

Occupational Health Guideline for Acetonitrile

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: CH_3CN
- Synonyms: Methylcyanide
- Appearance and odor: Colorless liquid with an ether-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for acetonitrile is 40 parts of acetonitrile per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 70 milligrams of acetonitrile per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

• Routes of exposure

Acetonitrile can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed. It may enter the body through the skin.

• Effects of overexposure

1. Short-term Exposure: Acetonitrile may cause a slight flushing of the face and a feeling of chest tightness. Inhaling acetonitrile may cause irritation of the nose and throat. High concentrations may cause such effects as nausea, vomiting, respiratory depression, weakness, chest or abdominal pain, vomiting blood, convulsions, shock, unconsciousness, and death. The effects may come on several hours after exposure has ceased. Splashes of the liquid in the eyes may cause irritation.

2. Long-term Exposure: None known

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to acetonitrile.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to acetonitrile at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the kidneys, liver, cardiovascular system, and central nervous system should be stressed. The skin should be examined for evidence of chronic disorders.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

• Summary of toxicology

Acetonitrile vapor is an asphyxiant due to its inhibitory action on metabolic enzyme systems. Effects are delayed and may be due to slow formation of cyanide ion. In male rats the LC_{50} was 7500 ppm for a single 8-hour exposure; there was prostration followed by convulsive seizures; at autopsy there was pulmonary hemorrhage. Rats repeatedly exposed to 665 ppm for 7 hours daily developed pulmonary inflammation, and there were minor changes in the liver and kidneys in some animals. Of 16 painters exposed to the vapor of a mixture containing 30 to 40% acetonitrile for two consecutive workdays, 10 developed symptoms ranging in severity from nausea, headache, and lassitude to vomiting, respiratory depression, extreme weakness, and stupor. Five of the victims were hospitalized, and of these one died; this worker experienced the onset of chest pain 4 hours after leaving the job on the second day of exposure, followed shortly by massive hematemesis, convulsions, shock, and coma, with death occurring 14 hours after cessation of exposure. At autopsy, cyanide ion concen-

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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trations (in ug%) were: blood 796, urine 215, kidney 204, spleen 318 and lung 128; cyanide ion was not detected in the liver. Two human subjects inhaled 160 ppm for 4 hours; one of them experienced a slight flushing of the face 2 hours later, and a slight feeling of bronchial tightness 5 hours later. A week prior to this, the same two subjects had inhaled 80 ppm with no effects. Humans accidentally inhaling 500 ppm for brief periods reported some irritation of nose and throat. In the rabbit eye, a drop of the liquid caused superficial injury. The liquid on the belly of a rabbit caused a faint erythema of short duration.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 41.05
2. Boiling point (760 mm Hg): 82 C (179 F)
3. Specific gravity (water = 1): 0.79
4. Vapor density (air = 1 at boiling point of acetonitrile): 1.3
5. Melting point: -45.7 C (-50 F)
6. Vapor pressure at 20 C (68 F): 73 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F):

Miscible in all proportions

8. Evaporation rate (butyl acetate = 1): 5.79

• Reactivity

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen and carbon monoxide) may be released in a fire involving acetonitrile.
4. Special precautions: Liquid acetonitrile will attack some forms of plastics, rubber, and coatings.

• Flammability

1. Flash point: 5.6 C (42 F) (closed cup)
2. Autoignition temperature: 524 C (975 F)
3. Flammable limits in air, % by volume: Lower: 4.4; Upper: 16.0
4. Extinguishant: Dry chemical, alcohol foam, carbon dioxide

• Warning properties

1. Odor Threshold: The *AIHA Hygienic Guide* reports that "three human subjects detected the odor at 40 ppm. Olfactory fatigue occurred in 2 to 3 hours."
2. Eye Irritation Level: Acetonitrile is not known to be an eye irritant.
3. Other Information: The *Hygienic Guide* reports that "humans accidentally inhaling 500 ppm for brief periods reported some irritation of nose and throat."
4. Evaluation of Warning Properties: Since the odor of acetonitrile is detectable at the permissible exposure limit and since olfactory fatigue does not occur rapidly, acetonitrile is treated as a material with adequate warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• General

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• Method

Sampling and analyses may be performed by collection of acetonitrile vapors using an adsorption tube with subsequent desorption with benzene and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure acetonitrile may be used. A detailed analytical method for acetonitrile may be obtained from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161, under the title "NIOSH Analytical Methods for Set L" (order number PB 250 159).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid acetonitrile.

• Clothing wet with liquid acetonitrile should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of acetonitrile from the clothing. If the clothing is to be

laundered or otherwise cleaned to remove the acetonitrile, the person performing the operation should be informed of acetonitrile's hazardous properties.

- Where exposure of an employee's body to liquid acetonitrile may occur, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

- Any clothing which becomes wet with or non-impervious clothing which becomes contaminated with acetonitrile should be removed immediately and not reworn until the acetonitrile is removed from the clothing.

- Employees should be provided with and required to use splash-proof safety goggles where liquid acetonitrile may contact the eyes.

SANITATION

- Skin that becomes contaminated with acetonitrile should be immediately washed or showered to remove any acetonitrile.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to acetonitrile may occur and control methods which may be effective in each case:

Operation	Controls
Use as a solvent for extractive distillation in manufacture of butadiene and isoprene	Process enclosure; local exhaust ventilation; personal protective equipment
Use as an extractive solvent in separation of fatty acids from fish liver oils; removal of phenol, tar, and color from petroleum hydrocarbons; recovery of various alcohols, acids, and dark wood rosin; and chemical analysis	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as a solvent and reaction medium for preparation of pharmaceuticals, water-proofing compounds, antistatic agents, detergents, polymers, dyestuff intermediates, and for chemical research	Process enclosure; local exhaust ventilation; personal protective equipment

Operation

Use as a solvent for recrystallization and purification of salts and metals

Use as a spinning solvent for synthetic fibers; use as a solvent for epoxy resin coatings

Use in organic synthesis in preparation of vitamins, perfumes, water softeners, and plasticizers

Use as a catalyst to promote ionization reactions and for preparation of catalysts

Use in low-temperature batteries for electrochemical properties; use in electrokinetic transducers and angular accelerometers

Use in miscellaneous operations for cyanide dyes, brighteners for metal, and deodorizers for specialty naphthas

Use during thermal decomposition of flexible polyurethane foams

Controls

Local exhaust ventilation; general dilution ventilation; personal protective equipment

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Local exhaust ventilation; general dilution ventilation; personal protective equipment

Personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If acetonitrile gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If acetonitrile gets on the skin, immediately flush the contaminated skin with water. If acetonitrile soaks through the clothing, remove the clothing immediately and wash the skin with water. Get medical attention immediately.

• Breathing

If a person breathes in large amounts of acetonitrile, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

When acetonitrile has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and 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.

• Special First Aid Procedures

First aid kits containing an adequate supply of amyl nitrite pearls (ampoules) should be maintained at each site where acetonitrile is used. When a person is suspected of receiving an overexposure to acetonitrile, immediately remove him from the contaminated area using established rescue procedures. Contaminated clothing should be removed and the acetonitrile washed from the skin immediately. Artificial respiration should be started at once if breathing has stopped. If the person is unconscious, amyl nitrite may be used as an antidote by a properly trained individual in accordance with established emergency procedures. Medical aid should be obtained immediately.

SPILL, LEAK, AND DISPOSAL PROCEDURES

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

• If acetonitrile 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, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable com-

bustion chamber equipped with an appropriate effluent gas cleaning device. Acetonitrile should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

• Waste disposal method:

Acetonitrile may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

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RESPIRATORY PROTECTION FOR ACETONITRILE

Condition	Minimum Respiratory Protection* Required Above 40 ppm
Vapor Concentration	
400 ppm or less	Any chemical cartridge respirator with an organic vapor cartridge(s). Any supplied-air respirator. Any self-contained breathing apparatus.
1000 ppm or less	Any chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).
2000 ppm or less	A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
4000 ppm or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 4000 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.

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

