Mercury Vapor Action Levels and Guidance for Indoor Spills

This document is a quick reference guide for public health and environmental officials who must evaluate environmental data collected from residential, school, and office settings where indoor mercury spills have occurred. Air concentrations at or above the action level should prompt a response. The Connecticut Department of Public Health (CT DPH) uses these levels to guide actions to be taken following a spill. The rationale for using these guidance values is provided in the tables below. It is important to note that these mercury action levels are intended as recommendations and are not regulatory or enforceable cleanup values.

CT DPH's guidance for mercury spills includes the updated mercury action levels jointly developed by two federal agencies, ATSDR and EPA (EPA 2019). These action levels are based upon the health guidance values (HGVs) derived by ATSDR and EPA data from human epidemiology studies that evaluated the health effects associated with inhalation of mercury vapors in air. ATSDR developed a chronic Minimal Risk Level (MRL) of 0.2 $\mu g/m^3$ based upon an occupational study of workers. The MRL means that exposure to air concentrations of mercury vapor up to 0.2 $\mu g/m^3$ every day for more than a year is unlikely to result in adverse, non-cancer health effects. EPA used the same study to develop a Reference Concentration (RfC) of 0.3 $\mu g/m^3$ using different exposure assumptions and uncertainty factors. CT DPH has adopted the federal mercury action levels and combined these values with information about field and laboratory testing methods and practices, remediation practices, and exposure factors in residential, school, and office settings to develop the guidance presented below.

CT DPH recommends that staff from the CT Department of Energy and Environmental Protection (DEEP) and environmental consultants contact CT DPH Environmental and Occupational Health Assessment Program staff at 860-509-7740 with any questions about application of this mercury guidance.

For additional information about metallic mercury health effects, residential clean-up guidance for compact fluorescent bulbs and mercury thermometers, and spill response in schools, please visit the CT DPH website: http://www.ct.gov/dph/mercury

Note to Environmental Consultants/Field Personnel:
CT DPH's guidance for mercury vapor is based on air data because the exposure route concern is inhalation. Dermal and ingestion exposures do not present a significant health risk with metallic mercury. Therefore, CTDPH does not review or comment on mercury results obtained from wipe samples.

Table 1: Mercury Action Levels and Guidance for Residential Indoor Spills (from USEPA 2019)[a,b]

Indoor Air Concentration (µg/m3)	Use of Action Level	Rationale for Action Level	Sampling Suggestions and other Considerations
Less than 1	Acceptable level for normal occupancy for most sensitive persons. No further response action needed	Experience has shown that response actions to reach levels lower than 1 µg/m^3 can be disruptive enough to cause more harm than benefit. 1 µg/m^3 is within an order of magnitude of health guidance values and indoor background levels. This concentration is 25 times lower than the concentrations referenced in the development of health guidance values.	No visible mercury; highest quality data.[c] Sampling in breathing zone of most sensitive person under normal conditions for use.
3 - 6	Acceptable level for unrestricted use of family vehicles under most conditions.	Exposure duration in most vehicles is short compared with other settings, allowing a higher concentration as the "floor" of this range. Requirement for no visible mercury means the source of vapors has been removed and concentrations should continue to fall. The "ceiling" of the range is based on the presumption that liquid mercury may still be present but not yet discovered.	No visible mercury; highest quality data.[c] Sampling in the passenger compartment under normal use conditions. Unusual use of the vehicle in this case would be extended family vacations.
3 - 6	Acceptable level to allow personal belongings to remain in owner's possession.	The sampling point suggested in the column to the right tends to concentrate the vapors higher than typical exposure conditions. Exposure frequency should be intermittent, and the duration should be short. The 6 µg/m^3 is based on the possibility that liquid mercury is present but may not have been discovered.	Survey instrument data generally acceptable.[d] Readings should be at the vents of appliances or headspace of bags. Bags should be warmed passively to ambient conditions and appliances/electronics should be at operating temperatures. Consider follow-up of survey instrument data with laboratory data.
Greater than 10	Isolation of contamination from residents or evacuation of residents	Indications are that 10 µg/m^3 may be the concentration at which urinary levels of mercury begin to increase. Other studies indicate this concentration may be the lowest toxic concentration (TCLo) for humans. Continued exposure may be harmful.	Survey instrument data acceptable.[d] Exposure to contaminant should be minimized.

[a] When using direct reading instruments, it is essential to take readings in enough locations to have a representative sample for assessing mercury vapor concentration in the room or area.

[b] Do not collect wipe samples for assessing exposure to mercury *vapor*. CT DPH will not evaluate wipe sample results for reoccupancy after a spill.

[c] Highest quality data would be NIOSH analytic results or equivalent (e.g., Lumex reading average over 8 hours).

[d] Survey instrument data considered to be any real time monitoring equipment (e.g., Jerome, MVI, VM 300, etc).

Table 2: Mercury Action Levels and Guidance for Indoor Spills in Other Locations (Non-Residential) (from USEPA 2019)[a,b]

Indoor Air Concentration (µg/m3)	Use of Action Level	Rationale for Action Level	Sampling Suggestions and other Considerations
Less than 3	Normal Occupancy for commercial settings where mercury exposure is not expected in normal course of work. (e.g., 29 CFR 1910 Subpart Z does not apply)	Concentration is based on residential action level of 1 µg/m^3 adjusted for a workday (i.e., 24/7 exposure reduced to 8/5- or 40-hour workweek). Persons exposed in these settings would not expect the presence of mercury as part of their normal employment.	No visible mercury; highest quality data.[c] Taken in breathing zone of most sensitive person under normal conditions for use. Pregnant workers should be offered alternate worksite.
1 - 3	Acceptable level for schools to resume normal operations.	Concentration is based on residential action level of 1 µg/m^3 adjusted for a typical school day.	No visible mercury; highest quality data.[c] Taken in breathing zone of most sensitive person under normal conditions for use. Pregnant workers and students should be offered temporary alternatives to working or attending the school.
3 - 6	Acceptable level for unrestricted use of vehicles under most conditions.	Exposure duration in most vehicles is short compared with other settings, allowing a higher concentration as the "floor" of this range. Requirement for no visible mercury means the source of vapors has been removed and concentrations should continue to fall. The "ceiling" of the range is based on the presumption that liquid mercury may still be present but not yet discovered.	No visible mercury; highest quality data.[c] Sampling in passenger compartment under normal use conditions. Unusual use of the vehicle in this case would be situations where the vehicle is the workplace.
Greater than 10	Isolation of contamination or evacuation of workers not covered by a health and safety program addressing exposure to mercury.	Indications are that 10 µg/m^3 may be the concentration at which urinary levels of mercury begin to increase. Other studies indicate this concentration may be the lowest concentration toxic to humans.	Survey instrument data acceptable.[d] Exposure to contaminant should be minimized.
25	Normal Occupancy for industrial settings where mercury exposure is expected in normal course of work. (e.g., 29 CFR 1910 Subpart Z does apply).	Based on the 1996 ACGIH TLV. Assumes hazard communications programs as required by OSHA; engineering controls as recommended by NIOSH; and medical monitoring as recommended by NIOSH and ACGIH are in place.	Survey instrument data acceptable.[d] Workers in these settings should be subject to OSHA standards for mercury (e.g., medical records, Subpart Z, HCS, HAZWOPER).

Indoor Air Concentration (µg/m3)	Use of Action Level	Rationale for Action Level	Sampling Suggestions and other Considerations
25	Upgrade responder protective ensemble to Level C[e] during uncontrolled releases of mercury	For response, workers subject to requirements of 29 CFR 1910.120, based on the ACGIH TLV, as recommended by the 1987 NIOSH/OSHA/USCG/EPA Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.	Survey instrument data acceptable.[d] Uncontrolled release refers to the absence of positive engineering controls on the material.

[a] When using direct reading instruments, it is essential to take readings in enough locations to have a representative sample for assessing mercury vapor. Concentration in the room or area.
[b] Do not collect wipe samples for assessing exposure to mercury *vapor*. CT DPH will not evaluate wipe sample results for reoccupancy after a spill.
[c] Highest quality data would be NIOSH analytic results or equivalent (e.g., Lumex reading average over 8 hours).
[d] Survey instrument data would be considered any real time monitoring equipment (e.g., Jerome, MVI, VM 300, etc.).
[e] Level C – EPA recommends use of full-face air-purifying respirators (APRs) with mercury vapor-specific cartridges for air mercury concentrations 25 – 615 µg/m^3.

Measurement of Mercury Vapor and Remediation

This guidance is not intended to be comprehensive. Readers should consult EPA (2019) for a more exhaustive discussion about measurement of mercury vapor and remediation.

Since there is no single protocol for cleaning up mercury spills in homes and schools, each situation will require thoughtful evaluation of a number of parameters before selecting a clean-up method. It is important to remember that the concentration of mercury vapor in an indoor space is influenced by a number of factors besides how much (quantity) of metallic mercury was spilled. These additional factors include room temperature, size of the room (volume), ventilation, how recently and how much the mercury source was disturbed prior to taking measurements, the surface area of the mercury source, and how long the mercury has been there. The presence of these factors may lead to higher or lower air concentrations. It is important to be aware of these modifying factors so that appropriate data interpretations can be made.

Some Factors Affecting Indoor Mercury Vapor Concentration:

- Room temperature
- Size of the room (volume)
- Ventilation
- How recently and how much the mercury source was disturbed prior to taking measurements
- Surface area of the mercury source
- How long the mercury has been there

Expect Higher Concentrations When:

- High room temperature
- Minimal ventilation
- A lot of movement that disturbs the source (like walking on a contaminated carpet, sitting on contaminated furniture)
- Large surface area (sweeping & vacuuming increase surface area)
- Recent (fresh) source

How To Measure

Regardless of which method is chosen, it is important to take enough samples in each area to develop a meaningful representation of the air concentration in each of those areas. Obviously, multiple data points will give a better representation than fewer. It is important to keep in mind that measurements of mercury vapor are highly affected by air currents. Even micro-currents that are created by someone simply walking past the sampler can cause a spike or drop in vapor concentration in the vicinity of the sampler. This is especially important to bear in mind when collecting grab samples with direct reading instrumentation (meters). The way to minimize this effect is to collect more samples and average the results, or to sample for a longer period of time to negate momentary spikes/drops in concentration.

Air contaminants stick to media in a solid sorbent tube after air is drawn through with a pump. Analysis occurs in the lab.

Practically speaking, this means that every time you write down a result, it should be an average of at least 3 collections. For example, if a Gold Film Mercury Vapor analyzer is used, press the button at least 3 times and average all of those readings to get one data point. Do this in each spot that you want to collect a sample. Alternatively, traditional industrial hygiene sampling may be performed by sampling for 2-8 hours (continuously) using a pump with a flow rate of 200–250 cc/min. Hopcalite or Hydrar are solid sorbent media used to collect mercury vapor with this method (NIOSH Method 6009).

One of the advantages of having a direct reading instrument is that it allows the field investigator to easily collect air samples in numerous locations in each room. In addition to scanning the entire affected room/area, look for potential "hot spots" where liquid mercury may accumulate. If metallic mercury is spilled in a room with tile or wood floors, collect air samples near cracks and crevices between floorboards/tiles, where mercury beads may become trapped. Also check cabinet interiors and drawers (especially corners and joints) if a thermometer or other device containing mercury broke there. If clothing may have been contaminated and then washed in a home washer, take meter readings inside of the washer and dryer. Don't forget to check the bottom of shoes. Note that it is critical for instruments to be properly calibrated before use. Guidance on instrument calibration can be found in EPA (2019).

Special portable direct reading instruments like this one provide instant mercury vapor results.

Where to Measure

Consider who might be exposed in the home, school, or office. Take measurements close to the breathing zone. This means that it may be necessary to collect air samples at different heights. For example, the breathing zone of an infant is close to the ground. In an office where adults are seated at desks for most of the day, the breathing zone would be around 4 feet from the ground.

Pay attention to the behaviors of the occupants. If there is a spill on the carpet in the living room and the children typically sit or lie on the floor in front of the TV, take at least three measurements in that area and average them. If the spill is on a couch, bed or chair, take at least three measurements there and average them. In both cases, occupants might have direct exposure for extended periods of time.

Breathing Zone Heights	
Infant	Near the floor
Toddlers & young kids	2-3 ft from the floor
Seated adults	4 feet from the floor
Standing adults	5-6 feet from the floor

Measurement After Remediation

Remediation activities are inherently disruptive and cause a lot of air movement. Measurements at the end of a clean-up day may indicate low to non-detectable air concentrations of mercury. However, despite the best clean-up efforts, sometimes we find elevated air concentrations a day or two after remediation has been performed. Why does this happen?

During the daytime, remediators may remove most solid/liquid sources of metallic mercury. However, some of this mercury may become suspended in the air, especially if the room is warm. During the evening, the room will presumably cool down. As the air cools, mercury vapor turns back into liquid and re-condenses onto surfaces in different/additional locations. It then re-vaporizes as the air warms and is again detectable with air monitoring equipment. Also, tiny mercury beads are sometimes left behind in cracks/crevices. They can become covered with dust, which may suppress vapor formation. The next day when the air is stirred up and dust is disturbed, those beads give off

vapor that is detectable with air monitoring equipment. The remediators may need to come back and re-clean. This rebound effect is normal and not an indication that they did an incomplete job the first time. We recommend that they continue to clean until the CT Action Guidelines are reached. You may wish to re-measure a day or two after the clean-up is complete to look for rebounding.

Application of CT DPH Guidance Values

Field investigators should re-scan the entire affected room/area to be sure the CT Guidance levels for re-entry are met before allowing people to re-occupy an area after a spill. Mercury toxicity is related to cumulative exposure. Exposure is determined by concentration multiplied by time (how much and for how long). Whereas emergency response personnel are concerned with short-term exposure to large amounts of contaminants, health professionals are also concerned with chronic, long term, low-level exposures that have effects which build up in the body. This is especially important with vulnerable populations such as children and pregnant women.

REFERENCES:

ATSDR 2022. Agency for Toxic Substances and Disease Registry (ATSDR). 2022. Toxicological Profile for Mercury (Draft for Public Comment). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

US EPA 2019. National Elemental Mercury Response Guidebook, United States Environmental Protection Agency, March 2019.

US EPA 1995. Integrated Risk Information System (IRIS) Chemical Assessment Summary for elemental mercury. National Center for Environmental Assessment, last updated June 1995.