

# OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR ALLYL ALCOHOL

## INTRODUCTION

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 Recommendations may be superseded by new developments; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information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

3-Hydroxypropene, 1-propene-3-ol, propenol, 2-propenol, 2-propenyl alcohol, allylic alcohol, 2-propene-1-ol, vinyl carbinol, Weed Drench

### • Identifiers

1. CAS No.: 107-18-6
2. RTECS No.: BA5075000
3. DOT UN: 1098 57
4. DOT labels: Flammable Liquid, Poison

### • Appearance and odor

Allyl alcohol is a clear, colorless, flammable liquid with a pungent, mustardlike odor. The odor threshold is reported to be below 0.8 part per million (ppm) parts of air.

## CHEMICAL AND PHYSICAL PROPERTIES

### • Physical data

1. Molecular weight: 58.1
2. Boiling point (at 760 mm Hg): 96°C (205°F)
3. Specific gravity (water = 1): 0.85 at 20°C (68°F)
4. Vapor density (air = 1 at boiling point of allyl alcohol): 2.0
5. Melting point: -129°C (-200.2°F)
6. Vapor pressure at 20°C (68°F): 19 mm Hg
7. Solubility: Miscible with water, alcohol, chloroform, ether, and petroleum ether
8. Evaporation rate: Data not available

### • Reactivity

1. Conditions contributing to instability: Heat, sparks, or open flame
2. Incompatibilities: Fire and explosion may result from contact of allyl alcohol with carbon tetrachloride, chlorosulfonic acid, diallyl phosphite plus phosphorus trichloride, nitric acid, oleum, sodium hydroxide, sulfuric acid, tri-n-bromomelamine, metal halides, caustic soda, or sodium, potassium, magnesium, aluminum, or their alloys.
3. Hazardous decomposition products: Toxic gases (such as carbon monoxide) may be produced when allyl alcohol decomposes.
4. Special precautions: Allyl alcohol attacks some coatings and forms of plastic and rubber.

### • Flammability

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

1. Flash point: 21.1°C (70°F) (closed cup)
2. Autoignition temperature: 378.3°C (713°F)

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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

U.S. DEPARTMENT OF LABOR  
Occupational Safety and Health Administration

3. Flammable limits in air (% by volume): Lower, 2.5; upper, 18.0

4. Extinguishant: Use dry chemical, alcohol foam, or carbon dioxide to fight fires involving allyl alcohol. Water may be ineffective, but it may be used to keep fire-exposed containers cool. If a leak or a spill has not ignited, water spray should be used to disperse the vapors and protect the individuals attempting to stop the leak.

Fires involving allyl alcohol should be fought upwind and from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Containers of allyl 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. Firefighters should wear a full set of protective clothing (including a self-contained breathing apparatus) when fighting fires involving allyl alcohol. Chemical protective clothing that is specifically recommended for allyl alcohol may not provide thermal protection unless so stated by the clothing manufacturer. Firefighters' protective clothing may not provide protection against permeation by allyl alcohol.

## EXPOSURE LIMITS

### • OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for allyl alcohol is 2 ppm ( $5 \text{ mg/m}^3$ ) as an 8-hr time-weighted average (TWA) concentration and 4 ppm ( $10 \text{ mg/m}^3$ ) as a short-term exposure limit (STEL). A STEL is a 15-min TWA exposure that should not be exceeded at any time during a workday. 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 2 ppm ( $5 \text{ mg/m}^3$ ) as an 8-hr TWA and 4 ppm ( $10 \text{ mg/m}^3$ ) as a STEL with a "Skin" notation [NIOSH 1992].

### • ACGIH TLV®

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned allyl alcohol a threshold

limit value (TLV) of 2 ppm ( $4.8 \text{ mg/m}^3$ ) as a TWA for a normal 8-hr workday and a 40-hr workweek with a "Skin" notation and a STEL of 4 ppm ( $9.5 \text{ mg/m}^3$ ) for periods not to exceed 15 min [ACGIH 1991b].

### • Rationale for limits

The limits are based on the risk of systemic effects and irritation associated with exposure to allyl alcohol.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

Exposure to allyl alcohol can occur through inhalation, ingestion, or contact with the skin, eyes, or mucous membranes. Allyl alcohol is rapidly absorbed through the skin.

### • Summary of toxicology

1. *Effects on Animals:* Allyl alcohol is a severe irritant of the eyes, nose, upper respiratory tract, and skin in animals; it also causes neurotoxic effects by all routes of exposure [Clayton and Clayton 1981]. Contact of this substance with the eyes of rabbits caused transitory corneal opacity, and skin contact caused mild irritation [NIOSH 1991; Grant 1986]. Although the 4- and 8-hr  $\text{LC}_{50}$ s in rats are 165 and 76 ppm, respectively, the lowest 4-hr lethal concentration in monkeys is 1,000 ppm [NIOSH 1991]. Rats acutely exposed to 3.9 ppm (a concentration capable of depressing the respiration rate by 50%) exhibited no signs of pulmonary irritation at necropsy [NLM 1991]. Animals sacrificed following acute inhalation showed signs of pulmonary edema and liver congestion and damage at autopsy [Proctor et al. 1988]. When rats were administered allyl alcohol and allowed 96 hr to recover before sacrifice, they developed acidophilia, vacuolation, and necrosis of the pancreatic acinar cells [NLM 1991]. The lowest reported oral  $\text{LD}_{50}$  in rats is 64 mg/kg [NIOSH 1991]. The dermal  $\text{LD}_{50}$  in rabbits is 45 mg/kg [NIOSH 1991]. Rats, rabbits, guinea pigs, and dogs exposed to 7 ppm for 7 hr/day during a 6-month period developed cloudy swelling and focal necrosis of the liver plus necrosis of the renal convoluted tubules. These effects were mild and reversible when exposure was discontinued [NLM 1991]. Rats that consumed drinking water containing allyl alcohol (100, 200, or 800 ppm for 15 weeks) had a dose-related decrease in water intake, food consumption, and weight gain but an increase in terminal organ weights for the liver, spleen, and kidneys [NLM 1991]. Allyl alcohol is directly mutagenic in some bacterial test systems [NIOSH 1991; NLM 1991].

2. *Effects on Humans:* Allyl alcohol is a severe irritant of the eyes, nose, upper respiratory tract, and skin in humans;

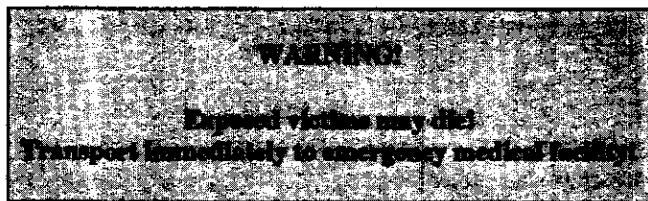
this substance can be absorbed through the skin in sufficient amounts to cause systemic toxicity. One man was temporarily blinded after being exposed to the vapor of allyl alcohol [Clayton and Clayton 1981]. Irritation of the eyes with tearing is noticeable at 5 ppm in some individuals, and irritation of the nose and throat begins at 10 to 15 ppm [ACGIH 1991a; Grant 1986]. Allyl alcohol is well absorbed through the skin, producing deep muscle pain believed to be caused by muscle spasm [Clayton and Clayton 1981]. In contact with the skin, allyl alcohol causes chemical burns with vesiculation and superficial necrosis [NLM 1991]. Inhalation exposures may lead to pulmonary edema [NLM 1991]. One worker died following a 1-hr exposure to 1,000 ppm [NIOSH 1991]. Systemic toxicity is manifested in humans as visceral congestion, periportal congestion of the liver, nephritis, and blood in the urine [ACGIH 1991a].

#### • Signs and symptoms of exposure

1. *Acute exposure:* Acute exposure to allyl alcohol can cause irritation of the nose, throat, and lungs, and severe overexposure may lead to pulmonary edema with slowly developing distress. Burns and corrosion of the skin plus muscle pain can occur following prolonged contact with the liquid. Exposure of the eyes to liquid or vapor causes irritation, tearing, pain behind the eyeballs, transient corneal injury, and blurred vision and photophobia during exposure to light.

2. *Chronic exposure:* No signs or symptoms of chronic allyl alcohol exposure have been reported, but it may exacerbate chronic respiratory, liver, and kidney disease.

#### • Emergency procedures



Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. *Immediately* initiate the following emergency procedures, continuing them as appropriate en route to the emergency medical facility:

1. *Eye exposure:* Tissue destruction and blindness may result from exposure to concentrated solutions, vapors, mists, or aerosols of allyl alcohol. *Immediately but gently* flush the eyes with large amounts of water for at least 15 min, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Severe burns, skin corrosion, and absorption of lethal amounts may result! *Immediately* remove contaminated clothing! *Immediately, continuously, and*

*gently* wash skin for at least 15 min. Use soap and water if skin is intact; use only water if skin is not intact.

3. *Inhalation exposure:* If vapors, mists, or aerosols of allyl 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 allyl alcohol or a solution containing it is ingested:

—Seek medical attention *immediately*.

—Do *not* induce vomiting.

—Have the victim rinse the contaminated mouth cavity several times with a fluid such as water. Immediately after rinsing, have the victim drink one cup (8 oz) of fluid and *no more*.

—Do *not* permit the victim to drink milk or carbonated beverages!

—Do *not* permit victim to drink any fluid if more than 60 min have passed since initial ingestion.

**NOTE:** These instructions must be followed exactly. Drinking a carbonated beverage or more than one cup of fluid could create enough pressure to perforate already damaged stomach tissue. The tissue-coating action of milk may impede medical assessment of tissue damage. Ingestion of any fluid more than 60 min after initial exposure could further weaken damaged tissue and result in perforation.

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 allyl alcohol and may result in worker exposures to this substance:

—Preparation of various allyl esters that serve as monomers and prepolymers in the manufacture of resins and plasticizers

—Use of allyl alcohol as a chemical intermediate

—Manufacture of pharmaceuticals and military poison gas

—Use of allyl alcohol as a fungicide, herbicide, and nematicide

—Manufacture of flavorings, perfumes, allyl esters, glycerol, acrolein, and glycerin

The following methods are effective in controlling worker exposures to allyl 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 allyl 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, respiratory tract, kidney, and liver. 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 allyl 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, respiratory, kidney, or liver disease.

### • 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 allyl alcohol exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of allyl alcohol on the eyes, skin, respiratory system, kidneys, and liver. 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. Although alcohols can be detected in the blood and urine of exposed individuals, no biological monitoring test acceptable for routine use has yet been developed for allyl 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 termina-

tion. 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 allyl alcohol is determined by using a solid sorbent tube (100/50-mg sections, 20/40 mesh) filled with coconut shell charcoal. Samples are collected at a maximum flow rate of 0.2 liter/min until a minimum air volume of 10 liters is collected. The sample is then treated with a carbon disulfide/dimethylformamide solution to extract the allyl alcohol. Analysis is conducted by gas chromatography using a flame ionization detector. The standard analytical error for this procedure is 0.18. This method is included in the OSHA Computerized Information System [OSHA 1989] and in Method 1402 of the *NIOSH Manual of Analytical Methods* [NIOSH 1984].

## PERSONAL HYGIENE

Because allyl alcohol can be absorbed through the skin in lethal amounts, workers should immediately and thoroughly wash with soap and water any areas of the skin that have come in contact with this substance.

Clothing and shoes contaminated with allyl 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 about the hazardous properties of allyl alcohol, particularly its potential for being absorbed through the skin in toxic amounts.

A worker who handles allyl 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 allyl alcohol or a solution containing allyl alcohol is handled, processed, or stored.

## STORAGE

Allyl 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]. Outside or detached storage is preferred; inside storage should be in a standard flammable liquids storage room that is separated from all oxidizing agents. Storage facilities and electrical service should be appropriate for this OSHA Class IB flammable liquid [29 CFR 1910.106]. Containers of allyl alcohol should be protected from physical damage and should be stored separately from oxidizing agents, heat, sparks, and open flame. To prevent static

sparks, containers should be grounded and bonded when this substance is transferred from one container to another. Only nonsparking tools may be used to handle allyl alcohol. Because empty containers that formerly contained allyl alcohol may contain product residues, they should be handled appropriately.

## SPILLS AND LEAKS

In the event of a spill or leak involving allyl alcohol, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. 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. Use water spray to reduce vapors if the spill or leak has not ignited.
6. Absorb small spills with vermiculite, sand, or other non-combustible materials and place the material in a covered container for later disposal.
7. For large liquid spills, build dikes far ahead of the spill to contain the allyl alcohol for later reclamation or disposal.

## SPECIAL REQUIREMENTS

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

If 1,000 lb or more of allyl alcohol is present at a facility, the owner or operator must comply with EPA's emergency planning requirements [40 CFR 355.30].

### • 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 equal to or greater than the

reportable quantity for that chemical, employers are required by EPA regulation resulting from 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 allyl alcohol is 100 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 are not required by Section 313 of the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022] to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of allyl alcohol emitted or released from their facility annually.

#### • Hazardous waste management requirements

EPA considers 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. Allyl 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. P005. This substance has been banned from land disposal and may be treated by fuel substitution or incineration. Allyl alcohol may also 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 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 allyl alcohol 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 substances 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 allyl 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. Workers should use only respirators that have been 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 about the selection and use of respirators and 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

Because allyl alcohol can be absorbed through the skin in lethal amounts, protective clothing should be worn to prevent skin contact. 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. The following materials have been tested against permeation by allyl alcohol and have demonstrated good-to-excellent resistance: butyl rubber, Viton<sup>®</sup>, and Teflon<sup>®</sup>. Both butyl rubber and Teflon may provide more than 8 hr of resistance to permeation by allyl alcohol. Neoprene, natural rubber, and polyvinyl alcohol have demonstrated poor resistance to permeation by allyl alcohol.

Safety glasses, goggles, or face shields should be worn during operations in which allyl 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 allyl alcohol. Contact lenses should not be worn if the potential exists for allyl alcohol exposure.

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