

Occupational Health Guideline for Lindane*

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: $C_6H_6Cl_6$
- Synonyms: 1,2,3,4,5,6-Hexachlorocyclohexane; gamma-hexachlorocyclohexane; benzene hexachloride
- Appearance and odor: Colorless solid with a musty odor (pure material is odorless).

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for lindane is 0.5 milligram of lindane per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

• Routes of exposure

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

• Effects of overexposure

Exposure to lindane may cause vomiting, restlessness, muscle spasms, convulsions, and respiratory failure. It may also cause severe breathing difficulties which may be delayed in onset. Exposure to lindane vapors may cause headache, vomiting, and irritation of the eyes, nose, and throat. Repeated exposure to lindane may cause severe blood disorders which may be fatal. Skin rash may also occur from exposure to this chemical.

• 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 lindane.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to lindane 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. Persons with a history of convulsive disorders would be expected to be at increased risk from exposure. Examination of the eyes, central nervous system, blood, liver, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.

—A complete blood count: Lindane may cause aplastic anemia. A complete blood count should be performed, including a red cell count, a white cell count, and a differential count of a stained smear, as well as hemoglobin and hematocrit. The concentration of lindane in the blood is an indication of the extent of absorption.

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

• Summary of toxicology

Lindane (the gamma isomer of hexachlorocyclohexane) dust or vapor is a convulsant and causes cancer in mice. Repeated feeding to rats of 800 ppm in the diet resulted in mild liver damage; kidney damage occurred at higher levels. Mice fed 400 ppm in the diet developed liver tumors and, in some cases, lung metastases. In humans, accidental ingestion has caused fatalities; effects were repeated, violent, clonic convulsions, sometimes superimposed on a continuous tonic spasm; respiratory difficulty and cyanosis secondary to the convulsions were common. Exposure to the vapor causes irritation of the eyes, nose, and throat, severe headache, and nausea. Lindane levels in the blood do not appear to increase with increased duration of exposure but primarily reflect recent lindane absorption; production workers

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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exposed to air levels of 31 to 1800 $\mu\text{g}/\text{m}^3$ had blood levels of 1.9 to 8.3 ppb. Lindane has been suspected as a cause of aplastic anemia in a number of cases reported from various countries; this condition may have been caused either by a contaminant, or a thermal breakdown product of lindane, because many of the cases were associated with a space vaporizer as the source of exposure. The dry material applied to the skin of rabbits caused moderate skin irritation.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 290.8
2. Boiling point (760 mm Hg): Decomposes
3. Specific gravity (water = 1): 1.89
4. Vapor density (air = 1 at boiling point of lindane):

Not applicable

5. Melting point: 112 C (234 F)
6. Vapor pressure at 20 C (68 F): 0.0000094 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F):

0.001

8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: Above 177 C (350 F) lindane decomposes to form toxic and irritating hydrogen chloride gas.

2. Incompatibilities: None

3. Hazardous decomposition products: Toxic gases and vapors (such as phosgene, hydrogen chloride, and carbon monoxide) may be released in a fire involving lindane.

4. Special precautions: None

• Flammability

1. Not combustible, but may be dissolved in a combustible solvent

• Warning properties

Since the vapor pressure is so low, warning properties are not considered.

Grant states that "as a dust, lindane is said to have caused irritation of the eyes and respiratory passages in particularly sensitive individuals. However, test applications of a 3% dust mixture with talc on the eyes and nasal mucosa of rabbits produced no irritation."

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 lindane using a filter with subsequent recovery with iso-octane and gas chromatographic analysis. An analytical method for lindane 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 skin contact with lindane or liquids containing lindane where skin contact may occur.

• If employees' clothing may have become contaminated with lindane or liquids containing lindane, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing contaminated with lindane should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of lindane from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the lindane, the person performing the operation should be informed of lindane's hazardous properties.

• Where exposure of an employee's body to lindane or liquids containing lindane may occur, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

• Non-impervious clothing which becomes contaminated with solid lindane should be removed promptly and non-impervious clothing which becomes contaminated with liquids containing lindane should be re-

moved immediately and not reworn until the lindane is removed from the clothing.

- Employees should be provided with and required to use dust- and splash-proof safety goggles where lindane or liquids containing lindane may contact the eyes.

SANITATION

- Skin that becomes contaminated with liquids containing lindane should be immediately washed or showered with soap or mild detergent and water to remove any lindane.
- Skin that becomes contaminated with solid lindane should be promptly washed or showered with soap or mild detergent and water to remove any lindane.
- Eating and smoking should not be permitted in areas where solid lindane is handled, processed, or stored.
- Employees who handle lindane or liquids containing lindane 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 lindane may occur and control methods which may be effective in each case:

Operation	Controls
Formulation of insecticides, scabicides, pediculicides, and vermifuges	Process enclosure; general dilution ventilation; personal protective equipment
Application as a pesticide on plant, animal, household, and agricultural premises and equipment	Personal protective equipment
Manufacture of lindane	Process enclosure; general dilution ventilation; 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 lindane or liquids containing lindane get 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 lindane or liquids containing lindane get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If lindane or liquids containing lindane soak 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.

• Breathing

If a person breathes in large amounts of lindane, 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 lindane or liquids containing lindane have 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 AND DISPOSAL PROCEDURES

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

- If lindane is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquid containing lindane should be absorbed in vermiculite, dry sand, earth, or a similar material.

- Waste disposal method:

Lindane may be disposed of in sealed containers in a secured sanitary landfill.

REFERENCES

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* SPECIAL NOTE

Lindane appears on the OSHA "Candidate List" of chemicals being considered for further scientific review regarding its carcinogenicity (*Federal Register*, Vol. 45, No. 157, pp. 5372-5379, 12 August 1980).

The International Agency for Research on Cancer (IARC) has evaluated the data on this chemical and has concluded that it causes cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 5, 1974.

RESPIRATORY PROTECTION FOR LINDANE

Condition	Minimum Respiratory Protection* Required Above 0.5 mg/m ³
Particulate Concentration 5 mg/m ³ or less	Any chemical cartridge respirator with an organic vapor cartridge(s) and dust and mist filter(s), including pesticide respirators which meet the requirements of this class. Any supplied-air respirator. Any self-contained breathing apparatus.
25 mg/m ³ or less	A chemical cartridge respirator with a full facepiece, organic vapor cartridge(s), and dust and mist filter(s), including pesticide respirators which meet the requirements of this class. A gas mask with a chin-style or a front- or back-mounted organic vapor canister and dust and mist filter, including pesticide respirators which meet the requirements of this class. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
500 mg/m ³ or less	A powered air-purifying respirator with an organic vapor cartridge and high efficiency particulate filter, including pesticide respirators which meet the requirements of this class. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
1000 mg/m ³ or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 1000 mg/m ³ ** 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 and particulates, including pesticide respirators which meet the requirements of this class. Any escape self-contained breathing apparatus.

*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 lindane; 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 1000 mg/m³, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.

