Occupational Health Guideline for Dimethyl-1,2-Dibromo-2,2-Dichloroethyl Phosphate

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: $(CH_3O)_2P(O)OCHBrCBrCl_2$ or $C_4H_7Br_2Cl_2O_4P$
- Synonyms: Naled; 1,2-dibromo-2,2-dichloroethyl dimethyl phosphate; Dibrom
- Appearance and odor: Colorless solid or straw-colored liquid with a slightly pungent odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate is 3 milligrams of dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate 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: If vapors of dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate are inhaled, effects on the respiratory system and the eyes are the first to appear. These include tightness of the chest, wheezing, cough, excessive salivation, nasal discharge, aching in and behind the eyes, blurred vision, tearing, and headache. After swallowing the liquid, intestinal effects include loss of appetite, nausea, vomiting, cramps, and diarrhea. If spilled on the skin, it may cause itching, redness, and irritation. On being absorbed through the skin, this chemical may cause twitching and sweating at the site of absorption. If splashed in the eye, it may cause irritation. Severe intoxication, which may occur from breathing this chemical, swallowing it, or absorbing it through the skin or eye, may cause lightheadedness, slurred speech, muscle twitching, irregular heart beat, convulsions, paralysis, coma, and death.

2. Long-term Exposure: Repeated exposure to levels of dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate may make a person more susceptible to the effects of this and related chemicals.

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 dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate 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 skin sensitization to dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate, reduced pulmonary function, convulsive disorders, or recent exposure to anticholinesterase agents would be expected to be at increased risk from exposure. Examination of the respiratory system, nervous system, cardiovascular system, and attention to the cholinesterase levels in the blood should be stressed. The skin should be examined for evidence of chronic disorders.

—Cholinesterase determination: Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate causes depressed levels of activity of cholinesterase in the serum and erythrocytes. The cholinesterase activity in the serum

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and erythrocytes should be determined by using medically acceptable biochemical assays prior to any exposure.

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis, with the exception of the cholinesterase determination which should be performed semiannually or at any time overexposure is suspected or signs or symptoms of toxicity occur.

• **Summary of toxicology**

This substance is an anticholinesterase agent; absorption may occur from inhalation of the vapor, by skin absorption, or ingestion of the liquid. Signs and symptoms of overexposure are caused by the inactivation of the enzyme cholinesterase, which results in the accumulation of acetylcholine in the nervous system, skeletal and smooth muscles, and secretory glands. The sequence of the development of systemic effects varies with the route of entry. The onset of signs and symptoms occurs promptly, and almost always within 12 hours. After inhalation of the vapor, respiratory and ocular effects are the first to appear, often within a few minutes after exposure. Respiratory effects include tightness in the chest and wheezing due to bronchoconstriction and excessive bronchial secretion; laryngeal spasms and excessive salivation may add to the respiratory distress; cyanosis may also occur. Ocular effects include miosis, aching in and behind the eyes (attributed to ciliary spasm), blurring of distant vision, tearing, rhinorrhea, and frontal headache. After ingestion of the liquid, gastrointestinal effects such as anorexia, nausea, vomiting, abdominal cramps, and diarrhea appear within 15 minutes to 2 hours. After skin absorption of the liquid, localized sweating and muscular fasciculations in the immediate area occur, usually within 15 minutes to 4 hours; skin absorption is somewhat greater at higher ambient temperatures and is enhanced by the presence of dermatitis. With severe intoxication by all routes, an excess of acetylcholine at the neuromuscular junctions of skeletal muscle causes weakness aggravated by exertion, involuntary twitchings, fasciculations, and eventually paralysis; the most serious consequence is paralysis of the respiratory muscles. Effects on the central nervous system include giddiness, confusion, ataxia, slurred speech, Cheyne-Stokes respiration, convulsions, coma, and loss of reflexes. The blood pressure may fall to low levels and cardiac irregularities including complete heart block may occur, but these are often reversed by the establishment of adequate pulmonary ventilation. In nonfatal cases, complete symptomatic recovery usually occurs within 1 week; increased susceptibility to the effects of anticholinesterase agents persists for long periods after exposure. Daily exposure to concentrations which are insufficient to produce symptoms following a single exposure may result in the onset of symptoms. Continued daily exposure may be followed by increasingly severe effects. Dermatitis occurred on the arms, face, neck, and abdomen of 9 of 12 persons working in a field of flowers which had been freshly sprayed with a solution of Dibrom; three of four workers patch-tested were positive to a 60% solution of Dibrom in xylene and negative to xylene alone. The liquid in the eye is expected to cause injury.

CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data**

1. Molecular weight: 381
2. Boiling point (760 mm Hg): Decomposes
3. Specific gravity (water = 1): 1.97
4. Vapor density (air = 1 at boiling point of dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate): Not
5. Melting point: 27 C (81 F)
6. Vapor pressure at 20 C (68 F): 0.0002 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble, decomposes about 10% per day in water
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Reactivity**

1. Conditions contributing to instability: None
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen bromide, hydrogen chloride, phosphoric acid, and carbon monoxide) may be released when dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate decomposes.
4. Special precautions: Liquid dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate will attack some forms of plastics, rubber, and coatings.

• **Flammability**

1. Not combustible

• **Warning properties**

Dibrom is not known to be an eye irritant.

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**

At the time of publication of this guideline, no measurement method for dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate had been published by NIOSH.

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 dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate, where skin contact may occur.
- If employees' clothing may have become contaminated with dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liqcontaining dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing which may have become contaminated with dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate, the person performing the operation should be informed of dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate's hazardous properties.
- Non-impervious clothing which becomes contaminated with dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate should be removed immediately and not reworn until the dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate is removed from the clothing.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate should be immediately washed or showered with soap or mild detergent and water to remove any dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate.
- Workers subject to skin contact with dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate should wash any areas of the body which may have contacted dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate at the end of each work day.
- Eating and smoking should not be permitted in areas where dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate are handled, processed, or stored.
- Employees who handle dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate 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 dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate may occur and control methods which may be effective in each case:

Operation	Controls
Use as an agricultural insecticide and acaricide applied to fruit, vegetables, and agronomic crops; use in domestic, commercial, and agricultural premises	Personal protective equipment
Use in compounding water-base paints and floor polishes for insecticidal properties	Process enclosure; 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 dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immedi-

ately. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**

If dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate get on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately.

• **Breathing**

If a person breathes in large amounts of dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate, 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 dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate 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 dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. If in the solid form, collect spilled material in the most convenient and safe manner for reclamation or for disposal in a secured sanitary landfill. Liquid dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate or liquids containing dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate should be absorbed in vermiculite, dry sand, earth, or a similar material.

• Waste disposal methods:

Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate may be disposed of:

1. If in the solid form, by disposing in a secured sanitary landfill.
2. If in the liquid form, by absorbing in vermiculite, dry sand, earth, or a similar material, and disposing in a secured sanitary landfill.

REFERENCES

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RESPIRATORY PROTECTION FOR DIMETHYL-1,2-DIBROMO-2,2-DICHLOROETHYL PHOSPHATE

Condition	Minimum Respiratory Protection* Required Above 3 mg/m³
Particulate Concentration	
15 mg/m³ or less	Any dust and mist respirator, except single-use, including pesticide respirators which meet the requirements of this class.
30 mg/m³ or less	Any dust and mist respirator, except single-use or quarter-mask respirator, including pesticide respirators which meet the requirements of this class. Any fume respirator or high efficiency particulate filter respirator. Any supplied-air respirator. Any self-contained breathing apparatus.
150 mg/m³ or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
1800 mg/m³ or less	A powered air-purifying respirator with a high efficiency particulate filter. A Type C supplied-air respirator operated in pressure-demand or other positive pressure mode.
Greater than 1800 mg/m³ 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 dust and mist respirator, except single-use, 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.