

ChemFacts

Safe Handling of Mercury and Mercury Compounds

Background Information

Mercury is a liquid metal that is environmentally persistent and bioaccumulates in the food chain. Mercury is present in both organic and inorganic forms. The inorganic form can be further divided into elemental mercury and mercuric salts. Organo-mercury consists of long and short alkyl and aryl compounds.

Elemental mercury evaporates at room temperature and reacts with many elements to form salts, amalgams, and organo-mercury compounds. A number of these compounds are considered "highly hazardous" by the US EPA (P list) All mercury containing waste is considered hazardous and requires special disposal considerations.

Hazards

All forms of mercury are toxic.

Mercury poisoning can result from inhalation, ingestion, and injection or absorption through the skin.

All forms of mercury penetrate the placental barrier and should be considered teratogenic and reproductive effectors.

The effects from exposure to excessive levels of airborne mercury or skin contact with mercury compounds may not be noticeable for months or years.

Elemental mercury

Poses a health hazard because it is volatile and can be absorbed through the skin. As a vapor, penetrates the central nervous system, where it is ionized and trapped, attributing to its extremely toxic effects. Is not well absorbed by the gastrointestinal tract; therefore, when ingested, it is only mildly toxic. Mercury metal and mercury compounds are highly hazardous if inhaled or if they remain on the skin for more than a short period of time.

Mercury vapor (i.e., elemental mercury) is readily absorbed through inhalation and can also pass through intact skin. After absorption, elemental mercury is carried by the blood to the central nervous system where it is oxidized. The oxidation product produces injury. Persons heavily exposed to elemental mercury will develop worsening tremors of

the hands, shyness, insomnia, and emotional instability (e.g., the symptoms of the Mad Hatter in *Alice in Wonderland*--a caricature of hat makers who cured felt in pools of mercury.) Mercury vapors can reach very high levels when the liquid is heated. Such levels will cause adverse effects in humans almost immediately if workplace controls are inadequate. Some equipment, such as thermometers, vacuum pumps, manometer, and sphygmomanometers, may contain mercury.

Inorganic Mercury salts (such as mercuric chloride) are toxic and corrosive. Toxicity ranges from high to moderate, depending on the form (LD₅₀ from 6-200 mg/kg). They accumulate mainly in the kidney causing renal damage.

Mercury fulminate, Hg(ONC)₂, is a detonator used in explosives. It is a heavy, practically non-hygroscopic, crystalline solid. When dry, it is very sensitive to heat, friction, spark, flame, and shock. The sensitivity is so great that accidents, especially during manufacturing, are numerous. Whether it is wet or dry, mercury fulminate must not be permitted to come into contact with materials such as aluminum, magnesium, zinc, copper, brass, or bronze.

Mercury(II) oxide is an oxidizer. It can cause organic materials to start burning in the same manner as any strong oxidizer. It also decomposes to mercury vapor upon exposure to light.

Organo-mercury compounds vary from very low toxicity (mercurochrome) to highly toxic (dimethylmercury) Toxicity depends on the likelihood of degradation to free mercuric ions which attack the nervous system causing tremors, impaired vision and hearing, and paralysis. In general the aryl (phenolic) forms are less toxic while the short chained alkyl (methyl) forms can be extremely toxic.

Dimethyl mercury, an extremely toxic material (LD₅₀ 50ug/kg), is a colorless, sweet-smelling liquid. It is a severe fire hazard, with a flash point of -4°C. This material rapidly penetrates the skin resulting in severe exposure from very minor quantities, which can be fatal. This form of mercury is known to have toxic effects on fetuses of exposed mothers and was responsible for the death of a laboratory worker in the United States in 1997 due to the use of inappropriate (latex) gloves. Extreme caution is required when working with this material and when selecting personal protective equipment (PPE).

Contact ES&H for more specific hazards and controls for mercury and its compounds,

Exposure Limits

Georgia Tech is not subject to Federal Occupational and Health Administration (OSHA) regulations and therefore does not need to adhere to the OSHA Permissible Exposure Limits (PEL). Georgia Tech Environmental Health and Safety (EH&S) has chosen to use a more protective standard, the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) to assess occupational exposures to hazardous substances

Form	TLV	STEL
Alkyl compounds	0.01 mg/m ³	0.03 mg/m ³
Aryl compounds	0.1 mg/m ³	
Elemental and inorganic forms	0.025 mg/m ³	

Before you purchase or start working with mercury or mercury compounds call EH&S for a Hazard Assessment

EH&S will

- Review the toxicological data for the material with which you intend to work.
- Inspect your work area.
- Review your Standard Operating Procedure for working with mercury/mercury compounds.
- Review the training records of all persons in the lab.
- Test engineering controls as appropriate.
- Test safety equipment as appropriate.
- Provide recommendations for PPE appropriate for the particular material with which you are working.
- Determine if medical surveillance of affected employees is needed.

Facility requirements for working with highly toxic mercury/mercury compounds

Fume hood tested at no less than 120 lfm average face velocity or Class II laminar flow hood tested at no less than 100 lfm average face velocity.

Eye wash station must be no less than 10 seconds from the work area and the path of travel must be free of obstructions (doors, fixtures) that may inhibit the immediate use

Emergency shower must be no less than 10 seconds from the work area and the path of travel must be free of obstructions (doors, fixtures) that may inhibit the immediate use

Floors must have vinyl coverings, either tile or sheet.

A mercury spill kit must be kept in the lab. It's location must be prominently displayed with a sign.

Work practices for all forms of mercury

Avoid using mercury whenever possible (purchase mercury-free equipment, look for less toxic alternatives in chemical syntheses).

Always read the MSDS for all the chemicals involved in your process before purchasing them. They may require special equipment for handling/storage that you will need to acquire prior to their arrival.

At all times practice strict chemical hygiene:

- Do not eat, drink, smoke, or apply cosmetics in the lab
- Do not store food in laboratory refrigerators
- Do not store chemicals in break room refrigerators
- Wash hands and face after handling mercury and before breaks or leaving for the day
- Avoid skin and eye contact- do not touch your face or rub your eyes in a laboratory

Dress appropriately to work in the lab- long pants, closed shoes (no open toes, no canvas)

Use appropriate Personal Protective Equipment

- Safety glasses with side shields (or wrap around style) or goggles must be worn by all persons, including those already wearing prescription glasses.
- Lab coat- knee length
- Gloves appropriate to ALL chemicals you are using- not just the mercury compounds. Contact EH&S for help in choosing gloves
- Here are some choices that apply JUST to mercury compounds-
 - Elemental mercury- Silver Shield®, Responder®, Tychem® BR/LV, Tychem® SL, Tychem TK
 - Mercuric chloride- Tychem BR/LV, Tychem SL, Tychem TK
 - Methyl Mercury – Nitrile (8 mil) over Silver Shield®
- Note that 8 mil nitrile gloves can always be worn over silver shield to restore dexterity.

Mercury/mercury compounds with a LD₅₀ of 50 mg/kg or less (highly or extremely toxic) must be handled in a fume hood or in a Class II biosafety cabinet. (Get this information from the MSDS or EH&S)

All materials with an LD₅₀ of 50 mg/kg or less (highly toxic) must be kept in locked, restricted access area (such as a locked lab)

Materials with an LD₅₀ of 5 mg/kg or less (extremely toxic) must additionally be kept in a locked cabinet and there must be a sign out sheet to keep a record of who has used the material, how much they used, and when they used it.

Depending on the form of mercury, animal dosing may have to be done in a fume hood (mandatory with methyl mercury). (This will be determined by EH&S during the Hazard Evaluation.)

Work with highly or extremely toxic materials must be limited to the areas indicated on your SOP

Waste Disposal

Depending on the form of mercury, animal bedding may have to be disposed of as hazardous waste. (This will be determined by EH&S during the Hazard Evaluation.)

Mercury contaminated animal carcasses should be sealed in plastic and frozen until they can be removed from the lab. Arrange for the waste to be picked up while still frozen by calling 4-6224 or 4-0499. Do not remove this waste from the freezer until a definite time for the pick up has been arranged.

Mercury contaminated waste including pipet tips, syringes, and stock bottles must be disposed of as hazardous waste. Waste should be collected in sealable disposable containers and stored in the fume hood until they can be removed from the lab. Call for waste pick up weekly- do not allow this waste to accumulate to the point of interfering with fume hood function. Call 4-6224 or 4-0499 to arrange a pick up.

Emergency procedures

If you are splashed with a chemical in an area of your body which cannot be put under a sink faucet and flooded immediately- you must use an emergency shower

If your clothing is involved- remove it on the way to the shower:

- Yell for help
- Remain in the shower for 15 minutes
- Get someone to call the GT Police (4-2500) Tell them that you will need an ambulance
- Do not re-don contaminated clothing

If you are splashed in the eyes:

- Yell for help
- Hold your eyelids open with your fingers as you rinse your eyes

- Have your helper watch a clock for you to make sure that you continue to rinse your eyes for a full 15 minutes

All chemical exposures involving mercury compounds require immediate medical attention at Grady Hospital

Take a copy of the MSDSs with you on the ambulance- present it to the treating physician when you get to the hospital.

Have someone inform your supervisor of the incident so he/she can file a First Report of Injury on your behalf.

Spills procedures

Some mercury compounds, particularly methyl mercury are extremely flammable. In the event of a spill of this material, immediately de-energize all sources of ignition in the laboratory.

As with any spill, you must use your own judgment as to whether this is a small spill that you can clean up yourself, or if you need to evacuate the lab and call for help by calling GT Police at 4-2500.

If you elect to clean up the spill yourself, apply the amalgam powder immediately to stop vapor emission. Follow kit directions to collect amalgamated waste, place it in containers provided. Call EH&S (4-6224) to have the waste picked up.

Always replace the spill kit with a new one, no matter how much material is left over from the clean up.

Medical Surveillance

EH&S will determine the need for biological monitoring or medical surveillance examinations of workers with potential for mercury exposure based on an evaluation of the operation; workplace controls; and any relevant human factors as well as input received from the research team. Departments/projects are responsible for covering the costs of medical surveillance.

Labels and Storage

The following controls apply to the labeling and storage of mercury and its compounds:

- Label all containers of metallic mercury and its compounds. Labels shall include:
 - The chemical name
 - Manufacturer or supplier
 - Manufacturer/suppliers address and telephone number

- NFPA hazard ratings
- IN addition, all mercury containers must carry the following warning

WARNING: VAPOR HARMFUL AT ROOM TEMPERATURE-MAY BE FATAL IF HEATED IN THE OPEN-DO NOT BREATHE VAPOR-USE WITH ADEQUATE VENTILATION-AVOID SKIN CONTACT.

Do not store mercury near chemicals that can create explosive mixtures with mercury (e.g., acetylene, ammonia, boron phosphodiiodide, chlorine dioxide, methyl azide, and ground sodium carbide) or radioactive materials. Keep mercury compounds that are oxidizers separate from organic materials and other combustibles.

Minimize the amount of mercury in use or in storage by practicing just in time ordering

Store liquid mercury in a cool place.

Use containers made of impact-resistant material or put them in sturdy secondary containers.

Keep mercury containers tightly closed when not in use.

Avoid cutting cartons that contain plastic bottles filled with mercury. A plastic bottle could be torn open and cause a mercury spill.

Refrigerate flammable mercury compounds (methyl mercury) only in explosion proof freezers/refrigerators

Training

All persons working with chemicals must be trained in the hazards of the workplace prior to beginning work, this includes

- Georgia Right to Know Law
- Basic Chemical Hygiene
- Bio-Safety/Universal Precautions
- How to use a fume hood
- Specific hazards, chemical and non-chemical of this laboratory
- (Contact EH&S for help with training)
- A review of the MSDSs for all chemical involved in each particular experiment
- How to use a mercury spill kit

What needs to be included in a Standard Operating Procedure (SOP)

A Standard Operating Procedure is an account of your process. It can be written as a narrative or as a check list. It should start with how to set up to do the process and should conclude with waste disposal. All safety precautions including, for example, fume hood use and glove selection should be included in the SOP. It should also include the specific areas where the material may be used (include room numbers).

Chemical specific handling procedures

Safe handling procedures specific to the chemical(s) you are using will be developed for you by GT EH&S

Contacts

Georgia Tech Police 404-894-2500

Georgia Tech Environmental Health and Safety Office
404-894-4635

Deborah Wolfe-Lopez, Chemical Safety Coordinator
404-385-2964
<mailto:deborah.wolfe-lopez@facilities.gatech.edu>

Ed Pozniak, Hazardous Materials Coordinator
404-894-6224
ed.pozniak@facilities.gatech.edu

Hazardous Waste Pick Up 4-6224 or 4-0499

Criteria Documentation

American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents, ACHIH, Cincinnati, Ohio, 2004

Bingham, E., Cohrssen, B., Powell, C., Patty's Toxicology Fifth Edition, Wiley-Interscience, New York, 2001.

Board of Regents of the University System of Georgia, Design Criteria for Laboratory Furniture and Fume Hoods, 2000

Georgia Department of Natural Resources, Title 45 Chapter 22. Public Employees Hazardous Chemical Protection and Right to Know Act of 1988.

Georgia Institute of Technology Business and Finance Manual Chapter 10.6 Environmental Health and Safety

Georgia Tech Lab Safety Manual www.safety.gatech.edu

Klassen, Curdis D. Casarett&Doull's Toxicology The Basic Science of Poisons, Fifth Edition, McGraw-Hill, New York, 1996

Laurence Livermore National Laboratory ES&H Manual Volume II Part 14.5
www.llnl.gov/es_and_h/hsm/doc_14.05/doc14-05.html

National Research Council, Prudent Practices in the Laboratory, Washington, D.C. 1995.

United States Environmental Protection Agency Title 40, *Code of Federal Regulations, Parts 260-273*, Resource Conservation and Recovery Act

Glossary of Terms

Absorption	A method whereby a substance can pass through intact, unbroken skin.
Amalgam	A mixture or alloy of mercury with other metals.
Central nervous system	Parts of the nervous system, including the brain and spinal cord.
Extremely toxic	Having an LD ₅₀ of <5 mgs/kg of animal body weight. Extremely toxic materials must be kept in a locked cabinet or drawer inside a locked room. They also require the use of sign out sheets to document who has used the material, how much they used and when.
Highly Toxic	Having an LD ₅₀ of 5-50 mgs/kg of animal body weight or an LC ₅₀ of <200 ppm or <2,000 mg/m ³ . Highly toxic materials must be kept in a locked room with restricted access.
LC ₅₀	Lethal concentration- 50 percent. The concentration in air at which 50 percent of the test animals died, usually within 1 hour. This value, when referring testing with rats or mice is the basis for evaluating the level of toxicity for hazardous substances
LD ₅₀	Lethal dose- 50 percent. The dose at which 50 percent of the exposed test animals died, usually within 1-2 hours. This value, when referring to oral dosing of rats or mice is the basis for evaluating the level of toxicity for hazardous substances
Manometer	An instrument used to measure gas and vapor pressure.
Mercury salts	Inorganic mercury compounds.

Metallic mercury	Mercury that is in its elemental state.
Moderately Toxic	Having an LD ₅₀ of 50-500mgs/kg of animal body weight or an LC ₅₀ of 200-2000 ppm or 2,000-20,000 mg/m ³
Organo-mercury compounds	Mercury compounds that include carbon atoms, bonding directly to the mercury.
Reproductive effects	Health effects which impact the ability to reproduce by negatively impacting fertility in the male or the female, or by affecting the female's ability to bring a pregnancy to full term (fetal death, spontaneous abortion)
Slightly Toxic	Having an LD ₅₀ of 500-5,000mgs/kg of animal body weight or an LC ₅₀ of 2,000-20,000 ppm or 20,000-200,000 mg/m ³
STEL- Short Term Exposure Limit	Exposure Limit <i>recommended</i> by the American Conference of Governmental Industrial Hygienists. This is the concentration in air to which a person can be exposed for no more than a 15 minute period up to 4 times in a 8 hour work shift. 15 minute exposure periods must be separated by at least 1 hour.
Terratogen	An agent which causes damage to the fetus, either anatomical or developmental, without affecting the health of the mother
TLV- Threshold Limit Value	Exposure limit <i>recommended</i> by the American Conference of Governmental Industrial Hygienists. This is the concentration in air which a person who is fit enough to come to work each day can be exposed to for 8 hours a day over a working lifetime without adverse health effects