

# **Indoor Air Mercury**

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## **Why is Mercury a Problem in Indoor Air?**

Mercury is a potent neurotoxin found in a variety of products. It affects the brain, liver and kidneys and can cause developmental disorders in children. Young children and developing fetuses are especially at risk.

Metallic, or elemental mercury, is a liquid at room temperature and like any other liquid it evaporates into the air, where it can be inhaled. Exposures can occur in the home when a mercury-containing item, such as a thermometer, breaks and is not properly cleaned up. They can occur in the workplace when mercury or mercury-containing device/materials are not carefully handled and safely managed or when workplace or storage areas are not properly ventilated. Exposures can also occur when children find and play with improperly stored mercury; many cases of mercury poisoning result for this reason.<sup>1</sup>

When spilled in a small, poorly-ventilated room, mercury can pose significant health threats. Very small amounts of metallic mercury, released into an enclosed space, (i.e., a few drops) can raise air concentrations of mercury to levels that may be harmful to health. The longer people breathe the contaminated air, the greater the risk to their health. In addition, metallic mercury and its vapors are extremely difficult to remove from clothes, furniture, carpet, and other porous items. If these items are not properly disposed or cleaned, the mercury can linger for months or years, continuing to pose a health threat.

The risk of exposure to mercury from indoor air is not insignificant. The Agency for Toxic Substances and Disease Registry's Hazardous Substances Emergency Events Surveillance system received 320 reports of mercury spills from the Northeast states each year for 1999 and 2000. Many of these incidents occurred in homes, workplaces, and schools. Six Poison Control Centers in the region received over 1,100 phone calls per year over the same time period of incidents or suspected exposures concerning mercury.

## **What are sources of mercury in indoor air?**

Elemental mercury is used in a variety of household products, including thermostats, glass thermometers, barometers, and switches in large appliances (e.g., gas-fired stoves). Other less common sources include novelty items, such as antique mercury glass and jewelry. The mercury in most of these devices is contained in glass or metal, and does not pose a risk unless the item is damaged or broken, releasing mercury vapors.

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<sup>1</sup> Though not the subject of this paper, dietary intake of mercury through contaminated food, primarily fish and seafood products, is the most important source of nonoccupational exposure to mercury. Public health advisories have been issued by federal and state authorities to assist people in avoiding fish contaminated with mercury.

Barometers, however, have small openings in order to measure air pressure. Mercury vapors may be slowly released from them without breakage.

Fluorescent bulbs contain a small amount of mercury vapor and a larger amount of mercury in a powder or dust form, which can become airborne if the bulb breaks. If the breakage is not cleaned up properly, the mercury can continue to circulate. Disposing of these bulbs in the trash can cause serious harm to health and environment.

Religious practice is another possible source of indoor air mercury. Some Caribbean-based religions, such as Santeria, Voodoo, and Palo Mayombe use metallic mercury in rituals. The mercury is sold under the name “azogue” in stores called “botanicas”. Followers of these religions sometimes wear an amulet containing mercury, sprinkle mercury in the home or car, mix it in bath water or perfume, or place it in devotional candles.

Whether accidental or intentional, spills of metallic mercury in a home or apartment threaten not only the health of the people currently living there, but the health of future residents who may be unknowingly exposed to mercury vapors releasing from contaminated floors or walls.

### Exposure Guidelines for Mercury Exposure:

Several environmental and occupational health standards have been set for mercury exposure (see Table I). Workplace standards are generally based on preventing adverse health effects from exposure over a 40-hour work week and tend to be higher than environmental exposure standards.

The Occupational Safety and Health Administration (OSHA) sets a legally enforceable ceiling limit for workplace exposure at 100 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ). Mercury concentration cannot exceed this level at any time during the work day. The National Institute for Occupational Safety and Health (NIOSH) sets its recommended exposure limit (REL) for mercury vapor at  $50 \mu\text{g}/\text{m}^3$  as a time weighted average (TWA). The American Conference of Governmental Industrial Hygienists (ACGIH), recommends a threshold limit value (TLV) of  $25 \mu\text{g}/\text{m}^3$  mercury vapor

| <b>Table I:<br/>Environmental and Occupational Health<br/>Standards for Inhalation Exposure to Mercury<br/>Vapor</b> |  |
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| Agency   | Mercury Concentration<br>( $\mu\text{g}/\text{m}^3$ ) <sup>1</sup> |
| OSHA Ceiling limit <sup>2</sup>  | 100  |
| NIOSH REL <sup>3</sup>   | 50   |
| ACGIH TLV <sup>4</sup>   | 25   |
| ATSDR MRL <sup>5</sup><br>ATSDR Action Level,<br>for indoor exposures  | 0.2<br>1.0   |
| EPA Rfc <sup>6</sup>   | 0.3  |

<sup>1</sup> micrograms per cubic meter  
<sup>2</sup> Ceiling limit = the concentration of mercury vapor cannot exceed this value at any time  
<sup>3</sup> REL = Recommended Exposure Limit, a time weighted average for an 8-hour day.  
<sup>4</sup> TLV = Threshold Limit Value, a time weighted average for an 8-hour day  
<sup>5</sup> MRL = minimal risk level  
<sup>6</sup> Reference concentration

as an average exposure for a normal 8-hour workday. All three agencies include a skin notation in their standards, indicating the mercury can be absorbed by intact skin, mucous membranes and eyes.

The Environmental Protection Agency (EPA) sets a reference concentration of  $0.3 \mu\text{g}/\text{m}^3$  for inhalation exposure to mercury. The reference concentration is a screening tool used to help risk assessors determine where to focus their investigations into hazardous exposures; adverse health effects do not necessarily result from exposure at the reference concentration. For example, if  $0.3 \mu\text{g}/\text{m}^3$  mercury was measured in air inside a building, EPA would further investigate the exposure.

Similarly, the Agency for Toxic Substances and Disease Registry has set a minimal risk level (MRL) for inhalation exposure at  $0.2 \mu\text{g}/\text{m}^3$ . The MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse health effects over a specified period of time. ATSDR also recommends an action level of  $1.0 \mu\text{g}/\text{m}^3$ , which triggers remediation if exceeded in indoor air.

## **Studies on Indoor Air Mercury**

Many studies and case reports document adverse health effects occurring as a result of a mercury spill in a home. Some of these provide the mercury levels that were measured in these homes. Other studies document adverse health effects and/or mercury levels resulting from intentional use of mercury in the home, such as for religious practices. A few provide background levels of mercury in randomly selected homes.

### **Thermometer Breakages**

Studies show that just one broken thermometer, if not properly cleaned up, can lead to indoor air mercury levels exceeding the EPA reference value and the ATSDR MRL, causing adverse health effects, particularly in children.

In one case report, three children suffered from mercury poisoning eight months after a single thermometer broke on a carpet in the children's room, but was not cleaned up. The room was small and had floor heating. One of the children, a 33-month old girl was admitted to the hospital for anorexia, weight loss, light sensitivity, and eczema(1).

Another study measured mercury levels in a home immediately after a thermometer broke on a vinyl-tiled kitchen floor. Although the author carefully cleaned the mercury, using post cards to gather the beads into one large globule, mercury was still detected at low levels throughout the house. The highest reading of  $25 \mu\text{g}/\text{m}^3$  was detected at the top of the stairs, which the author attributed to the eddying effect of air currents in his home. At floor level, mercury was found as high as  $140 \mu\text{g}/\text{m}^3$  from a hall carpet close to the kitchen door (2).

In a study of mercury levels in randomly selected homes in the New York area, mercury was detected at  $0.563 \mu\text{g}/\text{m}^3$  in a home where the tenant recalled breaking a thermometer on a tiled bathroom floor within the previous six months. Although the tenant had carefully cleaned the spill, residual mercury from the spill apparently continued to contaminate the air in the home (3). However, the study did not take into account intentional (ritualistic) uses of mercury or other previous mercury spills that may have also contributed to the elevated levels of mercury found in the home.

### **Other Accidental Spills**

Case reports on mercury spills from other products have documented indoor air mercury concentrations at levels far exceeding the EPA reference value and ATSDR MRL, and in some cases exceeding occupational health standards.

ATSDR reported on an incident in which an initially undetected spill from a mercury thermostat resulted in mercury concentrations ranging from  $1.5$  to  $4.5 \mu\text{g}/\text{m}^3$  at the breathing level of a small child. The parents discovered the spill when they found their two-year-old boy lying on a chair pushing around a bead of mercury with his tongue. Upon closer inspection, they found many small beads of mercury on the chair and surrounding carpet. The boy, who swallowed some of the beads, had elevated blood mercury. Investigators assessed the level of contamination in the chair and carpet by placing them in plastic bags and measuring mercury in the air space of the bag—detecting mercury up to  $50 \mu\text{g}/\text{m}^3$  (4).

Another paper describes the spilling of mercury from an antique clock onto a carpet in a home (5). Employees first cleaned the mercury with their bare hands and a vacuum. Indoor air mercury levels measured three days after the initial cleaning efforts were  $5$ - $10 \mu\text{g}/\text{m}^3$ . Mercury contamination in the vacuum and carpet were also evaluated. The amount of mercury spilled was not provided

In another incident, two children developed acute mercury poisoning and mercury vapor levels of  $50$ - $400 \mu\text{g}/\text{m}^3$  were found in their apartment. A previous tenant had apparently spilled a large jar of mercury several months earlier. The amount of mercury was unknown (6).

In 1997 ATSDR conducted an exposure investigation at a condominium complex in Arkansas in response to a couple's concern that they had brought mercury contamination with them from Nebraska to Arkansas. ATSDR did not provide details on the nature of the couple's original mercury exposure in Nebraska; however, levels as high as  $20 \mu\text{g}/\text{m}^3$  were found in their condominium in Arkansas. The back seat of the couple's car and the storage area for their vacuum had the highest levels (greater than  $999 \mu\text{g}/\text{m}^3$ ). Adjoining condominiums in the complex had mercury levels ranging from  $0.24$  to  $0.89 \mu\text{g}/\text{m}^3$ , suggesting contamination had spread beyond the original source (7).

### **Incidents involving children playing with mercury**

These studies show that children who find and play with mercury can be exposed at levels approaching occupational health standards, particularly if they are allowed to play with the mercury for an extended period of time.

The Center for Disease Control investigated an incident in which five children found five pints of mercury in an abandoned van and played with the mercury outdoors, inside homes and at school for 25 days.(8) Of 58 residential structures monitored for indoor mercury concentration, 17 were found to have levels in excess of  $15 \mu\text{g}/\text{m}^3$ .

In another case, a 9-year old boy suffered from neurological and kidney complications following mercury spillage from a blood pressure cuff brought into the home. (9) The boy played with the mercury which spilled on his bed and carpet for two days before informing his mother. His mother tried to dispose the mercury by vacuuming it and flushing it down the toilet. Very high levels of mercury were reportedly found in the boy's room, particularly around the carpet, but the levels were not provided in the paper.

In a third incident, a 15 year old boy suffered from acute mercury poisoning as a result of 300 grams of mercury spilling in his bedroom. Mercury was detected at  $10\text{-}40 \mu\text{g}/\text{m}^3$ . Details on the spill were not provided. (10)

In a more recent study, nine children had elevated urinary mercury levels, but no symptoms of mercury exposure, after playing for several days with a 6 ounce vial of mercury that they took from a neighbor who prepared mercury-filled amulets for practitioners of the Afro-Caribbean religion Santeria (11). Air mercury levels were not measured.

### **Religious Practices:**

A recent study reported that 93% of New York botanicas reported selling elemental mercury, and that, of 203 respondents, 44% of Caribbean individuals and 27% of Latin Americans reported using mercury. The same study conducted an exposure assessment of mercury from religious practices, estimating a mercury vapor concentration of  $600 \mu\text{g}/\text{m}^3$  for a high exposure scenario (placing a kilogram of mercury in an open cauldron) and  $0.02 \mu\text{g}/\text{m}^3$  for a low exposure scenario (periodically sprinkling small amounts of mercury from a sealed bottle) (12).

Other studies have been conducted on religious and cultural uses of mercury, but are beyond the scope of this report.

### **Background Mercury Levels in Homes**

Studies of background mercury levels in homes show that levels are higher than what is found in outdoor urban air ( $0.01 - 0.02 \mu\text{g}/\text{m}^3$ ), and may even exceed the EPA reference value and the ATSDR MRL if a spill has occurred previously in the home.

A recent study measured mercury levels in 12 indoor sites chosen to represent a cross-section of building types, locations and ages in the New York area (3). This study found mercury concentrations significantly elevated over outdoor concentrations, at a range of 0.0065 – 0.523  $\mu\text{g}/\text{m}^3$ . The average was 0.069  $\mu\text{g}/\text{m}^3$ . All but one of the sites had mercury levels elevated over outdoor air.

At several of the sites, no history of mercury contamination could be identified. This led authors to conclude that mercury releases from household devices could contaminate indoor air for decades following the first release of the metal. However, the authors of the study did not consider the possibility that the mercury residue was the result of prior cultural usage.

An earlier study investigating mercury levels in children of mercury workers found at least 10% of 39 control households had indoor air levels in excess of the EPA reference value (12). The median concentration in the randomly selected homes was 0.050  $\mu\text{g}/\text{m}^3$ , compared to a median of 0.24  $\mu\text{g}/\text{m}^3$  in the workers' homes.

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