

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR 2-BUTANONE

INTRODUCTION

This guideline summarizes pertinent information about 2-butanone 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 Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.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:** C₄H₈O

• **Structure:**

$$\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\text{CH}_3$$

• **Synonyms:** Ethyl methyl ketone, MEK, methyl ethyl ketone

• **Identifiers:** CAS 78-93-3; RTECS EL6475000; DOT 1193, label required: "Flammable Liquid"

• **Appearance and odor:** Clear and colorless liquid with an odor like acetone

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 72.12
2. Boiling point (at 760 mmHg): 79.6°C (175°F)
3. Specific gravity (water = 1): 0.806
4. Vapor density (air = 1 at boiling point of 2-butanone): 2.5
5. Melting point: -86.5°C (-123.7°F)
6. Vapor pressure at 20°C (68°F): 70 mmHg; at 25°C (77°F), 100 mmHg
7. Solubility in water, g/100 g water at 20°C (68°F): 25.6
8. Evaporation rate (butyl acetate = 1): 5.7
9. Saturation concentration (approximate) at 20°C (68°F): 10.2% (102,000 ppm); at 25°C (77°F), 13.2% (132,000 ppm)
10. Ionization potential: 9.48 eV

• Reactivity

1. Incompatibilities: Strong oxidizing agents
2. Hazardous decomposition products: Toxic vapors and gases (e.g., formaldehyde and carbon monoxide) may be released in a fire involving 2-butanone.

• Flammability

1. Flash point: -9°C (16°F) (closed cup)
2. Autoignition temperature: 515.5°C (959°F)
3. Flammable limits in air, % by volume: Lower, 2; upper, 10
4. Extinguishant: Carbon dioxide, dry chemicals, or alcohol foam
5. Class IB Flammable Liquid (29 CFR 1910.106), Flammability Rating 3 (NFPA)

• Warning properties

1. Odor threshold: 5 ppm
2. Eye irritation levels: 200-350 ppm
3. Evaluation of warning properties for respirator selection: Because of its odor, 2-butanone 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 2-butanone is 200 parts of 2-butanone per million parts of air (ppm) [590 milligrams of 2-butanone per cubic meter of air (mg/m³)] as a time-weighted average (TWA) concentration over an 8-hour workshift. The NIOSH REL is 200 ppm (590 mg/m³) as a TWA for up to a 10-hour workshift, 40-hour workweek. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV[®]) is 200 ppm (590 mg/m³) as a TWA for a normal 8-hour workday and a 40-hour workweek; the ACGIH short-term exposure limit (STEL) is 300 ppm (885 mg/m³) (Table 1).

Table 1.—Occupational exposure limits for 2-butanone

	Exposure limits	
	ppm	mg/m ³
OSHA PEL TWA	200	590
NIOSH REL TWA	200	590
ACGIH TLV [®] TWA	200	590
STEL	300	885

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

HEALTH HAZARD INFORMATION

• Routes of exposure

2-Butanone may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

• Summary of toxicology

Effects on animals: Acute inhalation of 2-butanone by guinea pigs caused narcosis, corneal opacities, emphysema, congestion of the brain, lungs, liver, and kidneys, and death. Inhalation of 2-butanone by pregnant rats caused an increased incidence of reduced lengths and weights in offspring.

• Signs and symptoms of exposure

1. *Short-term (acute):* Exposure to 2-butanone can cause headache, dizziness, drowsiness, vomiting, and numbness of the extremities. Irritation of the eyes, nose, and throat can also occur.

2. *Long-term (chronic):* Exposure to 2-butanone can cause dryness and irritation of the skin.

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 2-butanone, 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 risks. These should concentrate on the function and integrity of the eyes, skin, liver, kidneys, and 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 2-butanone at or below the NIOSH REL (especially if exposure occurs in combination with 2-hexanone). 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 concurrent dermatitis, a history of chronic skin disease, or a history and physical findings consistent with peripheral neuropathy.

• 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 2-butanone. 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 eyes, skin, liver, kidneys, and 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 and 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.

• Sentinel health events

Acute SHE's include: Contact and/or allergic dermatitis.

MONITORING AND MEASUREMENT PROCEDURES

• TWA exposure evaluation

Measurements to determine worker exposure to 2-butanone should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to deter-

mine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• Method

Sampling and analysis may be performed by collecting 2-butanone vapors with charcoal tubes followed by desorption with carbon disulfide and analysis by gas chromatography. Detector tubes or other direct-reading devices calibrated to measure 2-butanone may also be used if available. A detailed sampling and analytical method for 2-butanone may be found in the *NIOSH Manual of Analytical Methods* (method number 2500).

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 2-butanone.

Workers should be provided with and required to use splash-proof goggles where 2-butanone may come in contact with the eyes.

SANITATION

Clothing which is contaminated with 2-butanone 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 2-butanone from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of 2-butanone's hazardous properties.

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

Skin that becomes contaminated with 2-butanone 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 2-butanone 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 2-butanone 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 2-butanone

Operations	Controls
During spray application of vinyl and acrylic coatings; during mixing of dye solutions; during use in laboratories	Local exhaust ventilation, personal protective equipment
During surface spreading and coating of nitrocellulose and vinyl resins; during mixing, batching, and packaging of surface coating preparations; during forced drying of furniture finishes; during dewaxing; during use as a chemical intermediate	Local exhaust ventilation
During use in the application of adhesives for artificial leather	Dilution ventilation, personal protective equipment
During preparatory formulations of lacquers; during sponge or brush application of solvent for cleaning operations; during mixing of waterproofing compounds	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 2-butanone, an eye-wash fountain should be provided within the immediate work area for emergency use.

If 2-butanone 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 2-butanone, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If 2-butanone gets on the skin, wash it immediately with soap and water. If 2-butanone 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 locations 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 2-butanone 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 2-butanone, 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 2-butanone vapors. Burn the paper in a suitable location away from combustible materials.
4. Large quantities of liquids containing 2-butanone may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container. 2-Butanone should not be allowed to enter a confined space such as a sewer because of the possibility of an explosion.
5. Liquids containing 2-butanone 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 respira-

tor, 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 2-butanone

Condition	Minimum respiratory protection*†
Concentration:	
Less than or equal to 1,000 ppm	Any powered air-purifying respirator with organic vapor cartridge(s) (substance causes eye irritation or damage—eye protection needed) Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)
Less than or equal to 3,000 ppm	Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister Any supplied-air respirator operated in a continuous flow mode (substance causes eye irritation or damage—eye protection needed) Any self-contained breathing apparatus with a full facepiece Any supplied-air respirator with a full facepiece
Planned or emergency entry into environments containing unknown concentrations or levels above 3,000 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 200 ppm (590 mg/m³) (TWA).