

Occupational Health Guideline for Organo (Alkyl) Mercury

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.

APPLICABILITY

The general guidelines contained in this document apply to all organo (alkyl) mercury compounds. Physical and chemical properties of several specific compounds are provided for illustrative purposes.

SUBSTANCE IDENTIFICATION

Ethylmercuric chloride

- Formula: C_2H_5HgCl
- Synonyms: Chloroethylmercury; cerasan
- Appearance and odor: Colorless, odorless solid.

Dimethylmercury

- Formula: $(CH_3)_2Hg$
- Synonyms: Mercury dimethyl
- Appearance and odor: Colorless liquid with a weak, sweetish odor.

Diethylmercury

- Formula: $(C_2H_5)_2Hg$
- Synonyms: Mercury diethyl
- Appearance and odor: Colorless liquid with a weak, sweetish odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for organo (alkyl) mercury is 0.01 milligram of organo (alkyl) mercury per

cubic meter of air (mg/m^3) averaged over an eight-hour work shift, with a ceiling level of $0.04 mg/m^3$.

HEALTH HAZARD INFORMATION

• Routes of exposure

Organo (alkyl) mercury 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

Organo (alkyl) mercury compounds may cause damage to the central nervous system and are irritants of the eyes, respiratory tract, and skin. Symptoms of methyl and ethyl mercury intoxication may occur weeks to months after an acute exposure to toxic concentrations. The symptoms of acute and chronic intoxication from both compounds are similar and include numbness and tingling of the lips, hands and feet, staggering, joint pain, narrowing of vision, hearing difficulties, and emotional disturbances. With severe intoxication the symptoms are usually irreversible. Severe intoxication also results in periods of spasticity and jerking movements of the arms and legs, head or shoulders, and bouts of groaning, moaning, shouting, or crying. Other symptoms are dizziness, increased watering of the mouth, watering of the eyes, nausea, vomiting, and diarrhea or constipation. Infants born to mothers who have been exposed to large amounts of methyl mercury have shown mental retardation and cerebral palsy with convulsions. The symptoms of exposure to methoxyethyl mercury are loss of appetite, diarrhea, weight loss, and fatigue. Kidney damage has occurred. The alkyl mercury halides are irritating to the eyes, upper respiratory tract, and skin and may cause severe skin rash and burns. Allergic skin rashes may occur.

• 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 organo (alkyl) mercury.

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.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

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

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to organo (alkyl) mercury 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 central nervous system, the kidneys, and eyes should be stressed. The skin should be examined for evidence of chronic disorders.

—Blood test: Analysis of the blood for mercury may be useful in monitoring absorption.

—Urinalysis: Since kidney damage has been observed in humans exposed to organo mercury, a urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

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

- **Summary of toxicology**

Organo (alkyl) mercury compounds cause dysfunction of the central nervous system and irritate the eyes, mucous membranes, and skin. Symptoms of methyl and ethyl mercury intoxication may occur weeks to months after an acute exposure to toxic concentrations. The symptoms of acute and chronic intoxication from both compounds are similar and include numbness and tingling of the lips, hands, and feet; ataxia; dysarthria; concentric constriction of the visual fields (tunnel vision); impairment of hearing; and emotional disturbances. With severe intoxication, the symptoms are usually irreversible. Severe intoxication also results in incontinence, periods of spasticity and jerking movements of the limbs, head or shoulders, and bouts of groaning, moaning, shouting, or crying; less frequent symptoms are dizziness, hypersalivation, lacrimation, nausea, vomiting, and diarrhea or constipation. An epidemic of intoxication from ingestion of fish contaminated with methyl mercury occurred in the Minamata district in Japan, and methyl mercury intoxication is often referred to as Minamata disease. Infants born to mothers with exposure to large amounts of methyl mercury had mental retardation and cerebral palsy with convulsions; methyl mercury has a strong effect on cell division and chromosome segregation, which may produce chromosomal alterations. The biological half-life in humans for methyl mercury is about 70 days; since elimination is slow, irregular, and individualized, there is a considerable risk of an accumulation of mercury to toxic levels. A precise relationship between atmospheric levels and concentrations of mercury in blood or urine cannot be shown. Clinical observations indicate that concentrations of 50 to 100 ug mercury/100 ml of whole blood may be associated with symptoms of intoxication; concentrations around 10 to 20 ug mercury/100 ml are not associated with symptoms. In a

study of 20 workers engaged in the manufacture of organic mercurials and exposed for 6 years to mercury concentrations in air between 0.01 and 0.1 mg/m³, there was no evidence of physical impairment or clinical laboratory abnormalities. The symptoms of exposure to methoxyethyl mercury are anorexia, diarrhea, weight loss, and fatigue, and are probably due to inorganic mercury; kidney damage with albuminuria, and occasionally a nephrotic syndrome, has occurred. The alkyl mercury halides are irritating to the eyes, mucous membranes, and skin and may cause severe dermatitis and burns; skin sensitization has occasionally occurred.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data—Ethylmercuric chloride**

1. Molecular weight: 265.1
2. Boiling point (760 mm Hg): Sublimes above 40 C (104 F)
3. Specific gravity (water = 1): 3.48
4. Vapor density (air = 1 at boiling point of ethylmercuric chloride): 9.2
5. Melting point: 192 C (378 F)
6. Vapor pressure at 20 C (68 F): Much less than 1
7. Solubility in water, g/100 g water at 20 C (68 F): 0.00014
8. Evaporation rate (butyl acetate = 1): Data not available

- **Physical data—Dimethylmercury**

1. Molecular weight: 230.7
2. Boiling point (760 mm Hg): 95 C (203 F)
3. Specific gravity (water = 1): 3.2
4. Vapor density (air = 1 at boiling point of dimethylmercury): 7.9
5. Melting point: -80 C (-112 F) (approximately)
6. Vapor pressure at 20 C (68 F): 50 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

- **Physical data—Diethylmercury**

1. Molecular weight: 258.7
2. Boiling point (760 mm Hg): 159 C (318 F)
3. Specific gravity (water = 1): 2.5
4. Vapor density (air = 1 at boiling point of diethylmercury): 8.9
5. Melting point: Data not available (very low)
6. Vapor pressure at 20 C (68 F): 2 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: Elevated temperatures cause decomposition to flammable and explosive hydrocarbon gases.
2. Incompatibilities: Contact with strong oxidizers such as chlorine may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases

and vapors (such as toxic mercury fumes and carbon monoxide) may be released in a fire involving organo (alkyl) mercury.

4. Special precautions: Liquid organo (alkyl) mercury will attack some forms of plastics, rubber, and coatings.

- **Flammability**

1. Flash point: Ethylmercuric chloride: Not applicable; Dimethylmercury and diethylmercury: Data not available

2. Autoignition temperature: Data not available

3. Flammable limits in air, % by volume: Data not available

4. Extinguishant: Dry chemical, foam, carbon dioxide

- **Warning properties**

1. Odor Threshold: The American National Standards Institute (ANSI) states that many alkyl mercury compounds "are disagreeable in odor."

2. Irritation Levels: ANSI states that "the organo-mercurials are severe skin, eye, and mucous membrane irritants. The first complaints following surface contact may be delayed for several hours and are usually those of local warmth and redness, which progress to blistering. In cases of repeated exposure, skin sensitization may occur."

3. Evaluation of Warning Properties: Not all alkyl mercury compounds have adequate warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

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).

- **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of organo (alkyl) mercury. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Method**

An analytical method for organo (alkyl) mercury is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 6, 1980, available from the Government Printing Office,

Washington, D.C. 20402 (GPO No. 017-033-00369-6).

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 organo (alkyl) mercury or liquids containing organo (alkyl) mercury.

- If employees' clothing has had any possibility of being contaminated with organo (alkyl) mercury or liquids containing organo (alkyl) mercury, employees should change into uncontaminated clothing before leaving the work premises.

- Clothing which has had any possibility of being contaminated with organo (alkyl) mercury should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of organo (alkyl) mercury from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the organo (alkyl) mercury, the person performing the operation should be informed of organo (alkyl) mercury's hazardous properties.

- Where there is any possibility of exposure of an employee's body to organo (alkyl) mercury or liquids containing organo (alkyl) mercury, 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 organo (alkyl) mercury should be removed immediately and not reworn until the organo (alkyl) mercury 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 organo (alkyl) mercury or liquids

containing organo (alkyl) mercury contacting the eyes.

- Where there is any possibility that employees' eyes may be exposed to organo (alkyl) mercury or liquids containing organo (alkyl) mercury, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

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

Operation	Controls
Liberation during manufacture/production for use as fungicides and slimicides	Replacement/substitution; dilution ventilation; local exhaust ventilation; personal protective equipment
Liberation during processing mercury ore and during mining and extraction operations	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in treating and disinfecting of seeds and bulbs	Replacement/substitution; general dilution ventilation; personal protective equipment
Liberation during utilization (spraying) of seeds and bulbs	Replacement/substitution; general dilution ventilation; personal protective

Operation

Use as a wood, timber, and paper preservative and slimicide; liberation during analysis at seed control stations

Controls

equipment

Replacement/substitution; 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 organo (alkyl) mercury or solutions containing organo (alkyl) mercury compounds get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with these chemicals.

• Skin Exposure

If solid organo (alkyl) mercury or solutions containing organo (alkyl) mercury get on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If solid organo (alkyl) mercury or solutions containing organo (alkyl) mercury penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention.

• Breathing

If a person breathes in large amounts of organo (alkyl) mercury, 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 organo (alkyl) mercury 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 organo (alkyl) mercury compounds are spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. If in the solid form, collect for reclamation or disposal in sealed containers in a secured sanitary landfill.
4. If in the liquid form, 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. Large quantities can be collected and reclaimed or collected for reclamation or disposal in sealed containers in a secured sanitary landfill.

• Waste disposal methods:

Organo (alkyl) mercury may be disposed of:

1. If in the solid form, by collecting for reclamation or for disposal in sealed containers in a secured sanitary landfill.
2. If in the liquid form, 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. Large quantities can be collected and reclaimed or collected for reclamation or disposal in sealed containers in a secured sanitary landfill.

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RESPIRATORY PROTECTION FOR ORGANO (ALKYL) MERCURY

Condition	Minimum Respiratory Protection* Required Above 0.01 mg/m ³
Particulate or Vapor Concentration	
0.5 mg/m ³ or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
10 mg/m ³ or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 10 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 organo (alkyl) mercury vapors and particulates. 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 organo (alkyl) mercury; 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 10 mg/m³, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.