

Workplace Health and Safety Bulletin



Mercury at the Work Site

What is Mercury?

Mercury, also known as quicksilver, is a silvery-white metal that is a liquid at room temperature. It is found in the earth mainly in sulphide ores (cinnabar), from which it has been extracted for a variety of uses for centuries. Mercury is very dense; it is in fact heavier than lead. It also has a very low vapour pressure at room temperature, so the liquid easily transforms to vapour. When mercury is heated it forms an odourless, colourless gas.

Properties of Mercury

Mercury, when combined with other elements such as chlorine, sulphur or oxygen, form inorganic mercury compounds or “salts”. Mercury also combines with carbon to make organic mercury compounds. Mercury is very toxic, particularly in the chloride and methyl forms.

Mercury is considered to be a very stable element that does not burn or explode. However, when it is combined with ammonia, acetylene, oxalic acid or amines, compounds may be formed that can be explosive when agitated.

When spilled, mercury breaks up into tiny beads, which can lodge in cracks, sink traps and porous materials and can mix with dust. As a result, its surface area increases and its rate of vapourization also increases.

Uses of Mercury

Metallic mercury and mercury compounds have many uses:

Metallic mercury

- Mercury is used in thermometers, switches, pressure gauges (manometers), flowmeters, medical devices, electrodes, and electrical control equipment.
- Metallic mercury is also used for dental fillings, called amalgams, as it easily forms alloys with metals such as gold, silver and tin.
- Metallic mercury can be used to produce chlorine and to extract gold from ore.
- It is used in the manufacture of fluorescent light bulbs and mercury vapour lamps.

Mercury salts

- Mercury chloride is used as a fungicide.
- Mercurous chloride (calomel) is used as a fungicide and an insecticide.
- Mercury fulminate is a detonator widely used in explosives.
- Mercuric sulphide (vermillion) is a high-grade paint pigment, which has also been used as a pigment in cosmetics.
- Inorganic mercury was historically used in latex paints to prevent bacterial and fungal growth and therefore old cans of latex paint may contain mercury.

Organic mercury compounds

- Microorganisms convert metallic mercury into organic forms, which are more environmentally hazardous.
- Organic mercury compounds are used in a variety of commercial products (preservative in paints, waxes and pastes, catalysts, insecticides, antiseptics, mould retarders in latex paints, fungus-proofing of cloth, paper, cork, rubber and wood).

Health effects

Workers can be exposed to mercury by inhaling the vapour (pure mercury or mercury compounds), by absorption through the skin, hair follicles and sweat glands, or by ingestion.

Mercury tends to accumulate in several organs in the body, mainly the kidneys, brain and liver. It is cleared very slowly from the body. Its half-life in the body is, on average, 40-60 days, although the time depends on where the mercury is deposited.

Acute health effects

Short-term (acute) exposure effects to mercury depends on the form of mercury that the worker is exposed to.

Harmful effects from short-term (acute) exposure to elemental mercury are rarely seen due to controls used in workplaces where mercury exposure may occur. Historically, short-term exposure to high concentrations of mercury vapour caused harmful effects on the nervous, digestive and respiratory systems, as well as the kidneys. In most cases, exposure occurred when mercury was heated.

Initial exposure to high concentrations of mercury vapour cause symptoms similar to “metal fume fever” (fatigue, fever, and chills). Respiratory system effects include cough, shortness of breath, tightness and burning pains in the chest and inflammation of the lungs. In some cases, a potentially life-threatening accumulation of fluid in the lungs (pulmonary edema) has occurred. Classic signs of exposure to high concentrations of mercury are the inflammation of the inside of the mouth (stomatitis), sometimes with a metallic taste, excessive production of saliva and difficulty swallowing. Other digestive system effects include abdominal pains, nausea, vomiting and diarrhea.

Kidney injury is also common following exposure to high concentrations of mercury. Reported effects range from increased protein in the urine to kidney failure. Exposure to high concentrations of mercury has also caused increased blood pressure and heart rate.

The main effect from exposure to organic forms of mercury is damage to the nervous system. Health effects may include shaking, trembling and problems with balance. Mercury can also cause numbness in the feet and hands and numbness in the tongue and around the lips. In severe cases, mercury can affect vision and hearing and cause brain damage to occur.

Mercury and mercury compounds are also irritants and can cause severe dermatitis (inflammation of the skin). Skin sensitization has also been reported with exposure to organic mercury compounds.

Chronic health effects

The harmful effects of long-term (chronic) exposure to elemental mercury are usually caused by inhalation exposure. However, liquid mercury and vapour are also absorbed through the skin in small amounts and this route of exposure can contribute to the overall exposure.

Effects of the nervous system

Effects on muscle coordination, mood, behaviour, memory, feeling and nerve conduction have been reported following long-term occupational exposure to mercury. Nervous system effects include damage to the nerves of the arms and legs (polyneuropathy), reduced sensation and strength in the arms and legs, muscle cramps and decreased nerve conduction. A classic sign of mercury toxicity is a fine tremor, usually of the fingers, hands or arms and occasionally the eyelids, lips, tongue, and whole body. Many occupational studies indicate that tremors become more pronounced with longer exposures to mercury. Effects to the nervous system are sometimes referred to as “Mad Hatters Disease” since mercurous nitrate was historically used to make felt hats. These effects are often observed in workers who have had a fairly high exposure to mercury.

Behaviour and personality changes such as irritability, excitation and shyness, psychotic reactions such as delirium and hallucinations, loss of appetite, tiredness, sleeplessness, short-term memory loss and impaired nerve conduction have also been reported following long-term exposure.

Effects on the kidney

Many occupational studies indicate that moderate to high, long-term exposure to mercury, can cause damage to the kidneys. Early indicators of kidney injury include increased levels of protein in the urine (proteinuria) and increased levels of certain enzymes in the blood and urine.

Skin sensitization

Allergic skin sensitization has been reported in people with occupational exposure to liquid mercury or vapour. Once a person is sensitized to a chemical, contact with even a small amount causes outbreaks of dermatitis with symptoms such as skin redness, itching, rash and swelling. This can spread from the hands or arms to other parts of the body. Occupational skin sensitization to mercury has been observed in people exposed to mercury from dental amalgams, tattoos or breakage of medical instruments.

Effects on the heart

Mercury may affect the heart producing increased blood pressure and/or heart rate.

Effects on the eye

Long-term occupational exposure to mercury has caused a grayish-brown or yellow discoloration in the eyes of some people. This haze is not thought to affect vision. A gray band through the cornea (band keratopathy) has also been reported in a few people.

Mercury exposure and pregnancy

Mercury can be toxic to the fetus, particularly in the organic forms, since these forms can easily pass through the placenta. The unborn baby is very sensitive to mercury. Women who work with mercury and are breast-feeding can pass mercury to the baby through breast milk.

Cancer

The International Agency for Research on Cancer (IARC) has concluded that methyl mercury compounds are possibly carcinogenic to humans. Methyl mercury is classified as Group 2B. Metallic mercury and inorganic mercury compounds are in Group 3, which means that they are not classified in terms of their carcinogenicity to humans, due to a lack of scientific evidence.

Health assessment

There is no legislated requirement for workers exposed to mercury to have a medical assessment. However, where there is doubt whether a worker should risk exposure to mercury, an occupational physician should be consulted.

The American Conference of Governmental Industrial Hygienists (ACGIH) has published Biological Exposure Indices (BEI®) for mercury in both blood and urine. BEIs® adopted by the ACGIH represent levels of a substance likely to be found in samples taken from healthy workers who have been exposed to a chemical to the same extent as workers exposed at the Occupational Exposure Limit (OEL) in Alberta's health and safety legislation. Note that the use of biological indices which measure exposure after the fact is not a substitute for workplace air monitoring.

The BEIs® for mercury are:

- Total inorganic mercury in urine (pre-shift): (35 µg/g creatinine)
- Total inorganic mercury in blood (end of shift or workweek): (15 µg/L)

Preventative measures

Preventing exposure to mercury is the best way to protect health. Options that should be considered include the following (listed in order of preference):

- Substitution of mercury and mercury compounds with other less hazardous materials
- Use of engineering controls (such as enclosures, ventilation)

- Administrative controls (changes in work practices to reduce exposure, use of less hazardous chemical substitutes)
- Use of personal protective equipment

Substitution

One option to control exposure to mercury is to use other materials when practicable. Table 1 provides some examples of alternatives that can be used.

Table 1: Mercury Alternatives

Item	Alternative
Mercury gauges	Electronic or aneroid gauges
Manometers, pressure measuring devices	Aneroid and electronic manometers, analog (or vacuum) gauges
Switches and relays	Mercury-free switches, relays and gas equipment with electronic ignition, mechanical switches
Thermometers	Alcohol and mineral spirits, digital
Thermostat probes	Electric flame sensors, electronic ignition
Thermostats	Air controlled, reed switch, vapour filled diaphragm, snap-switch and programmable electronic
Batteries	Alkaline batteries, electrical devices
Solvents and solutions	Use mercury-free alternatives (e.g. zinc formalin solution instead of mercury chloride solution)
Dental amalgam	composites, glass ionomers, gold foil, gold alloy, metal-ceramic crowns, and gallium alloys
Paint (e.g. cadmium vermillion red paint, true vermillion paint) and glazes	Mercury-free paints
Dyes	Vegetable dyes
Moth repellants	Cedar chips, eucalyptus oil
Topical disinfectants containing mercurochrome or tincture of meriolate	Alcohol or hydrogen peroxide
Contact lens solution containing thimerosal, phenylmercuric acetate or phenylmercuric nitrate	Mercury-free solutions

Engineering controls

Engineering controls are used to eliminate exposure to a substance. Engineering controls remove the substance from the air or provide a barrier between the worker and the substance. Examples of engineering controls that can be used to prevent exposure to mercury include:

- Enclosures to isolate processes that use mercury.
- Local exhaust ventilation to capture mercury vapours at the source. Where ventilation systems are used, they must be properly designed and not vent back into the work area. Environmental standards may also restrict the amount of mercury that can be discharged to the outside air.
- Good workstation design to prevent spills and leaks from spreading. Where mercury is used, concrete floors sealed with epoxy and working surfaces with few crevices are preferred. Use of carpeting should be avoided.

Administrative controls

Work practices that can be used in the workplace to reduce exposure to mercury include:

- Educating workers about the hazards of mercury.
- Having a spill kit readily available and ensuring that workers have been trained in the use of the spill kits.
- Using good hygiene practices. Workers must not eat, drink or use tobacco products in areas where mercury or products containing mercury are used or stored. The hands and face should be washed before eating, drinking or smoking.
- Storing mercury properly. Keep product containers tightly sealed when they are not in use.
- Ensuring that unprotected workers are not in areas where products containing mercury are used.

Personal protective equipment (PPE)

If it is not practicable or feasible to use substitutes, engineering controls or administrative controls to reduce the potential for exposure, or they are not sufficient, the employer must provide workers with appropriate personal protective equipment.

Respiratory protective equipment

Respiratory protective equipment is needed to protect workers from inhaling airborne vapours. It is important to select the correct level of respiratory protection based on the type of work being done and the airborne concentrations of mercury at the work site. For metallic mercury and inorganic mercury compounds, NIOSH recommends the use of air purifying respirators with the appropriate protection factors. For organic mercury compounds, supplied air respirators should be used.

For more information



www.employment.alberta.ca/documents/WHS/WHS-PUB_ppe004.pdf

Guideline for the Development of a Code of Practice for Respiratory Protective Equipment – PPE004



www.employment.alberta.ca/documents/WHS/WHS-PUB_ppe001.pdf

Respiratory Protective Equipment: An Employer's Guide – PPE001



www.employment.alberta.ca/documents/WHS/WHS-PUB_mg005.pdf

Medical Assessment of Fitness to Wear a Respirator – MG005

Employers should also refer to the CSA Standard Z94.4-02, *Selection, Use and Care of Respirators*.

Other Body Protection

Since mercury and mercury vapours can be absorbed through the skin, solvent resistant gloves and other protective clothing are needed for workers who handle mercury.

Mercury Spills

Spills of metallic mercury can pose a serious problem if they are not addressed properly. If a mercury spill occurs at the work site, the employer should conduct a hazard assessment to determine the appropriate course of action to take. A hazard assessment should address the following questions:

- *What areas of the worksite were contaminated by the mercury spill?*

Mercury is dense and large drops shatter into many small droplets that can travel quickly over long distances. Mercury also amalgamates with other metals and therefore metal objects that mercury is spilled on are weaker and may not be suitable for further use. They often cannot be decontaminated and must be disposed of as mercury waste.

- *How much mercury was spilled?*

If the amount of mercury spilled was less than or equal to what is contained in a thermometer, the spill can generally be cleaned easily (see Appendix A). Large spills, involving more than the amount found in a household thermometer, should be reported to the local environmental authorities.

- *What type of surface did the spill occur on?*

Droplets and vapours tend to accumulate in crevices and very small spaces. Surfaces such as wood, linoleum or tile are easier to clean than porous materials such as carpeting or wood, which can become contaminated and may have to be disposed of as mercury waste.

- *Have any workers been contaminated with mercury?*

Workers contaminated with mercury should wash the affected area immediately using either an eyewash station or safety shower, as appropriate. If mercury is visible on any article of clothing or shoes, they should be removed and placed in a sealed container. Avoid walking on or touching any surface contaminated with mercury.

Workplace air monitoring

When mercury or a product containing mercury is used in the workplace, air monitoring should be done periodically to ensure that the Occupational Exposure Limit (OEL) is not exceeded. Air samples must be collected and analyzed using a method specified in Section 20 of the Occupational Health and Safety Code.

The US Occupational Safety and Health Administration (OSHA) also has some methods available for mercury monitoring, including one that uses passive badges and one that can be used for wipe and bulk sampling. These methods are available online at:

 www.osha.gov/dts/sltc/methods/toc.html

Portable instruments can be used to monitor for airborne mercury vapour and are useful as screening tools. Portable instruments are often used for screening when dealing with mercury spills. In Alberta, there is no action level for mercury in air when dealing with spills, however the US Environmental Protection Agency (EPA) recommends the use of 0.01 mg/m^3 for prescreening. It should be noted that EPA also recommends the use of NIOSH method 6009 to confirm instrument readings. This method can be found online at:

 www.cdc.gov/niosh/nmam/pdfs/2009

There are three main types of portable instruments; gold film sensor, portable atomic absorption spectrometers and cold vapour atomic analyzers. Gold film instruments use a gold film technology on a wheatstone bridge as a sensor. When mercury is present, it absorbs onto the gold film sensor, which undergoes a change in electrical resistance proportional to the mass of mercury absorbed onto its surface. Gold film mercury vapour analyzers are cross sensitive to carbon monoxide and sulphur compounds. Sulphur is a particularly common interference compound because, during the cleanup of mercury and its vapour, a sulphur-based compound often is used to convert elemental mercury into a mercuric salt. These instruments should not be used in areas where there are combustion sources present because of the generation of carbon monoxide. Smoking in the vicinity of the instrument should also be avoided.

Portable atomic absorption spectrometers and cold vapour instruments tend to be more sensitive. Other chemicals do not appear to interfere with the readings, however high humidity can cause false positive readings on spectrometers. These types of instruments tend to be more expensive than the gold film type.

Regulatory requirements

The Alberta occupational health and safety legislation has occupational exposure limits for occupational exposure limits for the organic, inorganic and elemental forms of mercury. These limits apply to workers directly involved with tasks using mercury or products containing mercury, and also to other workers in the workplace who may be exposed to mercury indirectly from these operations. It is important to note that OELs represent standards for the protection of most healthy workers. Steps must be taken to keep mercury levels as low as reasonably practicable.

The employer must also:

- train workers on the health hazards and the safe work procedures developed by the employer,
- comply with the requirements for handling and storage of materials,
- ensure the need for ventilation is properly assessed and systems that are installed are properly designed and maintained. Workers also need to be trained on the proper operation and maintenance of these systems.
- provide appropriate personal protective equipment (including respirators). Workers must use the required personal protective equipment and must be trained on its proper use and care.

Appendix A

Safe work procedures for spills less than or equal to the amount of a thermometer:

- Remove workers from the area and block off access.
- Avoid walking on or touching any surface contaminated with mercury. Personnel contaminated with mercury should wash the affected area immediately using either an eyewash station or safety shower, as appropriate.
- Don personal protective equipment such as rubber gloves and disposable boot covers to keep mercury droplets off personal clothing and skin.
- If mercury is visible on any article of clothing or shoes, they should be removed and placed in a sealed container.
- If possible, use a mercury spill kit (commercially available) for spills of this size.
- Contain the spill. Dike the mercury using rags or other disposable items to prevent the spreading.
- Work from the outside of the spill area to the center of the spill. Push the mercury beads together with a card, stiff paper or squeegee to form larger droplets.
- Push the mercury beads into a plastic dustpan or use an eyedropper or turkey baster to pick up the beads.
- Use a flashlight to look for mercury, as the light will reflect off the shiny silver mercury beads.
- Place mercury into a leak-tight plastic bag or wide-mouthed sturdy plastic container with a screw on lid and then place in a second sealed plastic bag.
- Use sticky side of duct tape to pick up any mercury beads that you couldn't pick up with the cardboard.
- Place contaminated protective equipment and items in a bag and seal with tape.
- Contact your municipal waste department for further disposal instructions.

It is important to remember the following when dealing with a mercury spill:

- Never use a vacuum cleaner to clean up mercury. The vacuum cleaner will put mercury into the air and contaminate it.
- Never use a broom to sweep up spilled mercury. It will break the droplets up into smaller droplets and spread them.
- Never pour mercury down a drain.
- Never wash mercury-contaminated items in a washing machine. Mercury may contaminate the machine.
- Never walk around if your footwear has become contaminated with mercury. Contaminated clothing can also spread mercury around.

Both Environment Canada and the US EPA provide good guidance on the steps to follow when dealing with a spill of mercury. This information is available online:



www.ec.gc.ca/mercury/en/cu.cfm

Mercury and the Environment - Environment Canada





www.epa.gov/mercury

US Environmental Protection Agency Mercury Website

Contact us:

Province-Wide Contact Centre

 Edmonton & surrounding area:
780-415-8690

 Throughout Alberta:
1-866-415-8690



Deaf or hearing impaired

- In Edmonton: **780-427-9999**

or

- **1-800-232-7215** throughout Alberta

Web Site



www.worksafe.alberta.ca

Getting copies of OHS Act, Regulation & Code:

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www.qp.gov.ab.ca



Edmonton 780-427-4952

Workplace Health and Safety



<http://employment.alberta.ca/whs-ohs>

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