

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR n-BUTYL MERCAPTAN

INTRODUCTION

This guideline summarizes pertinent information about n-butyl mercaptan for workers, employers, and 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 Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- **Formula:** C₄H₁₀S
- **Structure:** CH₃-(CH₂)₂-CH₂-SH
- **Synonyms:** n-Butanethiol; 1-butanethiol; butyl sulfhydrylate; thiobutyl alcohol
- **Identifiers:** CAS 109-79-5; RTECS EK6300000; DOT 2347, label required: "Flammable Liquid"
- **Appearance and odor:** Clear, colorless liquid with a strong, obnoxious odor like garlic or skunk

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical Data**
 1. Molecular weight: 90.19
 2. Boiling point (at 760 mmHg): 97.8°C (208°F)
 3. Specific gravity (water = 1): 0.8368
 4. Vapor density (air = 1 at boiling point of n-butyl mercaptan): 3.1
 5. Melting point: -116°C (-177°F)
 6. Vapor pressure at 20°C (68°F): 35 mmHg
 7. Solubility in water, g/100 g water at 20°C (68°F): 0.06
 8. Evaporation rate (butyl acetate = 1): 2.86
 9. Saturation concentration in air (approximate) at 20°C (68°F): 4.6% (46,000 ppm)
 10. Ionization potential: 9.14 eV
- **Reactivity**
 1. Incompatibilities: Strong oxidizing agents; n-butyl mercaptan should not be stored in copper or copper-containing materials.
 2. Hazardous decomposition products: Toxic vapors and gases (e.g., sulfur dioxide and carbon monoxide) may be released in a fire involving n-butyl mercaptan.

3. Caution: n-Butyl mercaptan will attack some forms of plastics, coating, and rubber.

• Flammability

1. Flash point: 2°C (35°F)
2. Extinguishant: Carbon dioxide, dry chemicals, or foam
3. Class IB Flammable Liquid (29 CFR 1910.106), Flammability Rating 3 (NFPA)

• Warning properties

1. Odor threshold: 1.0 to 48 ppb
2. Evaluation of warning properties for respirator selection: Because of its odor, n-butyl mercaptan can be detected below the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL); thus, it is treated as a chemical with adequate warning properties.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for n-butyl mercaptan is 10 parts of n-butyl mercaptan per million parts of air (ppm) [35 milligrams of n-butyl mercaptan per cubic meter of air (mg/m³)] as a time-weighted average (TWA) concentration over an 8-hour workshift. The NIOSH REL is 0.5 ppm (1.8 mg/m³) as a ceiling concentration determined in any 15-minute sampling period. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV[®]) is 0.5 ppm (1.5 mg/m³) as a TWA for a normal 8-hour workday and a 40-hour workweek (Table 1).

Table 1.—Occupational exposure limits for n-butyl mercaptan

	Exposure limit	
	ppm	mg/m ³
OSHA PEL TWA	10	35
NIOSH REL ceiling (15 min)	0.5	1.8
ACGIH TLV [®] TWA	0.5	1.5

HEALTH HAZARD INFORMATION

• Routes of exposure

n-Butyl mercaptan may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

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

- **Summary of toxicology**

1. *Effects on animals:* In mice and rats, inhalation of n-butyl mercaptan caused increased breathing rates, hyperactivity, uncoordinated movement, staggering gait, muscular weakness, partial skeletal muscle paralysis, deficient oxygenation of the blood (cyanosis), sedation, and death.

2. *Effects on humans:* In an industrial accident, seven workers were exposed to n-butyl mercaptan for approximately 1 hour at a concentration estimated between 50 and 500 ppm; all workers experienced some of the symptoms listed below, although the specific combination of symptoms varied for each individual.

- **Signs and symptoms of exposure**

Short-term (acute): Exposure to n-butyl mercaptan can cause irritation of the mucous membranes, weakness, malaise, increased respiration, neck pain, drowsiness, nausea, vomiting, sweating, dizziness, confusion, and coma.

RECOMMENDED MEDICAL PRACTICES

- **Medical surveillance program**

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control 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 and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) 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 surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

- **Preplacement medical evaluation**

Prior to placing a worker in a job with a potential for exposure to n-butyl mercaptan, the physician 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 risk. These should concen-

trate on the function and integrity of the nervous and respiratory systems. Medical surveillance for respiratory disease should be conducted by using the principles and methods recommended by NIOSH and the American Thoracic Society (ATS).

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to n-butyl mercaptan at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include chronic diseases of the respiratory system.

- **Periodic medical screening and/or biologic monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to n-butyl mercaptan. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the physiologic function of the nervous and respiratory systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population. The following tests should be used and interpreted according to standardized procedures and evaluation criteria recommended by NIOSH and the ATS: standardized questionnaires and tests of lung function.

- **Medical practices 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 which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population.

MONITORING AND MEASUREMENT PROCEDURES

- **Ceiling concentration evaluation**

Measurements to determine worker exposure should be taken during periods of maximum expected airborne concentrations of n-butyl mercaptan. Each measurement to determine the NIOSH REL (ceiling exposure) in the worker's breathing zone (air that most nearly represents that inhaled by the worker) should consist of a 15-minute sample or a series of consecutive samples that total 15 minutes. A minimum of three measurements should be taken during one workshift, and the highest of all measurements taken is an estimate of the worker's exposure. If the periods of maximum exposure are not clearly defined, a statistical procedure which can be used as a peak exposure detection strategy is given in the *Occupational Exposure Sampling Strategy Manual*.

• **Method**

Sampling and analysis may be performed by collecting n-butyl mercaptan vapors with Chromosorb 104 tubes, followed by desorption with acetone and analysis by gas chromatography. Detector tubes or other direct-reading devices calibrated to measure n-butyl mercaptan may be used if available. A detailed sampling and analytical method for n-butyl mercaptan may be found in the *NIOSH Manual of Analytical Methods* (method number S350).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, face shields (8-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with n-butyl mercaptan.

Workers should be provided with and required to use splash-proof safety goggles where n-butyl mercaptan may come in contact with the eyes.

SANITATION

Clothing which is contaminated with n-butyl mercaptan should be removed immediately and placed in closed containers for storage until it can be discarded or until provision is made for the removal of n-butyl mercaptan from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of n-butyl mercaptan's hazardous properties.

Change and shower rooms should be provided with separate locker facilities for street and work clothes.

Skin that becomes contaminated with n-butyl mercaptan should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle n-butyl mercaptan should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to n-butyl mercaptan may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for n-butyl mercaptan

Operations	Controls
During the manufacture and processing of n-butyl mercaptan; during use as an odorant for natural gas	Process enclosure, local exhaust ventilation, personal protective equipment
During use as a chemical intermediate in the manufacture of agricultural chemicals, herbicides, and defoliant	Process enclosure, local exhaust ventilation, personal protective equipment
During use in the polymer industry in the manufacture of polymerization catalysts, stabilizers, modifiers, and chain transfer agents	Process enclosure, local exhaust ventilation, personal protective equipment
During use as a solvent; during the cleaning and maintenance of storage vessels and equipment	Local exhaust ventilation, general dilution ventilation, personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

• **Eye exposure**

Where there is any possibility of a worker's eyes being exposed to n-butyl mercaptan, an eye-wash fountain should be provided within the immediate work area for emergency use.

If n-butyl mercaptan gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• **Skin exposure**

Where there is any possibility of a worker's body being exposed to n-butyl mercaptan, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If n-butyl mercaptan gets on the skin, wash it immediately with soap and water. If n-butyl mercaptan penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

• **Rescue**

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the location of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If n-butyl mercaptan is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities of liquids containing n-butyl mercaptan, absorb on paper towels and place in an appropriate container. Place towels in a safe place such as a fume hood for evaporation. Allow sufficient time for evaporation of the vapors so that the hood ductwork is free from n-butyl mercaptan vapors. Burn the paper in a suitable location away from combustible materials.
4. Large quantities of liquids containing n-butyl mercaptan may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container. n-Butyl mercaptan should not be allowed to enter a confined space such as a sewer because of the possibility of an explosion.
5. Liquids containing n-butyl mercaptan may be collected by vacuuming with an appropriate system. If a vacuum system is used, there should be no sources of ignition in the vicinity of the spill, and flashback prevention devices should be provided.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations, including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards, 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

For each level of respiratory protection, only those respirators that have the minimum required protection factor and meet other use restrictions are listed. All respirators that have higher protection factors may also be used.

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Table 3.—Respiratory protection for n-butyl mercaptan

Condition	Minimum respiratory protection*†
Concentration:	
Less than or equal to 5 ppm	Any supplied-air respirator Any self-contained breathing apparatus Any chemical cartridge respirator with organic vapor cartridge(s)
Less than or equal to 12.5 ppm	Any supplied-air respirator operated in a continuous flow mode Any powered air-purifying respirator with organic vapor cartridge(s)
Less than or equal to 25 ppm	Any self-contained breathing apparatus with a full facepiece Any supplied-air respirator with a full facepiece Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) Any powered air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister
Less than or equal to 500 ppm	Any supplied-air respirator with a half-mask and operated in a pressure-demand or other positive pressure mode (substance reported to cause eye irritation or damage—may require eye protection)
Less than or equal to 1,000 ppm	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown concentrations or levels above 1,000 ppm	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.

†The respiratory protection listed for any given condition is the minimum required to meet the NIOSH REL of 0.5 ppm (1.8 mg/m³) (ceiling).