

# OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR 2-BUTOXYETHANOL

## INTRODUCTION

This guideline summarizes pertinent information about 2-butoxyethanol for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

## SUBSTANCE IDENTIFICATION

### • Formula



### • Structure



### • Synonyms

2-Butoxy-1-ethanol; beta-butoxyethanol; o-butyl ethylene glycol; butyl glycol; butyl oxitol; ethylene glycol monobutyl ether; glycol butyl ether; monobutyl ether of ethylene glycol; n-butoxyethanol; Butyl Cellosolve; Dowanol EB; Ektasolve EB; Gafcol EB; Jeffersol EB; Poly-solv EB; EGBE

### • Identifiers

1. CAS No.: 111-76-2
2. RTECS No.: KJ8575000
3. DOT UN: 2369 26
4. DOT labels: St. Andrew's Cross; Flammable Liquid

### • Appearance and odor

2-Butoxyethanol is a clear, colorless liquid with a pleasant, etherlike odor. The odor threshold is reported to be 0.35 part per million (ppm) parts of air.

## CHEMICAL AND PHYSICAL PROPERTIES

### • Physical data

1. Molecular weight: 118.2
2. Boiling point (760 mm Hg): 171°C (340°F)
3. Specific gravity (water = 1): 0.90 at 20°C (68°F)
4. Vapor density (air = 1 at boiling point of 2-butoxyethanol): 4.1
5. Melting point: -70°C (-94°F)
6. Vapor pressure at 20°C (68°F): 0.8 mm Hg
7. Solubility: Miscible in water, alcohol, ether, mineral oil, and most organic solvents
8. Evaporation rate (butyl acetate = 1): 0.07

### • Reactivity

1. Conditions contributing to instability: Heat, sparks, and open flame
2. Incompatibilities: Fires and explosions may result from contact of 2-butoxyethanol with strong oxidizers or caustics.
3. Hazardous decomposition products: Toxic gases (such as carbon monoxide) may be released in a fire involving 2-butoxyethanol.
4. Special precautions: 2-Butoxyethanol attacks some coatings and some forms of plastic and rubber; at high temperatures, this substance may attack metallic aluminum.

### • Flammability

The National Fire Protection Association has assigned a flammability rating of 2 (moderate fire hazard) to 2-butoxyethanol.

1. Flash point: 62°C (143°F) (closed cup)
2. Autoignition temperature: 238°C (460°F)
3. Flammable limits in air (% by volume): Lower, 1.1 at 93°C (200°F); upper, 12.7 at 135°C (275°F)

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Public Health Service Centers for Disease Control  
National Institute for Occupational Safety and Health  
Division of Standards Development and Technology Transfer

U.S. DEPARTMENT OF LABOR  
Occupational Safety and Health Administration

4. Extinguishant: Use alcohol foam, carbon dioxide, dry chemical, Halon<sup>®</sup>, water spray, or fog to fight fires involving 2-butoxyethanol. Do *not* use a solid stream of water because it will scatter and spread the fire.

Fires involving 2-butoxyethanol should be fought upwind and from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Vapor explosion and poison hazards may occur indoors, outdoors, or in sewers. Vapors may travel to a source of ignition and flash back. Containers of 2-butoxyethanol may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool containers from the sides with water until well after the fire is out. Stay away from the ends of containers. Personnel should withdraw immediately if they hear a rising sound from a venting safety device or if a container becomes discolored as a result of fire. Dikes should be used to contain fire-control water for later disposal. If a tank car or truck is involved in a fire, personnel should isolate an area of a half mile in all directions. Firefighters should wear a full set of protective clothing (including a self-contained breathing apparatus) when fighting fires involving 2-butoxyethanol. Firefighters' protective clothing may not provide protection against permeation by 2-butoxyethanol.

## EXPOSURE LIMITS

### • OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for 2-butoxyethanol is 25 ppm (120 mg/m<sup>3</sup>) as an 8-hr time-weighted average (TWA). The OSHA PEL also bears a "Skin" notation, which indicates that the cutaneous route of exposure (including mucous membranes and eyes) contributes to overall exposure [29 CFR 1910.1000, Table Z-1-A].

### • NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 5 ppm (24 mg/m<sup>3</sup>) as a 10-hr TWA for a 40-hr workweek; the REL also bears a "Skin" notation [NIOSH 1990, 1992].

### • ACGIH TLV<sup>®</sup>

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned 2-butoxyethanol a threshold limit value (TLV) of 25 ppm (120 mg/m<sup>3</sup>) as a

TWA for a normal 8-hr workday and a 40-hr workweek. The ACGIH also assigns a "Skin" notation to 2-butoxyethanol [ACGIH 1991b].

### • Rationale for limits

The OSHA and ACGIH limits are based on the risk of hematologic and other systemic effects associated with exposure to 2-butoxyethanol. The NIOSH limit is based on tissue irritation, CNS depression, and adverse effects of exposure on the blood and hematopoietic systems.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

Exposure to 2-butoxyethanol can occur through inhalation, ingestion, skin absorption, and eye or skin contact.

### • Summary of toxicology

1. *Effects on Animals:* 2-Butoxyethanol is an irritant of the eyes, mucous membranes, and skin; it also causes hemolysis, kidney damage, reproductive effects, immunotoxicity, and embryotoxicity in animals. 2-Butoxyethanol caused severe corneal injury in rabbits [Tyler 1984]. When applied to the skin of rabbits for 4 hr, 2-butoxyethanol caused only mild irritation; extending the period of skin contact increased the degree of irritation [Tyler 1984]. Repeated application of this substance to rabbit skin caused systemic toxicity manifested as reduced body weight gain [Tyler 1984]. The oral LD<sub>50</sub> is about 530 mg/kg in rats and 490 mg/kg in rabbits [NIOSH 1991]. At autopsy, acutely-poisoned animals exhibited kidney damage, narcotic effects, and breathing difficulty before death [Proctor et al. 1988]. Rats exposed to 245 ppm in air for 6 hr/day for 9 days showed significant depressions in red blood cell counts and hemoglobin concentrations and increases in nucleated erythrocytes, reticulocytes, and lymphocytes [Dodd et al. 1983]. Exposure of rats to 77 ppm in air for 30 hr/week for 90 days caused mild hematologic alterations. Fourteen days after exposure ceased, these hematologic effects were no longer evident [Dodd et al. 1983]. Male rats given 500 or 1,000 mg/kg per day for 4 days by oral gavage showed leukopenia and anemia; testicular atrophy was apparent in animals in the 500-mg/kg group [Grant et al. 1985]. Rats given 222, 443, or 885 mg/kg of 2-butoxyethanol by gavage for 6 weeks (5 days/week) showed a dose-dependent decrease in hemoglobin concentration and red blood cell count; these changes were apparent at all dose levels [Krasavage 1986; Ghanayem et al. 1990]. Teratogenicity studies have shown that 2-butoxyethanol to cause maternal, embryonic, and fetal toxicity in rats at 100 or 200 ppm, and maternal and embryonic toxicity in rabbits at 200 ppm [Tyl et al. 1984].

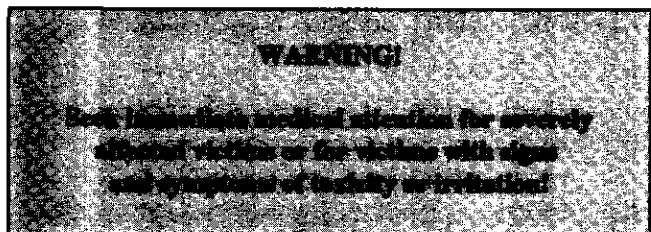
2. *Effects on Humans:* 2-Butoxyethanol is an irritant of the eyes and upper respiratory tract in humans. After an 8-hr exposure to 195 ppm, volunteers reported eye, nose, and throat discomfort; at 113 ppm for 4 hr, milder symptoms were experienced [Proctor et al. 1988]. Although humans appear to be less sensitive to the hematologic effects of 2-butoxyethanol than rats and mice, human red blood cells exposed in vitro showed increased fragility [Carpenter et al. 1956]. In one case report, a worker experienced two separate episodes of hematuria after being exposed to unspecified concentrations of 2-butoxyethanol and diethylene glycol monobutyl ether [Browning 1971].

#### • Signs and symptoms of exposure

1. *Acute exposure:* Acute exposure to 2-butoxyethanol can cause irritation of the eyes, nose, and throat, with pain and tearing of the eyes, runny nose, and cough; skin irritation with redness and cracking; and narcotic effects with difficult breathing.

2. *Chronic exposure:* Chronic exposure to 2-butoxyethanol can cause dermatitis and hematuria.

#### • Emergency procedures



Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure:* Tissue irritation may result from exposure to concentrated solutions, vapors, mists, or aerosols of 2-butoxyethanol. **Immediately and thoroughly** flush eyes with large amounts of water for at least 15 min, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Skin irritation or absorption of toxic amounts may result. **Immediately** remove contaminated clothing and **thoroughly** wash contaminated skin with soap and water for at least 15 min.

3. *Inhalation exposure:* If vapors, mists, or aerosols of 2-butoxyethanol are inhaled, move the victim to fresh air **immediately**.

If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Ingestion exposure:* Take the following steps if 2-butoxyethanol or a solution containing it is ingested:

—Have the victim rinse the contaminated mouth cavity several times with a fluid such as water.

—Have the victim drink a glass (8 oz) of fluid such as water.

—*Induce vomiting* by giving syrup of ipecac as directed on the package. If ipecac is unavailable, have the victim touch the back of the throat with a finger until productive vomiting ceases.

—Do **not** force an unconscious or convulsing person to drink fluid or to vomit.

5. *Rescue:* Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

## EXPOSURE SOURCES AND CONTROL METHODS

The following uses of 2-butoxyethanol may result in worker exposures to this substance:

—Use as a solvent for nitrocellulose resins and enamels, spray lacquers, quick-drying lacquers, varnishes, varnish removers, grease, oil, albumin, and dry cleaning compounds

—Use as a solvent for paints, printing inks, and dyestuffs and as an ingredient in agricultural chemicals, nonvolatile herbicides, brake oils, detergents for the automobile industry, penetrants, and softeners

—Use as a solvent for "soluble" mineral oils to hold soap in solution and to improve emulsifying properties

—Use as a solvent for protective coatings and metal cleaners

—Use as an agent to prevent spotting in textile printing and dyeing

—Use in production of acetate esters and phthalate and stearate plasticizers

—Use as a stabilizing agent in metal cleaners, textile lubricants, oils, hydraulic fluids, and liquid household cleaners

The following methods are effective in controlling worker exposures to 2-butoxyethanol, depending on the feasibility of implementation:

- Process enclosure
- Local exhaust ventilation
- General dilution ventilation
- Personal protective equipment

Good sources of information about control methods are as follows:

1. ACGIH [1992]. *Industrial ventilation—a manual of recommended practice*. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
2. Burton DJ [1986]. *Industrial ventilation—a self study companion*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
3. Alden JL, Kane JM [1982]. *Design of industrial ventilation systems*. New York, NY: Industrial Press, Inc.
4. Wadden RA, Scheff PA [1987]. *Engineering design for control of workplace hazards*. New York, NY: McGraw-Hill.
5. Plog BA [1988]. *Fundamentals of industrial hygiene*. Chicago, IL: National Safety Council.

## MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety or health, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

### • Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to 2-butoxyethanol, a licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the skin, kidneys, liver, respiratory system, and blood. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society [ATS 1987].

A preplacement medical evaluation is recommended to assess an individual's suitability for employment at a specific job and to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to 2-butoxyethanol at or below the prescribed exposure limit. The licensed health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with skin, kidney, liver, respiratory system, or blood diseases.

### • Periodic medical examinations and biological monitoring

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to 2-butoxyethanol exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of 2-butoxyethanol on the skin, kidney, liver, respiratory system, and blood. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. Although butoxy acetic acid (BAA), a metabolite of 2-butoxyethanol, can be detected in the urine of exposed individuals, excreted levels of butoxy acetic acid do not correlate with airborne concentrations of 2-butoxyethanol. Therefore, no biological monitoring test acceptable for routine use has yet been developed for

2-butoxyethanol. However, NIOSH has recommended guidelines for biological monitoring of BAA [NIOSH 1990].

- **Medical examinations recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of job placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

## **WORKPLACE MONITORING AND MEASUREMENT**

A worker's exposure to airborne 2-butoxyethanol is determined by using coconut shell charcoal tubes (100/50-mg sections, 20/40 mesh). Samples are collected at a maximum flow rate of 0.05 liter/min until a maximum air volume of 10 liters is collected. The sample is then treated with methylene chloride/methanol (95:5) to extract the 2-butoxyethanol. Analysis is conducted by gas chromatography using a flame ionization detector. The limit of detection for this procedure is 0.01 to 0.02 mg per sample. This method is described in Method 1403 of the *NIOSH Manual of Analytical Methods* [NIOSH 1984]. A similar method for sampling and analyzing 2-butoxyethanol is included in Method 83 of the *OSHA Analytical Methods Manual* [OSHA 1990].

## **PERSONAL HYGIENE**

2-Butoxyethanol can be absorbed through the skin in toxic amounts. Therefore, if 2-butoxyethanol contacts the skin, workers should immediately flush the skin with large amounts of water and then wash with soap and water.

Clothing and shoes contaminated with 2-butoxyethanol should be removed immediately, and provisions should be made for safely removing this chemical from these articles. Persons laundering contaminated clothing should be informed of the hazardous properties of 2-butoxyethanol, particularly its potential for being absorbed through the skin in toxic amounts.

A worker who handles 2-butoxyethanol should thoroughly wash hands with soap and water before eating, using tobacco products, or using toilet facilities.

Workers should not eat, drink, or use tobacco products in areas where 2-butoxyethanol is handled, processed, or stored.

## **STORAGE**

2-Butoxyethanol should be stored in a cool, dry, dark, well-ventilated area in tightly sealed, resin-coated, stainless steel containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. This substance should not be stored in aluminum containers. Electrical service in the storage area must be of explosionproof design. Containers of 2-butoxyethanol should be protected from physical damage and should be stored separately from strong oxidizers, strong caustics, heat, sparks, and open flame. Only nonsparking tools should be used to handle this substance. To prevent static sparks, all containers and equipment used to transfer 2-butoxyethanol must be bonded and grounded. Because containers that formerly contained 2-butoxyethanol may still hold product residues, they should be handled appropriately.

## **SPILLS AND LEAKS**

In the event of a spill or leak involving 2-butoxyethanol, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. The following steps should be undertaken following a spill or leak:

1. Do not touch the spilled material; stop the leak if it is possible to do so without risk.
2. Notify safety personnel.
3. Remove all sources of heat and ignition.
4. Ventilate potentially explosive atmospheres with maximally explosionproof ventilation.
5. Absorb small liquid spills with sand or other noncombustible absorbent material and place the material in a covered container for later disposal.
6. For large liquid spills, build dikes far ahead of the spill to contain the 2-butoxyethanol for later reclamation or disposal.

## **SPECIAL REQUIREMENTS**

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore

advised to determine periodically whether new information is available.

- **Emergency planning requirements**

2-Butoxyethanol is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022].

- **Reportable quantity requirements for hazardous releases**

Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the National Response Center of an accidental release of 2-butoxyethanol; there is no reportable quantity for this substance.

- **Community right-to-know requirements**

Employers are not required by Section 313 of SARA to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of 2-butoxyethanol emitted or released from their facility annually.

- **Hazardous waste management requirements**

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Although 2-butoxyethanol is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.], EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

## RESPIRATORY PROTECTION

- **Conditions for respirator use**

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of

respirators to control exposure. Respirators must be worn if the ambient concentration of 2-butoxyethanol exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

- **Respiratory protection program**

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information on the selection and use of respirators and on the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

## PERSONAL PROTECTIVE EQUIPMENT

Protective clothing should be worn to prevent any possibility of skin contact with 2-butoxyethanol. Gloves, aprons, gauntlets, boots, and other protective clothing should be worn as necessary. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. Butyl rubber and Saranex<sup>®</sup> have been recommended for use against permeation by 2-butoxyethanol and may provide protection for periods greater than 8 hr. Natural rubber, polyvinyl alcohol, and polyvinyl chloride have demonstrated poor resistance to permeation by 2-butoxyethanol.

If 2-butoxyethanol is dissolved in water or an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or face shields should be worn during operations in which 2-butoxyethanol might contact the eyes (e.g., through dust particles or splashes of solution). Eyewash fountains and emergency showers should be

available within the immediate work area whenever the potential exists for eye or skin contact with 2-butoxyethanol. Contact lenses should not be worn if the potential exists for 2-butoxyethanol exposure.

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