

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR 2-HEXANONE

INTRODUCTION

This guideline summarizes pertinent information about 2-hexanone 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 Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.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:** C₆H₁₂O
- **Structure:**
$$\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3$$
- **Synonyms:** Butyl methyl ketone, MBK, methyl butyl ketone, methyl n-butyl ketone
- **Identifiers:** CAS 591-78-6; RTECS MPI400000; DOT not assigned
- **Appearance and odor:** Colorless liquid with an odor like acetone but more pungent

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**
 1. Molecular weight: 100.18
 2. Boiling point (at 760 mmHg): 127.8°C (262°F)
 3. Specific gravity (water = 1): 0.8
 4. Vapor density (air = 1 at boiling point of 2-hexanone): 3.5
 5. Melting point: -57°C (-71°F)
 6. Vapor pressure at 20°C (68°F): 3.0 mmHg; at 25°C (77°F), 3.8 mmHg
 7. Solubility in water, g/100 g water at 20°C (68°F): 1.4
 8. Evaporation rate (butyl acetate = 1): Approximately 1
 9. Saturation concentration in air (approximate) at 20°C (68°F): 0.4% (4,000 ppm); at 25°C (77°F), 0.5% (5,000 ppm)
- **Reactivity**
 1. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
 2. Hazardous decomposition products: Toxic vapors and gases (e.g., carbon monoxide) may be released in a fire involving 2-hexanone.

3. Caution: 2-Hexanone will dissolve some forms of plastics, resins, and rubber.

• Flammability

1. Flash point: 25°C (77°F) (closed cup)
2. Autoignition temperature: 425°C (795°F)
3. Flammable limits in air, % by volume: Lower, 1.2; upper, 8
4. Extinguishant: Carbon dioxide, dry chemical, or alcohol foam
5. Class IC Flammable Liquid (29 CFR 1910.106), Flammability Rating 3 (NFPA)

• Warning properties

1. Odor threshold: 0.076 ppm
2. Eye irritation levels: 1,000 ppm
3. Evaluation of warning properties for respirator selection: Because of its odor, 2-hexanone can be detected below the National Institute for Safety and Health (NIOSH) recommended exposure limit (REL); thus, 2-hexanone 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-hexanone is 100 parts of 2-hexanone per million parts of air (ppm) [410 milligrams of 2-hexanone per cubic meter of air (mg/m³)] as a time-weighted average (TWA) concentration over an 8-hour workshift. The NIOSH REL is 1 ppm (4 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 5 ppm (20 mg/m³) as a TWA for a normal 8-hour workday and a 40-hour workweek (Table 1).

Table 1.—Occupational exposure limits for 2-hexanone

	Exposure limits	
	ppm	mg/m ³
OSHA PEL TWA	100	410
NIOSH REL TWA	1	4
ACGIH TLV [®] TWA	5	20

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

• Summary of toxicology

1. *Effects on animals:* Acute inhalation of 2-hexanone by guinea pigs caused central nervous system depression, narcosis, coma, and death. Subchronic inhalation of 2-hexanone by rats, cats, dogs, chickens, and monkeys produced peripheral neuropathy, characterized by paralysis, nerve swelling, and loss of nerve sheath covering.

2. *Effects on humans:* Chronic inhalation or dermal exposure of workers has caused peripheral neuropathy.

• Signs and symptoms of exposure

1. *Short-term (acute):* Exposure to 2-hexanone can cause headaches, drowsiness, and unconsciousness. Moderate irritation of the eyes, nose, and throat can also occur.

2. *Long-term (chronic):* Exposure to 2-hexanone can cause lightheadedness, weight loss, fatigue, intermittent tingling or prickling sensations in the arms or legs, and progressive weakness of the limbs. Dryness, irritation, and inflammation of the skin can also occur.

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-hexanone, 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-hexanone 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 a history of chronic skin disease or chronic concurrent dermatitis, or a history and physical findings consistent with peripheral neuropathy. In addition to the medical interview and physical examination, the means to identify these conditions may include electromyography of the extremities using standardized methods and evaluation criteria.

• 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-hexanone. 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 respiratory and nervous 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. Because occupational exposure to 2-hexanone may cause peripheral neuropathy after a prolonged period of induction-latency, the need for medical surveillance may extend well beyond termination of employment.

• Sentinel health events

1. Acute SHE's include: Contact and/or allergic dermatitis.
2. Delayed-onset SHE's include: Inflammatory and toxic neuropathy.

MONITORING AND MEASUREMENT PROCEDURES

• TWA exposure evaluation

Measurements to determine worker exposure to 2-hexanone 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 determine 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-hexanone vapors with charcoal adsorption tubes followed by desorption with carbon disulfide and analysis by gas chromatography. Detector tubes or other direct-reading devices calibrated to measure 2-hexanone may also be used if available. A detailed sampling and analytical method for 2-hexanone may be found in the *NIOSH Manual of Analytical Methods* (method number 1300).

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-hexanone.

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

SANITATION

Clothing which is contaminated with 2-hexanone 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-hexanone from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of 2-hexanone'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-hexanone 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 use of smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle 2-hexanone 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-hexanone 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-hexanone

Operations	Controls
During use as a commercial solvent for nitrocellulose, natural and synthetic resins, oils, waxes, vinyl polymers and copolymers, and cellulose acetates	Local exhaust ventilation, general dilution ventilation, personal protective equipment
During use as a solvent in the manufacture of varnish removers, vinyl lacquers, and nitrate wood lacquers	Local exhaust ventilation, general dilution ventilation, personal protective equipment
During use as an extractive solvent for paraffin wax; during use in the separation and purification of certain metals	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 2-hexanone, an eye-wash fountain should be provided within the immediate work area for emergency use.

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

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

Condition	Minimum respiratory protection*†
Concentration:	
Less than or equal to 10 ppm	Any supplied-air respirator Any self-contained breathing apparatus
Less than or equal to 25 ppm	Any supplied-air respirator operated in a continuous flow mode
Less than or equal to 50 ppm	Any self-contained breathing apparatus with a full facepiece Any supplied-air respirator with a full facepiece Any supplied-air respirator with a tight-fitting facepiece operated in a continuous flow mode
Less than or equal to 1,000 ppm	Any supplied-air respirator with a half-mask and operated in a pressure-demand or other positive pressure mode
Less than or equal to 2,000 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 2,000 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 1 ppm (4 mg/m³) (TWA).