![[logo] US EPA]() **U.S. Environmental Protection Agency**

<http://www.epa.gov/mercury/about.htm>

**MERCURY**

**Basic Information**

**In a nutshell: What’s mercury and why is it a concern?**

* Mercury is a naturally occurring element (Hg on the periodic table) that is found in air, water and soil. It exists in several forms: elemental or metallic mercury, inorganic mercury compounds, and organic mercury compounds. Elemental or metallic mercury is a shiny, silver-white metal and is liquid at room temperature. If heated, it is a colorless, odorless gas.
* Exposures to mercury can affect the human nervous system and harm the brain, heart, kidneys, lungs, and immune system.
* The most common way we are exposed to mercury is by eating fish or shellfish that are contaminated with mercury.

**Forms of mercury.** Mercury is a naturally occurring element that is found in air, water and soil. It exists in several forms: elemental or metallic mercury, inorganic mercury compounds, and organic mercury compounds.

**Sources of mercury.** Mercury is an element in the earth's crust. Humans cannot create or destroy mercury. Pure mercury is a liquid metal, sometimes referred to as quicksilver that volatizes readily. It has traditionally been used to make products like thermometers, switches, and some light bulbs.

Mercury is found in many rocks including coal. When coal is burned, mercury is released into the environment. Coal-burning power plants are the largest human-caused source of mercury emissions to the air in the United States, accounting for over 50 percent of all domestic human-caused mercury emissions (Source: [2005 National Emissions Inventory](http://www.epa.gov/ttn/chief/net/2005inventory.html)). EPA has estimated that about one quarter of U.S. emissions from coal-burning power plants are deposited within the contiguous U.S. and the remainder enters the global cycle. Burning hazardous wastes, producing chlorine, breaking mercury products, and spilling mercury, as well as the improper treatment and disposal of products or wastes containing mercury, can also release it into the environment. Current estimates are that less than half of all mercury deposition within the U.S. comes from U.S. sources.

**Sources of mercury compounds.** In the U.S., mercury compounds are manufactured in small amounts for specialty uses, such as chemical and pharmaceutical applications. Larger quantities of these compounds are generated as byproducts from pollution control activities at gold mines or in waste. Elemental mercury is processed in the U.S. from byproduct mercury compounds, and an unknown quantity of mercury compounds is imported into the United States for conversion to elemental mercury.

**Exposure to mercury.** Mercury in the air eventually settles into water or onto land where it can be washed into water. Once deposited, certain microorganisms can change it into methylmercury, a highly toxic form that builds up in fish, shellfish and animals that eat fish. Fish and shellfish are the main sources of methylmercury exposure to humans. Methylmercury builds up more in some types of fish and shellfish than others. The levels of methylmercury in fish and shellfish depend on what they eat, how long they live and how high they are in the food chain.

EPA works with the U.S. Food and Drug Administration (FDA) and with states and tribes to issue advice to women who may become pregnant, pregnant women, nursing mothers and parents of young children about how often they should eat certain types of commercially-caught fish and shellfish. Fish advisories are also issued for men, women, and children of all ages when appropriate. In addition, EPA releases an annual summary of information on locally-issued fish advisories and safe-eating guidelines to the public. Fish is a beneficial part of the diet, so EPA & FDA encourage people to continue to eat fish that are low in methylmercury.

Another less common exposure to mercury that can be a concern is breathing mercury vapor. These exposures can occur when elemental mercury or products that contain elemental mercury break and release mercury to the air, particularly in warm or poorly-ventilated indoor spaces.

**Health effects of mercury.** Mercury exposure at high levels can harm the brain, heart, kidneys, lungs, and immune system of people of all ages. Research shows that most people's fish consumption does not cause a health concern. However, it has been demonstrated that high levels of methylmercury in the bloodstream of unborn babies and young children may harm the developing nervous system, making the child less able to think and learn.

**Ecological effects of mercury**. Birds and mammals that eat fish are more exposed to mercury than other animals in water ecosystems. Similarly, predators that eat fish-eating animals may be highly exposed. At high levels of exposure, methylmercury's harmful effects on these animals include death, reduced reproduction, slower growth and development, and abnormal behavior.

**Reducing mercury releases.** EPA issues regulations that require industry to reduce mercury releases to air and water and to properly treat and dispose of mercury wastes. In 2010, EPA is working to develop emissions standards for power plants under [Clean Air Act section 112](http://www.epa.gov/lawsregs/laws/caa.html), consistent with the [D.C. Circuit’s February 2008 opinion (PDF)](http://pacer.cadc.uscourts.gov/docs/common/opinions/200802/05-1097a.pdf) (18pp, 51k, [about PDF](http://www.epa.gov/epahome/pdf.html)) regarding the Clean Air Mercury Rule (CAMR). On October 6, 2009, EPA published a [final rule that limits emissions, including emissions of mercury, from medical waste incinerators](http://www.regulations.gov/search/Regs/home.html#documentDetail?R=0900006480a3ceb7).

EPA works with partners in state, local and tribal governments to implement a variety of programs designed to reduce mercury pollution and impacts. Most of EPA's environmental regulations and programs are implemented by the states. In addition, under U.S. environmental laws, the states are often permitted to adopt local environmental laws and regulations that are more stringent than federal requirements. As of 2005, twenty- two states were implementing or developing overall [state-based mercury action plans](http://www.ecos.org/section/committees/cross_media/quick_silver/2005_mercury_compendium1/). Many of the state plans include pollution reduction elements that exceed federal requirements. In particular, the states in the Great Lakes basin and northeast region have led efforts to identify and pursue ways to reduce and prevent mercury releases to the environment, both as individual states and in multi-state collaborations.

EPA also works with industry to promote voluntary reductions in mercury use and releases. In December 2008, EPA, the ADA and the NACWA signed a Memorandum of Understanding (PDF)to establish a Voluntary Dental Amalgam Discharge Reduction Program. The goal of the program is for dentists to follow the [ADA’s best management practices (BMPs) for amalgam waste](http://www.ada.org/1540.aspx?currentTab=2).

EPA works with international organizations to prevent the release of mercury in other countries. EPA has provided expertise to the United Nations Industrial Development Organization (UNIDO)'s Global Mercury Project's small-scale gold (artisanal) mining project, which focuses on best management practices to reduce occupational exposures, emissions and mercury use.

The public can contribute to mercury reduction efforts by [correctly disposing of products that contain mercury](http://www.epa.gov/mercury/spills/index.htm#storing).

World Health Organization <http://www.who.int/mediacentre/factsheets/fs361/en/>

**Mercury and health**

Key facts

* Mercury is a naturally occurring element that is found in air, water and soil.
* Exposure to mercury – even small amounts – may cause serious health problems, and is a threat to the development of the child *in utero* and early in life.
* Mercury may have toxic effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes.
* Mercury is considered by WHO as one of the top ten chemicals or groups of chemicals of major public health concern.
* People are mainly exposed to methylmercury, an organic compound, when they eat fish and shellfish that contain the compound.

Mercury exists in various forms: elemental (or metallic) and inorganic (to which people may be exposed through their occupation); and organic (e.g., methylmercury, to which people may be exposed through their diet). These forms of mercury differ in their degree of toxicity and in their effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes.

Mercury occurs naturally in the earth's crust. It is released into the environment from volcanic activity, weathering of rocks and as a result of human activity. Human activity is the main cause of mercury releases, particularly coal-fired power stations, residential coal burning for heating and cooking, industrial processes, waste incinerators and as a result of mining for mercury, gold and other metals.

Once in the environment, mercury can be transformed by bacteria into methylmercury. Methylmercury then bioaccumulates (bioaccumulation occurs when an organism contains higher concentrations of the substance than do the surroundings) in fish and shellfish. Methylmercury also biomagnifies. For example, large predatory fish are more likely to have high levels of mercury as a result of eating many smaller fish that have acquired mercury through ingestion of plankton.

People may be exposed to mercury in any of its forms under different circumstances. However, exposure mainly occurs through consumption of fish and shellfish contaminated with methylmercury and through worker inhalation of elemental mercury vapours during industrial processes. Cooking does not eliminate mercury.

**Exposure to mercury**

All humans are exposed to some level of mercury. Most people are exposed to low levels of mercury, often through chronic exposure (continuous or intermittent long term contact). However, some people are exposed to high levels of mercury, including acute exposure (exposure occurring over a short period of time, often less than a day). An example of acute exposure would be mercury exposure due to an industrial accident.

Factors that determine whether health effects occur and their severity include:

* the type of mercury concerned;
* the dose;
* the age or developmental stage of the person exposed (the fetus is most susceptible);
* the duration of exposure;
* the route of exposure (inhalation, ingestion or dermal contact).

Generally, two groups are more sensitive to the effects of mercury. Fetuses are most susceptible to developmental effects due to mercury. Methylmercury exposure in the womb can result from a mother's consumption of fish and shellfish. It can adversely affect a baby's growing brain and nervous system. The primary health effect of methylmercury is impaired neurological development. Therefore, cognitive thinking, memory, attention, language, and fine motor and visual spatial skills may be affected in children who were exposed to methylmercury as fetuses.

The second group is people who are regularly exposed (chronic exposure) to high levels of mercury (such as populations that rely on subsistence fishing or people who are occupationally exposed). Among selected subsistence fishing populations, between 1.5/1000 and 17/1000 children showed cognitive impairment (mild mental retardation) caused by the consumption of fish containing mercury. These included populations in Brazil, Canada, China, Columbia and Greenland.

A significant example of mercury exposure affecting public health occurred in Minamata, Japan, between 1932 and 1968, where a factory producing acetic acid discharged waste liquid into Minamata Bay. The discharge included high concentrations of methylmercury. The bay was rich in fish and shellfish, providing the main livelihood for local residents and fishermen from other areas.

For many years, no one realized that the fish were contaminated with mercury, and that it was causing a strange disease in the local community and in other districts. At least 50 000 people were affected to some extent and more than 2000 cases of Minamata disease were certified. Minamata disease peaked in the 1950s, with severe cases suffering brain damage, paralysis, incoherent speech and delirium.

**Health effects of mercury exposure**

Elemental and methylmercury are toxic to the central and peripheral nervous systems. The inhalation of mercury vapor can produce harmful effects on the nervous, digestive and immune systems, lungs and kidneys, and may be fatal. The inorganic salts of mercury are corrosive to the skin, eyes and gastrointestinal tract, and may induce kidney toxicity if ingested.

Neurological and behavioral disorders may be observed after inhalation, ingestion or dermal exposure of different mercury compounds. Symptoms include tremors, insomnia, memory loss, neuromuscular effects, headaches and cognitive and motor dysfunction. Mild, subclinical signs of central nervous system toxicity can be seen in workers exposed to an elemental mercury level in the air of 20 μg/m3 or more for several years. Kidney effects have been reported, ranging from increased protein in the urine to kidney failure.

**How to reduce human exposure from mercury sources**

There are several ways to prevent adverse health effects, including promoting clean energy, stopping the use of mercury in gold mining, eliminating the mining of mercury and phasing out non-essential mercury-containing products.

Promote the use of clean energy sources that do not burn coal.

Burning coal for power and heat a major source of mercury. Coal contains mercury and other hazardous air pollutants that are emitted when the coal is burned in coal-fired power plants, industrial boilers and household stoves.

Eliminate mercury mining, and use of mercury in gold extraction and other industrial processes.

Mercury is an element that cannot be destroyed; therefore, mercury already in use can be recycled for other essential uses, with no further need for mercury mining. Mercury use in artisanal and small-scale gold mining is particularly hazardous, and health effects on vulnerable populations are significant. Non-mercury (non-cyanide) gold-extraction techniques need to be promoted and implemented, and where mercury is still used safer work practices need to be employed to prevent exposure.

Phase out use of non-essential mercury-containing products and implement safe handling, use and disposal of remaining mercury-containing products.

Mercury is contained in many products, including:

* batteries
* measuring devices, such as thermometers and barometers
* electric switches and relays in equipment
* lamps (including some types of light bulbs)
* dental amalgam (for dental fillings)
* skin-lightening products and other cosmetics
* pharmaceuticals.

A range of actions are being taken to reduce mercury levels in products, or to phase out mercury-containing products. In health care, dental amalgam is used in almost all countries. A 2009 WHO expert consultation concluded that a global near-term ban on amalgam would be problematic for public health and the dental health sector, but a phase down should be pursued by promoting disease prevention and alternatives to amalgam; research and development of cost-effective alternatives; education of dental professionals and the raising of public awareness.

Mercury use in some pharmaceuticals, such as thiomersal (ethyl mercury), which is used as a preservative in some vaccines, is very small by comparison with other mercury sources. There is no evidence that suggests a possible health hazard resulting from the amounts of thiomersal currently used in human vaccines.

Inorganic mercury is added to some skin-lightening products in significant amounts. Many countries have banned mercury-containing skin-lightening products because they are hazardous to human health.

**Political agreement**

The continued release of mercury into the environment from human activity, the presence of mercury in the food chain, and the demonstrated adverse effects on humans are of such concern that in 2013 governments agreed to the Minamata Convention on Mercury. The Convention obliges government Parties to take a range of actions, including to address mercury emissions to air and to phase-out certain mercury-containing products.

**WHO response**

The World Health Organization publishes evidence about the health impacts of the different forms of mercury, guidance on identifying populations at risk from mercury exposure, tools to reduce mercury exposure, and guidance on the replacement of mercury-containing thermometers and blood pressure measuring devices in health care. WHO leads projects to promote the sound management and disposal of health-care waste and has facilitated the development of an affordable, validated, non-mercury-containing blood pressure measuring device.

**The Mercury Cycle**



Image: <http://www.mercury.utah.gov/atmospheric_transport.htm>

Mercury in the environment is constantly cycled & recycled through a biogeochemical cycle. The cycle has 6 major steps:

1. Degassing of mercury from rock, soils, & surface waters, or emissions from volcanoes and from human activities.
2. Movement in gaseous form through the atmosphere.
3. Deposition of mercury on land and surface waters.
4. Conversion of the element into insoluble mercury sulfide.
5. Precipitation or bioconversion into more volatile or soluble forms such as methylmercury.
6. Reentry into the atmosphere or bioaccumulation in food chains.

Mercury cycles in the environment as a result of natural (ex: geothermal activity) and anthropogenic (human) activities. The primary anthropogenic sources are: fossil fuel combustion and smelting activities. Both these natural and human activities release elemental mercury vapor (Hg0) into the atmosphere. Once in the atmosphere, the mercury vapor can circulate for up to a year, and hence become widely dispersed. The elemental mercury vapor can then undergo a photochemical oxidation to become inorganic mercury that can combine with water vapors and travel back to the Earth’s surface as rain. This ‘mercury-water’ is deposited in soils and bodies of water. Once in soil, the mercury accumulates until a physical event causes it to be released again. (See forest fire research below) In water, inorganic mercury can be converted into insoluble mercury sulfide which settles out of the water and into the sediment, or it can be converted by bacteria that process sulfate into methylmercury. The conversion of inorganic mercury to methylmercury is important for two reasons:

* Methylmercury is much more toxic than inorganic mercury.
* Organisms require a long time to eliminate methylmercury, which leads to bioaccumulation

Now the methylmercury-processing bacteria may be consumed by the next higher organism up the food chain, or the bacteria may release the methylmercury into the water where it can adsorb (stick) to plankton, which can also be consumed by the next higher organism up the food chain. This pattern continues as small fish/organisms get eaten by progressively bigger and bigger fish until the fish are finally eaten by humans or other animals. Alternatively, both elemental mercury and organic (methyl) mercury can vaporize and re-enter the atmosphere and cycle through the environment.