Ethylene oxide

Material Safety Data Sheet

Hazard Alert Code Key:  EXTREME  HIGH  MODERATE  LOW

Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME
Ethylene oxide

STATEMENT OF HAZARDOUS NATURE

NFPA

SUPPLIER
Company: Santa Cruz Biotechnology, Inc.
Address:
2145 Delaware Ave
Santa Cruz, CA 95060
Telephone: 800.457.3801 or 831.457.3800
Emergency Tel: CHEMWATCH: From within the US and Canada: 877-715-9305
(1-800-CHEMCALL) or call +613 9573 3112

PRODUCT USE
The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation. DANGEROUS POISON. Fumigant for foodstuffs and textiles; to sterilize surgical instruments; agricultural fungicide; in organic syntheses, especially in the production of ethylene glycol and higher glycols. Starting material for the manufacture of acrylonitrile, non-ionic surfactants and ethanolamines. A petroleum demulsifier. Rocket propellant. Has also been used in flame retardants and to accelerate the ageing of tobacco leaves. Intermediate

SYNONYMS
C2-H4-O, oxirane, "1, 2-epoxyethane", amprolene, dihydrooxirene, "dimethylene oxide", E.O., "ethene oxide", ETO, merpol, oxacyclop propane, oxidoethane, oxyfume, "sterilizing gas", T-gas

Section 2 - HAZARDS IDENTIFICATION

CHEMWATCH HAZARD RATINGS

<table>
<thead>
<tr>
<th>Flammability</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body Contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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EMERGENCY OVERVIEW

RISK
Heating may cause an explosion.
Toxic by inhalation.
May cause CANCER.
May cause heritable genetic damage.
Irritating to eyes, respiratory system and skin.
Extremely flammable.
Risk of explosion if heated under confinement.

POTENTIAL HEALTH EFFECTS

ACUTE HEALTH EFFECTS

SWALLOWED
- Not normally a hazard due to physical form of product.
- Considered an unlikely route of entry in commercial/industrial environments.

EYE
- This material may produce eye irritation in some persons and produce eye damage 24 hours or more after instillation. Moderate inflammation may be expected with redness; conjunctivitis may occur with prolonged exposure.
- Not considered to be a risk because of the extreme volatility of the gas.

SKIN
- This material can cause inflammation of the skin on contact in some persons.
- The material may accentuate any pre-existing dermatitis condition.
- Open cuts, abraded or irritated skin should not be exposed to this material.
- Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.

INHALED
- Inhalation of vapors or aerosols (mists, fumes), generated by the material during the course of normal handling, may produce toxic effects.
- The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage.
- Material is highly volatile and may quickly form a concentrated atmosphere in confined or unventilated areas. Vapor is heavier than air and may displace and replace air in breathing zone, acting as a simple asphyxiant. This may happen with little warning of overexposure.
- The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation.
- Acute ethylene oxide vapour inhalation in humans has produced eye, nose and throat irritation, loss of taste and smell, headache, nausea, protracted vomiting, drowsiness, weakness, incoordination, dyspnea, cyanosis and pulmonary oedema. Symptoms of exposure may be delayed.

CHRONIC HEALTH EFFECTS
- Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems.
- There is sufficient evidence to suggest that this material directly causes cancer in humans.

Based on experiments and other information, there is ample evidence to presume that exposure to this material can cause genetic defects that can be inherited.

Limited evidence suggests that repeated or long-term occupational exposure may produce cumulative health effects involving organs or biochemical systems.

There is some evidence that inhaling this product is more likely to cause a sensitization reaction in some persons compared to the general population.

There is limited evidence that, skin contact with this product is more likely to cause a sensitization reaction in some persons compared to the general population.

There is some evidence that human exposure to the material may result in developmental toxicity. This evidence is based on animal studies where effects have been observed in the absence of marked maternal toxicity, or at around the same dose levels as other toxic effects but which are not secondary non-specific consequences of the other toxic effects.

Residues of ethylene oxide in sterilised medical devises have caused haemolysis, delayed sensitisation reactions and even anaphylaxis in patients.

Chronic vapour exposures reportedly lead to lymphocytosis, peripheral neuropathy and at low levels (below 50 ppm) chromosomal damage to lymphocytes. It has caused various mutations in 13 out of 14 plant or animal species tested and is suspected of being able to induce heritable mutations in humans. The incidence in leukaemia amongst workers exposed to ethylene oxide in a Swedish industrial plant was twice that expected in the general population.

Ethylene oxide is an electrophilic alkylating agent which reacts with nucleophiles such as carboxyl, amino-, phenolic, hydroxyl and sulfhydryl groups. The general biocidal properties of the substance are attributed to such reaction.

When administered by inhalation, ethylene oxide increased the incidences of alveolar/bronchiolar adenomas or carcinomas and hardener gland cystadenomas in mice of both sexes and malignant lymphomas, uterine adenocarcinomas adenosquamous carcinomas in female mice. It also increased the incidences of mononuclear cell leukemia and gliomas of the brain in rats in both sexes and peritoneal...
mesotheliomas in male rats. Subcutaneous injection induced local fibrosarcomas in female mice. Gavage induced local tumors, mainly squamous cell carcinomas of the forestomach, in female rats. Occupational exposure to ethylene oxide during its production, processing and clinical use has been related to an increased incidence of leukemia. Other neoplasms related to potential ethylene oxide exposure include oesophageal cancer, stomach cancer, pancreatic cancer, bladder cancer, brain and central nervous system cancer, neoplasms of lymphatic and haemopoietic tissue and Hodgkin's disease. Potential exposure to other compounds however may have occurred concurrently. The epoxide group is an alkylating agent and thus destroys nucleotides within the cell. This may cause cancer.

### Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>NAME</th>
<th>CAS RN</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethylene oxide</td>
<td>75-21-8</td>
<td>&gt;99.7</td>
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</tbody>
</table>

### Section 4 - FIRST AID MEASURES

**SWALLOWED**
- Not considered a normal route of entry.
- **EYE**
  - If product comes in contact with eyes remove the patient from gas source or contaminated area.
  - Take the patient to the nearest eye wash, shower or other source of clean water.
  - Open the eyelid(s) wide to allow the material to evaporate.
  - Gently rinse the affected eye(s) with clean, cool water for at least 15 minutes. Have the patient lie or sit down and tilt the head back. Hold the eyelid(s) open and pour water slowly over the eyeball(s) at the inner corners, letting the water run out of the outer corners.
  - The patient may be in great pain and wish to keep the eyes closed. It is important that the material is rinsed from the eyes to prevent further damage.
  - Ensure that the patient looks up, and side to side as the eye is rinsed in order to better reach all parts of the eye(s)
  - Transport to hospital or doctor.
  - Even when no pain persists and vision is good, a doctor should examine the eye as delayed damage may occur.
  - If the patient cannot tolerate light, protect the eyes with a clean, loosely tied bandage.
  - Ensure verbal communication and physical contact with the patient.
- **SKIN**
  - If skin or hair contact occurs:
    - Immediately flush body and clothes with large amounts of water, using safety shower if available.
    - Quickly remove all contaminated clothing, including footwear.
    - Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Center.
    - Transport to hospital, or doctor.
  - **INHALED**
    - Following exposure to gas, remove the patient from the gas source or contaminated area.
    - **NOTE:** Personal Protective Equipment (PPE), including positive pressure self-contained breathing apparatus may be required to assure the safety of the rescuer.
    - Prostheses such as false teeth, which may block the airway, should be removed, where possible, prior to initiating first aid procedures.
    - If the patient is not breathing spontaneously, administer rescue breathing.
    - If the patient does not have a pulse, administer CPR.
    - If medical oxygen and appropriately trained personnel are available, administer 100% oxygen.
    - Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or Poison Control Center for further instruction.
    - Keep the patient warm, comfortable and at rest while awaiting medical care.
    - **MONITOR THE BREATHING AND PULSE, CONTINUOUSLY.**
    - Administer rescue breathing (preferably with a demand-valve resuscitator, bag-valve mask-device, or pocket mask as trained) or CPR if necessary.

**NOTES TO PHYSICIAN**
- Treat symptomatically.
- For acute or short term repeated exposures to ethylene glycol:
  - Early treatment of ingestion is important. Ensure emesis is satisfactory.
  - Test and correct for metabolic acidosis and hypocalcemia.
  - Apply sustained diuresis when possible with hypertonic mannitol.
  - Evaluate renal status and begin hemodialysis if indicated. [I.L.O]
  - Rapid absorption is an indication that emesis or lavage is effective only in the first few hours. Cathartics and charcoal are generally not effective.
  - Correct acidosis, fluid/electrolyte balance and respiratory depression in the usual manner. Systemic acidosis (below 7.2) can be treated with intravenous sodium bicarbonate solution.
Ethanol therapy prolongs the half-life of ethylene glycol and reduces the formation of toxic metabolites.

Pyridoxine and thiamine are cofactors for ethylene glycol metabolism and should be given (50 to 100 mg respectively) intramuscularly, four times per day for 2 days.

Magnesium is also a cofactor and should be replenished. The status of 4-methylpyrazole, in the treatment regime, is still uncertain. For clearance of the material and its metabolites, hemodialysis is much superior to peritoneal dialysis.

[Ellenhorn and Barceloux: Medical Toxicology] It has been suggested that there is a need for establishing a new biological exposure limit before a workshift that is clearly below 100 mmol ethoxy-acetic acids per mole creatinine in morning urine of people occupationally exposed to ethylene glycol ethers. This arises from the finding that an increase in urinary stones may be associated with such exposures. Lahtinen J., et al: Occupational & Environmental Medicine 1996; 53, 595-600.

Those overexposed to ethylene oxide should be observed for at least 24 hours for possible delayed effects. Ethylene oxide reacts with water to form ethylene glycol.

Section 5 - FIRE FIGHTING MEASURES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Vapor Pressure (mmHg)</td>
<td>1140.093 @ 21 C</td>
</tr>
<tr>
<td>Upper Explosive Limit (%)</td>
<td>100</td>
</tr>
<tr>
<td>Specific Gravity (water=1)</td>
<td>0.87 @ 20 C(liq)</td>
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<tr>
<td>Lower Explosive Limit (%)</td>
<td>3</td>
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</table>

**EXTINGUISHING MEDIA**

- Water spray or fog.
- Foam.
- Dry chemical powder.
- BCF (where regulations permit).
- Carbon dioxide.

**FIRE FIGHTING**

For fires involving many gas cylinders:
- To stop the flow of gas, specifically trained personnel may inert the atmosphere to reduce oxygen levels thus allowing the capping of leaking container(s).
- Reduce the rate of flow and inject an inert gas, if possible, before completely stopping the flow to prevent flashback.
- DO NOT extinguish the fire until the supply is shut off otherwise an explosive re-ignition may occur.
- If the fire is extinguished and the flow of gas continues, use increased ventilation to prevent build-up of explosive atmosphere.
- Use non-sparking tools to close container valves.
- Be CAUTIOUS of a Boiling Liquid Evaporating Vapor Explosion, BLEVE, if fire is impinging on surrounding containers.
- Direct 2500 liter/min (500 gpm) water stream onto containers above liquid level with the assistance remote monitors.

**GENERAL**

- Alert Emergency Responders and tell them location and nature of hazard.
- May be violently or explosively reactive.
- Wear full body protective clothing with breathing apparatus.
- Consider evacuation.
- Fight fire from a safe distance, with adequate cover.
- If safe, switch off electrical equipment until vapor fire hazard removed.
- Use water delivered as a fine spray to control fire and cool adjacent area.
- Do not approach cylinders suspected to be hot.
- Cool fire exposed cylinders with water spray from a protected location.
- If safe to do so, remove cylinders from path of fire.
- Equipment should be thoroughly decontaminated after use.

**FIRE-FIGHTING PROCEDURES:**

- The only safe way to extinguish a flammable gas fire is to stop the flow of gas.
- If the flow cannot be stopped, allow the entire contents of the cylinder to burn while cooling the cylinder and surroundings with water from a suitable distance.
- Extinguishing the fire without stopping the gas flow may permit the formation of ignitable or explosive mixtures with air. These mixtures may propagate to a source of ignition.

**SPECIAL HAZARDS:**

- Excessive pressures may develop in a gas cylinder exposed in a fire; this may result in explosion.
- Cylinders with pressure relief devices may release their contents as a result of fire and the released gas may constitute a further source of hazard for the fire-fighter.
- Cylinders without pressure-relief valves have no provision for controlled release and are therefore more likely to explode if exposed to fire.

**FIRE FIGHTING REQUIREMENTS:**

- Positive pressure, self-contained breathing apparatus is required for fire-fighting of hazardous materials.
- Full structural fire-fighting (bunker) gear is the minimum acceptable attire.
- The need for proximity, entry and flash-over protection and special protective clothing should be determined for each incident, by a
competent fire-fighting safety professional.

GENERAL FIRE HAZARDS/HAZARDOUS COMBUSTIBLE PRODUCTS

- HIGHLY FLAMMABLE: will be easily ignited by heat, sparks or flames.
- Will form explosive mixtures with air.
- Fire exposed cylinders may vent contents through pressure relief devices thereby increasing fire intensity and/ or vapor concentration.
- Vapors may travel to source of ignition and flash back.
- Containers may explode when heated - Ruptured cylinders may rocket.
- Fire may produce irritating, poisonous or corrosive gases.
- Runoff may create fire or explosion hazard.
- May decompose explosively when heated or involved in fire.
- Contact with gas may cause burns, severe injury and/ or frostbite.
- POISONOUS: MAY BE FATAL IF INHALED, SWALLOWED OR ABSORBED THROUGH SKIN

Combustion products include: carbon monoxide (CO).
Decomposition may produce toxic fumes of: carbon dioxide (CO2), other pyrolysis products typical of burning organic material.
Contains low boiling substance: Closed containers may rupture due to pressure buildup under fire conditions.
Vented gas is more dense than air and may collect in pits, basements.

FIRE INCOMPATIBILITY
- Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.

PERSONAL PROTECTION

Glasses:
- Safety Glasses.
- Chemical goggles.
Gloves:
- 1. NEOPRENE 2. NITRILE
Respirator:
- Type AX Filter of sufficient capacity

Section 6 - ACCIDENTAL RELEASE MEASURES

MINOR SPILLS
- Avoid breathing vapor and any contact with liquid or gas. Protective equipment including respirator should be used.
- DO NOT enter confined spaces were gas may have accumulated.
- Increase ventilation.
- Clear area of personnel.
- Stop leak only if safe to so do.
- Remove leaking cylinders to safe place, release pressure under safe controlled conditions by opening valve.
- Keep area clear of personnel until gas has dispersed.

MAJOR SPILLS
- Remove leaking cylinders to a safe place.
- Fit vent pipes. Release pressure under safe, controlled conditions
- Burn issuing gas at vent pipes.
- DO NOT exert excessive pressure on valve; DO NOT attempt to operate damaged valve.
- Clear area of all unprotected personnel and move upwind.
- Alert Emergency Authority and advise them of the location and nature of hazard.
- May be violently or explosively reactive.
- Wear full body clothing with breathing apparatus.
- Prevent by any means available, spillage from entering drains and water-courses.
- Consider evacuation.
- Shut off all possible sources of ignition and increase ventilation.
- No smoking or naked lights within area.
- Use extreme caution to prevent violent reaction.
- Stop leak only if safe to do so.
- Water spray or fog may be used to disperse vapor.
- DO NOT enter confined space where gas may have collected.
- Keep area clear until gas has dispersed.

PROTECTIVE ACTIONS FOR SPILL

WARNING
MAY DECOMPOSE EXPLOSIONS AT HIGH TEMPERATURES.

SMALL SPILLS

<table>
<thead>
<tr>
<th>Name</th>
<th>Isolation Distance</th>
<th>Downwind Day</th>
<th>Protection Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene oxide</td>
<td>100 ft (30 m)</td>
<td>0.1 mile (0.2 km)</td>
<td>0.1 mile (0.2 km)</td>
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</tbody>
</table>

LARGE SPILLS

<table>
<thead>
<tr>
<th>Name</th>
<th>Isolation Distance</th>
<th>Downwind Day</th>
<th>Protection Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene oxide</td>
<td>200 ft (60 m)</td>
<td>0.3 mile (0.5 km)</td>
<td>1.1 mile (1.8 km)</td>
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</tbody>
</table>

FOOTNOTES

1 PROTECTIVE ACTION ZONE is defined as the area in which people are at risk of harmful exposure. This zone assumes that random changes in wind direction confines the vapour plume to an area within 30 degrees on either side of the predominant wind direction, resulting in a crosswind protective action distance equal to the downwind protective action distance.

2 PROTECTIVE ACTIONS should be initiated to the extent possible, beginning with those closest to the spill and working away from the site in the downwind direction. Within the protective action zone a level of vapour concentration may exist resulting in nearly all unprotected persons becoming incapacitated and unable to take protective action and/or incurring serious or irreversible health effects.

3 INITIAL ISOLATION ZONE is determined as an area, including upwind of the incident, within which a high probability of localised wind reversal may expose nearly all persons without appropriate protection to life-threatening concentrations of the material.

4 SMALL SPILLS involve a leaking package of 200 litres (55 US gallons) or less, such as a drum (jerican or box with inner containers). Larger packages leaking less than 200 litres and compressed gas leaking from a small cylinder are also considered "small spills". LARGE SPILLS involve many small leaking packages or a leaking package of greater than 200 litres, such as a cargo tank, portable tank or a "one-tonne" compressed gas cylinder.


6 IERG information is derived from CANUTEC - Transport Canada.

ACUTE EXPOSURE GUIDELINE LEVELS (AEGL) (in ppm)

AEGL 1: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL 2: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL 3: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

EMERGENCY RESPONSE PLANNING GUIDELINES (ERPG)

The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour WITHOUT experiencing or developing

- life-threatening health effects is:
  - ethylene oxide 500ppm

- irreversible or other serious effects or symptoms which could impair an individual’s ability to take protective action is:
  - ethylene oxide 50ppm

- other than mild, transient adverse effects without perceiving a clearly defined odour is:
  - ethylene oxide NA†
Ingredients considered according exceed the following cutoffs

- **Very Toxic (T+)**: $\geq 0.1\%$
- **Toxic (T)**: $\geq 3.0\%$
- **R50**: $\geq 0.25\%$
- **Corrosive (C)**: $\geq 5.0\%$
- **R51**: $\geq 2.5\%$
- **else**: $\geq 10\%$

where percentage is percentage of ingredient found in the mixture

### Section 7 - HANDLING AND STORAGE

#### PROCEDURE FOR HANDLING

- Consider use in closed pressurized systems, fitted with temperature, pressure and safety relief valves which are vented for safe dispersal.
- Check regularly for spills or leaks. Keep valves tightly closed but do not apply extra leverage to hand wheels or cylinder keys.
- Test for leakage with brush and detergent - NEVER use a naked flame.
- Leaking gland nuts may tightened if necessary.
- If a cylinder valve will not close completely, remove the cylinder to a well ventilated location (e.g. outside) and, when empty, tag as FAULTY and return to supplier.
- Obtain a work permit before attempting any repairs. DO NOT attempt repair work on lines, vessels under pressure.
- Atmospheres must be tested and O.K. before work resumes after leakage.
- DO NOT transfer gas from one cylinder to another.

#### RECOMMENDED STORAGE METHODS

- **Cylinder**
  - Ensure the use of equipment rated for cylinder pressure.
  - Ensure the use of compatible materials of construction.
  - Valve protection cap to be in place until cylinder is secured, connected.
  - Cylinder must be properly secured either in use or in storage.
  - Cylinder valve must be closed when not in use or when empty.
  - Segregate full from empty cylinders.

**WARNING:** Suckback into cylinder may result in rupture. Use back-flow preventive device in piping.

#### STORAGE REQUIREMENTS

- Cylinders should be stored in a purpose-built compound with good ventilation, preferably in the open.
- Such compounds should be sited and built in accordance with statutory requirements.
- The storage compound should be kept clear and access restricted to authorized personnel only.
- Cylinders stored in the open should be protected against rust and extremes of weather.
- Cylinders in storage should be properly secured to prevent toppling or rolling.
- Cylinder valves should be closed when not in use.
- Where cylinders are fitted with valve protection this should be in place and properly secured.
- Gas cylinders should be segregated according to the requirements of the Dangerous Goods Act(s).
- Cylinders containing flammable gases should be stored away from other combustible materials. Alternatively a fire-resistant partition may be used.
- Check storage areas for flammable or hazardous concentrations of gases prior to entry.
- Preferably store full and empty cylinders separately.
- Full cylinders should be arranged so that the oldest stock is used first.
- Cylinders in storage should be checked periodically for general condition and leakage.
- Protect cylinders against physical damage. Move and store cylinders correctly as instructed for their manual handling.

**NOTE:** A ‘G’ size cylinder is usually too heavy for an inexperienced operator to raise or lower.

### SAFE STORAGE WITH OTHER CLASSIFIED CHEMICALS

- **X**: Must not be stored together
- **O**: May be stored together with specific preventions
- **+**: May be stored together

#### Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION
## EXPOSURE CONTROLS

<table>
<thead>
<tr>
<th>Source</th>
<th>Material</th>
<th>TWA ppm</th>
<th>TWA mg/m³</th>
<th>STEL ppm</th>
<th>STEL mg/m³</th>
<th>Peak ppm</th>
<th>Peak mg/m³</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Canada - Alberta Occupational Exposure Limits</td>
<td>ethylene oxide (Ethylene oxide)</td>
<td>1</td>
<td>1.8</td>
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<td></td>
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<tr>
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<td>0.1</td>
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<td></td>
<td>A2; 1; R</td>
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<tr>
<td>US OSHA Permissible Exposure Levels (PELs) - Table Z1</td>
<td>ethylene oxide (Ethylene oxide; see 1910.1047)</td>
<td>1</td>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(STEL (Excursion limit)(as averaged over a sampling period of 15 minutes))</td>
</tr>
<tr>
<td>US ACGIH Threshold Limit Values (TLV)</td>
<td>ethylene oxide (Ethylene oxide)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TLV Basis: cancer; central nervous system impairment</td>
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<tr>
<td>US NIOSH Recommended Exposure Limits (RELs)</td>
<td>ethylene oxide (Ethylene oxide)</td>
<td>&lt;0.1</td>
<td>0.18</td>
<td>5</td>
<td>9</td>
<td>See Appendix A; Ca; (Ceiling ([10-min/day]))</td>
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<tr>
<td>US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)</td>
<td>ethylene oxide (ETHYLENE OXIDE)</td>
<td>0.09</td>
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<td>US - California Permissible Exposure Limits for Chemical Contaminants</td>
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<td>5</td>
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<td>See *12-202-35</td>
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<td>Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances</td>
<td>ethylene oxide (Ethylene oxide)</td>
<td>50</td>
<td>90</td>
<td>75</td>
<td>135</td>
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<td>US - Washington Permissible exposure limits of air contaminants</td>
<td>ethylene oxide (Ethylene oxide (see chapter 296-855 WAC))</td>
<td>1</td>
<td></td>
<td>5</td>
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<td>Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits</td>
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<td>T20</td>
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<td>1</td>
<td>1.8</td>
<td>5</td>
<td>9.0</td>
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<td>1</td>
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<td>TLV Basis: cancer; central nervous system impairment</td>
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<tr>
<td>US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants</td>
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</table>
Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)

<table>
<thead>
<tr>
<th>Material</th>
<th>Permissible Value (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethylene oxide</td>
<td>1.8</td>
</tr>
</tbody>
</table>

US - Oregon Permissible Exposure Limits (Z-1)

<table>
<thead>
<tr>
<th>Material</th>
<th>Permissible Value (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethylene oxide</td>
<td>1</td>
</tr>
</tbody>
</table>

TWA (See 1910.1047)

Canada - Northwest Territories Occupational Exposure Limits (English)

<table>
<thead>
<tr>
<th>Material</th>
<th>Permissible Value (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethylene oxide</td>
<td>10 20 50 100</td>
</tr>
</tbody>
</table>

Canada - Nova Scotia Occupational Exposure Limits (English)

<table>
<thead>
<tr>
<th>Material</th>
<th>Permissible Value (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethylene oxide</td>
<td>1</td>
</tr>
</tbody>
</table>

TLV Basis: cancer; central nervous system impairment

ENDOELTABLE

EMERGENCY EXPOSURE LIMITS

<table>
<thead>
<tr>
<th>Material</th>
<th>IDLH Value (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethylene oxide</td>
<td></td>
</tr>
</tbody>
</table>

ORIGINAL IDLH VALUE

Material: ethylene oxide

Odour Threshold Value: 257-690 ppm (detection), 493 ppm (recognition)

NOTE: Detector tubes for ethylene oxide, measuring in excess of 1 ppm, are available commercially.

Exposure at or below the TLV-TWA is thought reduce the potential oncogenic risk and the risk from potential, non-neoplastic adverse effects on lungs, liver, kidneys, endocrine system, blood forming elements and the central nervous system. OSHA recognised that ethylene oxide exposures at 1 ppm still might produce significant health risks. A quantitative risk assessment shows an excess cancer mortality risk of 12 to 23 deaths per 10,000 workers at this level. It must be stated that risk assessment models are fraught with much uncertainty.

Odour Safety Factor (OSF)

OSF = 0.0023 (ETHYLENE OXIDE).

PERSONAL PROTECTION

Consult your EHS staff for recommendations

EYE

- Safety glasses with side shields.
- Chemical goggles.
- Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. DO NOT wear contact lenses.

HANDS/FEET

NOTE: The material may produce skin sensitization in predisposed individuals. Care must be taken, when removing gloves and other protective equipment, to avoid all possible skin contact.

- When handling sealed and suitably insulated cylinders wear cloth or leather gloves.

OTHER

- Employees working with confirmed human carcinogens should be provided with, and be required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers and gloves prior to entering the regulated area.
- Employees engaged in handling operations involving carcinogens should be provided with, and required to wear and use half-face filter-type respirators with filters for dusts, mists and fumes, or air purifying canisters or cartridges. A respirator affording higher levels of protection may be substituted.
- Emergency deluge showers and eyewash fountains, supplied with potable water, should be located near, within sight of, and on the same level with locations where direct exposure is likely.
- Prior to each exit from an area containing confirmed human carcinogens, employees should be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers must be identified with suitable labels. For maintenance and decontamination activities, authorized employees entering the area should be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood.
Prior to removing protective garments the employee should undergo decontamination and be required to shower upon removal of the garments and hood.

- Protective overalls, closely fitted at neck and wrist.
- Eye-wash unit.

IN CONFINED SPACES:

- Non-sparking protective boots
- Static-free clothing.
- Ensure availability of lifeline.

Staff should be trained in all aspects of rescue work.

Rescue gear: Two sets of SCUBA breathing apparatus Rescue Harness, lines etc.

RESPIRATOR

- Positive pressure, full face, air-supplied breathing apparatus should be used for work in enclosed spaces if a leak is suspected or the primary containment is to be opened (e.g. for a cylinder change)
- Air-supplied breathing apparatus is required where release of gas from primary containment is either suspected or demonstrated.

GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:

"Forsberg Clothing Performance Index".

The effect(s) of the following substance(s) are taken into account in the computer-generated selection: ethylene oxide

- Protective Material CPI *
  - NEOPRENE C
  - NITRILE C
  - SARANEX-23 C

* CPI - Chemwatch Performance Index

A: Best Selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to Dangerous Choice for other than short term immersion

NOTE: As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation.

* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

RESPIRATOR

Selection of the Class and Type of respirator will depend upon the level of breathing zone contaminant and the chemical nature of the contaminant. Protection Factors (defined as the ratio of contaminant outside and inside the mask) may also be important.

<table>
<thead>
<tr>
<th>Breathing Zone Level ppm (volume)</th>
<th>Maximum Protection Factor</th>
<th>Half-face Respirator</th>
<th>Full-Face Respirator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>10</td>
<td>AX-1</td>
<td>-</td>
</tr>
<tr>
<td>1000</td>
<td>50</td>
<td>-</td>
<td>AX-1</td>
</tr>
<tr>
<td>5000</td>
<td>50</td>
<td>Airline*</td>
<td>-</td>
</tr>
<tr>
<td>5000</td>
<td>100</td>
<td>-</td>
<td>AX-2</td>
</tr>
<tr>
<td>10000</td>
<td>100</td>
<td>-</td>
<td>AX-3</td>
</tr>
<tr>
<td>100+</td>
<td>Airline* **</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

* - Continuous Flow ** - Continuous-flow or positive pressure demand.

The local concentration of material, quantity and conditions of use determine the type of personal protective equipment required. Use appropriate NIOSH-certified respirator based on informed professional judgement. In conditions where no reasonable estimate of exposure can be made, assume the exposure is in a concentration IDLH and use NIOSH-certified full face pressure demand SCBA with a minimum service life of 30 minutes, or a combination full facepiece pressure demand SAR with auxiliary self-contained air supply. Respirators provided only for escape from IDLH atmospheres shall be NIOSH-certified for escape from the atmosphere in which they will be used.

ENGINEERING CONTROLS

- Employees exposed to confirmed human carcinogens should be authorized to do so by the employer, and work in a regulated area.
- Work should be undertaken in an isolated system such as a “glove-box”. Employees should wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.
- Within regulated areas, the carcinogen should be stored in sealed containers, or enclosed in a closed system, including piping systems, with any sample ports or openings closed while the carcinogens are contained within.
- Open-vessel systems are prohibited.
- Each operation should be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation.
- Exhaust air should not be discharged to regulated areas, non-regulated areas or the external environment unless decontaminated. Clean make-up air should be introduced in sufficient volume to maintain correct operation of the local exhaust system.
- For maintenance and decontamination activities, authorized employees entering the area should be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood. Prior to removing protective garments the employee should undergo decontamination and be required to shower upon removal of the garments and hood.
- Except for outdoor systems, regulated areas should be maintained under negative pressure (with respect to non-regulated areas).
Local exhaust ventilation requires make-up air be supplied in equal volumes to replaced air.

Laboratory hoods must be designed and maintained so as to draw air inward at an average linear face velocity of 150 feet/ min. with a minimum of 125 feet/ min. Design and construction of the fume hood requires that insertion of any portion of the employees body, other than hands and arms, be disallowed.

## Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

### PHYSICAL PROPERTIES

Gas.
Mixes with water.
Toxic or noxious vapors/ gas.

<table>
<thead>
<tr>
<th>State</th>
<th>Compressed gas</th>
<th>Molecular Weight</th>
<th>44.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting Range (<em>°F</em>)</td>
<td>-169.06</td>
<td>Viscosity</td>
<td>0.32 cSt @ 0°C</td>
</tr>
<tr>
<td>Boiling Range (<em>°F</em>)</td>
<td>51.08</td>
<td>Solubility in water (g/L)</td>
<td>Miscible</td>
</tr>
<tr>
<td>Flash Point (<em>°F</em>)</td>
<td>-70.6</td>
<td>pH (1% solution)</td>
<td>Not available.</td>
</tr>
<tr>
<td>Decomposition Temp (<em>°F</em>)</td>
<td>&gt;1059.8</td>
<td>pH (as supplied)</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Autoignition Temp (<em>°F</em>)</td>
<td>804.2(in air)</td>
<td>Vapor Pressure (mmHg)</td>
<td>1140.093 @ 21 C</td>
</tr>
<tr>
<td>Upper Explosive Limit (%)</td>
<td>100</td>
<td>Specific Gravity (water=1)</td>
<td>0.87 @ 20 C(liq)</td>
</tr>
<tr>
<td>Lower Explosive Limit (%)</td>
<td>3</td>
<td>Relative Vapor Density (air=1)</td>
<td>1.5</td>
</tr>
<tr>
<td>Volatile Component (%vol)</td>
<td>~100</td>
<td>Evaporation Rate</td>
<td>Not available</td>
</tr>
<tr>
<td>Gas group</td>
<td>IIB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ETHYLENE OXIDE

- log Kow (Sangster 1997): - 0.3

### APPEARANCE

Colourless liquid or vapour with an ether-like, pungent (irritating) odour (sickening at moderate concentrations). Odour and irritating effects cannot be relied on to warn of dangerous concentrations. Miscible with water, alcohol and ether.

- log Kow -0.3

### Section 10 - CHEMICAL STABILITY

#### CONDITIONS CONTRIBUTING TO INSTABILITY

- Presence of incompatible materials.
- Product is considered stable.
- Hazardous polymerization will not occur.

Pure ethylene oxide is stable in a suitable closed container at room temperature. However, it can be dangerously reactive, undergoing hazardous, exothermic polymerization and thus presenting an explosion hazard. If the vapour is heated to 570 C it violently self-reacts with ignition. In the presence of many incompatible materials (acting as catalysts) it can undergo highly exothermic molecular rearrangement or self-polymerisation.

#### STORAGE INCOMPATIBILITY

- Epoxides are highly reactive with acids, bases, and oxidizing and reducing agents.
- Epoxides react, possibly with anhydrous metal chlorides, ammonia, amines and group 1 metals.
- Peroxides can cause polymerization of epoxides.

Avoid reaction with oxidizing agents. Ethylene oxide:
- is dangerously reactive - even small amounts of strong acids, alkalis, or oxidisers may cause reaction or may react under influence of heat, sunlight
- may rearrange chemically and/ or
- in contact with highly catalytic surfaces such as anhydrous chlorides of iron, tin or aluminium, pure oxides of iron or aluminium, and alkali hydroxides, may polymerise violently with evolution of heat
- may polymerise explosively on contact with amines, ammonia, metallic potassium, covalent halides
- may react violently with alcohols, aluminium, ammonia, amines, glycerol, dinitrogen pentaoxide, m-nitroaniline
- is incompatible with bromoethane, magnesium perchlorate, mercaptans, salts, combustible materials, mercaptans, organic bases
- may react in insulation forming low molecular weight polyethylene glycols that can spontaneously ignite at less than 100 C
- attacks some plastics, rubber and coatings
- may form explosive metal acetylides in contact with copper, magnesium, mercury, silver and their alloys (including solder)
flow or agitation may generate electrostatic charges due to low conductivity
High pressure, bench scale experiments, involving 1,2-epoxides require a well-designed agitated reactor, with adequate provision for reaction heat removal and emergency pressure relief, prevention of back-flow from the reactor to oxide storage vessels, avoidance of a reaction atmosphere of 100% ethylene oxide vapor and/or presence of air and the avoidance of the use of excess oxides. A range of exothermic decomposition energies for epoxides is given as 45-80 kJ/mol. The relationship between energy of decomposition and processing hazards has been the subject of discussion; it is suggested that values of energy released per unit of mass, rather than on a molar basis (J/g) be used in the assessment. For example, in "open vessel processes" (with man-hole size openings, in an industrial setting), substances with exothermic decomposition energies below 500 J/g are unlikely to present a danger, whilst those in "closed vessel processes" (opening is a safety valve or bursting disk) present some danger where the decomposition energy exceeds 150 J/g. BRETERICK: Handbook of Reactive Chemical Hazards, 4th Edition.

For incompatible materials - refer to Section 7 - Handling and Storage.

Section 11 - TOXICOLOGICAL INFORMATION

ETHYLENE OXIDE

TOXICITY AND IRRITATION

- unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances.

<table>
<thead>
<tr>
<th>TOXICITY</th>
<th>IRRITATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral (rat) LD50: 72 mg/kg</td>
<td>Skin (human): 1% /7 sec - Irritant</td>
</tr>
<tr>
<td>Inhalation (rat) LC50: 800 ppm/4 hr</td>
<td>Eye (rabbit): 18 mg/6h - Moderate</td>
</tr>
<tr>
<td>Inhalation (human) TCLo: 12500 ppm/10 s</td>
<td></td>
</tr>
<tr>
<td>Inhalation (woman) TCLo: 500 ppm/2 m</td>
<td></td>
</tr>
</tbody>
</table>

- Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergic condition known as reactive Airways Dysfunction Syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. RADS (or asthma) following an irritating inhalation is an infrequent disorder with rates related to the concentration of and duration of exposure to the irritating substance. Industrial bronchitis, on the other hand, is a disorder that occurs as result of exposure due to high concentrations of irritating substance (often particulate in nature) and is completely reversible after exposure ceases. The disorder is characterised by dyspnea, cough and mucus production.

The material may produce moderate eye irritation leading to inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

for ethylene oxide:
Ethylene oxide is very soluble in blood. Therefore, pulmonary uptake is expected to be fast and to depend only on the alveolar ventilation rate and the concentration of ethylene oxide in the inspired air. The rate of uptake of ethylene oxide in mice was 1.1 ug/kg body weight, per min, at an exposure level of 1 mg/m3. This corresponds to nearly 100% absorption of ethylene oxide from 1.1 litre of air per min and per kg body weight, which is the reported rate of alveolar ventilation in resting mice. No specific information pertaining to skin absorption is available, but accidental exposure of the skin of 3 industrial workers to 1% aqueous solution of ethylene oxide was reported to have resulted in marked nausea and profuse vomiting.

Human exposure mainly occurs through inhalation in sterilisation facilities and in production plants. In sterilisation facilities, 8-h time-weighted average levels have usually been below 36 mg/m3, with short-term exposures of about 100 mg/m3, and peak levels of up to 1800 mg/m3. In production plants, the time-weighted average has usually been below 4 mg/m3. Ambient levels at a distance from point sources of emission have been estimated to be below the limit of detection... Exposure to residues of ethylene oxide or its reaction products, haloxydrins and ethylene glycol, also occurs from fumigated foods, pharmaceutical products, and sterilised medical equipment. 2-Chloroethanol levels as high as several g/kg have been measured in food and levels of several hundred mg/kg in medical equipment.

When inhaled, ethylene oxide is readily absorbed, distributed throughout the body, and rapidly metabolized. Accordingly, most organs receive equivalent doses of the chemical and its metabolites. The degree of alkylation of proteins and DNA varies slightly between the different organs and blood. In man and rodents, the half-life of the compound in tissues has been estimated to be 9 - 10 min. Two metabolic pathways have been identified including hydrolysis to 1,2-ethanediol and conjugation with glutathione. Excretion is primarily via the urine. Ethylene oxide is moderately toxic for mammals (the LD50 for the rat is 280 - 365 mg/kg body weight; the 4-h LC50 is 2630 mg/m3). Both experimental animal and human data show that aqueous solutions of ethylene oxide are irritating for the skin and eyes; the irritant effects of ethylene oxide vapour or residues in medical equipment on the eyes and the respiratory tract have also been observed. These effects are often delayed. Severe skin irritation is characterized by the formation of vesicles. A concentration of 10 mg/litre produced mild irritation of the human skin; a concentration of 500 g/litre was most injurious to the human skin. Allergic contact dermatitis has been reported; systemic immunologically mediated allergy is considered rare. Respiratory tract irritation increases with inhaled vapour concentration and may result in severe life-threatening pulmonary disease. Repeated exposure (2 - 8 weeks) to ethylene oxide vapour at or above 900 mg/m3 produced sensory and motor neurological impairment and may result in a peripheral neuropathy. In animals, the latter was often accompanied by muscular atrophy; erosions in the medulla oblongata of monkeys, following 2 years of intermittent exposure (7 h/day, 5 days/week) to 90 and 180 mg/m3 indicated neuropathy in the brain, which may be related to the neuropathies observed in man and other animal species. Cardiovascular collapse and renal failure have been attributed to residues of ethylene oxide in medical equipment. Ethylene oxide alkylates DNA and is mutagenic for plants, microorganisms, insects, and mammals. Cytogenetic studies on man have shown dose-related increased frequencies of both sister chromatid exchanges (SCEs) and chromosomal aberrations; in one study, SCEs developed following daily exposure for less than 5 min per day.

The evidence that ethylene oxide is a reproductive toxin is less conclusive. Where foetal developmental effects have occurred, the doses of ethylene oxide approached or equaled those producing maternal toxicity. To date, impaired male reproductive function in animals has been demonstrated only at concentrations of 90 mg/m3 or more in long-term intermittent exposures or at higher air concentrations for brief exposures. In pregnant women, the results of one study suggest that occupational exposure estimated to be an 8-h time-weighted average of...
0.18 - 0.90 mg/m³, with peak concentrations up to 450 mg/m³, was associated with spontaneous abortions. However, limited exposure data prevents the establishment of a relationship between abortion rates and exposure levels. Ethylene oxide is carcinogenic for animals when administered by the intragastric, subcutaneous injection, and inhalation routes of exposure. In man, 2 studies have shown an association between ethylene oxide exposure and an excess risk of cancer, but both studies have limitations. Airborne concentrations of ethylene oxide in the 2 studies were reported to be time-weighted averages of 36 +/- 18 mg/m³ and 10 - 50 mg/m³, with occasional brief exposures in excess of the odour threshold (900 - 1260 mg/m³).

WARNING: This substance has been classified by the IARC as Group 1: CARCINOGENIC TO HUMANS. Tenth Annual Report on Carcinogens: Substance anticipated to be Carcinogen [National Toxicology Program: U.S. Dep. of Health & Human Services 2002].

**CARCINOGEN**

Ethylene oxide (NB: Overall evaluation upgraded from 2A to 1 based on mechanistic and other relevant data)  
International Agency for Research on Cancer (IARC) - Agents Reviewed by the IARC Monographs  
Group 1

<table>
<thead>
<tr>
<th>Substance</th>
<th>International Agency for Research on Cancer (IARC) - Agents Reviewed by the IARC Monographs</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene oxide</td>
<td>ND</td>
<td>Carcinogen Category A2</td>
</tr>
</tbody>
</table>

**ETHYLENE OXIDE**

US Environmental Defense Scorecard Recognized Carcinogens  
Reference(s) P65

**ETHYLENE OXIDE**

US Environmental Defense Scorecard Suspected Carcinogens  
Reference(s) P65

**Ethylene oxide**

US Air Toxics Hot Spots TSD for Describing Available Cancer Potency Factors  
IARC Class 1

<table>
<thead>
<tr>
<th>Substance</th>
<th>International Agency for Research on Cancer (IARC) - Agents Reviewed by the IARC Monographs</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene oxide</td>
<td>ND</td>
<td>Carcinogen Category A2</td>
</tr>
</tbody>
</table>

**REPROTOXIN**

ethylene oxide  
ILO Chemicals in the electronics industry that have toxic effects on reproduction  
Reduced fertility or sterility A

---

**Section 12 - ECOLOGICAL INFORMATION**

Refer to data for ingredients, which follows:

**ETHYLENE OXIDE:**

- Hazardous Air Pollutant: Yes
- Fish LC50 (96hr.) (mg/l): 90 (24hr)
- log Kow (Sangster 1997): - 0.3
- BOD5: 0.06
- COD: 1.74
- Half-life Soil - High (hours): 285
- Half-life Soil - Low (hours): 251
- Half-life Air - High (hours): 9167
- Half-life Air - Low (hours): 917
- Half-life Surface water - High (hours): 285
- Half-life Surface water - Low (hours): 251
- Half-life Ground water - High (hours): 285
- Half-life Ground water - Low (hours): 251
- Aqueous biodegradation - Aerobic - High (hours): 4320
- Aqueous biodegradation - Aerobic - Low (hours): 672
- Aqueous biodegradation - Anaerobic - High (hours): 17280
- Aqueous biodegradation - Anaerobic - Low (hours): 2688
- Photooxidation half-life air - High (hours): 9167
- Photooxidation half-life air - Low (hours): 917
- First order hydrolysis half-life (hours): 285
- Base rate constant [MOH)- HR]- 1: 1.0E- 04 M-

**for ethylene oxide:**

- log Kow : -0.3
- Koc : 16
- Half-life (hr) air : 2880
- Half-life (hr) H2O surface water : 216-336
- Henry's atm m³ /mol: 1.20E-04
- BOD 5: 0.06
- COD : 1.74

Ethylene oxide is not expected to bioaccumulate in the environment. Fish are the most susceptible aquatic organisms. An LC50 of 90 mg/litre
was observed for goldfish exposed for 24 h. 2-Chloroethanol, a degradation product in saline water, is equally toxic but, 1,2-ethanediol, a major degradation product, is much less toxic.

In the atmosphere, ethylene oxide degrades slowly by reacting with hydroxy-radicals; the estimated half-life is 100-200 days. In water it is removed by volatilisation, hydrolysis and to a lesser extent, biodegradation. Volatilisation half-lives for a model river and lake are estimated to be 5.9 hours and 38 days respectively. Ethylene oxide is not strongly adsorbed to soil and is not expected to bioconcentrate in the food chain.

Environmental fate:
The main pathway of entry of ethylene oxide into the environment is through its escape into the atmosphere due to evaporation and with vented gases during production, handling, storage, transport, and use. Most of the ethylene oxide applied as a sterilant or fumigant will enter the atmosphere.

At ambient levels, ethylene oxide will be removed from the atmosphere via oxidation by hydroxyl radicals. On the basis of a theoretical rate constant for this reaction, the atmospheric residence time of ethylene oxide was estimated to be 5.8 days. However, experimental data have shown the residence time to be 100 - 215 days, depending on the hydroxyl radical concentration and the ambient temperature (US EPA, 1985). Because of its high water solubility, ethylene oxide levels in air will also be reduced through washout by rain. The photochemical reactivity of ethylene oxide, in terms of its ozone-forming ability, is low. Evaporation from water is a significant removal process. Under specific conditions, a half-life of 1 h for the evaporation of ethylene oxide from water has been calculated. In the environment, chemical degradation in water through ionic reactions appears to be comparatively slow. In neutral, fresh water at 25 C, ethylene oxide is broken down to form 1,2-ethanediol with a half-life of 14 days. At 0 C, the half-life is 309 days. The reaction is acid- and base-catalysed. In the presence of halide ions, 2-haloethanol will also be formed. In neutral water of 3% salinity, at 25 C, 77% of ethylene oxide was found to react to form 1,2-ethanediol and 23%, to form 2- chloroethanol with a half-life of 9 days.

Ethylene oxide and its possible metabolites can be biodegraded slowly by aerobic microorganisms. Biological oxygen demands of 3 - 5% and 52% of the theoretical oxygen demand were determined for ethylene oxide after 5 and 20 days, respectively, using a domestic sewage seed.

Ecotoxicity:
LC50s of ethylene oxide for aquatic species have been reported to range from 90 mg/litre (goldfish, 24-h exposure) to 745 mg/litre (brine shrimp, 48-h exposure). Microorganisms in activated sludge showed 50% inhibition at concentrations between 10 and 100 mg/litre. Hydrolysis to 1,2-ethanediol results in detoxification. The toxicity of 2-chloroethanol for aquatic organisms resembles that of ethylene oxide, though 2-chloroethanol seems to be more toxic for Daphnia magna. Nevertheless, under environmental conditions, the conversion of ethylene oxide to 2-chloroethanol or 1,2-ethanediol will be slow.

DO NOT discharge into sewer or waterways.

### GESAMP/EHS COMPOSITE LIST - GESAMP Hazard Profiles

<table>
<thead>
<tr>
<th>Name / Cas No / RTECS No</th>
<th>Ingredient</th>
<th>Persistence: Water/Soil</th>
<th>Persistence: Air</th>
<th>Bioaccumulation</th>
<th>Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2= / CAS:75-21-8 / KX2450000</td>
<td>ethylene oxide</td>
<td>LOW (1)</td>
<td>3</td>
<td>3</td>
<td>CMR</td>
</tr>
</tbody>
</table>

Legend: EHS=GESAMP Number (EHS=GESAMP Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships) NRT=Net Register Tonnage, A1a=Bioaccumulation log Pow, A1b=Bioaccumulation BCF, A1=Bioaccumulation, A2=Biodegradation, B1=Acuteaquatic toxicity LC/ECIC50 (mg/l), B2=Chronic aquatic toxicity NOEC (mg/l), C1=Acute mammalian oral toxicity LD50 (mg/kg), C2=Acute mammalian dermal toxicity LD50 (mg/kg), C3=Acute mammalian inhalation toxicity LC50 (mg/kg), D1=Skin irritation & corrosion, D2=Eye irritation & corrosion, D3=Long-term health effects, E1=Tainting, E2=Physical effects on wildlife & benthic habitats, E3=Interference with coastal amenities, For column A2: R=Readily biodegradable, NR=Not readily biodegradable. For column D3: C=Carcinogen, M=Mutagenic, R=Reprotoxic, S=Sensitising, A=Aspiration hazard, T=Target organ systemic toxicity, L=Lung injury, N=Neurotoxic, I=Immunotoxic. For column E1: NT=Not tainting (tested), T=Tainting test positive. For column E2: Fp=Persistent float, F=Float, S=Sinking substances. The numerical scales start from 0 (no hazard), while higher numbers reflect increasing hazard. (GESAMP/EHS Composite List of Hazard Profiles - Hazard evaluation of substances transported by ships)

### Section 13 - DISPOSAL CONSIDERATIONS

#### A. General Product Information
Ignitability characteristic: use EPA hazardous waste number D001 (waste code I)

#### B. Component Waste Numbers
When ethylene oxide is present as a solid waste as a discarded commercial chemical product, off-specification species, as a container residue, or a spill residue, use EPA waste number U115 (waste code I,T).

#### Disposal Instructions
All waste must be handled in accordance with local, state and federal regulations.

- Evaporate or incinerate residue at an approved site.
- Return empty containers to supplier.
- Ensure damaged or non-returnable cylinders are gas-free before disposal.

### Section 14 - TRANSPORTATION INFORMATION
Air Transport IATA:

<table>
<thead>
<tr>
<th>ICAO/IATA Class:</th>
<th>2.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAO/IATA Subrisk:</td>
<td>2.1</td>
</tr>
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<td>UN/ID Number:</td>
<td>1040</td>
</tr>
<tr>
<td>Packing Group:</td>
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<tr>
<td>Special provisions:</td>
<td>A2</td>
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</table>

Cargo Only

<table>
<thead>
<tr>
<th>Packing Instructions:</th>
<th>Forbidden</th>
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<tbody>
<tr>
<td>Maximum Qty/Pack:</td>
<td>Forbidden</td>
</tr>
<tr>
<td>Passenger and Cargo</td>
<td>Passenger and Cargo</td>
</tr>
</tbody>
</table>

Passenger and Cargo

<table>
<thead>
<tr>
<th>Packing Instructions:</th>
<th>Forbidden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Qty/Pack:</td>
<td>Forbidden</td>
</tr>
<tr>
<td>Passenger and Cargo Limited Quantity</td>
<td>Passenger and Cargo Limited Quantity</td>
</tr>
</tbody>
</table>

Passenger and Cargo Limited Quantity

<table>
<thead>
<tr>
<th>Packing Instructions:</th>
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</tr>
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<tbody>
<tr>
<td>Maximum Qty/Pack:</td>
<td>-</td>
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</tbody>
</table>

Shipping Name: ETHYLENE OXIDE

Maritime Transport IMDG:

<table>
<thead>
<tr>
<th>IMDG Class:</th>
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</thead>
<tbody>
<tr>
<td>IMDG Subrisk:</td>
<td>2.1</td>
</tr>
<tr>
<td>UN Number:</td>
<td>1040</td>
</tr>
<tr>
<td>Packing Group:</td>
<td>None</td>
</tr>
<tr>
<td>EMS Number:</td>
<td>F-D , S-U</td>
</tr>
<tr>
<td>Special provisions:</td>
<td>None</td>
</tr>
</tbody>
</table>

Limited Quantities: 0

Shipping Name: ETHYLENE OXIDE or ETHYLENE OXIDE WITH NITROGEN up to a total pressure of 1MPa (10 bar) at 50°C

NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS: DOT

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Section 15 - REGULATORY INFORMATION

REGULATIONS

ethylene oxide (CAS: 75-21-8) is found on the following regulatory lists;

- Canada - Alberta Ambient Air Quality Objectives
- Canada - Albert Occupational Exposure Limits
- Canada - British Columbia Occupational Exposure Limits
- Canada - Northwest Territories Occupational Exposure Limits (English)
- Canada - Nova Scotia Occupational Exposure Limits
- Canada - Prince Edward Island Occupational Exposure Limits
- Canada - Prince Edward Island Occupational Exposure Limits - Carcinogens
- Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)
- Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits
- Canada - Saskatchewan Occupational Health and Safety Regulations - Designated Chemical Substances
- Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances
- Canada ARET (Accelerated Reduction / Elimination of Toxics) Substance List
- Canada Domestic Substances List (DSL)
- Canada Environmental Protection Act (CEPA) 1999 - Schedule 1 Toxic Substances List
- Canada Environmental Protection Act (CEPA) 1999 - Schedule 3 Export Control List - Part 2 Substances Subject to Notification or Consent
- Canada Ingredient Disclosure List (SOR/88-64)
- Canada National Pollutant Release Inventory (NPRI)
- Canada Priority Substances List (PSL1, PSL 2)
- Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (English)
- Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (French)
- GESAMP/EHS Composite List - GESAMP Hazard Profiles
- International Agency for Research on Cancer (IARC) - Agents Reviewed by the IARC Monographs
- International Chemical Secretariat (ChemSec) REACH SIN* List ("Substitute It Now!" 1.0)
- International Council of Chemical Associations (ICCA) - High Production Volume List
- OECD Representative List of High Production Volume (HPV) Chemicals
- United Nations List of Prior Informed Consent Chemicals (English)
- US - Alaska Limits for Air Contaminants
- US - California Air Toxics "Hot Spots" List (Assembly Bill 2588) Substances for which emissions must be quantified
- US - California Occupational Safety and Health Regulations (CAL/OSHA) - Hazardous Substances List
- US - California OEHHA/ARB - Chronic Reference Exposure Levels and Target Organs (CRELs)
- US - California Permissible Exposure Limits for Chemical Contaminants
- US - California Proposition 65 - Carcinogens
- US - California Proposition 65 - Maximum Allowable Dose Levels (MADLs) for Chemicals Causing Reproductive Toxicity
- US - California Proposition 65 - No Significant Risk Levels (NSRLs) for Carcinogens
- US - California Proposition 65 - Reproductive Toxicity
- US - California Toxic Air Contaminant List Category II
- US - Connecticut Hazardous Air Pollutants
- US - Hawaii Air Contaminant Limits
- US - Idaho - Limits for Air Contaminants
- US - Maine Chemicals of High Concern List
- US - Massachusetts Oil & Hazardous Material List
- US - Michigan Exposure Limits for Air Contaminants
- US - Minnesota Hazardous Substance List
- US - Minnesota Permissible Exposure Limits (PELs)
- US - New Jersey Right to Know Hazardous Substances
- US - Oregon Hazardous Materials
- US - Oregon Permissible Exposure Limits (Z-1)
- US - Pennsylvania - Hazardous Substance List
- US - Rhode Island Hazardous Substance List
- US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants
- US - Vermont Hazardous Constituents
Section 16 - OTHER INFORMATION

LIMITED EVIDENCE
- Ingestion may produce health damage*.
- Cumulative effects may result following exposure*.
- Possible respiratory and skin sensitizer*.
- May be harmful to the fetus/embryo*.
* (limited evidence).

REPRODUCTIVE HEALTH GUIDELINES
- Established occupational exposure limits frequently do not take into consideration reproductive end points that are clearly below the thresholds for other toxic effects. Occupational reproductive guidelines (ORGs) have been suggested as an additional standard. These have been established after a literature search for reproductive no-observed-adverse-effect-level (NOAEL) and the lowest-observed-adverse-effect-level (LOAEL). In addition the US EPA's procedures for risk assessment for hazard identification and dose-response assessment as applied by NIOSH were used in the creation of such limits. Uncertainty factors (UFs) have also been incorporated.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>ORG</th>
<th>UF</th>
<th>Endpoint</th>
<th>CR</th>
<th>Adeq TLV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethylene oxide</td>
<td>1.8 mg/m³</td>
<td>NA</td>
<td>D</td>
<td>600</td>
<td>Yes</td>
</tr>
</tbody>
</table>

- These exposure guidelines have been derived from a screening level of risk assessment and should not be construed as unequivocally safe limits. ORGS represent an 8-hour time-weighted average unless specified otherwise. CR = Cancer Risk/10000; UF = Uncertainty factor: TLV believed to be adequate to protect reproductive health: LOD: Limit of detection Toxic endpoints have also been identified as: D = Developmental; R = Reproductive; TC = Transplacental carcinogen Jankovic J., Drake F.: A Screening Method for Occupational Reproductive Health Risk: American Industrial Hygiene Association Journal 57: 641-649 (1996).

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- Classification of the mixture and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
- A list of reference resources used to assist the committee may be found at: www.chemwatch.net/references.
- The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

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