Oxygen Deficiency Hazard (ODH)

Training Course at Fermilab

Start Training

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Oxygen Deficiency Hazard (ODH)

Hi, my name is Martha Michels, Fermilab's Assistant Director for Environment, Safety, Health and Quality. Oxygen deficiency is a life-threatening hazard in some of Fermilab's facilities and experimental areas. This is due to the use of liquefied or compressed gases such as helium, nitrogen and argon. If released, these gases will displace the normal atmosphere that we breathe and can reduce the oxygen concentration to dangerous levels.

At workplaces in the US, the average annual fatality rate from oxygen deficient atmospheres is tragically about 8 people. Oxygen deficiency hazards have been present at Fermilab almost from the beginning. Yet in over 40 years, there has never been a fatality caused by oxygen deficiency at Fermilab. Help keep this good safety record intact by following the safety precautions outlined in this training.

Oxygen Deficiency Hazard (ODH)

Completing this training and passing this exam is part of the requirement to work in ODH areas at Fermilab. In addition to this training, you must have a current physical examination and approval from the Fermilab Medical Office to be "ODH Qualilfied". Contact the Medical Office at X3232 to schedule an appointment for the physical.

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Oxygen Deficiency Hazard (ODH)

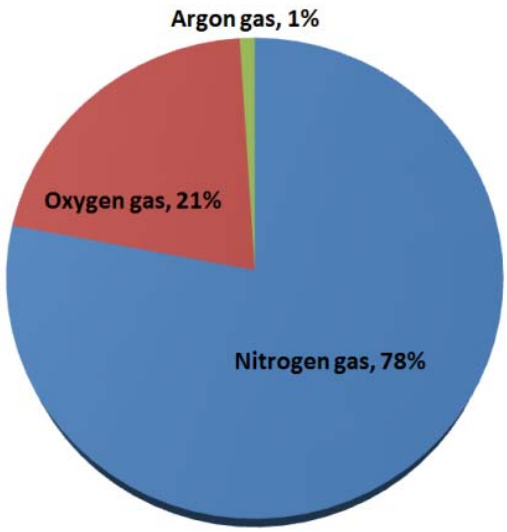
There are systems at Fermilab where failures can occur. Spilling or venting gasses result in an oxygen content being reduced to unsafe levels for breathing.

Oxygen Deficiency Hazard (ODH)

Our **normal breathing atmosphere** consists of 3 gases:

- Nitrogen (N_2), 78%
- Oxygen (O_2), 21%
- Argon (Ar), 1%

Volume of gases in our normal breathing atmosphere



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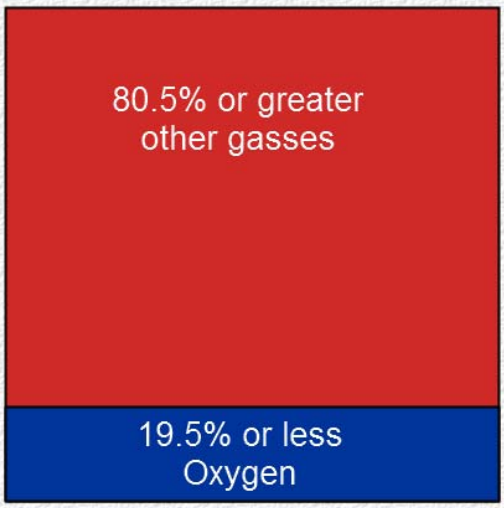
Oxygen Deficiency Hazard (ODH)

An **Oxygen Deficient Atmosphere** is defined as any time the oxygen concentration drops below 19.5%.

This oxygen level is defined by OSHA and defines the alarm set point for personal oxygen monitors used at Fermilab.



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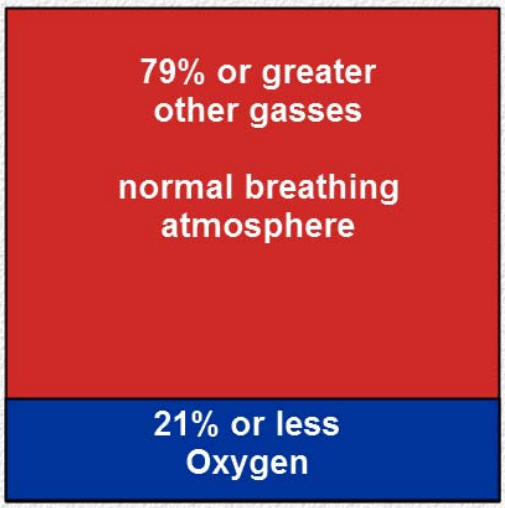
Oxygen Deficiency Hazard (ODH)

Effect Thresholds for Exposure to Reduced Oxygen on a Healthy Person

17% Oxygen
- Night vision is reduced
- Increased breathing volume
- Accelerated heartbeat

16% Oxygen
- Dizziness
- Reaction time doubled for novel tasks

15% Oxygen
- Impaired judgement
- Impaired coordination
- Rapid fatigue
- Shortened attention span



12% Oxygen
- Very faulty judgement
- Very poor muscular coordination
- Loss of consciousness
- Permanent brain damage

10% Oxygen
- Inability to move
- Nausea
- Vomiting

6% Oxygen
- Spasmatic breathing
- Convulsive movements
- Death occurs in 5-8 minutes

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Oxygen Deficiency Hazard (ODH)

Helium, nitrogen and argon are the gases most commonly used in Fermilab's cryogenic systems.

	Liquid state temperature at	Heavier or lighter than air?	At room temperature and pressure 1 liquid liter expands to
Helium	5 Kelvin / -451°F	Lighter than air above 40 K	769 liters of gas
Argon	88 Kelvin/ -301°F	Heavier than air	859 liters of gas
Nitrogen	77 Kelvin/ -321°F	Heavier than air when cold	687 liters of gas

They readily mix with air and displace oxygen as they warm up. They are colorless, odorless and tasteless.

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Oxygen Deficiency Hazard (ODH)

Room temperature compressed gases, which are common at Fermilab, can also pose an oxygen deficiency hazard.

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Oxygen Deficiency Hazard (ODH)

ODH Hazard Area Classifications

ODH Hazard Class	Operating hours per expected fatality without protective measures.
0	10,000,000 and higher
1	10,000,000 - 100,000
2	100,000 - 1,000

The goal of ODH risk assessment is to estimate the probability that a fatality will occur in an area and design protective measures to prevent those fatalities.

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Oxygen Deficiency Hazard (ODH)

ODH class 0 areas have been evaluated and found to have a very low hazard risk. There are no ODH-related entry requirements. They are not posted with signs.

ODH class 1 and 2 areas have been evaluated and found to have an elevated oxygen deficiency risk. They are posted with the signs seen here.

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Oxygen Deficiency Hazard (ODH)

Before entering ODH class 1 or 2 areas personnel shall be examined by the Fermilab Medical Office to determine fitness for ODH work.

Level	Meaning	Duration of Approval
ODH Qualified	Medically qualified to enter ODH Class 1 and 2 areas.	Typically 1-2 years based on the age and health status of the worker.
ODH Restricted	Medically qualified to enter ODH Class 1 and 2 areas when escorted by an ODH Qualified person.	Typically 1-2 years based on the age and health status of the worker.
ODH Excluded	Prohibited from entering any ODH Class 1 or 2 areas.	Excluded until reclassified by the Medical Office.

Each person evaluated by the Medical Office will fall into one of the qualifications levels listed above.

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Control Requirements for ODH Qualified Personnel

Environmental Controls	ODH Hazard Class 1	ODH Hazard Class 2
Medically approved as ODH qualified	✓	✓
ODH training	✓	✓
Personal Oxygen Monitor	✓*	✓*
Self-rescue Supplied Atmosphere Respirator	✓*	✓*
Multiple Personnel in communication (2 person rule)		✓

✓ = required * = Respirators and/or personal oxygen monitors may not be required if stated in entry sign posting

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Oxygen Deficiency Hazard (ODH)

Always refer to the posted entry sign for entry requirements. Some standard requirements may be excluded as shown below. In this example the emergency respirator is not required.

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Control Requirements for ODH Restricted Personnel

Environmental Controls	ODH Hazard Class 1	ODH Hazard Class 2
Must Not Be ODH Excluded	✓	✓
ODH Training or Briefing	✓	✓
Personal Oxygen Monitor	✓ *	✓ * ⊞
Self- Rescue Supplied Atmosphere Respirator	✓ * ⊞	✓ * ⊞
One-to-one escort by ODH Qualified Personnel	✓	✓
At least two ODH Qualified Personnel		✓

⊞

✓ = required

* = Respirators and/or personal oxygen monitors may not be required if stated in entry sign posting

⊞

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Oxygen Deficiency Hazard (ODH)

One-to-one escort by ODH-qualified personnel

An escort can be provided in special cases when the persons entering an area have not been medically classified or trained. Individuals shall be under the direct continuous supervision of individuals who are ODH medically qualified and trained. Note that escorted persons shall not have been designated as ODH-excluded by the Medical Office. If not evaluated by the Medical Office, the escort assumes responsibility for judging whether or not they believe the fitness of the escorted individual would significantly impede escape from the ODH operation in the event of an alarm. Contact the area SSO with any questions.

One-to-one escort by ODH-qualified personnel

It is the responsibility of ODH-qualified escorts to ensure that the personal oxygen monitor(s) of those being escorted are not past due for calibration and are returned to the issuing organization or individual after use. They must ensure the air pack is full.

The escort must also brief the escorted individual on emergency procedures and ODH equipment operation.

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Oxygen Deficiency Hazard (ODH)

Personal Oxygen Monitors

Fermilab model (Micro2)

Commercial model *01 Series* manufactured by RKI Inc.

Commercial model *OX-03 Series* manufactured by RKI Inc.

Fermilab currently uses three different models of personal oxygen monitors. Monitors can be found at the Main Control Room (Accelerator Division) or at the access areas.

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Oxygen Deficiency Hazard (ODH)

Fermilab model (Micro2)

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Oxygen Deficiency Hazard (ODH)

Fermilab model oxygen monitors are battery powered. They do not have an on/off switch.

Oxygen Deficiency Hazard (ODH)

An LED bar on the Fermilab model oxygen monitor indicates 17.5% to 22% oxygen. It will sound a slow pulsating alarm when the oxygen level drops below 19.5%

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Oxygen Deficiency Hazard (ODH)

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

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Oxygen Deficiency Hazard (ODH)

Fermilab model monitors must be worn on the outer surface of your clothing. They must NOT be in a pocket or covered by coats, etc.

The sensor and speaker shown here must not be covered.

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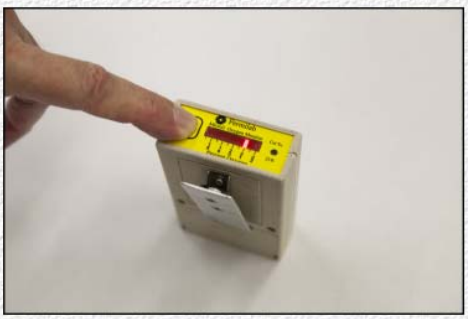
Oxygen Deficiency Hazard (ODH)

Daily Operation Check Procedure for the Fermi Model Oxygen Monitor

1. In a normal atmosphere, press the *Press to Read* button. A short beep should be emitted from the speaker as an audio check. A lighted bar graph should display the oxygen percentage.



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Warning!

If the monitor does not beep or light up when you press the button DO NOT USE the monitor.

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Oxygen Deficiency Hazard (ODH)

Daily Operation Check Procedure for the Fermi Model Oxygen Monitor

2. If the monitor doesn't read 21% in step 1, adjust the graph to 21% by inserting a jeweler's screwdriver in the *Cal to 21%* slot and slowly rotating the screwdriver.

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Daily Operation Check Procedure for the Fermi Model Oxygen Monitor

3. If 21% cannot be achieved, the bar graph does not light, or the beep cannot be heard, DO NOT USE THE MONITOR and return it for service.

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Oxygen Deficiency Hazard (ODH)

Fermilab also uses the O1 Series Oxygen Monitor.

Oxygen Deficiency Hazard (ODH)

The O1 Series monitor is a small single gas personal monitor that utilizes an advanced miniature sensor to detect the presence of oxygen.

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Oxygen Deficiency Hazard (ODH)

To turn on the O1 Series monitor, press and hold the POWER/MODE button for 1 second. Please note that:

- Monitors are NOT always energized.
- The audible alarm, vibrator and lights activate when the warm-up sequence occurs.

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Oxygen Deficiency Hazard (ODH)

In order to perform a fresh air adjustment:

1. Press and hold the AIR button. The LCD will display "hold".
2. Release the AIR button when the LCD displays "Adj".
3. The instrument will set reading to 20.9% volume oxygen.

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Oxygen Deficiency Hazard (ODH)

A low battery indicator is given on the LCD display when the last remaining bar of battery icon flashes and indicates the battery needs to be replaced.

- If the battery is dead, the gas reading indicates *FAIL* and double pulsing tone occurs every second.
- Use two AAA batteries. The video on the right will show you how to replace the batteries.

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Oxygen Deficiency Hazard (ODH)

The O1 Series will sound an audible alarm, vibrate, and flash a visual alarm when the oxygen level drops below 19.5%.

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Oxygen Deficiency Hazard (ODH)

To reset the alarm, press the *Power Mode* button after the reading has returned to above the alarm point.

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Oxygen Deficiency Hazard (ODH)

All oxygen monitors should be within the calibration date indicated by the sticker on the side of each unit.

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Oxygen Deficiency Hazard (ODH)

The O1 Series Monitor should be worn on the outer surface of your clothing. The top must be exposed. Wearing it in a pocket as shown below is acceptable.

The top of the monitor must be exposed to air.

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Oxygen Deficiency Hazard (ODH)

Press and hold the *POWER/MODE* button for 5 seconds to turn off the monitor.

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Oxygen Deficiency Hazard (ODH)

OX-03 Personal Oxygen Monitor

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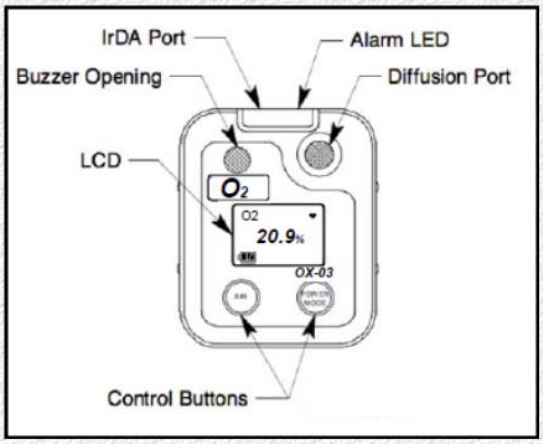
Oxygen Deficiency Hazard (ODH)



The OX-03 monitor is a small single gas personal monitor that utilizes an advanced miniature sensor to detect the presence of oxygen.

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Oxygen Deficiency Hazard (ODH)

OX-03 Start-up Procedure

1. Press and briefly hold down the POWER MODE button. The backlight will turn on and all the display segments will turn on. Release the button when you hear a beep.
2.

00:00 00:00

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OX-03 Start-up Procedure

3. The instrument will then indicate the number of days before the next calibration is due.

4. The instrument will cycle through several display screens showing its current settings and is complete when the instrument beeps twice.

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Oxygen Deficiency Hazard (ODH)

OX-03 Start-up Procedure

5. The display shown is the current percent oxygen and MUST READ 20.9%. If the reading is something other than 20.9%, you MUST perform a Fresh Air Adjustment.
6. To perform a Fresh Air Adjustment, find a fresh air environment that is of normal oxygen content and press the AIR button for 4 seconds, then release button. The adjustment will be complete and the display will be 20.9%.

Oxygen Deficiency Hazard (ODH)

OX-03 Start-up Problems

1. If the instrument indicates CAL, the instrument must not be used and MUST BE RETURNED to ESH&Q for calibration.
2. If the instrument indicates FAIL, the instrument must not be used and MUST BE RETURNED to ESH&Q for repair.

Click here for ESH&Q contact information

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Oxygen Deficiency Hazard (ODH)

The OX-03 monitor must be worn on the outer surface of your clothing. It must NOT be in a pocket or covered by a coat, etc.

The sensor and speaker shown here must not be covered.

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Oxygen Deficiency Hazard (ODH)

The OX-03 Monitor will sound an audible alarm, vibrate, and flash a visual alarm when the oxygen level drops below 19.5%.

The alarm will turn itself off when the oxygen concentration returns to above 19.5%.

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Oxygen Deficiency Hazard (ODH)

Shutdown Procedure

1. Press and hold down the POWER MODE button for 5 seconds. The instrument will turn off.
2. This operation must be performed after each use.

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Please contact a member of the ESH&Q Industrial Hygiene team for monitor calibration or failures or with any questions you may have.

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Oxygen Deficiency Hazard (ODH)

Emergency Escape Packs

ELSA Packs

OCENCO

Fermilab uses two different breathing escape pack models. They are the ELSA and OCENCO packs.

Personnel in an ODH Class 1 or 2 Area may require ready access to an escape pack. Refer to posted entery requirement to determine when carrying an escape pack is required.

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Oxygen Deficiency Hazard (ODH)

The ELSA pack supplies 5 minutes of air.

Emergency Life Support Apparatus - ELSA

ELSA packs are available in either orange or yellow.

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Oxygen Deficiency Hazard (ODH)

The gauge on the ELSA pack should read *FULL* which is indicated by the needle being in the green area.

Do not use this escape pack. The needle is not in the green area. It is below 3/4 full.

Oxygen Deficiency Hazard (ODH)

Turn the large knob counter-clockwise to start air flow.

This small cap will not activate air flow.

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Oxygen Deficiency Hazard (ODH)

Activating an Elsa Pack

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Oxygen Deficiency Hazard (ODH)

1

Alarms sounds.

2

Remove the hood & turn the large knob to open the valve.

3

Put the hood on your head.

4

Verify valve is open. Breath normally & leave the area.

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Oxygen Deficiency Hazard (ODH)

The OCENCO Escape Pack

The OCENCO escape packs:

- are not in general use at Fermilab.
- are issued to specific individuals or groups.
- require further training which your Senior Safety Officer can arrange.

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Oxygen Deficiency Hazard (ODH)

Many ODH areas have permanently mounted area oxygen monitors. The area monitors:

- are set to alarm at 18% or higher oxygen concentration.
- do not replace personal monitors as part of ODH control measures (unless an exclusion is posted).
- allow for remote monitoring of oxygen concentration and/or active ventilation control.
- In-place area oxygen monitors alarm with a high-pitched siren and flashing red light.

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Oxygen Deficiency Hazard (ODH)

ODH Emergency Response Procedures

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Oxygen Deficiency Hazard (ODH)

If your personal oxygen monitor alarms (oxygen <19.5%), follow the procedure below.

One person working alone

Put on the escape pack, evacuate the area and call x3131 to report the emergency.

Two or more people working together

If any other personal monitor is also alarming, everyone must put on his/her escape pack, evacuate the area and call x3131 to report the emergency.

If no other personal monitors are alarming, everyone must evacuate the area going away from the assumed source of the alarm. Notify operations personnel of the problem. Do not re-enter the area until the issue is resolved.

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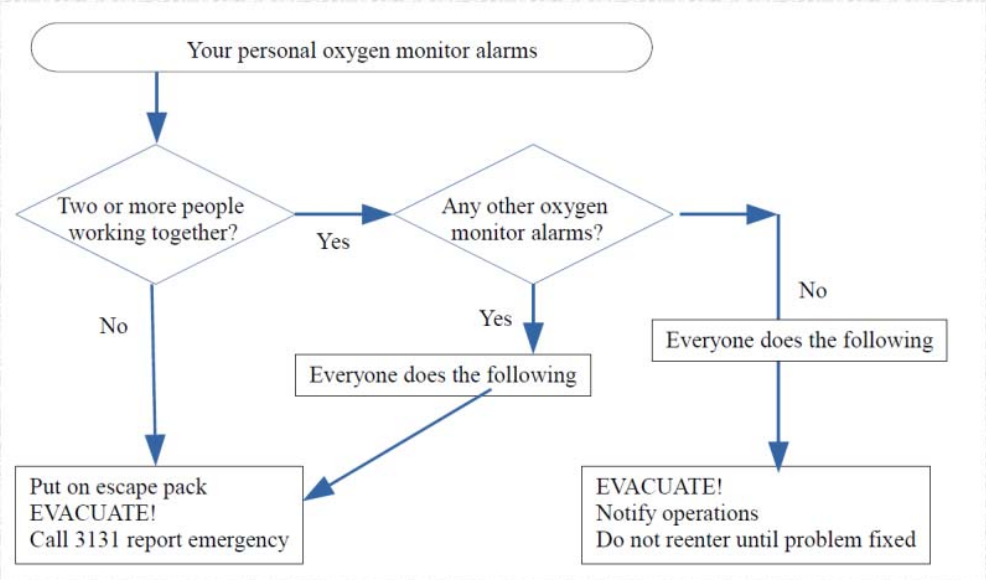
Oxygen Deficiency Hazard (ODH)

If your personal oxygen monitor alarms, (oxygen <19.5%) follow the procedure below.



Click here to view a larger version or this chart or to print it.

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If the area monitor alarms, follow the procedure below.

One person working alone

If your personal monitor is alarming, put on the escape pack, evacuate the area and call x3131 to report the emergency.

If your personal monitor is not alarming, evacuate the area going away from the assumed source of the alarm. Notify operations personnel of the problem. Do not re-enter the area until the issue is resolved.

Two or more people working together

If any personal monitor is alarming, everyone must put on his/her escape pack, evacuate the area and call x3131 to report the emergency.

If no personal monitors are alarming, everyone must evacuate the area going away from the assumed source of the alarm. Notify operations personnel of the problem. Do not re-enter the area until the issue is resolved.

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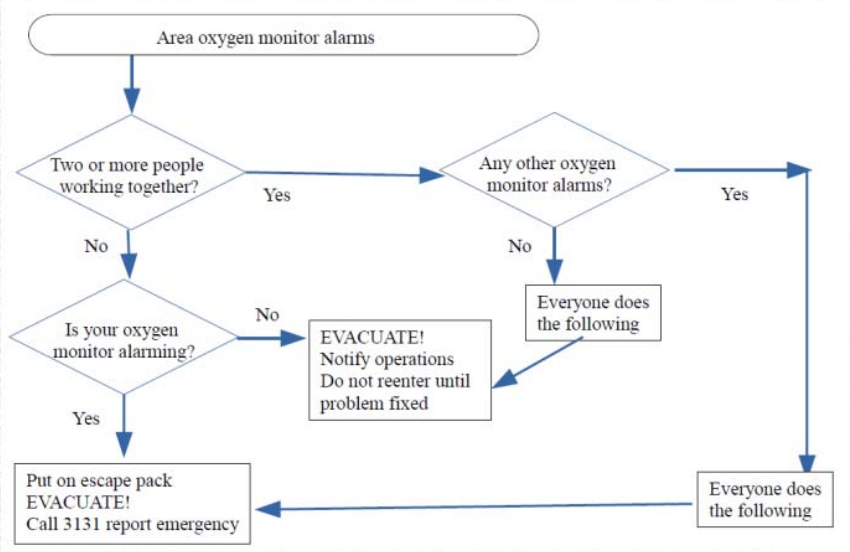
Oxygen Deficiency Hazard (ODH)

If the area monitor alarms, follow the procedure below.



Click here to view a larger version or this chart or to print it.

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Oxygen Deficiency Hazard (ODH)

If there are any other indications of a possible gas leak such as a vapor cloud or the sound of a gas leak, you should follow the procedures below.

One person working alone

If your personal monitor is alarming, put on the escape pack, evacuate the area and call x3131 to report the emergency.

If your personal monitor is not alarming, evacuate the area going away from the assumed source of the alarm. Notify operations personnel of the problem. Do not re-enter the area until the issue is resolved.

Two or more people working together

If any personal monitor is alarming, everyone must put on his/her escape pack, evacuate the area and call x3131 to report the emergency.

If no personal monitors are alarming, everyone must evacuate the area going away from the assumed source of the alarm. Notify operations personnel of the problem. Do not re-enter the area until the issue is resolved.

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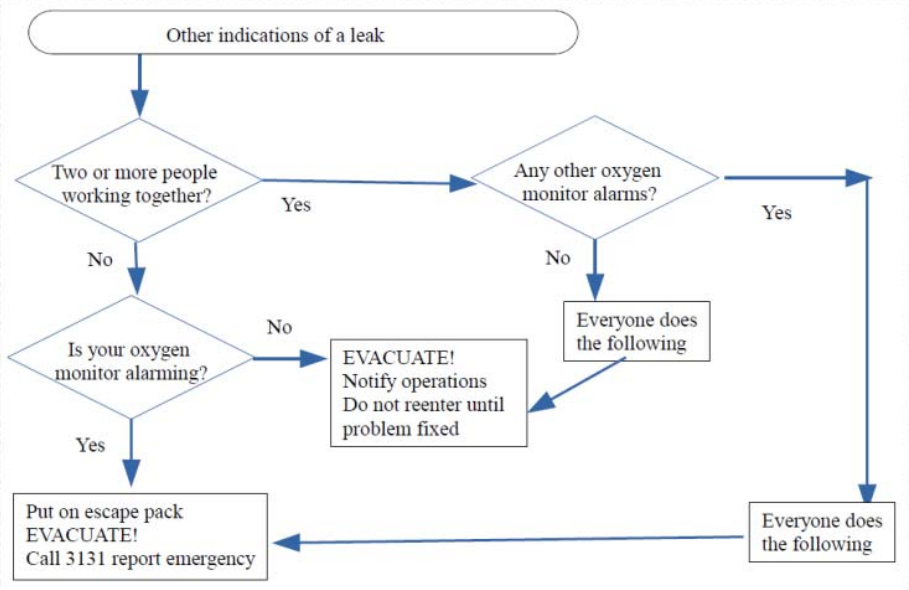
Oxygen Deficiency Hazard (ODH)

If there are other indications of a gas leak, follow the procedure below.



Click here to view a larger version or this chart or to print it.

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This concludes Oxygen Deficiency Hazard training.

In order to receive TRAIN credit for this course you must take and pass a test. Please click here to be directed to the webpage where you can request the test.

In order to be ODH qualified you must also be evaluated by the Medical Office (x3232).