



## MERCURY: EXPOSURE & EFFECTS

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Some of the metals are essential for the normal growth, development, reproduction and various other physiological functions of the body. However, their excess or deficiency in the body might lead to adverse biological effects. Human being can be exposed to certain metals through environment and also to higher doses during their occupation or accidental exposure. Mercury is a toxic metal and is the only metal which is liquid at room temperatures; in fact it is liquid at 298 Kelvin. Mercury is some-times called quicksilver because of its silvery-white appearance. It rarely occurs free in nature and is found mainly in cinnabar ore (HgS) in Spain and Italy. It is a heavy, odourless, lustrous liquid metal that sinks in water. Mercury can volatilize and enter into the air and, through air, it can enter water and the soil system. If a liquid effluent contains mercury it can directly deposit it in water and soil. Some bacteria found in soil and water can change mercury to its organic form, which is called methyl mercury, which is then taken in by live forms.

Source: *Lurking Menace: Mercury in the healthcare sector*, Toxics Link, June 2004

Human are exposed to mercury from various man made and natural sources. A substantial number of human are exposed to low doses of mercury through dental amalgam and professionals of dentistry are also exposed while preparing and filling up amalgam containing mercury (ATSDR, 1999). There are three forms of mercury: 1) organic 2) inorganic and 3) elemental mercury. Elemental mercury is absorbed mainly through inhalation. The inorganic salts are absorbed in our body through ingestion and they are highly irritating causing mucosal damage. Organic mercury compounds are readily absorbed in the body through all the available routes (Frazier and Hage, Reproductive Hazards of the Workplace 146, 1998)). Mercury is encountered in the workplace in two major forms: inorganic mercury, which includes both elemental and inorganic salt; and as organic mercury compounds, also known as alkyl mercury compounds. Occupational exposure to inorganic mercury compounds is much more common than the organic mercury compounds.

## USES AND CONSUMPTION

Presently, India is the second-largest user of mercury in the world (170190 tonnes a year) after the US (372 tonnes annually).

Occupational uses of mercury include manufacture of amalgams, lab equipments, valves, switches and rectifiers; as catalyst and pigments; and as medicines, biocides and antifouling agents (Frazier and Hage, 1998).

Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, dental fillings, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments

Source:<http://www.cseindia.org/dte-supplement/global-warming.htm>

### Major consumers of mercury in India

Form of mercury used	Consumers/Ingredients
Elemental mercury	<b>Chlor-alkali industry</b> (Mercury cell process) <b>Instrument manufacturing unit</b> <ol style="list-style-type: none"> <li>1. Clinical thermometers</li> <li>2. Laboratory thermometers</li> <li>3. Sphygmomanometer</li> <li>4. Barometers</li> <li>5. Other instruments</li> </ol>
Mercury oxide	<b>Health set-ups</b> <ol style="list-style-type: none"> <li>1. Drugs, pharmaceuticals</li> <li>2. Dental amalgams</li> <li>3. Others</li> </ol> <b>Electrical apparatus.</b> Electric switches <b>Fungicides</b> <ol style="list-style-type: none"> <li>1. Phenyl mercury acetate</li> <li>2. Methoxy ethyl mercury chloride</li> <li>3. Others</li> </ol>
Mercury Compounds	<b>Electrical apparatus</b> <ol style="list-style-type: none"> <li>1 Electric lamps                             <ol style="list-style-type: none"> <li>a) Fluorescent lamps</li> <li>b) Mercury vapour lamps</li> </ol> </li> <li>2 Batteries</li> </ol> <b>Paints</b> <b>Cosmetics</b>

Source: Mercury - Toxics Link Factsheet, Number 17 / Feb 2003

The consumption of fish is a common route by which mercury enters the human body; freshwater fish tends to have slightly higher mercury levels than marine species (Mercury in India, Toxic Pathways; Toxic Link, September 2003).



Some common uses of mercury

## SOURCES OF EXPOSURE

The exposure to mercury can result either from naturally occurring mercury or through atmospheric pollution. Natural mercury arises from the degassing of the earth's crust through volcanic gases and, probably, by evaporation from the oceans. Local levels in water derived from mercury ores may also be high (up to 80 µg/litre). Atmospheric pollution from industrial production is probably low, but pollution of water by mine tailings is significant.

Source: Mercury in India, Toxic Pathways; Toxic Link, Sep. 2003

The major sources of mercury pollution in India are chloralkali industries, industrial processes in thermal power plants, steel and cement industries, coal fired power and heat production, mercury-containing products such as Sphygmomanometer, blood pressure equipment, pesticides, dental amalgam, waste incineration processes etc.

Source:<http://www.cseindia.org/dte-supplement/global-warming.htm>

Bioaccumulation and bio-magnification:

Two properties that make mercury extremely unmanageable are bioaccumulation and bio-magnification. Bioaccumulation is the retention of the toxic substance in the tissues, especially muscles. Bio-magnification is the process by which the toxic metal increases in concentration as it moves up the food chain (up to 100,000 times the original levels, in some cases). Further organic mercury, mostly methyl mercury (MeHg) the most toxic one is bio-accumulating in the biota and subsequently biomagnified in the aquatic food chain, especially in fish

Source: Lurking Menace: Mercury in the healthcare sector, Toxics Link, June 2004

## Major emitters of mercury in India

Mercury	Consumers	Amount (approximate)
Mercury in effluent (mercury cell process)	Chloralkali industry	100-150 tonnes/annum
Mercury in effluents and soil	Instrument manufacturing industries	-
Mercury in air and fly ash	Coal-based thermal power plants	60 tonnes per annum
Mercury in air and Dust	Cement manufacturing Plants	-
Mercury in air	Burning of mineral Oil	-
Mercury in air and effluents	Disposal of municipal solid waste	-
Mercury in air	Disposal of medical wastes	-

Source: Mercury - Toxics Link Factsheet Number 17 / Feb 2003

### Levels of mercury (mg/l) in some air sample of rural and urban India

Permissible limit	0.001
Industrial Area, Panipat (Haryana)	0.268
Barsai Road, Panipat (Haryana)	0.074
Machua Village, Vatva (Gujarat)	0.115
Lali Village, Vatva (Gujarat)	0.211
Chiri Village, Vapi (Gujarat)	0.096
Sarangpur Village, Ankleshwar (Gujarat)	0.118
Bapunagar, Ankleshwar (Gujarat)	0.176
Pocharam Village, Patancheru (Andhra Pradesh)	0.058

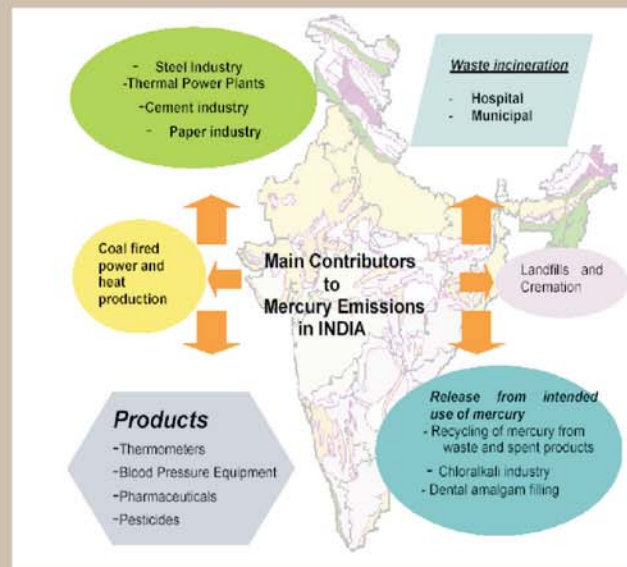
Source: Down to Earth, Aug 31, 1999

## HEALTH EFFECTS

Human exposure to mercury can happen through:

- Eating fish contaminated with organic mercury.
- Release of mercury from dental and medical treatments. Amount of mercury released from dental amalgams range from 3 to 17 g/day. (ATSDR, 1999).
- Breathing contaminated workplace air or skin contact during use in the workplace (dental, health services, chemical, and other industries that use mercury)
- Breathing vapours in air from spills, incinerators, and industries that burn mercury-containing fuels.
- From a pregnant woman/ nursing mother exposed to mercury to their child

The major target organs for the mercury toxicity are kidney and CNS. All forms of mercury are able to cause kidney damage if large amount enter the body (ATSDR, 1999). Pregnant women, breast-feeding women, the fetus new born and young children residing in the hot spot areas of the country are the potential vulnerable groups. The health effect of the mercury depends upon the compound to which a person is exposure. These are as follows:



Source: Guidance and awareness raising materials under new UNEP mercury programs (Indian scenario), Dr. RC Shrivastava, Ph.D.

### Mercury and its health effects at a glance

Chemical Form	Health effects
Methyl-Mercury	For fetuses, infants, and children, the primary health effect of methylmercury is impaired neurological development. Methylmercury exposure in the womb, resulting from a mother's consumption of fish and shellfish containing methylmercury, adversely affect a baby's growing brain and nervous system. Impacts on cognitive function, memory, attention, language, and fine motor and visual spatial skills have been seen in children exposed to methylmercury in the womb
Elemental Mercury	Elemental (metallic) mercury primarily causes health effects when it is breathed as a vapor. Inhaled mercury vapor may cause headaches, cough, chest pains, chest tightness, and difficulty in breathing. It may also cause chemical pneumonitis. Other symptoms include : tremors; emotional changes (e.g., mood swings, irritability, nervousness, excessive shyness); insomnia; neuromuscular changes (such as weakness, muscle atrophy, twitching); headaches; disturbances in sensations; changes in nerve responses; performance deficits on tests of cognitive function.
Inorganic mercury	High exposures to inorganic mercury may result in damage to the gastrointestinal tract, the nervous system, and the kidneys. Symptoms of high exposures to inorganic mercury include: skin rashes and dermatitis; mood swings; memory loss; mental disturbances; and muscle weakness.

Source: <http://www.epa.gov/hg/effects.htm>

## Acrodynia

Acrodynia is an idiosyncratic hypersensitivity response from exposure to mercury and is characterized by certain cardiovascular, dermal, and neurological effects, among others. This occurs, in part, because there is some overlap between symptoms characteristic of acrodynia and those seen in persons who are not hypersensitive and, in part, because not every report of a study in which the symptoms were observed states whether the authors

considered the affected person to have suffered from **acrodynia**.

Source: <http://www.atsdr.cdc.gov/toxprofiles/tp46.html>

## MINAMATA DISEASE

Minamata disease (Minamata-byô), sometimes referred to as Chisso-Minamata disease (Chisso-Minamata-byô), is a neurological syndrome caused by severe mercury poisoning. Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma and death follow within a few weeks after the onset of symptoms. A congenital form of the disease can also affect fetuses in the womb. Minamata disease was first discovered in Minamata city in Kumamoto prefecture, Japan in 1956. It was caused by the release of methyl mercury in the industrial wastewater from the Chisso Corporation's chemical factory, which continued from 1932 to 1968. This highly toxic chemical bioaccumulated in shellfish and fish in Minamata Bay and the Shiranui Sea, which when eaten by the local population resulted in mercury poisoning. While cat, dog, pig and human deaths continued over more than 30 years, the government and company did little to prevent the pollution.

As of March 2001, 2,265 victims had been officially recognised (1,784 of whom had died) (Official government figure as of March 2001. See "Minamata Disease: The History and Measures, ch2") and over 10,000 had received financial compensation from Chisso. (See "Minamata Disease Archives", Frequently asked questions, Question 6) Lawsuits and claims for compensation continue to this day

Source: [http://en.wikipedia.org/wiki/Minamata\\_disease](http://en.wikipedia.org/wiki/Minamata_disease)

### Other Occurrences of mercury poisoning

- The phrase "Mad as a hatter" is likely a reference to mercury poisoning, as mercury-based compounds were once used in the manufacture of felt hats in the 18th and 19th century. (The Mad Hatter character of Alice in Wonderland was almost certainly inspired by an eccentric furniture dealer, not by a victim of mercury poisoning.) (Waldron 1983).

- An early scientific study on mercury poisoning was in 1923-6 by the German inorganic chemist, Alfred Stock, who himself became poisoned, together with his colleagues, by

breathing mercury vapour that was being released in his laboratory from the equipments diffusion pumps, float valves, and manometers all these contained mercury, and also due to accidentally mercury spilt which remained in the cracks of the linoleum floor covering. He published a number of papers on mercury poisoning, founded a committee in Berlin to study cases of possible mercury poisoning, and introduced the term micromercurialism (Stock 1926)

- The term Hunter-Russell syndrome derives from a study of mercury poisoning among workers in a seed packing factory in England in the late 1930s because they breathed vapour of methylmercury that was used as a seed disinfectant and preservative. (Hunter et al 1940)

- Widespread mercury poisoning occurred in rural Iraq in 1971-1972, when grain treated with a methyl mercury-based fungicide that was intended for planting and subsequently used by the rural population for the preparation of bread. The incident caused at least 6530 cases of mercury poisoning including 459 deaths (Engler, 1985)

- On August 14, 1996, Karen Wetterhahn, a chemistry professor working at Dartmouth College, spilled a small amount of dimethylmercury on her latex glove. She began experiencing the symptoms of mercury poisoning five months later and, despite aggressive chelation therapy, died a few months later from brain malfunction due to mercury intoxication. (The Karen Wetterhahn story - University of Bristol web page documenting her death, retrieved December 9th 2006 and OSHA update following Karen Wetterhahn's death)

- In April of 2000, Alan Chmurny attempted to kill a former employee, Marta Bradley, by pouring mercury into the ventilation system of her car. (Engler 1985)

- The first emperor of unified China, Qin Shi Huang Di, was driven insane and killed by mercury pills intended to give him eternal life.

### References:

Waldron HA (1983). "Did the Mad Hatter have mercury poisoning?". *Br Med J (Clin Res Ed)* 287 (6409): 1961. PMID 6418283.

Stock, Alfred (1926). "Die Gefaehrlichkeit des Quecksilberdampfes". *Zeitschrift für angewandte Chemie* 39: 461-466. doi:10.1002/ange.19260391502.

Hunter, D, Bomford, R R, and Russell, D S (1940). "Poisoning by methylmercury compounds". *Quart. J. Med.* 9: 193-213.

Engler, Robert (April 27 1985). "Technology out of Control". *The Nation* 240.

The Karen Wetterhahn story - University of Bristol web page documenting her death, retrieved December 9th 2006  
OSHA update following Karen Wetterhahn's death

Mercury has been found in at least 714 of 1,467 National Priorities List sites identified by the Environmental Protection Agency. (Agency for Toxic Substances and Disease Registry. Division of Toxicology and Environmental Medicine ToxFQAQs™ for Mercury (Mercurio) April 1999).

## PREVENTION

### 1.Environmental monitoring:

Regularly monitor mercury levels in air, water, soil and food materials.

#### Tolerance Guidelines

Title	Details
Max. permissible limit in water	1 g/l
Max. concentration in compost	0.15 mg/kg dry basis
Max. concentration in treated Leachate	10 g/l in land, surface water and public sewers
Max. allowed / recommended levels of mercury in fish	0.5 ppm total mercury
National data on consumption	NA

Source: Ministry of Commerce, Govt. of India, 1995

### Permissible Limits

Permissible concentration of mercury as recommended by the National Institutes of Safety and Health, USA for occupational exposure is 0.05 mg/m<sup>3</sup> (NIOSH, 1973). The current OSHA standard for mercury is a ceiling level of 0.1 milligram of mercury per cubic meter of air (0.1 mg/m<sup>3</sup>). NIOSH has recommended that the mean permissible exposure limit may be changed to 0.05 mg/m<sup>3</sup> over an eight-hour work shift.

Source: Occupational Health Guideline for Inorganic Mercury, From U.S. Department of Health and Human Services and U.S. Department of Labor,; September 10, 2005 (Last modified)

### 2.Medical surveillance

The following medical procedures should be made available to each employee who is exposed to mercury at potentially hazardous levels:

#### Initial Medical Examination:

A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline data for future health monitoring. Persons with a history of allergies or known sensitization to mercury, chronic respiratory disease, nervous system disorders, or kidney disease would be expected to be at increased risk from exposure.

#### Urinalysis:

Since kidney damage has been observed in humans exposed to mercury, a urinalysis should be carried out at least for specific gravity, albumin, glucose, and a microscopic

examination of centrifuged sediment. Determination of mercury level in urine may be helpful in assessing the extent of absorption.

#### Periodic Medical Examination:

The aforementioned medical examinations should be repeated on annual.

Source: Occupational Health Guideline for Inorganic Mercury, From U.S. Department of Health and Human Services and U.S. Department of Labor,; September 10, 2005 (Last modified)

### 3.IEC activities:

In order to create a general awareness among the public through various awareness programmes should be arranged. Therefore, it is necessary to establish a task force group to coordinate and implement the mercury action plan and poison information centres to provide round-the-clock information.

Source:<http://www.cseindia.org/dte-supplement/global-warming.htm>

### 4.Minimisation of Exposure Risk

- Advise children not to play with shiny, silver liquids.
- Medications containing mercurial salts should be stored safely and properly disposed.
- Pregnant women and women of childbearing age should limit their consumption of fish with high levels of MeHg e.g. shark and swordfish.

### 5.Safer alternatives

There is an urgent need to bring in some policy for gradual shift from mercury containing equipment to safer alternatives.

### 6.Proper handling and disposal

Healthcare staff needs to be trained to handle this toxic metal safely and the disposal and emission issues need to be addressed.

### 7.Personal Protective Equipment

Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective devices/clothing necessary to prevent repeated or prolonged skin contact with liquid mercury. Non-impervious clothing which becomes contaminated with mercury should be removed promptly and not re-use until the mercury is removed from the clothing.

Source: Occupational Health Guideline for Inorganic Mercury, From U.S. Department of Health and Human Services and U.S. Department of Labor,; September 10, 2005 (Last modified)

### 8.Emergency First Aid Procedures

In the event of an emergency, institute first aid procedures and

get the medical attention immediately.

**Eye Exposure:**

If liquid mercury gets into the eyes, wash eyes immediately with large quantity of water, lifting the lower and upper lids occasionally. Contact lenses should not be worn when working with this chemical.

**Skin Exposure:**

If liquid mercury gets on the skin, promptly wash the contaminated skin with soap or mild detergent and water. If liquid mercury penetrates through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water.

**Breathing:**

If a person breathes in large volume of mercury, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and keep him at rest.

**Swallowing:**

When large quantities of mercury have been swallowed or mercury has been swallowed repeatedly and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not apply the same practice with an unconscious person.

**9.Generate data on the environmental release of mercury and its origin and speciation.**

**Legislations**

Two rules that deal with hazardous substances are: The Hazardous Waste Management and Handling Rules (1989), which list mercury and mercury containing waste as hazardous waste. Another rule is the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989, which includes a few mercury compounds

Source: Lurking Menace: Mercury in the healthcare sector Toxics Link June 2004.

Ingested elemental mercury is only 0.01 per cent absorbed, but methyl mercury is nearly 100 percent absorbed from the gastrointestinal tract (Mercury in India, Toxic Pathways;Toxic Link, September 2003).

There is consumer legislation in place the Prevention of Food Adulteration Act, 1955, which aims to protect consumers from adulterated food and ensure food safety. The Rules declare mercury as a poisonous metal and limit its concentration in fish to 0.5 ppm and in other food items upto 1.0 ppm. Methyl mercury concentration in fish is limited to 0.25 ppm.

Source: The Prevention of Food Adulteration Act and Rules, 1955.

The WHO and the Food and Agriculture Organisation (FAO), in their codex alimentarius guidelines, have also limited the concentration of methyl mercury to 0.5 mg/kg for all fishes except predatory fishes, and 1 mg/kg for predatory fishes such as shark, swordfish, tuna, pike, etc.

Source: UNEP Chemicals, Global Mercury Assessment Report, 2002, p. 30.

A draft notification was issued by the Ministry of Environment and Forests in 2000 for a phased elimination of mercury from consumer products including thermometer, fluorescent tube, batteries, electrical thermostat and switches, medical instruments, certain pharmaceutical and agricultural products with an exemption for essential products.<sup>1</sup> Government of India is trying to ensure that potentially harmful mercury wastes are recycled or disposed off under strict standards to prevent the emission into the environment<sup>2</sup>

Sources: 1.Ministry of Environment and Forest. The Gazette of India, Ministry of Environment and Forest Government of India, Notification. S.O. 908(E). September 2000

2.Dr. R. C. Srivastava, Global Mercury Assessment: Comments and inputs on Draft Assessment Report. Source of pollution and its effect on environment and health, 2002

Although individual thermometers only contain a small amount of mercury, hospitals break hundreds every year. This has contributed to healthcare becoming the third largest source of mercury contamination in the environment as reported in a World Health Organization survey here: <http://tinurl.com/vt2h63>

**Mercury Toxicity Seminar**

Dr. Hartman's Mercury Toxicity Seminar is being organized at 1721 Lafayette Road, New Enterprise, PA 16664 on May 6, 2008 where the dangers of mercury (amalgam) fillings will be discussed. Mercury has been used for many years to fill and preserve teeth, despite its proven toxicity. The seminar is free, and those desiring to attend can contact organisers at 800-732-9630 <http://www.healthbychoice.net/>

## IMPORTANT WEBLINKS

<http://www.epa.gov/iris/subst/0692.htm>.

toxicological profile for mercury.

<http://www.epa.gov/iris/subst/0370.htm>.

<http://www.epa.gov/iris/subst/0073.htm>

<http://www.epa.gov/waterscience/criteria/methylmercury/index.html>

<http://www.mii.org/Minerals/photomercury.html>

<http://www.webelements.com/webelements/scholar/elements/mercury/key.html>

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

[http://www.balanceyournutrition.com/In\\_Focus\\_mercury\\_toxicity.htm](http://www.balanceyournutrition.com/In_Focus_mercury_toxicity.htm)

### Other links

<http://www.epa.gov/seahome/mercury/src/outmerc.htm>

<http://www.healthbenchmarks.org/Mercury/>

<http://www.noharm.org/mercury/issue>

[http://www.sustainablehospitals.org/HTMLSrc/IP\\_factsheet\\_contents.html](http://www.sustainablehospitals.org/HTMLSrc/IP_factsheet_contents.html) - mercury

<http://www.h2e-online.org/tools/mercury.htm>

<http://www.mercurypoisoned.com/>

[http://www.toxicteeth.net/about\\_Us.cfm](http://www.toxicteeth.net/about_Us.cfm)

[www.informinc.org](http://www.informinc.org)

<http://www.nih.gov/od/ors/ds/nomercury/>

[www.ewg.org](http://www.ewg.org)

[http://www.findarticles.com/cf\\_dls/m0ISW/2001\\_May/73959332/p1/article.jhtml/term](http://www.findarticles.com/cf_dls/m0ISW/2001_May/73959332/p1/article.jhtml/term)

<http://www.mercurypoisoningfyi.com/>

<http://www.testfoundation.org/>

<http://www.chem.unep.ch/mercury/default.htm>

<http://europa.eu.int/comm/environment/chemicals/mercury/>

[Http://www.toxicteeth.com](http://www.toxicteeth.com)

### NIOH News

The National Institute of Occupational health conducted a tentative training course sponsored by the Central Pollution Control Board on 'Indoor Air Pollution and Health Impact' from Nov 27 to Nov 29, 2007 at NIOH, Ahmedabad. Participants from different State Pollution Control Boards participated in this programme. Experts from the Institute and various reputed institutions made their esteemed presence and delivered their lecture. Related topics were discussed as well as air monitoring and analytical equipments were demonstrated during the session.

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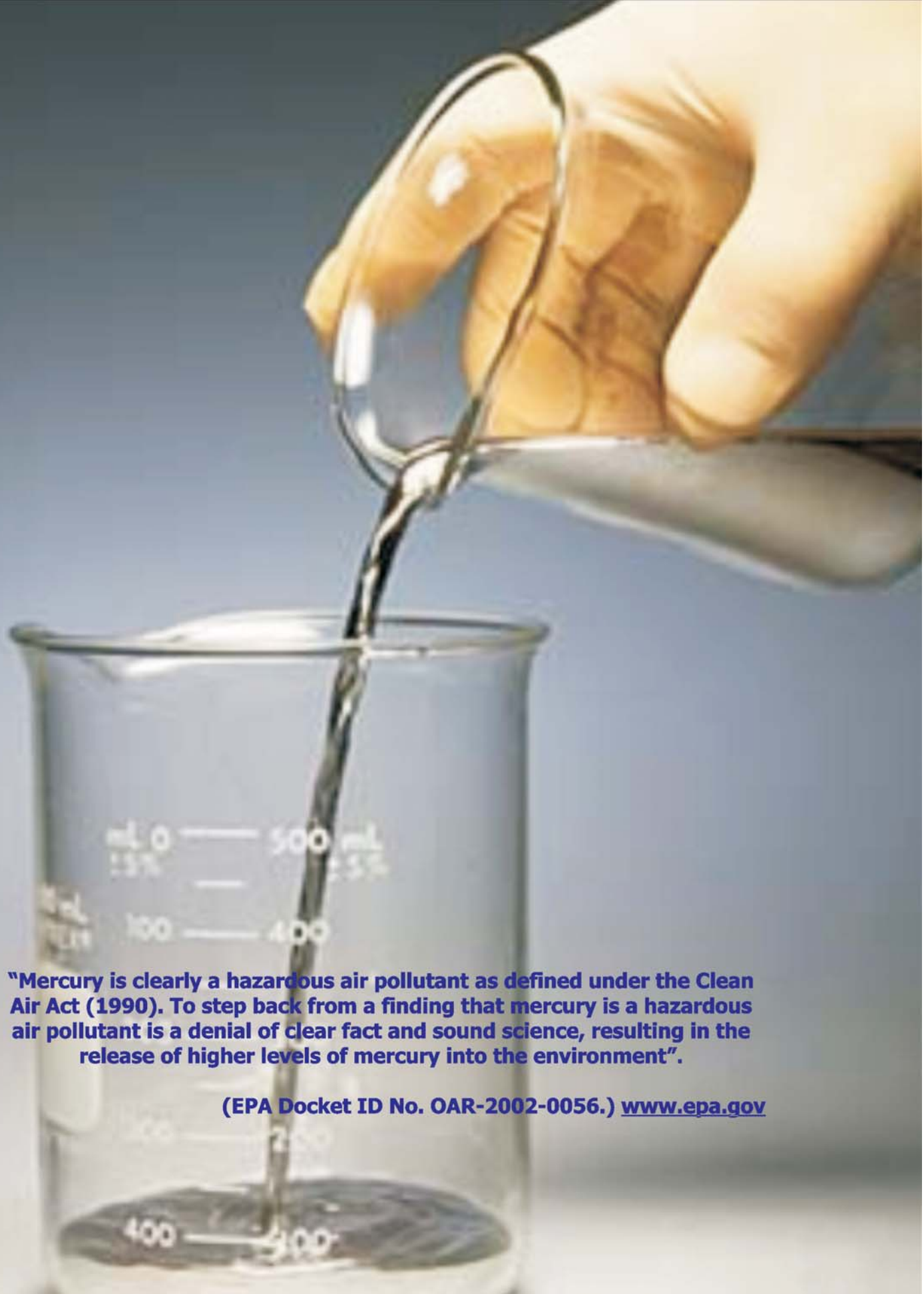
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**"Mercury is clearly a hazardous air pollutant as defined under the Clean Air Act (1990). To step back from a finding that mercury is a hazardous air pollutant is a denial of clear fact and sound science, resulting in the release of higher levels of mercury into the environment".**

**(EPA Docket ID No. OAR-2002-0056.) [www.epa.gov](http://www.epa.gov)**