

Occupational Health Guideline for Acrolein

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: $\text{CH}_2=\text{CHCHO}$
- Synonyms: Acrylic aldehyde; acrylaldehyde; propenal; allylaldehyde
- Appearance and odor: Clear, colorless, or yellowish liquid with a piercing, disagreeable odor that causes tears

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for acrolein is 0.1 part of acrolein per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 0.25 milligram of acrolein per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

- Routes of exposure
Acrolein can affect the body if it is inhaled, is swallowed, or comes in contact with the eyes or skin.
- Effects of overexposure
 1. *Short-term Exposure:* Acrolein may cause irritation of the eyes, nose, throat, lungs, and skin. It may cause skin burns. It may also cause a feeling of pressure in the chest, headache, dizziness, and upset stomach. Death can rapidly take place if high concentrations are breathed.
 2. *Long-term Exposure:* Chronic effects of exposure to acrolein are skin irritation and occasionally skin allergy appearing as hives or a rash.

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 acrolein.

• Recommended medical surveillance

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

1. *Initial Medical Examination:*

—A complete medical history and physical examination with emphasis on the heart and lungs: The purpose is to detect pre-existing medical conditions which might place the exposed employee at increased risk from reported effects, and to establish a baseline for future health monitoring. Examination of the heart and lungs should be stressed.

—14" x 17" chest roentgenogram: Acrolein may cause lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Acrolein is reported to cause decreased pulmonary function. Periodic surveillance is indicated.

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is considered necessary only when indicated by the results of pulmonary function testing.

• Summary of toxicology

The main toxic effects of acrolein are severe irritation of the eyes, skin, upper respiratory tract, and lungs, leading to pulmonary edema. Systemic absorption is unlikely because of the severe irritant effect. Hypersensitivity has been reported.

CHEMICAL AND PHYSICAL PROPERTIES

- Physical data
 1. Molecular weight: 56
 2. Boiling point (760 mm Hg): 51.7 C (125 F)
 3. Specific gravity (water = 1): 0.84
 4. Vapor density (air = 1 at boiling point of acro-

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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lein): 1.94

5. Melting point: $-87\text{ C} (-125\text{ F})$

6. Vapor pressure at $20\text{ C} (68\text{ F})$: 214 mm Hg

7. Solubility in water, g/100 g water at $20\text{ C} (68\text{ F})$: 22

8. Evaporation rate (butyl acetate = 1): Data not available

• Reactivity

1. Conditions contributing to instability: Acrolein is stabilized by a polymerization inhibitor (usually hydroquinone). If this is not present in adequate concentration, acrolein can polymerize and explode its container. The polymerization is also speeded up by temperatures at or above $200\text{ C} (392\text{ F})$. Another type of polymerization, also liberating much heat, is caused by alkalis or strong acids.

2. Incompatibilities: Contact with oxidizing agents, acids, alkalis, and ammonia may cause fires and explosions.

3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide and peroxides) may be released in a fire involving acrolein.

4. Special precautions: None

• Flammability

1. Flash point: $-26\text{ C} (-15\text{ F})$ (closed cup)

2. Autoignition temperature: $235\text{ C} (455\text{ F})$

3. Flammable limits in air, % by volume: Lower: 2.8; Upper: 31

4. Extinguishant: Dry chemical, carbon dioxide, or alcohol foam

• Warning properties

1. Odor Threshold: Summer reports an odor threshold of 15 ppm; Stern reports 1.8 ppm; May reports 1.5 and 0.2 ppm; and the *AIHA Hygienic Guide* reports 0.4 ppm.

2. Eye Irritation Level: Grant states that "for human beings, exposure to 5.5 ppm of acrolein in air is intolerable in the first minute. Exposure to 1 ppm induces lacrimation and becomes intolerable in 4 to 5 minutes. Even the U.S. maximum allowable industrial concentration of 0.5 ppm is said to be more than enough to produce warning sensation of irritation." Grant also notes that "the vapor causes a burning sensation in the eyes at low concentration and is violently irritant and lacrimatory at high concentrations."

3. Evaluation of Warning Properties: Through its irritant effects, acrolein can be detected at or near the permissible exposure limit. The *Documentation of TLV's* notes that "the 0.1 ppm limit is sufficiently low to minimize, but not entirely prevent, irritation to all exposed animals."

For the purposes of this guideline, acrolein is treated as a material with good 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 acrolein in an impinger containing sodium bisulfide, followed by treatment with trichloroacetic acid, and colorimetric analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure acrolein may be used. An analytical method for acrolein is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 1, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00267-3).

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 any possibility of skin contact with liquid acrolein.

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

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

- Where there is any possibility of exposure of an employee's body to liquid acrolein, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Any clothing which becomes wet with liquid acrolein or non-impervious clothing which becomes contaminated with liquid acrolein should be removed immediately and not reworn until the acrolein is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid acrolein contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to liquid acrolein, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with liquid acrolein should be immediately washed or showered to remove any acrolein.
- Eating and smoking should not be permitted in areas where liquid acrolein is handled, processed, or stored.
- Employees who handle liquid acrolein should wash their hands thoroughly before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Liberation during organic synthesis of 1,2,6-hexanetriol, methionine, glutaraldehydes, acrylates, artificial resins, synthetic fibers, and polyurethane foams	Local exhaust ventilation
Liberation during heat cracking of animal and some vegetable fats; liberation during synthesis of glycerine	Local exhaust ventilation
Use as a fungicide to prevent slime	Personal protective equipment
Liberation during welding of metal coated with surface-protecting fluids	Local exhaust ventilation; personal protective equipment

Operation

Controls

Liberation during use of internal combustion engines in confined spaces

General dilution ventilation

Use as a herbicide to control aquatic weeds in drainage and irrigation channels

Personal protective equipment

Use as a denaturant in alcohol

General dilution ventilation; 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 acrolein gets into the eyes, wash eyes immediately with large amounts of water, 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

If acrolein gets on the skin, immediately flush the contaminated skin with water. If acrolein soaks through the clothing, remove the clothing immediately and flush the skin with water. When there are chemical burns or evidence of skin irritation, get medical attention promptly.

• Breathing

If a person breathes in large amounts of acrolein, 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 acrolein has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

• 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.

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 acrolein 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. For large quantities, cover with sodium bisulfite (NaHSO_3), add a small amount of water and mix. Then, after one hour, flush with large amounts of water and wash the site with soap solution. Liquid acrolein should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

- Waste disposal methods:

Acrolein may be disposed of:

1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.
2. For small quantities, by absorbing it in vermiculite, dry sand, earth, or a similar material and disposing of in a suitable combustion chamber.
3. For large quantities, by mixing with a flammable liquid (such as acetone) and atomizing in a suitable combustion chamber.

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RESPIRATORY PROTECTION FOR ACROLEIN

Condition	Minimum Respiratory Protection* Required Above 0.1 ppm
Vapor Concentration	
5 ppm or less	A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s). 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.
Greater than 5 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 with a full facepiece providing protection against organic vapors. Any escape self-contained breathing apparatus with a full facepiece.

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

**Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of acrolein; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 5 ppm, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.

