

Occupational Health Guideline for Soluble Thallium Compounds

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 soluble thallium compounds. Physical and chemical properties of several specific compounds are provided for illustrative purposes.

SUBSTANCE IDENTIFICATION

- **Names and Formulas:** 1) Thallium sulfate: Tl_2SO_4 ; 2) Thallium acetate: $TlC_2H_3O_2$; 3) Thallium nitrate: $TlNO_3$
- **Appearance and odor:** Thallium sulfate, thallium acetate, and thallium nitrate are all colorless, odorless solids.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for soluble thallium compounds is 0.1 milligram of soluble thallium compounds per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**
Soluble thallium compounds can affect the body if they are inhaled or if they come in contact with the eyes or skin, or if they are swallowed. They may enter the body through the skin.
- **Effects of overexposure**
Soluble thallium compounds are very toxic and cause cumulative intoxication. Many deaths have resulted

from swallowing these compounds. Poisoning from industrial exposure has been rarely reported — those that have, were not fatal. Swallowing soluble thallium compounds may cause nausea, vomiting, diarrhea, abdominal pain, and bleeding from the gut. These symptoms are followed or accompanied by drooping of the eyelids, crossed eyes, weakness, numbness, and tingling of the arms and legs, trembling, and pain and tightness of the chest. The hair may fall out after two to three weeks. Severe intoxication may result in prostration, rapid heartbeat, convulsions, and psychosis. Recovery may be complete but permanent effects such as staggering, visual difficulties, trembling, and mental abnormalities have been reported. Liver and kidney damage have occurred. Repeated exposure over a prolonged period may produce variable symptoms. These may include loss of hair, soreness of the mouth, trembling, severe weight loss, and emotional disturbance.

- **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 soluble thallium compounds.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to soluble thallium compounds 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 eyes, nervous system, lungs, liver, kidneys, gastrointestinal tract, and body hair should be stressed.

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

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

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

• **Summary of toxicology**

Soluble thallium compounds are extremely toxic and cause a cumulative intoxication affecting primarily the nervous system and the body hair. Many deaths have resulted from ingestion. The lethal oral dose of thallium acetate for humans is estimated to be about 12 mg/kg body weight. Ingestion causes nausea, vomiting, diarrhea, abdominal pain and gastrointestinal hemorrhage, which usually occur within 1 to 3 days. These are followed or accompanied by ptosis, strabismus; peripheral neuritis, pain, weakness, and paresthesias in the legs, tremor; retrosternal tightness and chest pain. Severe alopecia usually occurs after 2 to 3 weeks and is pathognomonic of the toxic effects of thallium. Severe intoxication may result in prostration, tachycardia, blood pressure fluctuations, convulsive seizures, choreiform movements, and psychosis. Recovery may be complete, but permanent residual effects such as ataxia, optic atrophy, tremor, mental abnormalities, and foot-drop have been reported. In cases of fatal intoxication, typical autopsy findings include pulmonary edema, necrosis of the liver, nephritis, and degenerative changes in peripheral axons. Prolonged ingestion of thallium produces a variable clinical picture which includes stomatitis, tremor, cachexia, polyneuropathy, alopecia, and emotional disturbance. In a study of 15 workers who had handled solutions of organic thallium salts over a 7.5-year period, 6 workers suffered thallium intoxication; chief complaints were abdominal pain, fatigue, weight loss, pain in the legs, and nervous irritability; 3 of the workers had albuminuria and 1 had hematuria.

CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data**

These data correspond to the the three substances identified above.

1. Molecular weight: 1) 504.81; 2) 263.41; 3) 266.4
2. Boiling point (760 mm Hg): Decomposes
3. Specific gravity (water = 1): 1) 6.8; 2) 3.7; 3) 5.5
4. Vapor density (air = 1 at boiling point of soluble thallium compounds): Not applicable
5. Melting point: 1) 632 C (1170 F); 2) 110 C (230 F); 3) 206 C (403 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): 1) 4.87; 2) Very soluble; 3) 10
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Reactivity**

1. Conditions contributing to instability: None.
2. Incompatibilities: None.
3. Hazardous decomposition products: None.
4. Special precautions: None.

• **Flammability**

1. Flash point: Data not available
2. Autoignition temperature: Data not available
3. Flammable limits in air, % by volume: Data not available
4. Extinguishant: Water, carbon dioxide, foam, dry chemical

• **Warning properties**

Grant describes some effects on the eye produced by systemic thallium poisoning. In addition, Grant states that "experiments concerned with the local effects of thallium on the eye suggest that contact of thallium salts with the eye, such as by accidental splash contamination, is unlikely to cause serious damage, especially if promptly washed away with water. Experimentally, a rather drastic exposure of a rabbit eye for ten minutes to a neutral saturated solution of thallium chloride, with the epithelium preliminarily removed to facilitate penetration, caused moderate edema and haze in the cornea, which gradually cleared from the periphery but left a nebulous area axially. Splash contact with intact epithelium presumably would be even less damaging."

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 on a filter with a subsequent atomic absorption spectrophotometric analysis. An analytical method for soluble thallium compounds is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 5, 1979, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00349-1).

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 soluble thallium compounds where skin contact may occur.

- If employees' clothing may have become contaminated with soluble thallium compounds, employees should change into uncontaminated clothing before leaving the work premises.

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

- Non-impervious clothing which becomes contaminated with soluble thallium compounds should be removed promptly and not reworn until the soluble thallium compounds are removed from the clothing.

- Employees should be provided with and required to use dust- and splash-proof safety goggles where soluble thallium compounds may contact the eyes.

SANITATION

- Skin that becomes contaminated with soluble thallium compounds should be promptly washed or showered to remove any soluble thallium compounds.

- Eating and smoking should not be permitted in areas where soluble thallium compounds are handled, processed, or stored.

- Employees who handle soluble thallium compounds 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 soluble thallium compounds may occur and control methods which may be effective in each case:

Operation

Use in laboratory for analytical and research purposes

Use in manufacture of special lenses, plates and prisms, medicinals, pyrotechnic products, and fuel additives for internal combustion engines

Manufacture of soluble thallium compounds and application as a rodenticidal agent

Controls

Local exhaust ventilation; personal protective equipment

Local exhaust ventilation; personal protective equipment

Local exhaust ventilation; personal protective equipment; product substitution

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 soluble thallium compounds 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 soluble thallium compounds get on the skin, promptly flush the contaminated skin with water. If soluble thallium compounds penetrate through the clothing, remove the clothing promptly and flush the skin with water. Get medical attention.

• Breathing

If a person breathes in large amounts of soluble thallium compounds, 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 soluble thallium compounds 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 soluble thallium compounds are spilled, the following steps should be taken:

1. Ventilate area of spill.

2. For small quantities, sweep onto paper or other suitable material, place in a sealed container for disposal. Large quantities may be reclaimed; however, if this is not practical, collect spilled material in the most convenient and safe manner and deposit in sealed containers for disposal.

3. Liquids containing soluble thallium compounds may be absorbed in vermiculite, dry sand, earth, or a similar material and deposited in sealed containers for disposal.

- Waste disposal method

Soluble thallium compounds may be disposed of in sealed containers in a secured sanitary landfill.

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RESPIRATORY PROTECTION FOR SOLUBLE THALLIUM COMPOUNDS

Condition	Minimum Respiratory Protection* Required Above 0.1 mg/m³
Dust or Mist Concentration	
0.5 mg/m ³ or less	Any dust and mist respirator, except single-use.
1 mg/m ³ or less	Any dust and mist respirator, except single-use or quarter-mask respirator.
Dust, Mist, or Fume Concentration	
1 mg/m ³ or less	Any fume respirator or high efficiency particulate filter respirator. Any supplied-air respirator. Any self-contained breathing apparatus.
5 mg/m ³ 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.
20 mg/m ³ or less	A powered air-purifying respirator with a full facepiece, helmet, or hood, and a high efficiency particulate filter. 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 20 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 dust and mist respirator, except single-use. Any escape self-contained breathing apparatus.

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