



Washington State Department of
Labor & Industries

Ethylene Oxide

Training on the hazards of ethylene oxide (EtO) in the workplace



Developed by the Division of Occupational Safety & Health (DOSH)
for employee training

October, 2009



Ethylene Oxide

What this training will cover:

Health and fire hazards of ethylene oxide

How you can be exposed to ethylene oxide

How we control your ethylene oxide exposure

How to protect yourself from ethylene oxide

Use of respirators

Medical surveillance & medical removal

DOSH rules on ethylene oxide

What is Ethylene Oxide (EtO)?

- A colorless gas above 51°F, liquid below 51°F
- Ether-like, sweet odor at toxic levels
- Highly flammable & explosive
- Highly reactive, penetrating
- Heavier than air



Charging sterilizer with EtO

Other names for ethylene oxide:

- 1,2-epoxyethane
- oxirane
- dimethylene oxide
- ethene oxide

Uses of Ethylene Oxide

- Sterilant for medical equipment and supplies
- Fumigant for certain agricultural products
- Sterilant for spices & cosmetics
- Intermediate in chemical manufacturing of antifreeze and other products.



EtO medical sterilizers

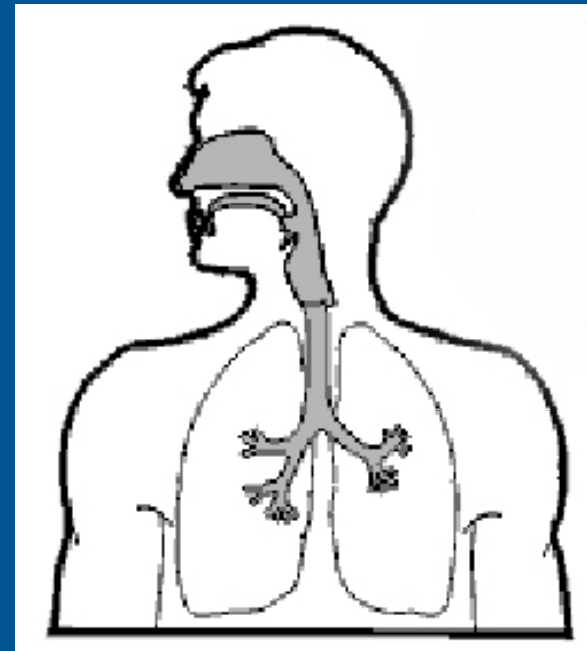
Ethylene Oxide Is Highly Toxic

- Cancer hazard
- Reproductive hazard
- Mutagenic hazard
- Neurotoxic hazard

Health Effects of EtO Exposure

Inhalation of large amounts of EtO can cause:

- Respiratory irritation and lung injury
- Headache
- Nausea, vomiting
- Diarrhea
- Shortness of breath
- Cyanosis - low blood oxygen levels
- Neurological dysfunction



Health Effects of EtO Exposure

Chronic exposure to EtO can cause:



- Cancer - leukemia
- Reproductive effects
- Mutagenic changes
- Neurotoxicity
- Occupational asthma (reactive airway syndrome)
- Sensitization

Health Effects of EtO Exposure

Skin effects from exposure to ethylene oxide:

- Severe irritation
- Allergic contact dermatitis
- Second degree burns
- Frostbite
- Sensitization



Ethylene oxide dermatitis

Health Effects of EtO Exposure

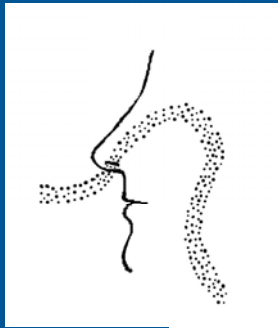
Eye effects from exposure to ethylene oxide:

- Irritation
- Corneal burn
- Cataracts

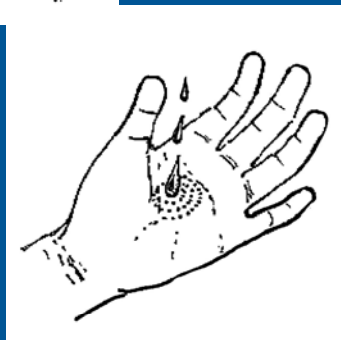


How can you be exposed?

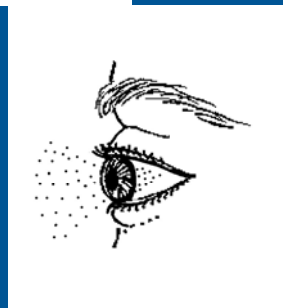
Routes of Exposure



- Inhalation



- Skin contact



- Eye contact

How or When Can You Be Exposed?

In healthcare, you can be exposed during:

- Unloading of sterilized or fumigated materials
- Direct handling of sterilized materials (off-gassing)
- Cylinder changing



Removing sterilized items

How or When Can You Be Exposed? (con't.)

You can also be exposed from:

- Inadequate ventilation of the aerator
- Improper or incomplete aeration of the ethylene oxide chamber after the sterilizing process
- Accidental leakage from poor gas-line connections



Aerator

The following operations/work areas where you may be exposed to EtO are:

[List the operations in employee work areas where EtO is present.]

EtO Permissible Exposure Limits (PELs)

8-hour time-weighted average exposure limit:
one part per million (ppm) in the air

Short-term exposure limit (STEL):
five parts per million (ppm) in the air

EtO Permissible Exposure Limits (PELs)

ACTION LEVEL:

0.5 parts per million in the air
as an 8-hour TWA

Levels of EtO in the air above the action level triggers the following requirements:

- air monitoring
- medical examinations
- labeling
- employee information & training

Warning labels on containers are required:

- On all containers whose contents may cause exposure above action level or STEL
- On containers of EtO during transport



BREATHING AIRBORNE
CONCENTRATIONS OF
ETO IS HAZARDOUS

Exposure Control Areas



- Exposure control areas are areas where levels of EtO exceed or could exceed the permissible exposure limits (PELs)
- Warning signs must be posted at access points to exposure control areas

Exposure Control Areas (cont.)

- Only authorized personnel are permitted entry
- Appropriate respirators available for use
- Cannot eat, drink, smoke, chew gum or tobacco or apply cosmetics or store food, beverages or cosmetics in the area



The following areas are Exposure Control Areas:

[List here all worksite exposure control areas.]

Exposure Control Plan

We have an exposure control plan to protect you from exposure to EtO. It includes:

- A schedule for periodic leak surveys
- procedures for emergency actions in the event of a release of EtO
- an employee alarm system
- written copy for you to view



Exposure to EtO can be reduced by:

- Engineering Controls
- Work Practices
- Personal Protective Equipment
- Respiratory Protection

Engineering control examples for EtO

- EtO is only used for materials which are sensitive to heat or moisture and cannot be steam sterilized.
- Sterilizers and aerators are located so that personnel other than those required by the operations are not exposed.
- Double-tank system with a T-valve are used to prevent the release of any EtO during the switchover to a new tank.

More engineering control examples for EtO

- Exhaust ventilation system (hood) area installed to protect against accidental releases
- Liquid/gas separator and local exhaust ventilation are used to control high levels of EtO at the point of waste discharge
- Specialized gas-line connections to minimize EtO leakage during use and during change-out of EtO cylinders
- Sterilizer/aerator door gaskets, valves, and fittings replaced when necessary

We use the following controls to reduce the amount of ethylene oxide you are exposed to:

[List company controls here]

Recommended Work Practices for EtO

For EtO fire hazard:

- Keep EtO containers tightly sealed in a cool, well-ventilated area
- Keep away from ignition source
- Keep areas where EtO is used clear of other combustible materials

More recommended work practices for EtO

- Keep sterilizer door sealed until the sterilization is completed and the EtO has been removed from the chamber
- Keep sterilized materials as far away from your breathing zone as possible
- Avoid handling materials before they are aerated, by keeping materials in one container throughout the procedures
- If you must handle individual items before aeration, use disposable impermeable gloves

Required work practices at this worksite

[List worksite-specific work practices that reduce or control exposures here.]

Our Hazard Communication Program

All employees are trained on the hazards of the specific chemicals to which they use or are exposed.

Material safety data sheets (MSDS) provide information on product ingredients and hazards of chemicals.

All employees have access to the MSDSs.

All containers of chemicals are labeled with the name and hazards of the contents.

Material Safety Data Sheet

Chemical Name: Ethylene Oxide

Weight By %: 84 to 97%

Chemical Family: Epoxide

Formula: (CH₂)₂O

Molecular Weight: 44.06 gms/mole

CAS Number: 75-21-8

CAS Name: Oxirane

Synonyms: EO, EtO, Dihydroxirene, 1-2 Epoxyethane, Dimethylene Oxide, Oxane, Oxirane, Alkene Oxide, Alpha/Beta-Oxidoethane, Oxacyclopropane.

Product Uses: Chemical intermediate for production of antifreeze, polyester resins, non-ionic surfactants and specialty solvents; sterilizing agent for controlling microorganisms in health care applications; fumigant for controlling insect infestation in whole and ground spices and cosmetics.

Exposure Limits:

NIOSH REL: Ca TWA <0.1 ppm (0.18 mg/m³) C 5 ppm (9 mg/m³) [10-min/day] See Appendix A

OSHA PEL: [1910.1047] TWA 1 ppm 5 ppm [15-minute Excursion] IDLH Ca [800 ppm] See: [75218](#) Conversion 1 ppm = 1.80 mg/m³

Physical Description

Colorless gas or liquid (below 51°F) with an ether-like odor.

MW: 44.1 BP: 51°F FRZ: -171°F

Sol: Miscible VP: 1.46 atm IP: 10.56 eV

RGasD: 1.49 Sp.Gr: 0.82 (Liquid at 50°F)

Fl.P: NA (Gas) -20°F (Liquid) UEL: 100% LEL: 3.0%
Flammable Gas

Incompatibilities & Reactivities

Strong acids, alkalis & oxidizers; chlorides of iron, aluminum & tin; oxides of iron & aluminum; water

Detection and monitoring of ethylene oxide

We conduct air monitoring by attaching air sampling devices to employees exposed to ethylene oxide.

You or your representatives are allowed to observe the monitoring.

We must provide written notification of monitoring results to you within five business days after we receive them.



EtO sampling dosimeter



EtO direct reading instrument

Notification of results

If air monitoring results are above either the TWA_8 or STEL permissible exposure limit (PEL), we will provide you with written notification of the following within fifteen business days after we receive the results :

When monitoring results are:

$TWA_8 > 1 \text{ ppm}$
or
 $STEL > 5 \text{ ppm}$

Corrective actions being taken and a schedule for completion;

and

Any reason why exposures cannot be lowered to below the PELs.



Detection and monitoring of ethylene oxide

We also use an ethylene oxide detector system and room monitors to detect any leakage of gas.

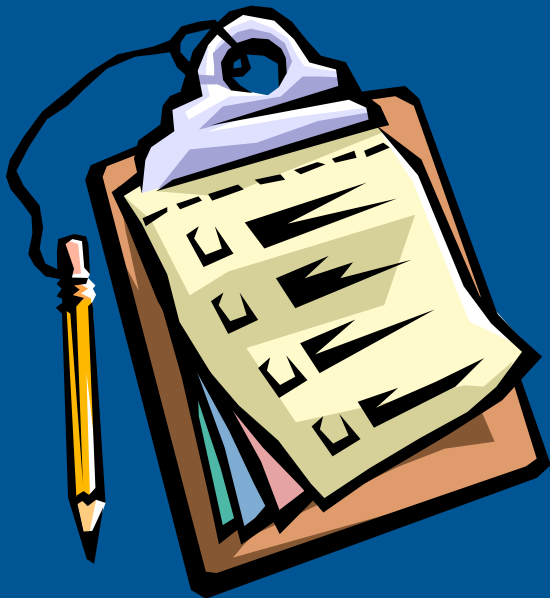


EtO Room Monitor



EtO Monitoring Station

Detection and monitoring of ethylene oxide



We also monitor for leaks at gas-line connectors.

We keep a written log for any detected leak and any service done on an ethylene oxide chamber.

These are the results of our air monitoring:

[List results here.]

Personal Protective Equipment

When working with EtO you may need to wear:

- A respirator assigned to you
- Eye protection either through the use of a full-facepiece respirator, or chemical safety goggles
- Skin protection by use of chemical protective gloves, coveralls, boots and/or other protective clothing

When is a respirator needed?

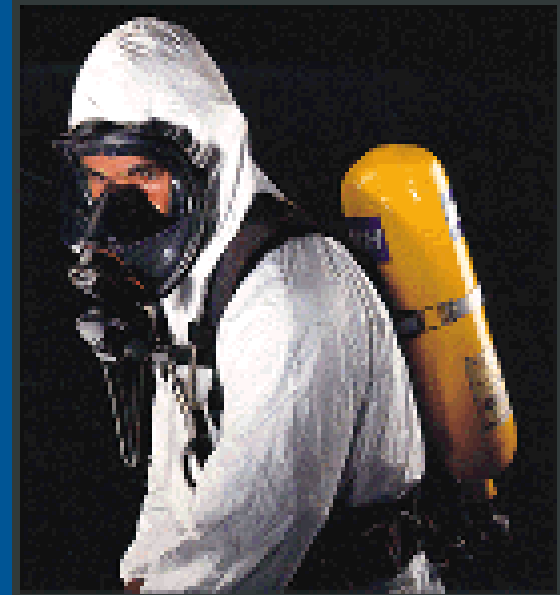
You will need a respirator for protection from ethylene oxide if the PEL is exceeded. This can occur in the following situations:

- During installation or implementation of feasible engineering controls and work practices;
- During maintenance, repair, and operations when engineering and work practice controls are not feasible;
- When engineering and work practice controls are not currently available to reduce exposures to or below the PEL; and
- During emergencies (leaks or spills of EtO)

Respirators for EtO protection

Because of EtO's poor warning properties, a supplied air respirator is the only acceptable respirator suitable for protection.

Either an airline respirator or self-contained breathing apparatus (SCBA) must be used.



Using a respirator

To prevent inhaling ethylene oxide, make sure your respirator fits properly before entering an area where ethylene oxide gas exists.

If you think your respirator is leaking, leave the area immediately and have it re-fitted, repaired or replaced.

If you know or believe you have inhaled ethylene oxide, let your supervisor know immediately.

Personal Protective Equipment

The following PPE provides at least 4 hours of protection:

- Butyl rubber gloves, suits, and boots
- Teflon™ gloves, suits, and boots
- PE/EVAL - 4H™ and Silver Shield™ brand gloves



Spills And Emergencies

If EtO gas is leaked or liquid EtO is spilled, we will do the following :

- Evacuate persons not wearing protective equipment from area of leak until clean-up is complete.
- Remove all ignition sources.
- Ventilate area of leak to disperse the gas and to allow liquid EtO to evaporate.
- Stop flow of gas. If a cylinder is leaking and can't be stopped in place, we will move it to a safe place in the open air, and repair the leak or allow cylinder to empty.

How to Protect Yourself

In the case of a spill or release of EtO:

- Leave the area immediately
- Do not attempt to clean up the spill
- Secure the area to prevent others from entering
- Notify your supervisor

Our EtO spill & emergency procedures

[Detail your emergency response procedures here:]

Medical Evaluations

What medical evaluation is needed?

A medical exam is made available to you before you start working around ethylene oxide.

Annual medical exams are made available to you if you are or may be exposed to ethylene oxide above 0.5 ppm, 30 days or more per year.

The medical exam includes a complete physical exam and blood tests.



Medical Evaluations (con't.)

Medical evaluations will also be made available to you:

If you have been exposed to EtO during an emergency situation.

If you want medical advice on EtO exposure and reproductive health.

Whenever you develop signs and symptoms commonly associated with ethylene oxide.

Medical Evaluations (con't.)

Medical evaluations will be provided at no cost to you. This includes travel costs and wages associated with any time spent obtaining the medical evaluation.

The medical evaluations will be available at reasonable times and places.

When employment with exposure ends, you are entitled to a medical evaluation if you have not had an evaluation within the six-month period before exposure ends.

Results of the Medical Evaluation

We must obtain the licensed health care provider's written opinion for the medical evaluation and make sure that you receive a copy within five business days after we receive the written opinion.



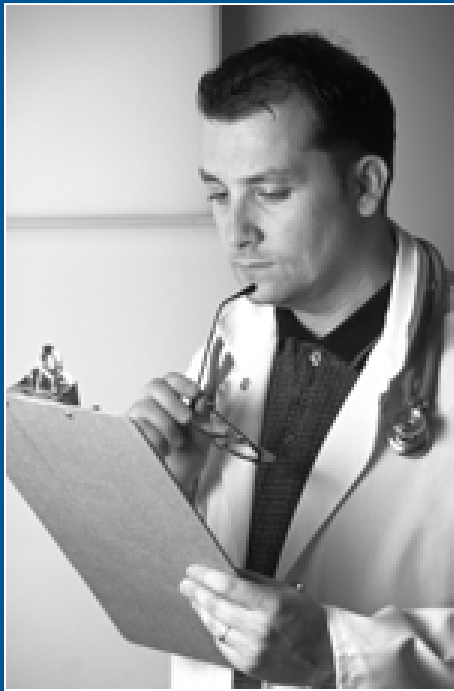
Temporary Medical Removal

If abnormalities show up in the blood tests, the doctor may ask for additional tests and temporary removal from exposure.

In that case, we will find other work for you in an area where you are not exposed to ethylene oxide.



Permanent Medical Removal



Permanent medical removal may be required if you have experienced serious health effects of ethylene oxide exposure.

Depending on your medical condition, you may not be able to return to your original position.

If the doctor recommends permanent job removal, we will seek a job transfer for you.

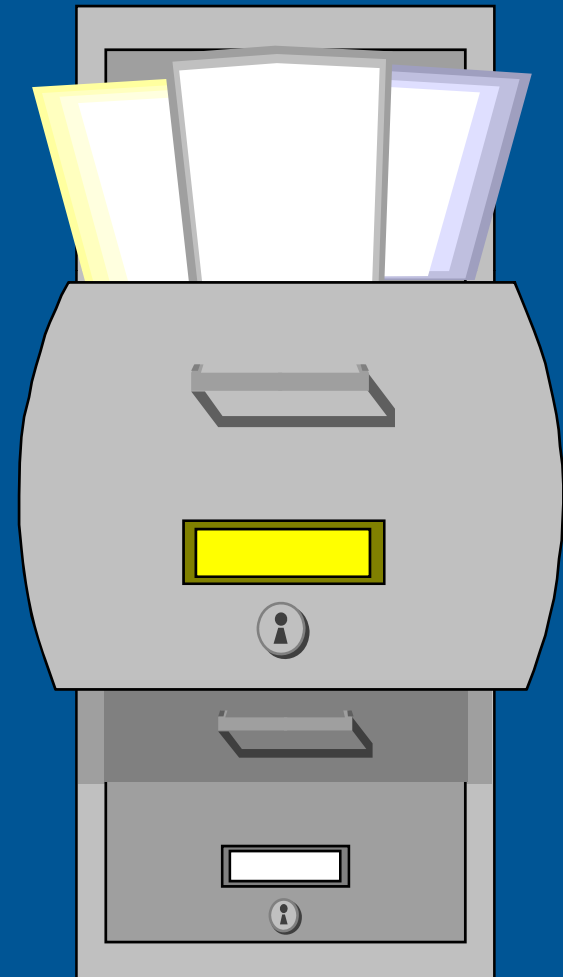
Our Medical Evaluation Program

[Describe details of worksite specific medical evaluation program here.]

Medical and Air Monitoring Records

You have the right to see any of your medical records related to ethylene oxide.

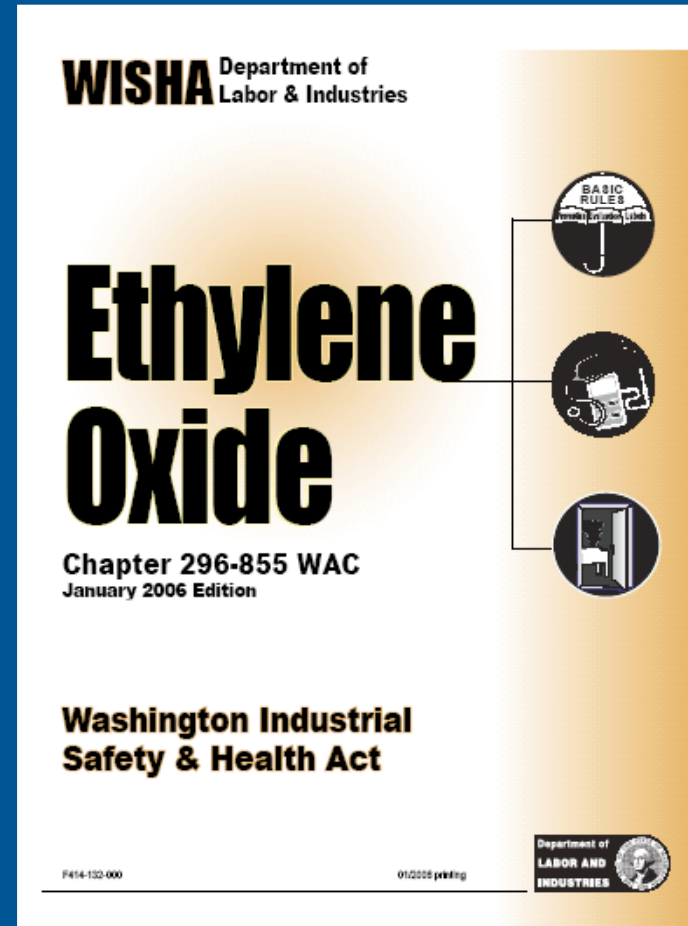
You also have the right to see results of any air sampling for ethylene oxide we have done.



Ethylene Oxide Regulations

The DOSH ethylene oxide regulations contains much more information in detail.

A copy of this standard is available.



Links to handouts:

The Substance safety data sheet, [WAC 296-62-07383 Appendix A](#)

The Substance technical guidelines, [WAC 296-62-07385 Appendix B](#)

Medical Surveillance guidelines [WAC 296-62-07387 Appendix C](#)