

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR n-BUTYL ALCOHOL

INTRODUCTION

This guideline summarizes pertinent information about n-butyl alcohol 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 Recommendations may be superseded by new developments; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information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

1-Butanol, n-butanol, n-propyl carbinol, NBA, butyl hydroxide, butyric alcohol, normal primary butyl alcohol, methylal propane, propylmethanal, 1-hydroxybutane

• Identifiers

1. CAS No.: 71-36-3
2. RTECS No.: EO1400000
3. DOT UN: 1120 26
4. DOT label: Flammable Liquid

• Appearance and odor

n-Butyl alcohol is a flammable, colorless liquid with a mild, wine-like odor. The odor threshold is reported to be between 0.12 and 11.0 parts per million (ppm) parts of air.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 74.1

2. Boiling point (at 760 mm Hg): 117° to 118°C (243° to 244°F)
3. Specific gravity (water = 1): 0.81 at 20°C (68°F)
4. Vapor density (air = 1 at boiling point of n-butyl alcohol): 2.6
5. Melting point: -90°C (-130°F)
6. Vapor pressure at 20°C (68°F): 6 mm Hg
7. Solubility: Slightly soluble in water; miscible with alcohol, ether, and many other organic solvents
8. Evaporation rate (butyl acetate = 1): 0.46

• Reactivity

1. Conditions contributing to instability: Heat, sparks, and open flame
2. Incompatibilities: Fires and explosions may result from contact of n-butyl alcohol with strong oxidizers, strong mineral acids, alkali metals, or halogens.
3. Hazardous decomposition products: Toxic gases (such as carbon monoxide) may be released in a fire involving n-butyl alcohol.

4. Special precautions: None

• Flammability

The National Fire Protection Association has assigned a flammability rating of 3 (severe fire hazard) to n-butyl alcohol.

1. Flash point: 37°C (98°F) (closed cup)
2. Autoignition temperature: 343°C (650°F)
3. Flammable limits in air (% by volume): Lower, 1.4; upper, 11.3
4. Extinguishant: Use carbon dioxide, dry chemical, or alcohol foam to fight fires involving n-butyl alcohol. Water may be ineffective, but it may be used to cool fire-exposed containers.

Fires involving n-butyl alcohol should be fought upwind and from the maximum distance possible. Isolate the hazard area

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and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and should ventilate closed spaces before entering. Containers of n-butyl alcohol 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 n-butyl alcohol. Firefighters' protective clothing may not provide protection against permeation by n-butyl alcohol.

EXPOSURE LIMITS

• OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for n-butyl alcohol is 50 ppm (150 mg/m³) as a ceiling limit. A worker's exposure to n-butyl alcohol shall at no time exceed this limit. 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 50 ppm (150 mg/m³) as a ceiling limit with a "Skin" notation [NIOSH 1992].

• ACGIH TLV®

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned n-butyl alcohol a ceiling limit of 50 ppm (152 mg/m³), which should not be exceeded during any part of the working exposure. The ACGIH has also assigned n-butyl alcohol a "Skin" notation [ACGIH 1991b].

• Rationale for limits

The limits are based on the risk of possible vestibular and auditory nerve injury as well as headaches and irritation associated with exposure to n-butyl alcohol.

HEALTH HAZARD INFORMATION

• Routes of exposure

Exposure to n-butyl alcohol can occur through inhalation, ingestion, skin absorption, and eye or skin contact.

• Summary of toxicology

1. *Effects on Animals:* n-Butyl alcohol is an irritant of the eyes, skin, and respiratory tract in animals; at high concentrations, exposure causes narcosis. In rabbits, n-butyl alcohol causes moderate skin irritation upon contact and severe corneal irritation when instilled into the eyes [NIOSH 1991]. The dermal LD₅₀ in rabbits ranges from 3,400 to 5,300 mg/kg [NIOSH 1991; IPCS 1987]. The oral LD₅₀s in rats ranges from 700 to 2,100 mg/kg [IPCS 1987]. The 4-hr LC₅₀ for rats is 8,000 ppm [NIOSH 1991]. Death also occurred in two of six female rats that inhaled 9,000 ppm for 7 hr. Half of another group of female rats that inhaled 8,000 ppm for 7 hr also developed narcosis. However, females that inhaled 6,000 ppm were asymptomatic throughout and after the 7-hr exposure period [Nelson et al. 1989]. Mice exposed to 3,300 ppm for 7 hr showed no effects, and 6,600 ppm caused giddiness within 1 hr, prostration within 2 hr, and loss of reflexes after 3 hr, with respiratory failure, deep narcosis, and death in some animals [Clayton and Clayton 1981]. Guinea pigs exposed to 100 ppm for 4 hr/day, 6 days/week for a total of 64 exposures showed lymphocytopenia and erythropenia; at autopsy, lung hemorrhage and degeneration of the liver and kidneys were seen [Clayton and Clayton 1981]. Groups of female rats were exposed to 8,000, 6,000, 3,500, or 0 ppm sec-butyl alcohol for 7 hr/day on gestation days 1 through 19. Absorbed daily doses for each of these exposure concentrations were theorized to be 800, 600, 350, or 0 mg/kg, respectively. Two of 18 dams exposed at 8,000 ppm died. Fetal weights were slightly depressed at 8,000 and 6,000 ppm. A slight but statistically significant increase in skeletal malformations (primarily rudimentary cervical ribs) occurred in pups obtained from 8,000-ppm-exposed dams who exhibited the presence of maternal toxicity (reduced weight gain and food consumption) [Nelson et al. 1989]. n-Butyl alcohol was not mutagenic when tested with in vitro assays [IPCS 1987]. Two long-term n-butyl alcohol tests have been performed but were considered inadequate for assessment of carcinogenic activity [IPCS 1987].

2. *Effects on Humans:* n-Butyl alcohol causes eye, skin, and upper respiratory tract irritation in exposed workers. Volunteers reported mild irritation of the eyes, nose, and throat when exposed to 25 ppm. Unacclimatized subjects exposed to 50 ppm experienced pronounced throat irritation, and several of them developed delayed onset headaches [ACGIH 1991a]. Workers chronically exposed to 100 ppm rarely complained of eye irritation, whereas previous exposures to 200 ppm or more caused corneal inflammation, an ocular burning sensation, blurred vision, lacrimation, and photophobia [ACGIH 1991a]. Repeated or prolonged contact of n-butyl alcohol with the skin causes defatting and contact dermatitis, and this substance can be absorbed through the skin in toxic amounts [Proctor et al. 1988].

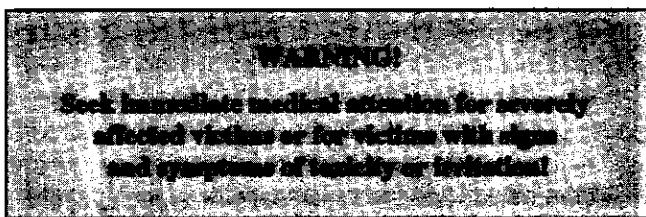
Vertigo and auditory nerve and vestibular system damage have been reported in Mexican and French workers exposed both to n-butyl alcohol and workplace noise, but the relative contribution of the alcohol to these effects has not been determined [ACGIH 1991a; Proctor et al. 1988].

• Signs and symptoms of exposure

1. *Acute exposure:* Acute exposure to n-butyl alcohol can cause redness and tearing of the eyes, scratchy throat, itching and redness of the skin, headache, ataxia, prostration, deep narcosis, respiratory failure, and death.

2. *Chronic exposure:* Chronic exposure to n-butyl alcohol can cause photophobia, blurred vision, corneal vacuoles, and defatting and itching of the skin. Chronic exposure to n-butyl alcohol can cause vertigo and may increase the extent of hearing loss among workers exposed to both noise and n-butyl alcohol.

• 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 n-butyl alcohol. **Immediately and thoroughly** flush eyes with large amounts of water, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Skin irritation may result. **Immediately** remove contaminated clothing and **thoroughly** wash contaminated skin with soap and water.

3. *Inhalation exposure:* If vapors, mists, or aerosols of n-butyl alcohol 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 n-butyl alcohol 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 operations may involve n-butyl alcohol and may result in worker exposures to this substance:

—Formulation of nitrocellulose lacquers, latexes, rayon detergents, esters, other butyl compounds, and plastic and rubber cements

—Use of n-butyl alcohol as a solvent or diluent in brake fluids, perfumes, detergents, adhesives, denatured alcohol, surface coatings, fats, waxes, natural and synthetic paints, resins, shellac, varnishes, gums, vegetable oils, dyes, camphor, and alkaloids

—Manufacture of artificial leather, safety glass, derivatives of butyl alcohol (including chemicals, herbicides, flotation agents, and urea and melamine formaldehyde resins), pharmaceuticals (including antibiotics, hormones, and vitamins), and bactericides for veterinary use

—Use of n-butyl alcohol during photographic processing operations and in the manufacture of photographic film

—Use of n-butyl alcohol in textile making as a swelling agent, dye ingredient, and waterproofing agent

—Use of n-butyl alcohol as an azeotropic dehydration agent and blending agent in laboratory analysis and in microscopy to prepare paraffin imbedding materials

The following methods are effective in controlling worker exposures to n-butyl alcohol, 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 n-butyl alcohol, 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 eyes, skin, and respiratory tract. 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 n-butyl alcohol 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 eye, skin, or respiratory tract 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 n-butyl alcohol exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of n-butyl alcohol on the eyes, skin, and respiratory tract. 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. No biological monitoring test acceptable for routine use has yet been developed for n-butyl alcohol.

• 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 n-butyl alcohol is determined by using charcoal tubes (100/50-mg sections, 20/40 mesh). To determine TWA concentrations, samples are collected at a maximum flow rate of 0.2 liter/min until a maximum air volume of 10 liters is collected; to determine ceiling limit concentrations, samples are collected for a minimum of

5 min. The sample is desorbed with carbon disulfide/isopropanol (99:1) or carbon disulfide/dimethylformamide (99:1). Analysis is conducted by gas chromatography using a flame ionization detector. The limit of detection for this procedure is 0.01 mg per sample. This method is described in Method No. 1401 of the *NIOSH Manual of Analytical Methods* [NIOSH 1984].

PERSONAL HYGIENE

If n-butyl alcohol contacts the skin, workers should flush the affected areas immediately with plenty of water for 15 min and then wash with soap and water.

Clothing and shoes contaminated with n-butyl alcohol 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 n-butyl alcohol, particularly its potential to be absorbed through the skin.

A worker who handles n-butyl alcohol should thoroughly wash hands, forearms, and face 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 n-butyl alcohol or a solution containing n-butyl alcohol is handled, processed, or stored.

STORAGE

n-Butyl alcohol should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. All electrical service in the storage area must meet OSHA requirements for Class IC flammable liquids [29 CFR 1910.106]. Small amounts of n-butyl alcohol should be stored in metal safety cans in OSHA-approved safety cabinets or storerooms. Containers of n-butyl alcohol should be protected from physical damage and should be stored separately from oxidizing agents, strong mineral acids, alkali metals, halogens, explosives, organic peroxides, radioactive materials, heat, sparks, and open flame. Drums must be equipped with self-closing valves, pressure vacuum bungs, and flame arrestors. Only nonsparking tools may be used to handle n-butyl alcohol. To prevent static sparks, containers should be grounded and bonded for transfers. Because containers that formerly contained n-butyl alcohol may hold product residues, they should be handled appropriately.

SPIILLS AND LEAKS

In the event of a spill or leak involving n-butyl alcohol, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup

has been completed. 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.
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 n-butyl alcohol for later reclamation or disposal.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities for 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

n-Butyl alcohol 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

A hazardous substance release is defined by EPA as any spilling, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of hazardous substances into the environment (including the abandonment or discarding of contaminated containers). In the event of a release that is above the reportable quantity for that chemical, employers are required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the proper Federal, State, and local authorities.

The reportable quantity for n-butyl alcohol is 5,000 lb. If an amount equal to or greater than this quantity is released within a 24-hr period in a manner that will expose persons outside the facility, employers are required to do the following:

- Notify the National Response Center *immediately* at (800) 424-8802 or at (202) 426-2675 in Washington, D.C. [40 CFR 302.6].
- Notify the emergency response commission of the State likely to be affected by the release [40 CFR 355.40].

—Notify the community emergency coordinator of the local emergency planning committee (or relevant local emergency response personnel) of any area likely to be affected by the release [40 CFR 355.40].

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

Employers who own or operate facilities in SIC codes 20 to 39, who employ 10 or more workers, and who manufacture 25,000 lb or more or otherwise use 10,000 lb or more of n-butyl alcohol per calendar year are required by EPA [40 CFR 372.30] to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of n-butyl alcohol 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. n-Butyl alcohol is listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.] and has been assigned EPA Hazardous Waste No. U031. This chemical is approved for land disposal as long as the concentration in the waste or treatment residual does not exceed 2.6 mg/kg. n-Butyl alcohol also may be disposed of in an organometallic or organic lab pack that meets the requirements of 40 CFR 264.316 or 265.316.

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 n-butyl alcohol 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. If the use of respirators is necessary, the only respirators permitted are those 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 n-butyl alcohol. 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. Teflon[®] has been recommended for use against permeation by n-butyl alcohol and may provide protection for periods greater than 8 hr. Materials that may withstand permeation for more than 4 but fewer than 8 hr are butyl rubber, neoprene, nitrile rubber, polyethylene, and polyethylene/ethylene vinyl alcohol. Polyvinyl alcohol and polyvinyl chloride provide questionable protection from permeation, and natural rubber has demonstrated poor resistance to permeation by n-butyl alcohol.

If n-butyl alcohol 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 n-butyl alcohol might contact the eyes (e.g., through 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 n-butyl alcohol. Contact lenses should not be worn if the potential exists for n-butyl alcohol exposure.

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