MERCURY SAFETY GUIDELINES

Elemental mercury (or liquid mercury) is an extremely toxic substance used in electricity, lighting (compact or tubular fluorescents), scientific research application and instrumentation. All forms of mercury (inorganic and organic) are toxic. Liquid mercury is 1000× less volatile than water at room temperature but can still generate enough toxic vapors if stirred or placed close to a heat source. Whenever possible, less hazardous materials should be substituted for mercury. This document discusses the properties, health and safety hazards of mercury and how to appropriately protect yourself from potential mercury exposures. Also included are emergency procedures for dealing with accidental mercury contact, including first aid treatment information.

WARNING: Mercury and mercury vapors are highly toxic. The effects of exposure may not be noticed until long after serious damage has been done. All forms of mercury are toxic and mercury poisoning can result from inhalation, ingestion, and injection or absorption through the skin. Chronic exposure may lead to teratogenic and systemic effects.

1. Properties

Names: Elemental mercury, quicksilver, hydrargyrum, liquid mercury, liquid silver

Chemical Formula: Hg

CAS #: 7439-97-6

Physical aspect: Silver-white liquid (heavy liquid); odorless

Common uses: Thermometers, barometers, manometers, sphygmomanometers, float valves, electrical switches, lighting (compact and tubular fluorescent), batteries, scientific research applications and in amalgam material for dental restoration

Physical and toxicological properties of mercury are summarized in **Table 1**.

Table 1. Physical and Toxicological Properties of Mercury

Molar Mass	200.59 $g.mol^{-1}$
Boiling point	356.7°C
Melting point	-38.9°C
Vapor pressure	0.002 mm Hg @ 25°C
Vapor Density	6.93 (air = 1)
Specific Gravity/Density:	13.59 (water = 1)
PEL (TWA)	0.05 mg/m^3 (vapor)
IDHL	10 mg/m^3

2. Hazard Classification

WHMIS (2015):

Corrosive to metals (Category 1)
Acute Inhalation Toxicity - Vapors (Category 2)
Reproductive Toxicity (Category 1B)
Specific target organ toxicity - repeated exposure target Organs - Central nervous system (CNS), kidney (Category 1)

NFPA 704:

Flammability: non-flammable/will not burn
Health hazard: extremely toxic
Instability/Reactivity: stable under normal temperatures and pressures, hazardous polymerization will not occur

3. Health Hazards

Liquid mercury poses a health hazard because it is volatile. Mercury poisoning can result from inhalation, ingestion, and injection or absorption through the skin. As a vapor, it penetrates the central nervous system, where it is ionized and trapped, attributing to its extremely toxic effects. It i not well absorbed by the gastrointestinal tract; therefore, when ingested, it is only mildly toxic. All forms of mercury (inorganic and organic mercury compounds) are highly hazardous if inhaled or if they remain on the skin for more than a short period of time. In addition, it has the ability to penetrate the placental barrier and should be considered teratogenic and reproductive effectors.

Chronic exposure to mercury may cause permanent central nervous system damage, fatigue, weight loss, tremors and personality changes. It may cause liver and kidney damage and reproductive and fetal effects. The effects from exposure to excessive levels of airborne mercury or skin contact with mercury compounds may not be noticeable for months or years. Prolonged or repeated exposure may cause inflammation of the mouth and gums, excessive salivation, and loosening of the teeth.

a) Skin Exposure

Mercury may be absorbed through intact skin in harmful amounts. It may cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material. Mercury causes skin irritation and possible burns. It may cause skin rash (in milder cases), and cold and clammy skin with cyanosis or pale color.

b) Eye exposure

Exposure to mercury or mercury compounds can cause discoloration on the front surface of the lens, which does not interfere with vision. It causes eye irritation and possible burns. The contact with mercury or mercury compounds can cause ulceration of the conjunctiva and cornea.

c) Inhalation

Mercury vapors (*i.e.*, elemental mercury) cannot be seen with the naked eye. They are 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. Mercury vapors can reach very high levels when the liquid is heated. Inhalation of mercury vapors can cause chemical burns to the respiratory tract and metal fume fever, a condition characterized by flu-like symptoms with metallic taste, fever, chills, cough, weakness, chest pain, muscle pain and increased white blood cell count. Exposure to mercury fumes might also cause central nervous system effects including vertigo, anxiety, depression, muscle incoordination, and emotional instability. Please refer to the following link for a video concerning mercury vapors:
Mercury Vapors Experiment

d) Ingestion

Mercury ingestion may cause severe and permanent damage to the digestive tract or even cause perforation of the digestive tract. It may cause effects similar to those for inhalation exposure, including systemic effects. Chronic ingestion may cause accumulation of mercury in body tissues.

4. Safety Precautions for Mercury Use

a) Training

Students and employees who handle mercury must have read the Safety Data Sheet (SDS) and receive training on the hazards of mercury from their respective department. They must know what to do in the event of a spill or an exposure incident. The SDS must always be kept the immediate vicinity of the working area along with the Standard Operating Procedure (SOP) developed by the student/employee's department.

b) Ventilation

All operations involving open sources of liquid mercury or any mercury-containing organic/inorganic compounds must be carried out in a certified chemical fume hood.

c) Eye Protection

Chemical goggles or a face shield MUST be worn when handling liquid mercury. Safety glasses are sufficient when handling solid mercury-containing organic/inorganic compounds or materials.

d) Gloves

Always consult the manufacturer's glove selection guide when selecting gloves for working with mercury. Organo-mercury compounds can easily pass through latex gloves. A researcher at Dartmouth died in June of 1997 from acute mercury poisoning. Her exposure was the result of approximately one-half of a milliliter of dimethyl mercury falling on her latex glove covered hand during an experiment. The reason for her exposure was that dimethyl mercury easily permeates latex gloves. After this mercury

poisoning case was discovered, studies were made to look at glove resistance to organo-mercury compounds. As a result, it is now recommended to wear highly resistant, flexible, plastic-laminate gloves when handling dimethyl mercury and other similarly dangerous substances. For increased protection, such thin gloves can be worn under long-cuffed, heavy-duty outer gloves made of neoprene.

Here are some choices that apply JUST to mercury compounds:

- **Elemental mercury**: Silver Shield®, Responder®, Tychem® BR/LV, Tychem® SL, Tychem TK; double layer, Neoprene/Nitrile disposable gloves can also be used.
- **Mercuric chloride**: Tychem BR/LV, Tychem SL, Tychem TK
- **Methyl mercury**: Nitrile (8 mil) over Silver Shield®

e) Protection Clothing

A lab coat (full sleeves) along full-length pants and close-toed shoes MUST be worn when handling mercury and other mercury-containing compounds.

f) Respiratory Protection

Lab personnel intending to use/wear a respirator mask must be trained and fit-tested by EHS. Only mercury (Hg) vapor cartridges must be used with half-face and full-face respirators. Respirators should be used only under any the following circumstances:

- As a last line of defense (*i.e.*, after engineering and administrative controls have been exhausted);
- When Permissible Exposure Limit (PEL) has exceeded or when there is a possibility that PEL will be exceeded (see **Table 1**);
- Regulations or SOP require the use of a respirator;
- As PPE in the event of a chemical spill, clean-up process.

g) Safe Work Practice

- Always work in a well-ventilated area when handling mercury or mercury-containing materials.
- Absolutely no eating, drinking or chewing gum where mercury is used.
- The area must be equipped with an emergency shower, an eyewash station and a first aid kit.
- A mercury spill kit should be available in areas where mercury is being used.
- Never add water to mercury.
- Whenever possible, less hazardous materials should be substituted for mercury. Mercury thermometers can be replaced with alternatives. Vacuum gauges can be used to replace manometers and oil diffusion pumps can replace mercury diffusion pumps.

5. Storage, Spill and Waste Issues

a) Storage

Keep mercury stored in a tightly closed container at all times in a cool, well-ventilated area. As a part of hazard communication, clearly label mercury storage area as 'Mercury storage area – HIGHLY TOXIC'. Always store in a Nalgene/polypropylene secondary container. Even the secondary containment must be clearly labeled. Do not store above temperatures of 25°C. Store away from acids, oxidizers and metals.

b) Spills

If the spill is small and occurred on a non-porous area such as linoleum or hardwood flooring, it can probably be cleaned by trained lab personnel. If the spill occurred on a porous item that can be thrown away (like a small rug or mat), this item should discarded readily as mercury waste.

Mercury spill-kit must be readily available in the labs that store and/or handle mercury for research purposes. Spill clean up must be performed if and only if the lab personnel are trained and feel comfortable cleaning up Mercury (Hg) spill. Mercury spill-kits are commercially available. They usually include gloves, sponges impregnated with a material to absorb mercury, absorbent powder that reacts with mercury to form a harmless amalgam, and plastic bags for disposal. Some kits may include a small hand held pump. Another alternative is to make your own spill kit. You will need:

- Disposable gloves;
- Disposable shoe covers (double plastic bags will work);
- Index card or rubber squeegee/mop;
- Disposable syringe or a vacuum trap flask fitted with tubing and a Pasteur pipet;
- Inactivating solutions and/or powders.

In the event of a small spill:

A thermometer contains about 1.5 grams of mercury. A spill from a broken thermometer can be cleaned-up by laboratory personnel.

1. Clean-up the spill immediately after it has occurred.
2. Prevent the spread of the spilled mercury. DO NOT allow people to walk through spill area.
3. Wear disposable gloves and shoe covers or place double plastic bags over your shoes during the clean up.
4. Push the mercury droplets together into a bead using an index card or rubber squeegee.
5. Aspirate the beaded mercury into a disposable syringe, or use a disposable Pasteur Pipet attached with tubing to a vacuum flask to aspirate the mercury into the flask. The flask should contain water. Always have a second vacuum flask between the mercury flask and the house vacuum.
6. Chemically inactivate any residual mercury. There are several methods to inactivate the residual mercury:
   - Use a commercial inactivating powder following its directions for use.
   - Sprinkle zinc powder over the spill area, and then moisten the zinc with a 5 to 10% sulfuric acid solution until a paste is formed. Scour the contaminated surface and allow the paste to dry. Sweep up the dried paste.
   - Wash the contaminated area with a detergent solution. Rinse and then swab the area with a calcium polysulfide solution containing two to four tablespoons of calcium polysulfide per gallon of water. Residual mercury can also be removed by wiping with a vinegar-soaked swab followed by peroxide.
7. Place the collected mercury and materials used in the clean up into a clear plastic bag. Double bag and label the waste.
8. Contact EHS (hazardouswaste@concordia.ca) for waste pick-up.

Never use a regular vacuum to clean up mercury or to go over spill areas after they have been cleaned up. Do not use a broom during cleanup.

In the event of a large spill:

1. Help contaminated or injured persons.
2. Evacuate the spill area. Avoid breathing vapors.
3. Keep others from entering contaminated area.
4. Contact Campus Safety and Prevention Services (CSPS) at ext. **3717** providing them the information about the spill.

c) Waste Handling

Never put mercury contaminated material in regular waste. Furthermore, mercury waste should be placed in a chemically compatible container with a sealed lid separated from other chemical waste. Mercury waste is treated differently than other types of hazardous waste. All waste containers must be labeled with a hazardous waste label with the full chemical name written out.

6. Fire, Incompatibilities and Explosion Hazard

Liquid mercury is non-flammable; use most appropriate agent to extinguish surrounding fire (water spray, dry chemical, carbon dioxide or appropriate foam). At high temperatures, mercury oxide is formed and reaches a maximum effect around 350°C. Decomposition occurs around 400°C. Ground mixtures of sodium carbide and mercury, aluminum, lead, or iron can react vigorously.

Mercury is incompatible or reacts violently with: acetylinic compounds, ammonia, boron diiodophosphide, ethylene oxide, metals (*e.g.*, aluminum, potassium, lithium, sodium, rubidium, calcium), metal oxides, methyl azide, methylsilane, oxidants (*e.g.*, bromine, peroxyformic acid, chlorine dioxide, nitric acid, tetracarbonynickel, nitromethane, silver perchlorate, chlorates, sulfuric acid, nitrates), oxygen, tetracarbonylnickel.

Corrosive Effects: The high mobility and tendency to dispersion exhibited by mercury, and the ease with which it forms alloys (amalga) with many laboratory and electrical contact metals, can cause severe corrosion problems in laboratories. Mercury can attack copper and copper alloy materials.

7. Emergency Procedures

a) Skin Contact

1. Remove contaminated clothing, jewelry, and shoes immediately.
2. Wash affected area with soap or mild detergent and large amounts of water until no evidence of chemical remains (15-20min).
3. Contact CSPS ext. **3717** to get medical attention.
4. Wash clothing before reuse.
5. Contaminated shoes should be destroyed.

b) Eye Contact

1. Immediately rinse eyeball and inner surface of eyelid with water for 15 minutes by forcibly holding the eye open.
2. Contact CSPS ext. **3717** to get medical attention.

c) Inhalation

1. Remove from exposure and move to fresh air immediately.
2. Contact CSPS ext. **3717** to get medical attention.
3. If breathing is difficult, give oxygen.
4. Do NOT use mouth-to-mouth resuscitation.
5. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.

d) Ingestion

1. Do not induce vomiting.
2. If victim is conscious and alert, give 2-4 cups of milk or water. Wash mouth out with water.
3. Never give anything by mouth to an unconscious person.
4. Contact CSPS ext. **3717** to get medical attention.

8. Compact Fluorescent Light Bulbs

Compact fluorescents, like their tubular fluorescent precursors, contain a small amount of mercury—typically around five milligrams. Mercury is essential to a fluorescent bulb's ability to emit light; no other element has proved as efficient. The problem comes when a bulb breaks. Mercury escapes as vapor that can be inhaled and as a fine powder that can settle into carpet and other textiles.

L'Institut National de Santé Publique du Québec published risk exposures on mercury when breakage of such fluorescent compact light occurs. The studies revealed that about 1mg of mercury could escape over a period of a few days. If the release happens in a small non-ventilated room, mercury concentrations in air could get over 0.2 $\mu g/m^3$. However, considering that the breakage of a compact fluorescent light bulb happens rarely and that the direct exposition period might be very short, the health risks associated are very low. However, if a compact fluorescent light bulb breaks, the following safety precautions should be followed:

1. The important thing is not to touch the heavy metal.
2. After airing out the room, the larger pieces of the bulb should be scooped off hard surfaces with stiff paper or cardboard or picked up off carpeted surfaces with gloves to avoid contact.
3. Use sticky tape or duct tape to pick up smaller fragments; then, on hard surfaces, wipe down the area with a damp paper towel or a wet wipe.
4. All materials should be placed in a sealable plastic bag or, even better, in a glass jar with a metal lid.

In all cases of exposures, a copy of the SDS must be brought to the emergency room, as the treating physician might be unaware of the treatment measures for mercury. All mercury incidents must be

reported to your Supervisor and to Environmental Health & Safety. **An injury/near-miss report must be filled for any incident involving mercury spill or exposure.**

If you have any concerns about the use of mercury at Concordia University, or if you want to exchange mercury thermometer(s) with eco-friendly alternatives, please contact Environmental Health & Safety at **ehs@concordia.ca**

Prepared: April 2013

Revision dates: August 2016, July 2024.

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