by the sticker on the side of each unit.

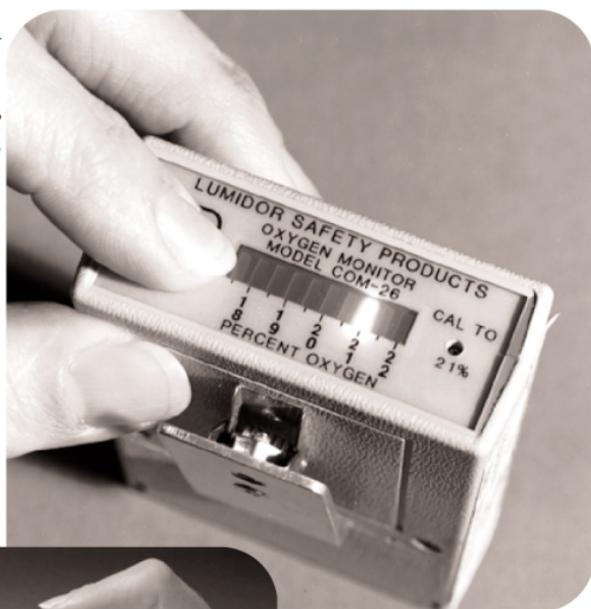
5.) Should be worn on the outer surface of your clothing. They should not be in a pocket or be covered by coats, etc.

Daily Operational Check Procedure

First, depress the “Press to Read” button. A short beep will be emitted from the “speaker” as an audio check.

Then, a lighted bar graph will display oxygen percent.

(This should be 21% in normal atmosphere.)

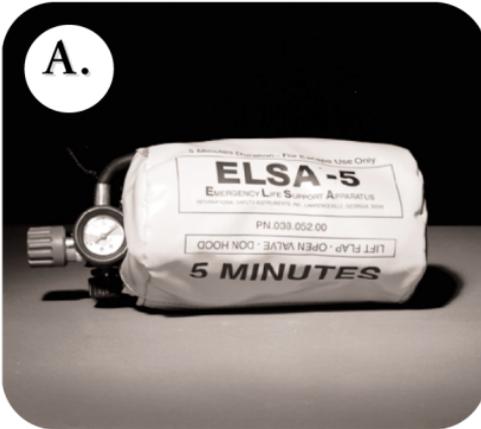


If necessary, adjust the graph to 21% by inserting a jeweler's screwdriver in “Cal to 21%” slot and rotating screwdriver slowly.

Lastly, if 21% can not be achieved, the bar graph does not light, or the beep can not be heard, **DO NOT USE MONITOR & return for service.**

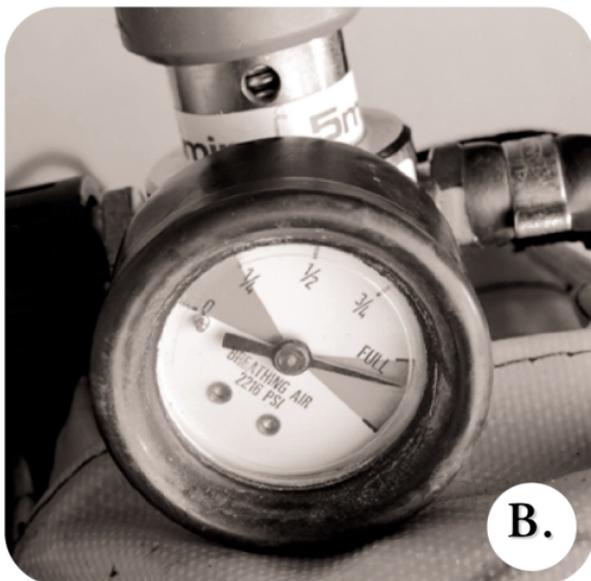
Emergency Escape Packs

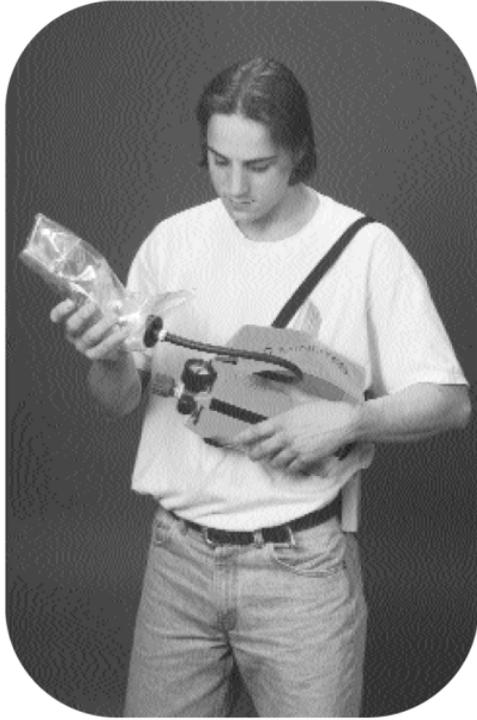
For most ODH areas, each person is required to carry their own escape pack. Fermilab uses the ELSA pack which supplies 5 minutes of air. This section outlines the proper procedure for checking, activating, and donning the escape pack.



ELSA Pack

Gauge should read FULL (green area).





Lift flap & remove hood.



2.

Turn red valve to “ON”.



Pull hood over head.

Emergency Procedures

Personal Oxygen Monitor Alarm @ 19.5%

One person working alone: A. Don Escape pack, evacuate, dial 3131, and report emergency.

Two or more people working together: B. Compare readings, if other monitors read ok, then everyone must evacuate and solve the problem with monitor before going back in. If other monitors confirm low oxygen levels, follow procedure for A.

In-Place Oxygen Monitor Alarm

One person working alone: C. Monitor personal oxygen monitor and as long as it reads greater than 19.5%, evacuate tunnel or enclosure going away from the assumed source of the alarm. After exiting, notify operations of the problem. If personal oxygen monitor alarms follow procedure for A.

Two or more people working together: D. Compare readings on personal monitors. If these other monitors read ok, everyone evacuate tunnel or enclosure, notify operations of the problem and do not go back into the tunnel or enclosure until the problem has been solved. If other monitors confirm low oxygen levels, follow procedure for A.

Other Indications of a Possible Gas Leak (vapor cloud, sound of gas leak, etc.)

One person working alone: E. Monitor personal oxygen monitor and as long as it reads greater than 19.5%, evacuate tunnel or enclosure going away from the problem area. After exiting, notify operations of the problem. If personal oxygen monitor alarms, follow procedure for A.

Two or more people working together: F. Compare oxygen readings, if other monitors read o.k., every one evacuate tunnel or enclosure, going away from the problem area. After exiting, notify operations of the problem. If personal oxygen monitor alarms, follow procedure for A.

3131

In any emergency, Dial x3131 from any Laboratory phone. When dialing from either a pay phone or cellular phone, dial 630-840-3131. Remember to STAY ON THE LINE until the operator indicates that no more information is needed and that help is on the way. Be prepared to give the following information to the Emergency Operator:

- *Nature of the emergency*
- *Location of the emergency*
- *Your name*
- *Other additional info*

The information contained in this booklet is meant to serve as a general review between annual requalification sessions. If you require more detailed information or have questions that have not been answered in the Avideo presentation, the lectures or this handout, contact your supervisor or the Safety Officer for your Division or Section.

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