Mercury is highly toxic, causing damage to the nervous system at even relatively low levels of exposure. It is particularly harmful to the development of unborn children. It collects in human and animal bodies and can be concentrated through the food chain, especially in certain types of fish. The Commission’s Directorate-General for Health and Consumer Protection has recommended that women who are breastfeeding or who are or might become pregnant should limit their consumption of large predatory fish, such as swordfish, shark, marlin, pike and tuna.

It is well known that mercury has no respect for national or regional boundaries, travelling long distances through the atmosphere, and has contaminated both the European and global food supplies at levels posing a significant risk to human health, according to the World Health Organisation, food safety authorities, medical and public health professionals around the world. Even the arctic, which has no sources of mercury pollution, is experiencing dangerous levels of contamination in its marine mammals and other species which are part of the food supply.

The chemistry of mercury and its forms in the environment(1)

Mercury occurs naturally in the environment and exists in different forms. In pure form it is known as “elemental” or “metallic” mercury (Hg(0) or Hg0). Mercury is rarely found in nature as the pure, liquid metal, but rather within compounds and inorganic salts. Mercury can be bound to other compounds as monovalent or divalent mercury (also expressed as Hg(I) and Hg(II) or Hg2+, respectively). Many inorganic and organic compounds of mercury can be formed from Hg(II).

Several forms of mercury occur naturally in the environment. The most common natural forms of mercury found in the environment are metallic mercury, mercuric sulphide, mercuric chloride, and methylmercury. Some micro-organisms and natural processes can change the mercury in the environment from one form to another.

Mercury is mined as mercuric sulphide (cinnabar ore). Through history, deposits of cinnabar have been the source ores for commercial mining of metallic mercury. The metallic form is most simply refined from mercuric sulphide ore by heating the ore to temperatures above 540°C. This vaporises the mercury in the ore, and the vapours are then captured and cooled to form the liquid metal mercury.

Elemental mercury is a shiny, silver-white metal that is a liquid at room temperature and is traditionally used in thermometers and some electrical switches. If not enclosed, at room temperature some of the metallic mercury will evaporate and form mercury vapours. Mercury vapours are colourless and odourless. The higher the temperature, the more vapours will be released from liquid metallic mercury. Some people who have breathed mercury vapours report a metallic taste in their mouths. Elemental mercury in the atmosphere can undergo transformation into inorganic mercury forms, providing a significant pathway for deposition of
emitted elemental mercury.

Inorganic mercuric compounds include mercuric sulphide (HgS), mercuric oxide (HgO) and mercuric chloride (HgCl2). These mercury compounds are also called mercury salts. Most inorganic mercury compounds are white powders or crystals, except for mercuric sulphide, which is red and turns black after exposure to light. Some mercury salts (such as HgCl2) are sufficiently volatile to exist as an atmospheric gas. However, the water solubility and chemical reactivity of these inorganic (or divalent) mercury gases lead to much more rapid deposition from the atmosphere than for elemental mercury. This results in significantly shorter atmospheric lifetimes for these divalent mercury gases than for the elemental mercury gas.

When mercury combines with carbon, the compounds formed are called "organic" mercury compounds or organomercurials. There is a potentially large number of organic mercury compounds (such as methylmercury, dimethylmercury, phenylmercury, and ethylmercury); however, by far the most common organic mercury compound in the environment is methylmercury. Like the inorganic mercuric compounds, both methylmercury and phenylmercury exist as "salts" (for example, methylmercuric chloride or phenylmercuric acetate). When pure, most forms of methylmercury and phenylmercury are white crystalline solids. Dimethylmercury, however, is a colourless liquid.

The most common organic mercury compound that micro-organisms and natural processes generate from other forms is methylmercury. Methylmercury is of particular concern because it can build up (bioaccumulate and biomagnify) in many edible freshwater and saltwater fish and marine mammals to levels that are many thousands of times greater than levels in the surrounding water.

Being an element, mercury cannot be broken down or degraded into harmless substances. Mercury may change between different states and species in its cycle, but its simplest form is elemental mercury, which itself is harmful to humans and the environment. Once mercury has been liberated from either ores or from fossil fuel and mineral deposits hidden in the earth’s crust and released into the biosphere, it can be highly mobile, cycling between the earth’s surface and the atmosphere. The earth’s surface soils, water bodies and bottom sediments are thought to be the primary biospheric sinks for mercury.
Mercury is released by natural sources like volcanoes, by evaporation from soil and water surfaces, as well as through the degradation of minerals and forest fires. However, it should be noted that a part of today’s emissions from soil and water surfaces is composed of previous deposition of mercury from both anthropogenic and natural sources. Mercury is also contained as a trace element in coal. The large use of coal-fired power plants in generating electricity, make mercury emissions to the air from this source among the world’s largest.

Examples of uses of mercury, in no particular order, include:

As a metal (among others):

- For extraction of gold and silver (for centuries)
- As a cathode in the mercury-cell process for chlor-alkali production
- In electrical and electronic switches
- In fluorescent lamps
- In discharge lamps (e.g. streetlights and some automobile headlights)
- In thermometers
- In thermostats
- In manometers for measuring and controlling pressure (sphygmomanometers)
- Barometers
- In dental amalgam fillings

As a chemical compound (among others):

- In batteries
- Vaccines (as preservative in form of ethylmercury in thimerosal)
- Biocides/fungicides in paper industry, paints and on seed grain
- In pharmaceutical antiseptics
- Laboratory analysis reactants
- Catalysts (e.g. to produce vinyl chloride monomer)
- Pigments and dyes (may be historical)
- Detergents (may be historical)
- Soaps and creams (as a bactericide and/or whitening agent)
- Explosives (may be historical)

Many of these uses have been reduced significantly in many industrialised countries, particularly during the last two decades. However, many of the uses discontinued in the OECD countries are still alive in other parts of the world. Several of these uses have been prohibited or severely restricted in a number of countries because of their adverse impacts on humans and the environment.

In the EU mercury is not used in detergents, soaps, paints, biocides, gold mining (except in French Guyana) and mercury-containing soaps are banned for export by Annex V of Regulation (EC) No. 304/2003 of the European Parliament and of the Council of 28 January 2003 concerning the export and import of dangerous chemicals (OJ L 63, 6.3.03, p. 1-26).

Mercury enters the environment (air, water and soil) mainly through:

- Coal combustion.
- Municipal and medical waste incinerators.
- Steel production.
- Cement production.
- Chlor-alkali production
- Crematoria
- Artisanal gold-mining
- Dental amalgams
- Mercury-containing waste
- Smelting and refining of metal ores

**Mercury exposure and effects**

Mercury and its compounds are highly toxic to humans, ecosystems and wildlife. High doses can be fatal to humans, but even relatively low doses can have serious adverse neurodevelopmental impacts, and have recently been linked with possible harmful effects on the cardiovascular, immune and reproductive systems.(3)
The toxicity of mercury depends on its chemical form, and thus symptoms and signs are rather different in exposure to elemental mercury, inorganic mercury compounds, or organic mercury compounds (notably alkylmercury compounds such as methylmercury and ethylmercury salts, and dimethylmercury). The sources of exposure are also markedly different for the different forms of mercury. For alkylmercury compounds, among which methylmercury is by far the most important, the major source of exposure is diet, especially fish and other seafood. This is because methylmercury bioaccumulates, meaning larger predatory fish (such as tuna, sharks, marlins) have much higher levels of methylmercury in their bodies than non-predatory fish. (4)

For elemental mercury vapour, the most important source for the general population is dental amalgam, but exposure at work may in some situations exceed this by many times (for example for nurses in hospitals, for dental nurses, dentists and workers in labs). For inorganic mercury compounds, diet is the most important source for the majority of people. However, for some segments of populations, use of skin-lightening creams and soaps that contain mercury, and use of mercury for cultural/ritualistic purposes or in traditional medicine, can also result in substantial exposures to inorganic or elemental mercury. (5)

Organic mercury, in the form of methylmercury, is the most toxic form humans are usually exposed to. Methylmercury is a well-documented neurotoxicant, which may in particular cause adverse effects on the developing brain. Moreover, this compound readily passes both the placental barrier and the blood-brain barrier, therefore, exposures during pregnancy are of highest concern. Also, some studies suggest that even small increases in methylmercury exposures may cause adverse effects on the cardiovascular system, thereby leading to increased mortality. Given the importance of cardiovascular diseases worldwide, these findings, although yet to be confirmed, suggest that methylmercury exposures need close attention and additional follow-up. Moreover, methylmercury compounds are considered possibly carcinogenic to humans (group 2B) according to the International Agency for Research on Cancer (IARC, 1993), based on their overall evaluation. (6)

Eating contaminated fish is the major source of human exposure to methylmercury. The populations most at risk are fetuses, infants, and young children. (8) Consequently, fish consumption by pregnant women, young children, and women of childbearing age is cause for concern because of the likelihood of mercury exposure. Experts estimate that almost half (44%) of young children in France could have levels exceeding health standards, which would put them at risk for mercury poisoning. The EU Extended Impact Assessment states that anywhere from 3 to 15 million people in Europe alone have mercury levels around the recommended limit and a percentage have levels ten times as high, at which there are clear neurodevelopmental effects. (10)
One of the worst industrial disasters in history was caused by the dumping of mercury compounds into Minamata Bay, Japan. The Chisso Corporation, a fertilizer and later petrochemical company, was found responsible for polluting the bay from 1932-1968. It is estimated that over 3,000 people consuming fish from the lake suffered various deformities, sever mercury poisoning symptoms or death from what became known as Minamata disease. The Supreme Court in November 2005 held the central government and Kumamoto Prefecture responsible for Minamata disease in awarding 71.5 million yen in damages to plaintiffs in the nation's worst-ever case of industrial poisoning.

The main route of exposure for elemental mercury is by inhalation of the vapours. About 80 percent of inhaled vapours are absorbed by the lung tissues. This vapour also easily penetrates the blood-brain barrier and is a well-documented neurotoxicant. Intestinal absorption of elemental mercury is low. Elemental mercury can be oxidized in body tissues to the inorganic divalent form.

Neurological and behavioural disorders in humans have been observed following inhalation of elemental mercury vapour. Specific symptoms include tremors, emotional lability, insomnia, memory loss, neuromuscular changes, and headaches. In addition, there are effects on the kidney and thyroid. High exposures have also resulted in death. With regard to carcinogenicity, the overall evaluation, according to IARC (1993), is that metallic mercury and inorganic mercury compounds are not classifiable as to carcinogenicity to humans (group 3). A critical effect on which risk assessment could be based is therefore the neurotoxic effects, for example the induction of tremor. The effects on the kidneys (the renal tubule) should also be considered; they are the key endpoint in exposure to inorganic mercury compounds. The effect may well be reversible, but as the exposure to the general population tends to be continuous, the effect may still be relevant.

References:
(5) UNEP Global Mercury Assessment, December 2002, Summary of the report, paragraph 53

(6) UNEP Global Mercury Assessment, December 2002, Summary of the report, paragraph 56

(7) Methy mercury bioaccumulates, meaning larger predatory fish have much higher levels of methylmercury in their bodies than non-predatory fish. For a list of fish with low and high levels of mercury see: Physicians for Social Responsibility - Mercury in fish http://www.mercuryaction.org/uploads/PSR_Hg3_FishC.pdf


(11) http://en.wikipedia.org/wiki/Mercury_(element)#Applications


(13) UNEP Global Mercury Assessment, December 2002, Summary of the report, paragraphs 57-58