

Occupational Health Guideline for n-Propyl Nitrate

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: $C_3H_7NO_2$
- Synonyms: None
- Appearance and odor: Colorless to pale yellow liquid with an ether-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for n-propyl nitrate is 25 parts of n-propyl nitrate per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 110 milligrams of n-propyl nitrate per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

• Routes of exposure

n-Propyl nitrate can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.

• Effects of overexposure

1. Short-term Exposure: Animal studies show that n-propyl nitrate causes temporary low blood pressure and may affect the ability of the blood to carry oxygen by forming methemoglobin. In man, methemoglobin formation may cause bluish discoloration of the skin, headache, weakness, drowsiness, nausea, rapid heart beat, shortness of breath, and unconsciousness.

2. Long-term Exposure: In animals repeated or prolonged exposure to n-propyl nitrate has caused irritation and thickness of the skin. It may also cause anemia.

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 n-propyl nitrate.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to n-propyl nitrate 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 blood, cardiovascular system, skin, nervous system, and kidneys should be stressed.

—A complete blood count: n-Propyl nitrate has been shown to cause methemoglobinemia in animals. Persons with blood disorders may be at increased risk from exposure. A complete blood count should be performed including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis. Methemoglobin determinations should be performed if overexposure is suspected or signs and symptoms of toxicity occur.

• Summary of toxicology

n-Propyl nitrate vapor causes anoxia due to the formation of methemoglobin. Exposure of rats to 10,000 ppm for 4 hours caused nasal irritation, dyspnea, methemoglobinemia, weakness, cyanosis, and death. In dogs repeatedly exposed to 260 ppm for 26 weeks, hemoglobinuria and mild anemia appeared during the first 2 weeks of exposure but then subsided. n-Propyl nitrate may induce hypotension in animals by direct action on vascular muscles. The liquid when placed into the eyes of rabbits caused mild transient inflammation with no evidence of corneal damage. The liquid applied to the skin of rabbits daily for 10 days caused staining, inflam-

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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mation, and thickening of the skin but no evidence of systemic toxicity. n-Propyl nitrate has the potential to form methemoglobin in man; the effects of methemoglobinemia result from anoxia and include cyanosis especially evident in the lips, nose, and ear lobes; other effects are weakness, dizziness, and severe headache.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 105.1
2. Boiling point (760 mm Hg): 111 C (231 F)
3. Specific gravity (water = 1): 1.06
4. Vapor density (air = 1 at boiling point of n-propyl nitrate): 3.6
5. Melting point: Less than -101 C (-150 F)
6. Vapor pressure at 20 C (68 F): 18 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Data not available

• Reactivity

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with either strong oxidizers or with combustibles 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 n-propyl nitrate.
4. Special precautions: n-Propyl nitrate will attack some forms of plastics, rubber, and coatings.

• Flammability

1. Flash point: 20 C (68 F) (closed cup)
2. Autoignition temperature: 175 C (347 F)
3. Flammable limits in air, % by volume: Lower: 2; Upper: 100
4. Extinguishant: Foam, dry chemical

• Warning properties

1. Odor Threshold: According to the *Documentation of TLVs*, "the odor is stated to be detectable at 50 ppm and above."
2. Eye Irritation Level: n-Propyl nitrate is not known to be an eye irritant.
3. Evaluation of Warning Properties: Since its odor threshold is only twice the permissible exposure limit, n-propyl nitrate 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 vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure n-propyl nitrate may be used. An analytical method for n-propyl nitrate is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

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 n-propyl nitrate.
- Clothing wet with n-propyl nitrate should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of n-propyl nitrate from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the n-propyl nitrate, the person performing the operation should be informed of n-propyl nitrate's hazardous properties.
- Non-impervious clothing which becomes contaminated with n-propyl nitrate should be removed promptly and any clothing which becomes wet with liquid n-propyl nitrate should be removed immediately and not reworn until the n-propyl nitrate is removed from the clothing.

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

SANITATION

- Skin that becomes contaminated with n-propyl nitrate should be promptly washed or showered with soap or mild detergent and water to remove any n-propyl nitrate.
- Employees who handle liquid n-propyl nitrate should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use in liquid rocket propellants	Local exhaust 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 liquid n-propyl nitrate 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 liquid n-propyl nitrate gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If liquid n-propyl nitrate soaks through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention promptly.

• Breathing

If a person breathes in large amounts of n-propyl nitrate, 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 liquid n-propyl nitrate 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.

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 n-propyl nitrate 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, stir with a solution of sodium hydroxide or soda ash in water until oily layer disappears, then flush. Large quantities can be burned under the supervision of personnel qualified to dispose of explosives. Liquid n-propyl nitrate should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of n-propyl nitrate vapors are permitted.

- Waste disposal method:

n-Propyl nitrate may be disposed of as described above.

REFERENCES

- Acme Company: *Protection Guide - n-Propyl Nitrate*.
- American Conference of Governmental Industrial Hygienists: "n-Propyl Nitrate," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- Boysen, J. E.: "Health Hazards of Selected Rocket Propellants," *Archives of Environmental Health*, 7:77-81, 1963.
- Hamilton, A., and Hardy, H.: *Industrial Toxicology* (3rd ed.), Publishing Sciences Group, Acton, Massachusetts, 1974.
- Hood, D. B.: "Toxicity of n-Propyl Nitrate and Isopropyl Nitrate," Haskell Laboratory for Toxicology and Industrial Medicine Report No. 21-53, E. I. duPont de Nemours and Company, Wilmington, Delaware, 1953.
- International Labour Office: *Encyclopedia of Occupational Health and Safety*, McGraw-Hill, New York, 1971.
- Mangelsdorff, A. F.: "Treatment of Methemoglobinemia," *A.M.A. Archives of Industrial Health*, 14:148-153, 1956.
- Murtha, E. F., et al.: "Some Pharmacological Effects of N-Propyl Nitrate," *Journal of Pharmacology and*

Experimental Therapeutics, 118:77-83, 1956.

• Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.

• Rinehart, W. E., et al.: "Studies on the Toxicity of n-Propyl Nitrate Vapor," *American Industrial Hygiene Association Journal*, 19:80-83, 1958.

RESPIRATORY PROTECTION FOR N-PROPYL NITRATE

Condition	Minimum Respiratory Protection* Required Above 25 ppm
Vapor Concentration	
250 ppm or less	Any chemical cartridge respirator with a cartridge containing non-combustible sorbents and providing protection against n-propyl nitrate. Any supplied-air respirator. Any self-contained breathing apparatus.
1000 ppm or less	Any chemical cartridge respirator with a full facepiece and a cartridge containing non-combustible sorbents and providing protection against n-propyl nitrate. A gas mask with a chin-style or a front- or back-mounted canister containing non-combustible sorbents and providing protection against n-propyl nitrate. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
2000 ppm or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 2000 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 containing non-combustible sorbents and providing protection against n-propyl nitrate. Any escape self-contained breathing apparatus.

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