



Mercury in Fluorescent Lighting

UNNECESSARY HEALTH RISKS
AND ACTIONABLE SOLUTIONS



AUTHORS

Peter Maxson, Expert to UNEP on mercury issues, Director, Concorde East / West Sprl

Michael Bender, Mercury Policy Project

Alicia Culver, Responsible Purchasing Network

Edited by Ana Maria Carreño, Clean Lighting Coalition/CLASP

ACKNOWLEDGEMENTS

We would like to thank the following individuals and their organizations for their valuable comments and review of this report: Hester Paul, Kathy Attar and Roxana Amaya-Fuentes (Children's Environmental Health Network), Andria Ventura (Clean Water Action California), Kyra Naumoff (Healthy Babies Bright Futures), Rebecca Meuninck (Ecology Center), Eric Gibbs and Lina Kelsaite (CLASP).

We would also like to thank Dr. Philippe Grandjean (Harvard T.H. Chan School of Public Health) for reviewing the report and Edward Groth, PhD (Groth Consulting Services) for his research for the 2008 Mercury Policy Project report that the current report builds upon.

This report was funded by the [Clean Lighting Coalition \(CLiC\)](#), a global partnership working to capture the health, economic and environmental benefits of phasing out mercury-based lighting technologies. CLiC is coordinated by CLASP, an international appliance, energy efficiency and market development not-for-profit organization.



TABLE OF CONTENTS

Executive Summary	4
1. Fluorescent lamps release mercury into the environment	7
1.1. Mercury in fluorescent lights	8
1.2. Mercury release pathways	9
1.3. Spent lamp recycling and disposal	10
2. Health risks from exposure to mercury	11
2.1. Elemental (metallic) mercury exposure	12
2.2. No “safe” levels of mercury in the body	13
2.3. No consensus on “safe” levels of mercury in indoor air	13
3. Mercury exposure risks to vulnerable populations	15
3.1. Mercury exposure in the home	16
3.2. Elemental mercury exposure during developmental phases	17
3.3. Mixed exposures during developmental phases	18
3.4. Others who are disadvantaged or chronically exposed	20
4. Mercury exposure risks to workers	21
4.1. Workers in lamp manufacturing plants	22
4.2. Workers in lamp recycling facilities	22
4.3. Other lamp handling and storage risks	23
4.4. Workers dealing with municipal waste and landfill sites	23
5. LEDs are a clean and safer alternative to fluorescent lamps	25
5.1. LEDs have a lower overall environmental impact than fluorescent lamps	27
5.2. LEDs eliminate mercury exposure to workers, consumers and the environment	27
5.3. LEDs are more energy-efficient than fluorescent lamps	28
5.4. LEDs last longer than fluorescent lamps	29
5.5. LEDs often pay for themselves quickly	29
6. Recommendations	30
Appendix 1 – Cleaning Up Mercury Spills	39

Executive Summary

All fluorescent lamps¹ contain mercury, a neurotoxin that can cause harmful and long-term health effects. This report outlines the health risks and environmental impacts of fluorescent lighting, highlights the many compelling advantages of transitioning to mercury-free alternatives, and gives actionable solutions to phase out mercury-added lamps in the United States. The findings and recommendations are synthesized in the following key points:

Mercury is a chemical of major public health concern, yet is still used in all fluorescent lighting.

Fluorescent lamps release mercury whenever they are broken. Because fluorescent lighting is ubiquitous, lamp breakage can occur in homes, schools, child care settings, office and apartment buildings, retail stores, factories, health care and other facilities.

There is no “safe” level of exposure to mercury. When a fluorescent lamp breaks, the clean-up recommendations detailed by the US Environmental Protection Agency (EPA) are ‘above and beyond’ what most people are aware of and prepared to do. This includes immediate evacuation, ventilating the room for several hours, shutting off central heating and cooling to avoid mercury dispersion, collecting all contaminated materials (clothing, protective gloves, rugs) in a sealed plastic container, and following their local government’s disposal recommendations.²

Those most at risk include:

- **Infants and toddlers**, who are likely to be most exposed to mercury vapor when a lamp breaks, especially in an unventilated space. Uptake of mercury vapor in early life not only results in a higher relative dose than in adults, but also increases the risk of developmental disabilities.
- **Workers**, who handle fluorescent lamps at manufacturing and recycling facilities as well as maintenance workers in commercial and institutional buildings (e.g., offices, schools, hotels, hospitals, and apartment buildings). In many cases, workers are unlikely to be informed about the risks and the appropriate measures to reduce exposure.
- **Communities of color and people living in low-income neighborhoods**, who may be chronically exposed to a combination of toxic substances, including mercury. Such multiple toxic chemical exposures can erode health overtime and result in higher levels of illness over time, especially in communities with lower access to medical support.

In the past, fluorescent lamps were promoted as an energy-efficient alternative to incandescent and halogen lamps, and the risks associated with mercury in fluorescents were tolerated as a necessary trade-off. Today, thanks to major advances in light-emitting diode (LED) technology, mercury-free LED lamps can cost-effectively replace fluorescents in virtually all applications. In addition, LEDs last longer than fluorescent lamps, and due to their lower energy consumption, their use results in less mercury and other harmful air pollutants released from coal-burning power plants.

Several health and environmental organizations partnered on the release of this report to highlight the risks posed by mercury in fluorescent lamps and recommend the following immediate actions:

- **The Biden Administration** should support an international phase-out of all general-purpose fluorescent lamps by 2025 at the upcoming Fourth Meeting of the Conference of the Parties (COP4) of the Minamata Convention on Mercury. This would support a proposal submitted to COP4 by the African Parties to the Convention.
- **The federal government** can phase out the manufacture and sale of fluorescent lamps in the United States by 2025. To accomplish this, the Biden Administration can work with:
 - Congress to strengthen federal lighting-efficiency policies and direct the **US Department of Energy** to conduct a new regulatory analysis of fluorescent lighting, including replacing the statutory category and definition of “general service fluorescent lamp” with a category and definition that would encompass both fluorescent and LED retrofit lamps, thereby enabling DOE to consider the cost effectiveness of mercury-free LED options in the regulation.

1 In order to avoid confusion, this report uses the term “lamp” instead of “bulb,” “light” or “light bulb” to identify any individual light source. Light fixtures or luminaires may contain more than one lamp or light source.

2 See more detailed guidance in Appendix 1.

- **The Environmental Protection Agency (EPA)** to establish new regulations under the Toxic Substances Control Act that would require manufacturers to phase out fluorescent lamps in order to prevent avoidable mercury releases into the environment. This would mirror proposals by the EU under its Restriction of Hazardous Substances (RoHS) Directive.
 - **State and local governments** can update their mercury reduction laws to prohibit the manufacture and sale of fluorescent lighting equipment for general purpose lighting applications. They can also immediately commit to purchasing only LED lighting equipment for their operations and update their websites so they are no longer promoting fluorescent lamps as an environmentally preferable or energy-efficient lighting technology.
 - **Utilities** can stop promoting fluorescent lighting equipment and offer rebates and other incentives only for LEDs.
 - **Lighting equipment manufacturers, retailers and distributors** can stop selling mercury-added lamps and provide improved collection and responsible disposal of fluorescent lamps.
 - **Unions and trade associations** that deal with the installation, replacement, and disposal of fluorescent lamps can advocate for safer, mercury-free LED alternatives to protect the health and safety of their members.
 - **Non-profit organizations** can promote LEDs as the most energy-efficient, cost-effective and environmentally preferable lighting option, remove any support for fluorescent lighting from their websites, and urge government agencies to adopt new policies phasing out the manufacture, sale and procurement of fluorescent lighting equipment.
 - **Schools, hospitals, public housing facilities, child care centers and government office buildings – as well as individual households and businesses** – can eliminate mercury exposure risks to vulnerable people by removing all fluorescent lamps as soon as possible and ensuring that they are disposed of properly. Replacing incandescent, halogen and fluorescent lighting equipment with LEDs can also reduce electricity bills and lower mercury and greenhouse gas emissions from coal-fired power plants.
- For more details on these recommendations, see page 30.



1. Fluorescent lamps release mercury into the environment

1.1. Mercury in fluorescent lights





All fluorescent lamps³ contain mercury. During the lifecycle of a fluorescent lamp – from lamp manufacturing to transportation, use and final disposal – there are many ways that mercury may be released into the environment.

The most common types of fluorescent lamps are compact fluorescent lamps (CFLs) and linear fluorescent lamps (LFLs). Most CFLs were designed to replace standard incandescent light bulbs, including the familiar pear-shaped lamp, and are commonly used in homes and home-based businesses including child care facilities. Most LFLs are straight tubes that come in various lengths (e.g., 2-foot, 4-foot, 8-foot); others are U-shaped or circular. They are most often used in commercial and institutional facilities such as government and business office buildings, schools, hospitals, colleges and universities.

The mercury in lamps is a significant portion of all mercury introduced into the U.S. economy in mercury-added products. Mercury-added lamps sold in the U.S. in 2018 contained 1.8 metric tons of mercury, which was about 17% of the total mercury in products sold in the U.S. that year, according to data reported to the U.S. Environmental Protection Agency (US EPA). In 2020, there were more than 2.7 billion CFLs and LFLs in use (“installed stock”) in the U.S., containing an estimated 12-15 metric tons of mercury, not including a significant quantity of mercury in lamps not in use (i.e., commercial and private inventories, lamps awaiting disposal, etc.). Fluorescent lamps discarded in 2020 contained more than 4 metric tons of mercury, of which more than 75% were not recycled or safely disposed (USDOE 2017, IMERC 2018, USDOE 2019, USEPA 2020a, USEPA 2020b, USEPA 2021e).

TABLE 1

TYPICAL MERCURY CONTENT IN FLUORESCENT LAMPS ON THE MARKET

TYPE OF FLUORESCENT LAMP	CHARACTERISTICS	MERCURY CONTENT PER LAMP
 T12 (1.5 inches in diameter) Linear Fluorescent Lamp	Relatively low energy efficiency and high mercury content; oldest of the fluorescent tubes.	5 mg up to 90 mg
 T8 (1 inch in diameter) Linear Fluorescent Lamp	The most commonly used fluorescent tube on the market, especially 4-foot lengths.	10 mg or less
 T5 (5/8 inch in diameter) Linear Fluorescent Lamp	Introduced in the mid-1990's as a more efficient alternative to T8 fluorescent tubes.	5 mg or less
 Compact Fluorescent Lamp	Introduced around 1980 in response to the oil-shocks of the early 1970's; promoted in the past as a more efficient alternative to incandescent lamps. Has either a screw base or pin base.	5 mg or less

³ In order to avoid confusion, this report uses the term “lamp” instead of “bulb,” “light,” or “light bulb” to identify any individual light source. Light fixtures or luminaires may contain more than one lamp or light source.

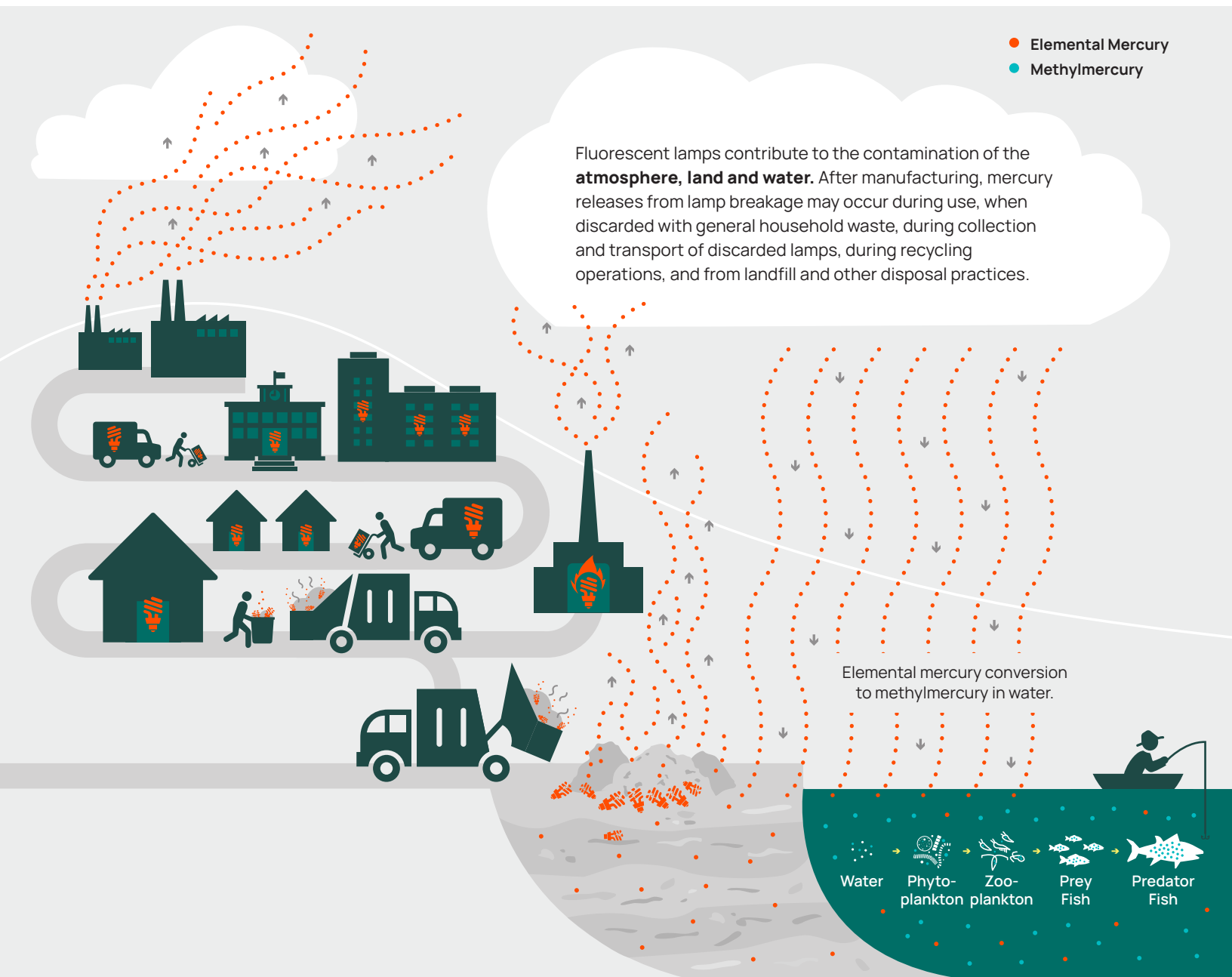
1.2. Mercury release pathways

Mercury releases during the lifecycle of fluorescent lamps contaminate the atmosphere, land and water. This contamination may occur during manufacturing or result from lamp breakage during installation, when spent lamps are comingled with general household waste, during collection or transport of discarded lamps, during processing or recycling of spent lamps, or when lamps are landfilled, incinerated or otherwise disposed of.

When emitted to the air, mercury can be transported globally in the atmosphere for up to a year. It ultimately settles on land or in water. Mercury can be washed from the soil into surface waters, where some of it is converted into organic methylmercury by certain bacteria and abiotic chemical processes (Böse-O'Reilly et al. 2010), and accumulates up through the food chain into the fish people eat, as summarized in Figure 1.

FIGURE 1

FLUORESCENT LAMPS RELEASE MERCURY TO THE ENVIRONMENT



1.3. Spent lamp recycling and disposal

Recycling of fluorescent lamps has been promoted as the primary way to prevent environmental mercury contamination. Such an approach, however, fails to take into account mercury releases during manufacturing, breakage during transport, end-of-life collection, and recycling. Moreover, recycling rates in the U.S. remain low. Most fluorescent lamps – particularly from households – are not collected separately and recycled; instead, they end up in the general waste stream (see box).

At some point, most fluorescent lamps in the waste stream break, and the mercury begins to volatilize. Gaseous mercury can then be emitted at various stages of the disposal process, including:

- on the way to a landfill or other waste management facility (from collection containers, transport vehicles, and transfer stations);
- from the active portion (i.e., the working face) of the landfill, and during waste handling operations (i.e., transport, dumping, spreading, compacting and burial);
- from the surface of covered, inactive portions of landfills (NEWMOA 2021);
- from landfill gas vents (many municipal sites collect the methane gas produced at landfills and either burn it, harness it as an energy source, or vent it to the atmosphere);
- from the stack of a municipal waste incinerator unless the incinerator has a pollution control device specifically designed to collect mercury; or
- from various informal disposal practices.



The U.S.-wide fluorescent lamp recycling rate is estimated at only 23% (USEPA 2021e). The National Electrical Manufacturers Association (NEMA) estimates that businesses recycle less than one third of their waste lamps (Lamprecycle 2021), and the recycling rate is even lower for lamps used in households, even in states with extended producer responsibility (EPR) programs. Only seven states (CA, MA, ME, MN, NH, VT and WA) have enacted EPR laws, which require lamp manufacturers to create a statewide recycling program and in some cases ban mercury-added lamps from going into the regular trash (Lamprecycle 2021; RSE 2017).

2. Health risks from exposure to mercury

Mercury is highly toxic to humans. It is on the World Health Organization’s list of the 10 chemicals or groups of chemicals of major public health concern, as it affects the nervous, digestive and immune systems (WHO 2020, 2021).

As presented in Table 2, mercury exists in three forms: elemental, inorganic and organic. Each form of mercury is toxic in its own way. Vulnerable groups, such as infants and young children, are likely to be affected at much lower levels of exposure than most adults (Mutter et al. 2007).

2.1. Elemental (metallic) mercury exposure

Elemental mercury is a liquid metal that vaporizes readily and is the form of mercury found in fluorescent lamps (as a liquid or an amalgam). Exposures to elemental mercury most often occur when mercury is spilled, or when a product that contains elemental mercury, such as a fluorescent lamp, breaks.

When inhaled as a vapor, elemental mercury can be absorbed by the lungs, migrate to the brain and damage the central nervous system. The half-life of mercury in the human brain is several years to several decades, which means that once mercury is in the brain, some amount will likely remain in the brain for much of a person’s life (Bjørklund et al. 2017). Symptoms of mercury exposure can include tremors, emotional changes, insomnia, neuromuscular changes, headaches, and poor performance on tests of mental acuity. Higher exposures can also cause kidney damage, respiratory failure and death (USEPA 2021a).

TABLE 2
KEY MERCURY EXPOSURE PATHWAYS AND EFFECTS

MERCURY FORM	KEY EXPOSURE PATHWAYS	TYPICAL SOURCES	TOXIC EFFECTS OBSERVED IN
Elemental (metallic)	<ul style="list-style-type: none"> Inhalation 	<ul style="list-style-type: none"> Emissions from coal-fired power plants Broken fluorescent lamps Broken thermometers Dental amalgams 	<ul style="list-style-type: none"> Central nervous system Immune system Kidneys Lungs
Inorganic (primarily mercuric chloride)	<ul style="list-style-type: none"> Ingestion Dermal 	<ul style="list-style-type: none"> Laxatives Cosmetic products Antiseptics 	<ul style="list-style-type: none"> Kidneys Skin (acrodynia) Central nervous system Gastrointestinal tract
Organic (primarily methylmercury)	<ul style="list-style-type: none"> Ingestion (oral) Parenteral (other ingestion) Placental 	<ul style="list-style-type: none"> Fish (accumulated through the food chain) Insecticides Fungicides 	<ul style="list-style-type: none"> Central nervous system Cardiovascular system

Source: Adapted from Böse-O'Reilly et al. (2010)

2.2. No “safe” levels of mercury in the body

For many years, scientists have attempted to define no-observed-adverse-effect levels (NOAELs) for mercury, i.e., levels of exposure at which no negative health effects are observed. Different NOAELs have been proposed for different subjects (e.g., adult, child, fetus), different lengths of exposure (e.g., acute, chronic), and different societal groups (e.g., workers, general public), etc. In the late 1990s, NOAELs were determined for mercury levels in urine, blood and hair. However, there is ample evidence that mercury concentrations in urine, blood and hair may not accurately reflect the mercury accumulations in body tissues - especially the brain and kidneys - and that current NOAELs are not adequately protective (Drasch et al., 2001, 2004).

As mercury can give rise to allergic and immunotoxic reactions which may be genetically regulated, in the absence of adequate dose-response studies for immunologically sensitive individuals, it has not been possible to set a level for mercury in blood or urine below which mercury related symptoms will not occur. (Kazantzis 2002).

More recent research confirms mercury as a “non-threshold” toxic substance, meaning that it can cause adverse effects “at virtually all levels of exposure” (Rahman and Singh 2019). In particular, fetuses and infants are highly susceptible to the effects of mercury exposure due to their more rapid metabolism, smaller size (i.e., higher dose-to-weight ratio), rapidly developing organs (especially the brain), and their lack of or limited ability to eliminate mercury from the body. (Mutter et al. 2007).

2.3. No consensus on “safe” levels of mercury in indoor air

Acute or chronic mercury exposure can cause adverse effects during any period of development. Mercury is a highly toxic element; there is no known safe level of exposure. (Böse-O'Reilly et al. 2010).

The complex toxicity of mercury has resulted in diverse guidance on what is considered a “safe” level of mercury in the air. Mercury vapor intake is a particular concern because 80% of inhaled mercury is absorbed by the body. As shown in Table 3 on the next page, the mercury concentration in outside air in the U.S. is typically less than 10 ng/m³. Many years ago, “safe” chronic (long-term) low-level exposure limits were set some 50-300 times higher than this baseline, with occupational exposure limits set at 100 times higher than chronic exposure limits. These standards, most of which have not been updated in many years, describe levels of exposure (including safety margins) that are intended to pose no appreciable health hazard to workers, the general public, or other identified groups.

For the most vulnerable groups, on the other hand, there is little data on the concentration of mercury in indoor air that might be considered safe. Moreover, there is evidence that mercury exposure limits that were once considered “safe”, do not necessarily provide adequate protection from harm, especially for vulnerable populations (Bjørklund et al. 2017; Mutter et al. 2007). There is clearly a need to reduce wherever possible the unnecessary mobilization and release of mercury, which does not break down in the environment and therefore represents an increasing risk to the health and safety of future generations.



TABLE 3

RECOMMENDED LIMITS FOR SAFE EXPOSURE TO MERCURY VAPOR IN AIR

AGENCY AND/OR EXPLANATION OF EXPOSURE LIMITS	MERCURY CONCENTRATION IN AIR (ng/m ³)*	REFERENCE
Typical U.S. ambient (outside) air	1 - 10	ATSDR 2012
American Conference of Governmental and Industrial Hygienists ACGIH (occupational exposure 8 h, 5-day week)	25,000	ACGIH 2014
Agency for Toxic Substances and Disease Registry (ATSDR), a branch of the Centers for Disease Control, Minimal Risk Level (MRL), e.g., chronic exposure for children	200	ATSDR 2012
US Environmental Protection Agency (EPA) Reference Concentration (RfC) for chronic (long-term) exposure	300	USEPA 1995
California Chronic Reference Exposure Level (REL), Office of Environmental Health Hazard Assessment	30	OEHHA 2019
California acute (short-term = 1-hour ave.) REL	600	OEHHA 2019
ATSDR "reoccupancy" mercury level, i.e., when it is safe to let people re-enter a building that has been contaminated with mercury	1,000	ATSDR 2012

*All units are given in nanograms, or billionths of a gram, per cubic meter of air

Over the years, a variety of mercury exposure limits have been recommended by different agencies in order to protect groups with different vulnerabilities from exposures over longer or shorter time periods, using different safety margins and lacking broad consensus. In research carried out by the State of Maine, following the breakage of a single CFL, the mercury concentration in the study room air often exceeded the Maine Ambient Air Guideline of 300 ng/m³, with short episodes over 25,000 ng/m³, and sometimes exceeding 50,000 ng/m³.

3. Mercury exposure risks to vulnerable populations

While mercury is toxic to all humans, there are several groups that tend to be more sensitive and/or more susceptible to the effects of mercury:

- (1) developing fetuses, infants and children and, by association, pregnant people and breast-feeding mothers;**
- (2) people more highly exposed to mercury and/or a mixture of pollutants (described below); and**
- (3) people with underlying health conditions that could be exacerbated by, or that could worsen the effects of, mercury exposure.**

Fluorescent lamp-related mercury exposure risk is generally proportional to the exposure dose. The risk might be lower in many cases but for the fact that the health of many individuals is already compromised by a range of other exposures. Communities that are predominantly Black, Latinx or Native American as well as people living in low-income neighborhoods have been shown to be especially vulnerable because there tends to be a higher concentration of polluting facilities such as landfills and industrial sites located in or near these communities, not to mention the often substandard housing stock.

3.1. Mercury exposure in the home

Fluorescent lamps can easily break during installation or removal, or when a fixture is knocked over. When a lamp is discarded, it can break in the trash even before it leaves the home or workplace. Or it can break outside in a dumpster or garbage truck, or at a store taking part in a recycling program.

When broken, most of the mercury in a lamp is released in vapor form, but some may adhere to surfaces inside the lamp and some may be released as tiny liquid droplets. Initial release of the mercury vapor is the most immediate health concern since that is when the mercury levels are likely to be more elevated. In an unventilated space, infants and toddlers at floor level are likely to have the most exposure to mercury vapor from a broken lamp.

In 2007, the State of Maine carried out 45 experimental trials to better understand mercury exposure risks resulting from a broken CFL in a small/medium-sized room. Mercury concentrations at a height of five feet (adult breathing zone) and one foot (infant/toddler breathing zone) above the study room floor were continuously monitored. Most notable was the variability of results depending on the type of lamp, when it was manufactured, how long it had been used, the amount of ventilation, and the cleanup method.

The study showed that the more time that passes between breakage and clean-up and the higher the temperature at the time of breakage, the more mercury will be released. When breakage occurs on a carpet, a rug or upholstered furniture, mercury can be absorbed by textile fibers. This mercury can later vaporize gradually, or more rapidly if the textile fibers are agitated by foot traffic, a broom, a vacuum, etc.

Following the breakage of a single CFL, the mercury concentration in the study room air often exceeded the Maine Ambient Air Guideline of 300 ng/m³, with short episodes over 25,000 ng/m³, and sometimes over 50,000 ng/m³. In most cases, a short period of ventilation was sufficient to significantly reduce the concentration of mercury in the air after breakage. However, the mercury air concentration sometimes rebounded when the room was no longer ventilated, particularly with certain types of lamps and during/after vacuuming. In non-vacuumed situations, mercury readings one foot above the floor were generally found to be greater than those at five feet.

Cleaning up a broken CFL with a vacuum in an unventilated room not only contaminated the vacuum cleaner (which was not easily decontaminated), but also raised the mercury concentration above the Maine Ambient Air Guideline, where it sometimes lingered for hours. Vacuuming also tended to mix the air in the room, resulting in the mercury concentrations at one foot and five feet to be similar immediately after doing so. Finally, even weeks after a clean-up, vacuuming a carpet in an unventilated room where a lamp had broken re-elevated the mercury concentration above the Maine Ambient Air Guideline (Maine DEP 2008).

Based on this research, any room in which a fluorescent lamp has broken – even if the incident occurred weeks or months previously – not only presents an exposure risk to occupants in the near term, but also presents a longer term risk due to the difficulty of properly cleaning up the mercury.

Given the risks of exposure when fluorescent lamps break, the best option is to replace them with safer LEDs. However, because countless lamps are still in use, these and related guidelines should be considered when a lamp does break:

- 1 Get people and pets out of the room, and avoid the breakage area on the way out.
- 2 Open a window or door for ventilation and leave the room for 5-10 minutes.
- 3 Never use a vacuum cleaner or broom, which could agitate and heat up lamp residues, adding to mercury vapor in the air.
- 4 Never allow people who are wearing mercury-contaminated shoes or clothing to walk around the house.
- 5 Never use a washing machine to launder clothing or other items that may have come in contact with mercury.



See Appendix 1 and full clean-up instructions: [ATSDR guidance](#); [US EPA guidance](#)

3.2. Elemental mercury exposure, especially during developmental phases

Children are at higher risk from mercury exposure than adults for several reasons. Children breathe more air per pound of bodyweight, are developing rapidly and tend to be more physically active. Therefore, the uptake of mercury vapor in children results in a higher internal dose (Miller et al. 2002; Bjørklund et al. 2017). Furthermore, during pregnancy, fast cell proliferation and migration occur during the second and third trimesters of gestation, and continue through the first 2-3 years of life, while neural development extends from the embryonic period through adolescence (Rice and Barone 2000; Bose-O'Reilly et al. 2010). Since mercury inhibits cell division and migration during development, the fetus and young child are particularly at risk of developmental disabilities.

Many studies describe the health risks to infants and children from low-level mercury exposures (Mutter et al. 2007, Böse-O'Reilly et al. 2010, Grandjean and Landrigan 2014). Even if only a fraction of the mercury in a fluorescent lamp is released in the hours after breakage (Aucott et al. 2003), a single broken lamp can generate mercury vapor levels in indoor air well above the state and federal safety guidelines (Maine DEP 2008, Sarigiannis et al. 2012). It is especially important that households with infants and/or young children take steps to minimize their risk of fluorescent lamp breakage (Li and Jin 2011, Salthammer et al. 2011, Singhvi et al. 2014). Reducing mercury exposure risks is also critical in home-based child care facilities, as many children in the U.S. spend 40+ hours a week in these settings.

3.3. Mixed exposures, especially during developmental phases

When an individual is exposed to a mixture of toxic pollutants, the health effects of any or all of them can be magnified in unpredictable ways. As described by Grandjean and Landrigan (2014):

A serious difficulty that complicates many epidemiological studies of neurodevelopmental toxicity in children is the problem of mixed exposures. Most populations are exposed to more than one neurotoxicant at a time, and yet most studies have only a finite amount of power and precision in exposure assessment to discern the possible effects of even single neurotoxicants.

Even if the exposure to a toxic substance is well below the NOAEL, mixed exposures to sub-NOAEL doses of toxic substances have been demonstrated to induce health effects that any of the individual substances would not induce at such a low dose. Moreover, such effects are magnified in vulnerable groups. As can be seen in the diagram below, every time one vulnerability or exposure overlaps with another, the health risk is magnified.

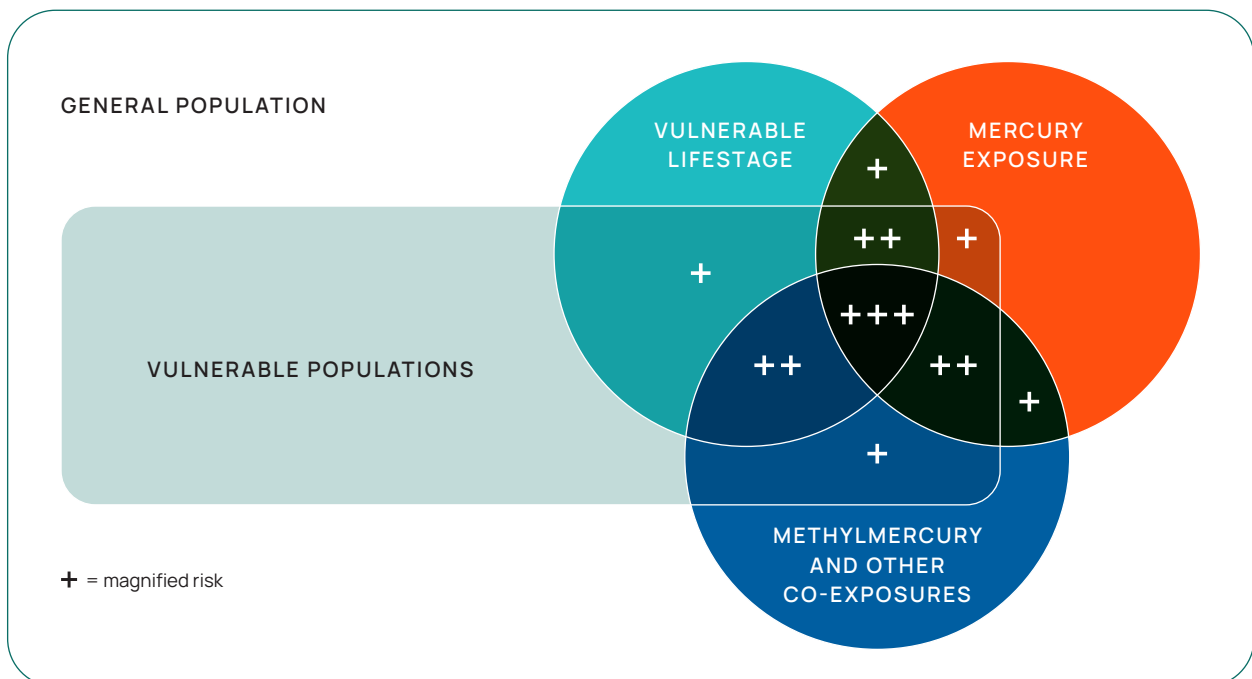
Mixed exposures to multiple metals, for example, have shown this effect, in particular during early stages of development (Sanders et al. 2015). Likewise, research on nerve cells exposed to lead, cadmium, arsenic and mercury found that the neurotoxic effects of the four

metals together, which are frequently all present in children living in environmentally polluted areas, were more severe than those induced by any two or three of these metals (Zhou et al. 2018).

In 2019, Healthy Babies Bright Futures purchased and tested 168 commercially available baby foods and found toxic heavy metals present in 95 percent of them. Even at the trace levels detected, these contaminants can alter the developing brain and erode a child's IQ. The report further noted that baby foods may also contain other neurotoxic chemicals – including perchlorate, phthalates and glyphosate – that can combine to further exacerbate health effects (HBBF 2019).

Motivated by the 2019 HBBF report to better understand and address the issue, the U.S. House of Representatives in February 2021 published a follow-up report confirming that commercial baby foods are tainted with significant levels of heavy metals. Among others, the level of mercury contamination was found to be up to five times higher than allowed under existing regulations for other food products. According to the report, “Exposure to toxic heavy metals causes permanent decreases in IQ, diminished future economic productivity, and increased risk of future criminal and antisocial behavior in children. Toxic heavy metals endanger infant neurological development and long-term brain function” (USHR Staff Report).

FIGURE 2
MAGNIFIED EFFECTS OF MIXED EXPOSURES ON VULNERABLE POPULATIONS



95 percent of baby foods tested contained one or more toxic heavy metals

1 in 4 baby foods contained all 4 toxic heavy metals assessed by our testing lab, including arsenic and lead.

TABLE 4

HEAVY METALS FOUND IN BABY FOODS

HOW MANY BABY FOODS HAD MULTIPLE HEAVY METALS IN A SINGLE CONTAINER?		IN HOW MANY BABY FOODS WAS EACH HEAVY METAL FOUND?	
4 metals	26% of baby foods	Lead	94%
3 metals	40%	Cadmium	75%
2 metals	21%	Arsenic	73%
1 metal	8%	Mercury	32%
0 metals	5% (9 foods)		



3.4. Others who are disadvantaged or chronically exposed

Marginalized and low-income people tend to be more exposed to a combination of toxic materials, due to factors like proximity to industrial facilities, construction projects and roadway emissions, occupying old or poorly maintained housing (with lead and asbestos exposures) and relying on subsistence fishing as a key food source, among others. Across geographies and income levels, most pollutant emission sources consistently result in higher exposures for people of color (Tessum et al. 2021; Hajat et al. 2015; Brender et al. 2011).

The increasing body of scientific evidence concerning mercury exposure risks provides an opportunity for U.S. regulatory agencies to revise their exposure guidelines to better account for the mixed toxic exposures to which some people are already subjected. In those instances where the science is inconclusive, adequate safety margins should be adopted to safeguard the health of the more vulnerable communities, many of which also have insufficient access to medical care.



Unequal access to energy-efficient lighting

The availability of energy-efficient lighting is not equitably distributed across socioeconomic groups, with poorer households at a distinct disadvantage. A case study in Wayne County, Michigan, explored the lack of equal access to energy-efficient lighting by evaluating disparities in lamp availability and price in 130 stores. It found: (1) energy-efficient lamps were less available and more expensive in disadvantaged areas and smaller stores; and (2) the costs to upgrade from incandescent and halogen lamps to CFLs or LEDs were also higher in poorer areas (Reames et al. 2018).



4. Mercury exposure risks to workers

Worker exposures to mercury during manufacturing, recycling and disposal of fluorescent lamps.

As mentioned previously, the organs most affected by the inhalation of elemental mercury vapor are the brain and kidneys. Weakened memory, insomnia, dizziness and tremors, among other symptoms, have been observed in workers at higher exposures. However, various studies (Piikivi & Tolonen 1989 and Ngim et al. 1992, as cited in WHO 2003) have also observed impaired neurobehavioral functions associated with long-term occupational exposure to mercury vapor at lower levels – in the range of 20,000-30,000 ng/m³, which sometimes exceeds the ACGIH “safe” occupational exposure level of 25,000 ng/m³ (see Table 3). Effects included slower and weaker measured brain activity, as well as significantly worse performance on a range of neurobehavioral (motor, visual, logical, etc.) tests. These findings were reaffirmed more recently by the World Health Organization (WHO 2020, 2021). Likewise, kidney damage has been shown at low-level long-term occupational exposure to mercury vapor concentrations of 25,000-50,000 ng/m³ (Langworth et al. 1992; Satoh 2000; SCHER 2010).

Below is an overview of mercury exposure risks to workers during the manufacture, recycling and disposal of fluorescent lamps.

4.1. Workers in lamp manufacturing plants

Today, very little fluorescent lamp manufacturing takes place in the United States. However, consumers are increasingly concerned about the working conditions of those who manufacture the products they buy no matter where they are produced. Most fluorescent lamps purchased in the U.S. are made in China. Within lamp manufacturing plants, emissions or spills can occur during purification and transfer of mercury, during injection of mercury into the lamp (“dosing”), and from broken lamps and manufacturing wastes. These kinds of releases can contaminate the working area and pose a health risk to workers (Corazza and Boffito 2008).

4.2. Workers in lamp recycling facilities

Although it has failed to realize its potential, recycling of fluorescent lamps has long been promoted as the primary way to minimize mercury releases from spent lamps. For lamps that don’t end up in landfills or



Exposure risks to workers in CFL manufacturing

Researchers studying a CFL manufacturing facility in China documented elevated mercury concentrations in the hair of workers, in rice grown in the proximity of the factory (compared to rice brought in from outside the area), and in residents consuming local rice (Liang et al. 2015).

incinerators, end-of-life lamp management includes separate collection, transport and recycling, any of which may result in lamp breakage. All types of end-of-life lamp management potentially expose workers, but some operations are riskier and more difficult to manage.

Large recycling facilities typically use a “dry” process in which lamps are crushed inside units that operate under negative air pressure. They are designed to capture mercury vapor in a two-stage carbon filtration system. According to the design specifications and permit requirements for most recycling facilities, the exhaust air needs to be monitored and the filters changed out frequently.

Drum-top crushers, on the other hand, are simple devices designed to reduce the volume of fluorescent lamp waste. They are not designed for nor capable of preventing mercury emissions even when used according to manufacturer instructions with the recommended carbon filters (NEWMOA 2016). Because drum-top crushers are often operated without required filter changes and by untrained workers without adequate protective gear and monitoring devices, significant mercury releases and occupational exposures commonly occur during their operation. Opening the unit to change out the crusher top also results in significant mercury release and worker exposure (ATSDR 2003, Lucas et al. 2006).

Several states (including California, Vermont and Minnesota) prohibit the use of drum-top crushers



Worker exposure at a Wisconsin fluorescent lamp recycling facility

A 2017 investigation of environmental contamination at a fluorescent lamp recycling facility in Madison, Wisconsin found elevated mercury levels among five of seven workers (two declined to be tested), and clinical signs of mercury toxicity (e.g., tremors) in two of those five workers. Use of personal protective equipment was inadequate, and mercury levels in indoor air exceeded safe thresholds. Mercury levels in indoor air varied within the building, with a maximum of 207,400 ng/m³ at floor level on the crushing platform, approximately eight times higher than the American Conference of Governmental and Industrial Hygienists (ACGIH) threshold limit value of 25,000 ng/m³. Mercury was also found in workers' vehicles, indicating the risk of take-home exposure (Wilson et al. 2018).

because of the health and safety risks they pose to workers due to inevitable mercury emissions and the difficulty of adequately regulating numerous small processors.

4.3. Other lamp handling and storage risks

In addition to lamp breakage and subsequent mercury releases, other catastrophic accidents can place both workers and local communities at risk. For instance, in Cleveland, Ohio, an unpermitted warehouse operated by Fluorescent Recycling, Inc., caught on fire in 2018, exposing the community to toxic fumes and runoff containing mercury and polychlorinated biphenyls (PCBs). This fire occurred approximately two years after Ohio EPA issued a compliance order directing the company to clean up the warehouse following an inspection that found more than two million spent fluorescent lamps, many of them broken, 250 drums of PCB-containing lighting ballasts, and other electronic equipment stored in the building. After the fire, the Ohio EPA worked with the U.S. EPA to remove more

than 400 tons of fluorescent lamps and debris from the building. The clean-up lasted seven months and cost the EPA \$1.3 million. Moreover, further testing after the clean-up showed that the warehouse was still contaminated with mercury. "This crumbling warehouse was crammed full of hazardous junk that put the neighboring community at risk," Ohio Attorney General Dave Yost said (Ohio AG 2019, ALM 2021).

Fluorescent lamp drop-off locations that are part of recycling programs may also put store workers and customers at risk. Many mercury-added lamps can easily break when they are collected for recycling in drop-off bins such as the one pictured here. Often linear fluorescent tubes end up in CFL recycling bins that may not be designed for them. At such locations, store workers as well as customers dropping off spent lamps can become exposed to mercury vapor even when they try to recycle fluorescent in accordance with product guidance.



4.4. Workers dealing with municipal waste and landfill sites

Municipal waste contaminated with mercury from discarded products has long been a challenge, as landfill operators generally don't regularly monitor the mercury concentration of waste (Southworth et al. 2005). This leaves workers as well as local communities near landfill sites exposed to unknown levels of mercury vapor, particularly emanating from the working face of a landfill and when trash is dumped awaiting incineration. Mercury releases to air at landfill sites can be significant, as described on the next page.

Mercury emissions at landfill sites

Mercury emissions to the air were measured at several landfills in Florida. Releases were found in landfill gas (LFG) from active vent systems, passive emissions from the landfill surface, and emissions from daily activities at each working face (WF) of the landfill. Of most concern were the WF emissions of approximately 200-400 mg/h where workers could be exposed during working hours, as the WF would generally not be covered with soil until the end of the day. Attempts to identify specific mercury sources in the waste were not successful due to the extent of waste mixing. However, since lamps and fever thermometers are most easily broken, it is likely that these sources were largely responsible for the mercury emissions at the WF. The authors estimated atmospheric mercury releases from municipal landfill operations in the state of Florida at 10-50 kg/year (Lindberg et al. 2005).



5. LEDs are a safer alternative to fluorescent lamps

Over the past decade, the availability, price and performance of LED lighting equipment has improved to the point where it is now considered the most cost-effective and reliable lighting option in the U.S. marketplace.

While fluorescent lamps have long been promoted as the best replacement for inefficient incandescent and halogen lighting equipment, LEDs are now considered superior to both compact fluorescent lamps (CFLs) and linear fluorescent lamps (LFLs such as T8s), for many reasons:

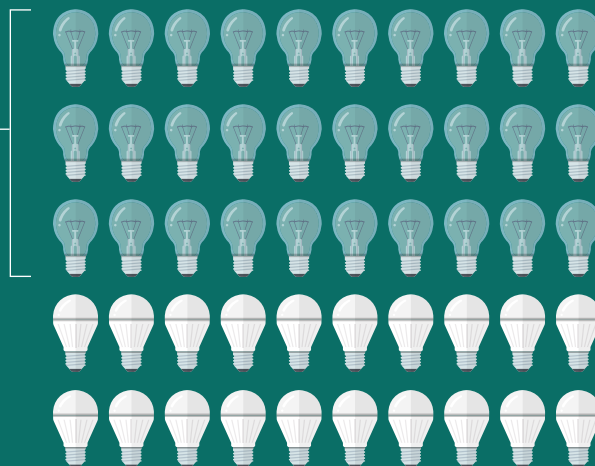
- Unlike fluorescent lamps, LEDs are mercury-free, eliminating all risk of mercury exposure from breakage
- LEDs are the most energy-efficient type of lighting technology, typically using half as much electricity as fluorescent to provide the same illumination, significantly lowering energy bills
- Many LED products are dimmable, which yields further energy savings and improves user comfort
- LEDs typically last 2-3 times longer than fluorescent lamps, so they don't have to be changed as often and they generate less waste
- LEDs have the lowest overall lifecycle environmental impact
- LEDs offer benefits such as instant full brightness and better light quality

Indeed, LED lamps have become increasingly popular with American consumers. According to a 2020 report by Apex Analytics, 60% of retail lamp sales are now LEDs. In other words, CFLs are no longer needed or preferred by U.S. consumers (Apex Analytics 2020).

In 2019, the U.S. Department of Energy concluded that LEDs "are revolutionizing the lighting market," explaining that they "have surpassed, or matched, all conventional lighting technologies in terms of energy efficiency, lifetime, versatility, and color quality, and, due to their increasing cost competitiveness, LEDs are successfully competing in a wide variety of lighting applications. Going forward, LED technology is expected to continue to improve, with increasing efficacy and decreasing prices while enabling new opportunities for lighting design and energy savings" (USDOE, 2019).

The average American home has approximately
50 lamp sockets.

About 60%
of them still contain an
inefficient lamp.



**High-quality,
\$2 LED lamps**
could be installed in
those sockets and save
Americans over \$6
billion a year to light their
homes.

Source: US EPA 2017

5.1. LEDs have a lower overall environmental impact than fluorescent lamps

In 2017, a review of 13 lifecycle assessments comparing LED products with conventional alternatives found that LED lamps have the best environmental performance for both indoor and outdoor lighting applications. The study also noted that LED lamps have the lowest environmental impact, driven primarily by their higher efficiency compared to conventional technologies (Franz and Wenzl 2017). The environmental performance of LEDs has continued to improve since that review, with further improvements in LED efficacy.

5.2. LEDs eliminate mercury exposure to workers, consumers and the environment

Unlike fluorescent lamps, LEDs are not made with mercury, so there is no potential for exposure to this neurotoxic substance at any point in the LED lifecycle from manufacture through disposal. And due to their



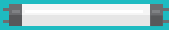
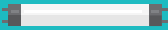
higher efficiency compared to fluorescent lamps, LEDs reduce electricity consumption and the related mercury emissions from coal-fired power plants on the electric grid.

While LEDs may contain small amounts of toxic materials such as lead or arsenic, they do not pose a direct danger to users. Unlike fluorescent lamps, if an LED lamp breaks, the toxic materials in it will not vaporize or expose people to them. In addition, LEDs are much less prone to breakage because their casings are often made of plastic instead of glass. Consequently, consumers do not have to carefully handle LEDs to prevent them from releasing toxic chemicals in a home, institution or office building.

Consumers should look for LED lighting products that comply with the European Union's Restriction of Hazardous Substances (RoHS) Directive because they are largely free of lead, cadmium and other chemicals of concern. In addition, although LEDs are much safer than fluorescent lamps, as with all electronic waste, they should be disposed of properly.

TABLE 5

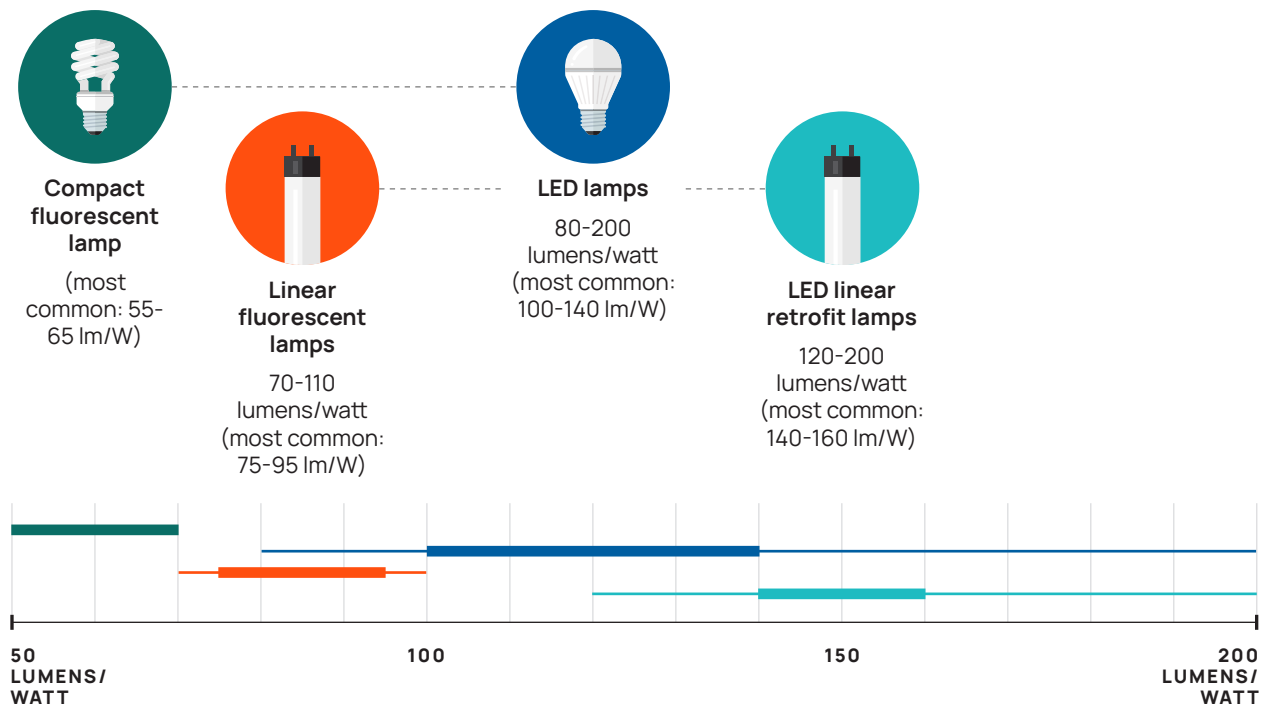
COMPARISON OF COMMON FLUORESCENT LIGHTING TO LED OPTIONS

LAMP TYPE	 TYPICAL HOUSEHOLD COMPACT FLUORESCENT LAMP (CFL)	 REPLACEMENT LED	 TYPICAL WORKPLACE T8 LINEAR FLUORESCENT LAMP (LFL)	 REPLACEMENT LED
Watts for equivalent light	15W	7.5W	32W	15.5W
Energy efficiency	Low	High	Low	High
Typical lifespan*	4.8 years	10.3 years	5.5 years	13.7 years
Yearly electricity cost*	\$3.04	\$1.52	\$13.51	\$6.55
Contains mercury	Yes	No	Yes	No

* Assumes 4 hours/day for CFL and replacement LED, and 10 hours/day for LFL and replacement LED; Average US national electricity prices, July 2021: Domestic \$0.1390/kWh and Non-Domestic \$0.1157/kWh (US DOE, Energy Information Administration, October 2021).

FIGURE 3

EFFICACY RANGES OF VARIOUS LAMPS



Sources: USDOE 2021, SSL Annex 2020, DLC 2020

5.3. LEDs are more energy-efficient than fluorescent lamps

For the past few years, government agencies, utilities and environmental organizations throughout the U.S. have been increasingly promoting LEDs – rather than CFLs – as the most energy-efficient replacement for incandescent and halogen lamps because of their superior ability to reduce energy consumption. For example, the U.S. EPA’s ENERGY STAR program now reports that LED lamps can produce the same brightness as incandescent and halogen lamps while using 70-90% less electricity (USEPA, 2021b). In 2017, the ENERGY STAR program increased its minimum efficacy requirements for lamps to 80 lumens per watt for omnidirectional lamps, effectively phasing out CFLs from the program. LED lamps have continued to improve since then, to the point that they are now approximately 50% more energy-efficient than fluorescent lamps (SEA/CLASP 2020).

While LED lamps are highly energy-efficient in general, many models can reduce electricity consumption further because they are easily dimmable. Notably, more than 90% of the LED lamps on the ENERGY STAR list are dimmable (USEPA 2021d). Moreover, a growing number of LED lamps can yield additional energy

savings and other performance benefits by operating with intelligent controllers, including “smart home” integrations that enable consumers to manage their lighting use from apps and other centralized platforms.

Government agencies across the U.S. have documented substantial cost savings by transitioning from conventional lighting to LEDs. According to the *2020 Maryland Green Purchasing Committee Annual Report*, the state reduced its yearly electricity bill by approximately \$60,000 by purchasing LEDs instead of incandescent, halogen and fluorescent lamps for its operations. Since LED lamps typically last 5-10 years, the total electricity savings are projected to be \$300,000-\$600,000 over the life of these products.

The superior energy efficiency of LEDs compared to fluorescent lamps has an important, indirect mercury-reduction benefit because it reduces demand for electricity generated by coal-fired power plants, which are a significant contributor to emissions of mercury, greenhouse gases (GHGs) and other pollutants. Thus, the argument that fluorescent lamps should be tolerated – and even promoted – as an important way to reduce energy consumption and power plant emissions is no longer valid.

5.4. LEDs last longer than fluorescent lamps

LED lamps typically last 2-3 times longer than the fluorescent lamps they replace. Home Depot, a major U.S. supplier of fluorescent and LED lighting equipment, estimates that while quality CFLs last about 10,000 hours, quality LEDs last about 25,000 hours (Home Depot 2021). While the rated life of specific CFLs and LED lamps varies, LEDs as a class outperform CFLs.

The comparison is similar for LFL tubes and their LED replacements. While LFLs typically have a rated life of between 18,000-24,000 hours, the LED retrofit tubes for those installations are often rated for 50,000-70,000 hours.

5.5. LEDs often pay for themselves quickly

Because of their high efficiency combined with low prices, LEDs pay for themselves relatively quickly – often within a year. Therefore, it makes economic sense to replace fluorescent lamps with LEDs even if they have not reached failure point.

Many lighting suppliers that offer both LEDs and fluorescent lamps highlight short payback periods from upgrading fluorescent lamps to LEDs. For example:

- LEDvance (formerly OSRAM Sylvania) states on their website that the payback period of retrofitting with an LED tube is as short as four months: “Payback of acquisition and replacement costs possible after only four months.” LEDvance further notes that there are great energy savings potentials – “Up to 70% compared to similar fluorescent lamps” (LEDvance 2021)

- Regency Lighting, a major lighting supplier, offers an on-line calculator and case studies demonstrating the cost-effectiveness of upgrading larger facilities to LEDs. Its calculated payback period to recover the cost of the LED conversion through energy savings is 10 months (Regency Lighting 2019).

In applications such as these with very short payback periods, the cost of the LED upgrade is recovered within a company’s fiscal year through immediate reductions in their operating costs. Furthermore, Grainger, a major U.S. wholesaler of lighting equipment to government agencies and businesses, noted, “In addition to saving energy, LEDs emit less heat, reducing the load on HVAC systems and are also controllable, and more compact, offering more design flexibility.” (Grainger 2021)

5.6. LED lamps are widely available

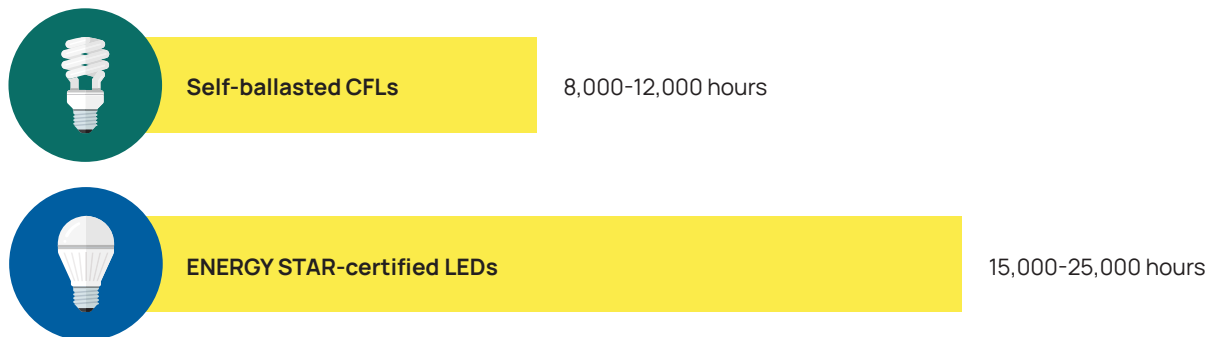
LED lamps can replace most types of fluorescent lamps used for general-purpose lighting applications. This includes screw-base and pin-base CFLs as well as linear fluorescent T12s, T8s and T5s.

LED lamps can replace virtually every type of CFL, including standard omni-directional lamps, floodlights, decorative bulbs, and more. As of 2021, there are over 10,000 models of ENERGY STAR-certified LEDs available for sale in the United States (US EPA, 2021). Across the United States, LED lamps are widely available in supermarkets, hardware stores and other retail shops in all neighborhoods, giving consumers direct, easy access to mercury-free, energy-efficient lighting for their homes. In addition, the Qualified Product List of the Design Lights Consortium (DLC, 2021) includes more than 750 models of 4-pin LED retrofits for CFLs.

LED lamps that can replace LFLs are available in different lengths, diameters, light colors, and levels of light output. The DLC List includes 29,000 models of LED lamps that can replace straight as well as u-shaped T8 fluorescent lamps as well as T5 LFLs.

FIGURE 4

RATED LIFE OF SELF-BALLASTED CFLS AND LED LAMPS



Sources: USDOE 2021; USEPA 2021c

6. Recommendations

Below is a summary of the most important actions that government agencies, utilities, manufacturers, retailers, nonprofit organizations, educational and health care facilities, property owners and landlords, child care and other early learning facilities, public housing facilities, and consumers can take to accelerate the transition from fluorescent lighting to more energy-efficient, mercury-free LED technology. These actions will minimize direct mercury exposure risks associated with the breakage of fluorescent lamps during their manufacture, use, recycling and disposal. They will also reduce indirect mercury exposure from releases of this highly toxic substance into the environment by coal-fired power plants because LEDs use less electricity than fluorescent lamps.



The federal government can:

- **Support an international phase-out of all general-purpose fluorescent lamps no later than 2025** at the upcoming Fourth Meeting of the Conference of the Parties of the Minamata Convention on Mercury. This would support a [proposal submitted](#) by the African Parties to the Convention and would be aligned with the Biden Administration's recently issued [Executive Order 14008: Tackling the Climate Crisis at Home and Abroad \(2021\)](#).
- **Lead by example by phasing out the manufacture and sale of fluorescent lamps in the United States by 2025.** To accomplish this, the Biden Administration can work with Congress to revise federal lighting energy-efficiency policies and require US DOE to conduct a new regulatory analysis of fluorescent lighting, including a new statutory definition of "general service fluorescent lamp" which would allow the term to encompass both fluorescent and LED retrofit lamps, thereby enabling DOE to consider the cost effectiveness of mercury-free LED options in the regulation.

The European Commission has already taken similar action under its Restriction of Hazardous Substances (RoHS) and EcoDesign Directives. Under Ecodesign, Europe banned CFLs with integral ballasts and T12 linear fluorescent lamps on 1 September 2021, and will ban most T8 linear fluorescent tubes on 1 September 2023. Under the RoHS Directive, Europe is currently proposing to phase out the remaining CFLs, T8s and T5 fluorescent lamps in 2022 or 2023.
- **Commit to immediately start purchasing only LED lighting equipment for its facilities** except when no LED products are available to meet a specific need. This is consistent with President Biden's 2021 [Executive Order 14008](#), which established a goal "to lead the Nation's effort to combat the climate crisis by example – specifically, by aligning the management of Federal procurement and real property, public lands and waters, and financial programs to support robust climate action."
- This action would also bring the federal government into compliance with the Energy Policy Act (EPAAct) and federal acquisition regulations, which direct federal agencies to purchase ENERGY STAR-certified lighting products or DesignLights Consortium (DLC)-listed lamps, retrofit kits and luminaires based on Federal Energy Management Program (FEMP) guidance.
- As a first step, the [US EPA's Environmentally Preferable Purchasing \(EPP\) Program](#) can adopt Green Lighting Specifications for all federal agencies to incorporate into their contracts. The EPA's EPP Program has already recommended specifications, standards and ecolabels for federal purchasing across several other important product categories such as IT equipment, cleaners and office supplies. By doing so, it "harnesses the power of the over 550 billion dollar federal pocketbook to catalyze a more sustainable marketplace for all." The EPA should also collaborate with the US Department of Energy's Sustainable Acquisition Program, which encourages DOE sites to purchase products on its [Priority Products List](#) that have the most sustainable attributes, including LED lighting equipment.



The Environmental Protection Agency can:

- **Establish new regulations under the Toxic Substances Control Act (“TSCA”) that force manufacturers to phase out fluorescent lamps.** Thus far, EPA has determined that mercury does not warrant further assessment or regulation under the TSCA to avoid duplicative action being taken to implement and comply with the Minamata Convention. But under TSCA, EPA has the authority to regulate mercury and mercury-containing products like fluorescent lamps to go beyond the current scope of the Convention and align with the Amendment proposed by the Africa Region.
- **Reassess its existing regulatory approach because it is inadequate to protect human health** – as outlined in this report – and draft a rule providing mercury-containing product manufacturers adequate notice and time to phase out mercury use.



States and local governments can:

- **Adopt and enforce mercury reduction laws to phase out the sale of fluorescent lamps for general-purpose lighting applications.** For example, [Vermont law](#) bans sales of mercury-containing lamps unless the manufacturer has demonstrated that no alternative mercury-free lamp with equivalent performance is available at a comparable cost. Many jurisdictions have already done this for other types of mercury-added products.
- **Update their guidance, including in their websites and other media platforms, to ensure consistent messaging about the hazards of mercury in fluorescent lamps and the advantages of LEDs** including reduced use and risk of toxic materials, better energy efficiency, longer product life, consumer cost savings, and other health, environmental and economic benefits.
- **Adopt new lighting specifications that prohibit vendors from offering fluorescent lamps, fixtures and ballasts on their state supply contracts.** [Maryland](#), [Minnesota](#), and [New York State](#) are already using this approach.



In 2007, California adopted the *Lighting Efficiency and Toxics Reduction Act*, which prohibits the sale of general-purpose lighting in the state if it exceeds certain levels of hazardous substances (e.g., mercury or lead) prohibited by the European Union’s Restriction of Hazardous Substances (RoHS) Directive. This law should be updated because it references the now defunct EU RoHS Directive from 2003 (2002/95/EC) rather than the current version adopted in 2012 (2011/65/EU), which establishes more stringent limits on the mercury content of CFLs and LFLs. Furthermore, in June 2021 the European Commission proposed new revisions for mercury-lighting under the RoHS Directive, phasing out most fluorescent lamps within the next two years.

- **Develop contracts for environmentally preferable lighting equipment** that offer a wide array of LED lighting products at discounted prices to state agencies, local governments, educational and health care facilities, and nonprofit organizations. [New York State](#) and the [City of San Francisco](#) have developed lighting contracts that feature LED lamps and luminaires.
- **Set “Green Lighting” goals to motivate employees, businesses and the public to purchase LED lamps and fixtures.** An example of this is California’s *Million LED Lamp Challenge*, which is working “to make high-quality, high-efficiency light sources available at a great price” to the students, staff and alumni of the University of California, California State Universities, and California Community Colleges and has created a model LED lighting equipment specification.

I PLEDGE TO LIGHT MY MOMENTS WITH ENERGY STAR



If all Americans replaced their inefficient light bulbs with ENERGY STAR certified LED bulbs, we would save \$1.5 billion dollars in annual energy bills, and prevent 17 billion pounds of annual carbon pollution.

[Disclaimer](#)

- **Track and report cost savings, reductions in greenhouse gas emissions, and other benefits that result from purchases of LED lighting equipment.** Maryland and Massachusetts do this. For example, in its *FY2020 Environmentally Preferable Purchasing Annual Report*, the Massachusetts Operational Services Division calculated approximately \$2 million in annual cost savings – and nearly \$18 million in lifetime cost savings – in 2020 resulting from purchases of LEDs by state agencies, local governments and other users of its statewide contracts.



Schools, child care facilities, healthcare facilities, public housing facilities, and the general public can:

- **Replace all fluorescent lighting equipment with LED lamps, retrofit kits and luminaires, prioritizing facilities where pregnant or nursing people, and children live or gather. Immediately remove lighting equipment that contains old magnetic fluorescent ballasts (pre-1979) that could leak PCBs.**
 - LED lighting equipment for commercial and institutional settings can be found on the DesignLights Consortium’s Qualified Products list at designlights.org/search/.
 - ENERGY STAR-certified residential-grade LEDs are widely available in stores and can be found at: www.energystar.gov/productfinder/product/certified-light-bulbs/.
 - Public agencies and institutions as well as nonprofit organizations can often buy LED lighting equipment at discounted prices using state and local government contracts.
- **Replace incandescent, halogen, and fluorescent lamps with LEDs** to lower their electricity bills and reduce emissions from power plants that contribute to climate change and mercury build-up in the environment. Utility rebates may be available to offset the cost.
- **Ensure that fluorescent lamps are managed and disposed of properly.** Mercury-added lamps currently in use present health and environmental risks and must be handled with care. Earth911 and other websites help consumers identify permitted lamp recycling sites nationwide.



Lighting equipment manufacturers and distributors can:

- **Offer more LED lighting products that are certified by the ENERGY STAR program or included on the DesignLights Consortium’s Qualified Products List** in order to give consumers confidence that they are buying high-quality products. They should also team up

with utilities to offer rebates at the point of sale, especially for linear LEDs.

- **Stop selling fluorescent lighting equipment.** Remove information from websites promoting fluorescent lamps as environmentally preferable or energy-efficient options, including outdated references to ENERGY STAR certification.
- **Provide free collection and responsible disposal of CFLs and LFLs** for at least three years after they are no longer marketed. Team up with lamp recyclers that have earned a sustainability certification (e.g., e-Stewards or R2) to ensure that spent lamps are handled responsibly.
- **Support fluorescent lamp phase-out legislation** and encourage National Electrical Manufacturers Association (NEMA) and other relevant trade associations to do the same.



Utilities can:

- **Advocate for federal, state and local policies that phase out fluorescent lamps** and support a more rapid transition to LED technologies. This will reduce peak power demand and related mercury and greenhouse gas emissions.
- **Educate customers through bill inserts and other channels** about the energy and economic benefits of replacing incandescent, halogen and fluorescent lamps with LEDs even before the existing bulbs fail.
- **Stop promoting CFLs and LFLs, and offer rebates only for LED lighting equipment (especially to replace fluorescent T8 tube lamps).** They can also collaborate with retailers to offer in-store rebates at the point of sale, provide increased financing, sponsor giveaways, and/or offer other incentives for LED replacements.



Environmental organizations can:

- **Unequivocally promote LEDs** as the most energy-efficient and environmentally preferable lighting equipment option, remove any support for fluorescent lighting from their websites, and urge government agencies and businesses to do the same.
- **Advocate for federal, state and local policies to phase out the manufacture and sale of fluorescent lamps in the United States – and globally – to hasten the transition to LEDs.** This includes the adoption of procurement policies that prohibit public agencies from purchasing fluorescent lamps (except when no LED replacement is available) and commitments by lighting manufacturers and retailers to stop selling mercury-added lamps.

References

- ACGIH 2014. TLVs and BEIs Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure. American Conference of Governmental and Industrial Hygienists (ACGIH), Cincinnati, Ohio, 2014.
- ALM 2021. Judge orders owner of Cleveland fluorescent light bulb warehouse to clean up contaminated site following 2018 blaze, posted Dec 03, 2019, by Cory Shaffer, cleveland.com, ©Advance Local Media LLC. <https://www.cleveland.com/court-justice/2019/12/judge-orders-owner-of-cleveland-fluorescent-light-bulb-warehouse-to-clean-up-contaminated-site-following-2018-blaze.html>
- Apex Analytics 2020. *LED Market Update*. https://www.creedlighttracker.com/wp-content/uploads/2020/05/Spring-2020-Lighting-Update_050520_PDF.pdf.
- ATSDR 2003. Health Consultation: Drum-Top Bulb Crusher Demonstration at the Minneapolis-St. Paul International Airport, Bloomington, Hennepin County, Minnesota. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Division of Health Assessment and Consultation, Atlanta, Georgia. December 1, 2003.
- ATSDR 2012. Chemical-Specific Health Consultation for Joint EPA/ATSDR National Mercury Cleanup Policy Workgroup: Action Levels For Elemental Mercury Spills. Division of Toxicology and Environmental Medicine Prevention, Response and Medical Support Branch Emergency Response Team, Agency for Toxic Substances and Disease Registry, March 22, 2012. https://www.atsdr.cdc.gov/emergency_response/Action_Levels_for_Elemental_Mercury_Spills_2012.pdf
- Aucott et al. 2003. Michael Aucott, Michael McLinden and Michael Winka, Release of Mercury From Broken Fluorescent Bulbs, *Journal of the Air & Waste Management Association Volume 53*, 2003 - Issue 2.
- Bjørklund et al. 2017. Geir Bjørklund, Maryam Dadar, Joachim Mutter, Jan Aaseth, The toxicology of mercury: Current research and emerging trends. *Environmental Research* 159 (2017) 545–554.
- Bse-O'Reilly et al. 2010. Stephan Bse-O'Reilly, Kathleen M. McCarty, Nadine Steckling, Beate Lettmeier, Mercury Exposure and Children's Health, *Curr Probl Pediatr Adolesc Health Care* 2010; 40:186–215.
- Brender et al. 2011. J. D. Brender, J. A. Maantay and J. Chakraborty, Residential proximity to environmental hazards and adverse health outcomes. *Am. J. Public Health* 101, S37–S52 (2011).
- Corazza and Boffito 2008. Alessio Corazza and Claudio Boffito, Mercury dosing solutions for fluorescent lamps, *Journal of Physics D Applied Physics* 41(14):144007, July 2008. DOI: 10.1088/0022-3727/41/14/144007
- DLC 2020. DesignLights Consortium, Solid-State Lighting Technical Requirements, Version 5.0, Final Version, April 28, 2020 Update; www.designlights.org/solid-state-lighting/qualification-requirements/technical-requirements-V5-0/v5-0-tech-req-PDF/
- DLC 2021. DesignLights Consortium (DLC) Qualified Products List. April 2021. <https://www.designlights.org/search/>.
- Drasch et al. 2001. G Drasch, S Bse-O'Reilly, C Beinhoff, G Roider and S Maydl (2001). The Mt. Diwata study on the Philippines 1999—Assessing mercury intoxication of the population by small scale gold mining. *Sci. Total Environ.* 267:151-168.
- Drasch et al. 2004. G Drasch, S Bse-O'Reilly, S Maydl and G Roider (2004). Response to the letter of the Human Biomonitoring Commission. *Int. J. Hyg. Environ. Health* 207:183-184.
- EEA 2013. Late lessons from early warnings: science, precaution, innovation. European Environment Agency, Copenhagen, 2013.
- Franz and Wenzl. 2017. Manuela Franz & Franz P. Wenzl (2017). Critical review on life cycle inventories and environmental assessments of LED-lamps, *Critical Reviews in Environmental Science and Technology*, 47:21, 2017-2078, DOI: 10.1080/10643389.2017.1370989
- Grainger 2021. W.W. Grainger, Inc., "The Benefits of T8 LEDs," <https://www.grainger.com/know-how/business-operations/energy-management/kh-benefits-of-t8-leds>, accessed on April 25, 2021.
- Grandjean and Landrigan 2014. Philippe Grandjean and Philip J Landrigan, Neurobehavioural effects of developmental toxicity, *Lancet Neurol.* 2014 March; 13(3): 330–338. doi:10.1016/S1474-4422(13)70278-3.
- Hajat et al. 2015. A. Hajat, C. Hsia and M. S. O'Neill, Socioeconomic disparities and air pollution exposure: A Global Review. *Curr. Environ. Heal. Rep.* 2, 440–450 (2015).
- Home Depot 2021. Home Depot, "Buying Guide: LED Versus Fluorescent," <https://www.homedepot.com/c/ab/led-vs-fluorescent/9ba683603be9fa5395fab907883f8f3>, accessed April 25, 2021.
- IMERC 2018. *IMERC Fact Sheet: Mercury Use in Lighting*, Interstate Mercury Education and Reduction Clearinghouse, December 2018. http://www.newmoa.org/prevention/mercury/imerc/factsheets/lighting_2018.pdf
- Kazantzis 2002. George Kazantzis (2002). Mercury exposure and early effects: An overview. *Med. Lav.* 93:139–147.
- Lamprecycle 2021. 'Lighting manufacturers, through their trade association, National Electrical Manufacturers Association (NEMA), developed lamprecycle.org to provide a one-stop source of information about recycling mercury-added "lamps."' <https://www.lamprecycle.org/about-lamprecycle/> accessed 7 May 2021; Lamprecycle.org estimates that "businesses recycle over 30% of their waste lamps." <https://www.lamprecycle.org/> accessed 7 May 2021; "...seven states have enacted laws that make lamp recycling mandatory..." <https://www.lamprecycle.org/residential-lighting/> accessed 7 May 2021
- Langworth et al. 1992. S Langworth, CG Elinder, KG Sundquist and O Vesterberg, Renal and immunological effects of occupational exposure to inorganic mercury, *British Journal of Industrial Medicine* 1992;49:394–401. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1012120/pdf/brjindmed00018-0020.pdf>

- LEDvance, 2021. LED Tubes Online Special 2020/21 Simply Impressive: Future-Proof LED Tubes from LEDvance. LEDvance website visited 19 June 2021. <https://www.ledvance.com/professional/products/product-stories/led-tubes-online-special>
- Li and Jin 2011. Y Li and L Jin. Environmental Release of Mercury from Broken Compact Fluorescent Lamps. *Environmental Engineering Science*, 2011; 110705072037001 DOI: 10.1089/ees.2011.0027. <https://www.state.nj.us/dep/dsr/research/mercury-bulbs.pdf>
- Liang et al, 2015. Peng Liang, Xinbin Feng, Chan Zhang, Jin Zhang, Yucheng Cao, Qiongzi You, Anna Oi Wah Leung, Ming-Hung Wong and Sheng-Chun Wu, Human exposure to mercury in a compact fluorescent lamp manufacturing area: By food (rice and fish) consumption and occupational exposure. *Environmental Pollution, Volume 198*, March 2015, Pages 126-132. https://www.sciencedirect.com/science/article/pii/S0269749114005363?casa_token=MgcDf_WezUcAAAAA:axvEh4NR4Sh2vE3K0Kd7ISdR6cZisGZ76lt_f79hj3m8JAuXKiP24NsuvJAgwhTdFtNvqImO5g
- Lindberg et al. 2005. Steve E. Lindberg, George R. Southworth, Mary Anna Bogle, T.J. Blasing, Jim Owens, Kelly Roy, Hong Zhang, Todd Kuiken, Jack Price, Debra Reinhart & Hala Sfeir (2005). Airborne Emissions of Mercury from Municipal Solid Waste. I: New Measurements from Six Operating Landfills in Florida. *Journal of the Air & Waste Management Association*, 55:7, 859-869, DOI: 10.1080/10473289.2005.10464684
- Lucas et al. 2006. Alan Lucas and Robert Emery, Assessing Occupational Mercury Exposures During the On-site Processing of Spent Fluorescent Lamps, *Journal of Environmental Health*, March 2006.
- Maine 2008. Maine compact fluorescent lamp study, Maine Department of Environmental Protection, February 2008. <http://www.maine.gov/dep/rwm/homeowner/cfreport/cfreportwoapp.pdf>
- Mitchell et al. 2018. Mark Mitchell, Rueben Warren, David Bellinger and Doris Browne, Is Dental Amalgam Toxic to Children of Color? *Journal of the National Medical Association*, Volume 110, Issue 4, August 2018, pp 414-416.
- Mutter et al. 2007. Joachim Mutter, Johannes Naumann and Corina Guethlin, Comments on the Article "The Toxicology of Mercury and Its Chemical Compounds" by Clarkson and Magos (2006), *Critical Reviews in Toxicology*, 37:537-549, 2007. DOI: 10.1080/10408440701385770.
- MPP 2008. Shedding Light on Mercury Risks from CFL Breakage. Prepared by Edward Groth, PhD for The Mercury Policy Project. <http://ledgobeyondgreen.com/images/mercury-risks.pdf>
- NEWMOA 2016. Summary of Northeast State's Policies Regarding Use of Drum Top Crushers. Northeast Waste Management Officials' Association, March 2016. <https://www.epa.gov/sites/production/files/2016-03/documents/newmoa.pdf> accessed 21 June 2021.
- NEWMOA 2021. Summary of Research on Mercury Emissions from Municipal Landfills, Northeast Waste Management Officials' Association, <http://www.newmoa.org/prevention/mercury/landfillfactsheet.cfm> accessed 9 June 2021.
- Ngim et al. 1992. CH Ngim, SC Foo, KW Boey and J Jeyaratnam, Chronic neurobehavioural effects of elemental mercury in dentists, *British Journal of Industrial Medicine* 1992;49:782-790. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1039326/pdf/brijndmed00023-0040.pdf>
- OEHHA 2019. OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary, Office of Environmental Health Hazard Assessment, California, 4 November 2019. <https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary>
- Ohio AG 2019. Court Orders Cleanup, Penalty for Illegal Hazardous Waste Facility. Dave Yost, Ohio Attorney General, December 3, 2019. <https://www.ohioattorneygeneral.gov/Media/News-Releases/December-2019/Court-Orders-Cleanup-Penalty-for-Illegal-Hazardous>
- Piikivi & Tolonen 1989. L Piikivi & U Tolonen, EEG findings in chlor-alkali workers subjected to low long term exposure to mercury vapour, *British Journal of Industrial Medicine* 1989;46:370-375. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1009788/pdf/brijndmed00134-0010.pdf>
- Rahman et al. 2019. Z Rahman & VP Singh, The relative impact of toxic heavy metals (THMs) (arsenic (As), cadmium (Cd), chromium (Cr) (VI), mercury (Hg), and lead (Pb)) on the total environment: an overview. *Environ Monit Assess* (2019) 191: 419. <https://doi.org/10.1007/s10661-019-7528-7>
- Reames et al. 2018. Tony G. Reames, Michael A. Reiner, M. Ben Stacey, An incandescent truth: Disparities in energy-efficient lighting availability and prices in an urban U.S. county. *Applied Energy, Volume 218*, 15 May 2018, pp 95-103.
- Regency Lighting, 2019. "Why you shouldn't use those fluorescent tubes before upgrading to LED", by Nina Frye, Regency Lighting; October 4, 2019. <https://insights.regencylighting.com/why-you-shouldnt-use-those-fluorescent-tubes-before-you-convert-to-led-calculator>
- Rice 2000. D Rice and S Barone Jr., Critical periods of vulnerability for the developing nervous system: evidence from humans and animal models. *Environ Health Perspect* 2000;108 (suppl 3):511-33.
- RPN 2021. RPN review of ENERGY STAR certification list of LED light bulbs, April 25, 2021; <https://www.energystar.gov/productfinder/product/certified-light-bulbs/results>
- RSE 2017. Independent Third Party Audit of the Manufacturers' Program for Collection and Disposal of Mercury-containing Lamps. Audit carried out by RSE USA for the National Electrical Manufacturers Association (NEMA). <https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/NEMALampProgramAudit.pdf>
- Sanders et al. 2015. Alison P. Sanders, Birgit Claus Henn, and Robert O. Wright, Perinatal and Childhood Exposure to Cadmium, Manganese, and Metal Mixtures and Effects on Cognition and Behavior: A Review of Recent Literature. *Curr Environ Health Rep*. 2015 Sep; 2(3): 284-294. doi: 10.1007/s40572-015-0058-8
- Salthammer et al. 2011. T. Salthammer, E. Uhde, A. Omelan, A. Lüdecke and H.J. Moriske, Estimating human indoor exposure to elemental mercury from broken compact fluorescent lamps (CFLs), *International Journal of Indoor Environment and Health*, Dec 2011. <https://doi.org/10.1111/j.1600-0668.2011.00764.x>

- Sarigiannis et al. 2012. D.A. Sarigiannis, S.P. Karakitsios, M.P. Antonakopoulou, A. Gotti, Exposure analysis of accidental release of mercury from compact fluorescent lamps (CFLs), *Science of The Total Environment Volumes 435–436*, 1 October 2012, Pages 306–315.
- Satoh 2000. Hiroshi Satoh, Occupational and Environmental Toxicology of Mercury and Its Compounds, *Industrial Health* 2000;38:153–164. https://www.jstage.jst.go.jp/article/indhealth1963/38/2/38_2_153/_pdf
- SCHER 2010. Opinion on Mercury in Certain Energy-saving Light Bulbs, Scientific Committee on Health and Environmental Risks, European Commission (DG Health & Consumers), adopted 19 May 2010.
- SEA/CLASP, 2020. Clarifications on Lighting Europe's Comments to the RoHS Committee, A report for the Committee on the Restriction of Hazardous Substances (RoHS) addressing Lighting Europe's comments of 20 May and 9 June relating to the exemption application for fluorescent lighting; Dr. Peter Bennich, Swedish Energy Agency and Michael Scholand, LC, CLASP Europe; 12 July 2020. <https://www.clasp.ngo/research/all/clarifications-on-lighting-europes-comments-to-the-rohs-committee/>
- Singhvi et al. 2014. Raj Singhvi, Ajay Taneja, Jay Patel, Charles Gasser & Dennis J. Kalnicky, Hg Vapor Emission from Broken Compact Fluorescent Lamps (CFLs) in an Acrylic Chamber, *Environmental Forensics Volume 15*, 2014 - Issue 1. https://www.tandfonline.com/doi/full/10.1080/15275922.2013.872716?casa_token=aUdwjX7CW98AAAAA%3AX_ZQN9fw5YiGorryD74_s95BND62daNfvQXVFC2ipcll99JgHQgogGzZYIVP5ERbgocDwXrgGsqy
- Southworth et al. 2005. GR Southworth, SE Lindberg, MA Bogle, H Zhang, T Kuiken, J Price, et al. Airborne emissions of mercury from municipal solid waste. II: Potential losses of airborne mercury before landfill. *J Air Waste Manag Assoc* 2005;55:870–7.
- SSL Annex 2020. Solid State Lighting Annex: Quality and Performance Requirements, LED Lighting Products, 25 November 2020. https://www.iea-4e.org/wp-content/uploads/2021/03/Task_6_LED_Lighting_Product_Quality_Performance_-_Nov_2020.pdf
- Tessum et al. 2021. Christopher W. Tessum, David A. Paoletta, Sarah E. Chambliss, Joshua S. Apte, Jason D. Hill, Julian D. Marshall, PM2.5 pollutants disproportionately and systemically affect people of color in the United States. *Sci. Adv.* 2021; 7.
- USDOE 2013. US Department of Energy. *Fact Sheet: Life-cycle Assessment of Energy and Environmental Impacts of LED Lighting Products*. https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/lca_factsheet_apr2013.pdf
- USDOE 2017. *2015 U.S. Lighting Market Characterization*, Prepared by Navigant Consulting for the Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, November 2017. https://www.energy.gov/sites/default/files/2017/12/f46/lmc2015_nov17.pdf
- USDOE 2019. *Energy Savings Forecast of Solid State Lighting in General Illumination Applications*, Prepared by Navigant Consulting for the Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, December 2019. https://www.energy.gov/sites/default/files/2020/02/f72/2019_ssl-energy-savings-forecast.pdf
- USDOE 2020. US Department of Energy, Office of Energy Efficiency and Renewable Energy, Federal Energy Management Program, *Overview of Industry Research on LED Lighting Technology and Application to the Federal Sector*, November 24, 2020, <https://www.energy.gov/sites/default/files/2020/12/f82/Industry-Research-LED-Lighting.pdf>
- USDOE 2021a. US Department of Energy, "Fluorescent Lighting," Undated webpage accessed on April 26, 2021; <https://www.energy.gov/energysaver/save-electricity-and-fuel/lighting-choices-save-you-money/fluorescent-lighting>
- USDOE 2021b. US Department of Energy's Compliance Certification Database, visited 19 May 2021. https://www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A*
- USEPA 1999. EPA Final Rule, Hazardous Waste Management System, Modification of the Hazardous Waste Program, Hazardous Waste Lamps, *Federal Register*, 1999. Vol. 64, No. 128.
- USEPA 1995. Mercury, elemental; CASRN 7439-97-6, Integrated Risk Information System (IRIS), Chemical Assessment Summary, US Environmental Protection Agency (EPA) National Center for Environmental Assessment, 1995. https://iris.epa.gov/static/pdfs/0370_summary.pdf
- USEPA 2000. Mercury Compounds, US EPA, updated January 2000. <https://www.epa.gov/sites/production/files/2016-09/documents/mercury-compounds.pdf>
- USEPA 2020a. Inventory of Mercury Supply, Use, and Trade in the United States – 2020 Report (Reporting Year 2018), Office of Chemical Safety and Pollution Prevention, U.S. Environmental Protection Agency https://www.epa.gov/sites/production/files/2020-03/documents/10006-34_mercury_inventory_report.pdf
- USEPA 2020b. Updated Totals for the Inventory of Mercury Supply, Use, and Trade in the United States 2020 Report, December 2020, Office of Chemical Safety and Pollution Prevention, U.S. Environmental Protection Agency (https://www.epa.gov/sites/production/files/2021-01/documents/updated_mercury_inventory_totals_december_2020.pdf)
- USEPA 2021a. Health Effects of Exposures to Mercury. <https://www.epa.gov/mercury/health-effects-exposures-mercury> (accessed 2 April 2021).
- USEPA 2021b. US Environmental Protection Agency, ENERGY STAR Program, *LED Bulbs Made Easy: Just Look for the ENERGY STAR*, Undated fact sheet accessed on April 26, 2021. www.energystar.gov/sites/default/files/asset/document/purchasing_checklist_revised.pdf.
- USEPA 2021c. ENERGY STAR Program Requirements and Criteria for CFLs – Version 4.3, accessed on May 8, 2021. https://www.energystar.gov/sites/default/files/specs/ENERGY_STAR_CFL_V4.3.pdf
- USEPA 2021d. US Environmental Protection Agency, ENERGY STAR website accessed on April 26, 2021; <https://www.energystar.gov/productfinder/product/certified-light-bulbs>
- USEPA 2021e. 2017 National Emissions Inventory: January 2021 Updated Release, Technical Support Document; EPA-454/R-21-001, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Emissions Inventory and Analysis Group, Research Triangle Park, North Carolina, February 2021. <https://www.epa.gov/sites/production/>

[files/2021-02/documents/nei2017_tsd_full_jan2021.pdf](#)

USHR Staff Report 2021. Baby Foods Are Tainted with Dangerous Levels of Arsenic, Lead, Cadmium, and Mercury. Staff Report, Subcommittee on Economic and Consumer Policy, Committee on Oversight and Reform, U.S. House of Representatives, February 4, 2021. <https://oversight.house.gov/sites/democrats.oversight.house.gov/files/2021-02-04%20ECP%20Baby%20Food%20Staff%20Report.pdf>

WHO 2003. Concise International Chemical Assessment Document 50 – Elemental Mercury and Inorganic Mercury Compounds: Human Health Aspects, World Health Organization, 2003.

WHO 2020, 2021. World Health Organization (accessed 28 June 2021): 10 chemicals of public health concern (2020). <https://www.who.int/news-room/photo-story/photo-story-detail/10-chemicals-of-public-health-concern>
Chemical Safety and Health: mercury. <https://www.who.int/teams/environment-climate-change-and-health/chemical-safety-and->

[health/health-impacts/chemicals/mercury](#)
Preventing Disease Through Healthy Environments - Exposure to Mercury: A Major Public Health Concern, Second edition (2021). <https://apps.who.int/iris/rest/bitstreams/1341885/retrieve>

Wilson et al. 2018. E Wilson, JS Lafferty, R Thibodeaux, et al. Occupational Mercury Exposure at a Fluorescent Lamp Recycling Facility – Wisconsin, 2017. *MMWR Morb Mortal Wkly Rep* 2018;67:763–766. DOI: <http://dx.doi.org/10.15585/mmwr.mm6727a3>^{external icon}.

Zhou et al. 2018. Fankun Zhou, Jie Xie, Shuyun Zhang, Guangming Yin, Yanyan Gao, Yuanyuan Zhang, Dandan Bo, Zongguang Li, Sisi Liu, Chang Feng and Guangqin Fan, Lead, cadmium, arsenic, and mercury combined exposure disrupted synaptic homeostasis through activating the Snk-SPAR pathway. *Ecotoxicology and*



Appendix 1 – Cleaning Up Mercury Spills

Guidance by the Agency for Toxic Substances and Disease Registry (ATSDR)
and the United States Environmental Protection Agency (US EPA)

Mercury Quick Facts

Cleaning up Mercury Spills in Your House

If a thermometer or other small mercury-containing item such as a thermostat or compact fluorescent light bulb breaks, you may be able to clean it up yourself. Follow the steps in this flier to clean up the spill. If the mercury spill is larger than two tablespoons, follow the instructions in this flier and get professional help to clean up the spill.

What NEVER to Do When Cleaning Up a Mercury Spill



- **Never use a vacuum cleaner or broom to clean up the spill.**

A vacuum cleaner or broom will break the mercury into smaller drops and spread it around more. Tiny mercury droplets will settle throughout the area, increasing the spread of the mercury in the room. The droplets will evaporate faster and increase your chance of breathing high levels of mercury vapor. They will be harder to clean up.



- **Never pour mercury down a drain.**

The mercury can become lodged in the “p” traps and may continue to vaporize into the room. Mercury can also pollute septic tanks or wastewater-treatment plants.



- **Never allow people who are wearing mercury-contaminated shoes or clothing to walk around the house.**

This will help limit the spread of spilled mercury.



- **Never use a washing machine to launder clothing or other items that may have come in contact with mercury.**

Mercury can contaminate the washer and/or pollute sewage. Throw all clothing that came in contact with liquid mercury in the trash. If mercury is visible on the clothing take it to your local household hazardous waste collection site for disposal. Wash clothing or other items that were exposed to mercury vapor during the cleanup, but did not get mercury directly on them.

Add your message here.



ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

Updated June 2012

How to Clean Up a Small Mercury Spill (a broken thermometer, thermostat or compact fluorescent bulb)

Step 1: Isolate the spill and ventilate the area right away.



- The person who will clean up the spill should have everyone else, **especially children**, leave the spill area, including pets. **Don't** let anyone walk through the mercury on their way out.
- Open all windows and doors that open to the outside of the house.
- Close all doors between the room where the mercury was spilled and the rest of the house.
- Close all cold air returns so that mercury vapor is not carried throughout the house.
- Turn down heaters and turn up single-room air conditioners, but don't use central air conditioning.
- Use fans to blow mercury-contaminated air outside. Turn off fans that do not blow air to the outside.

Step 2: Get the items needed to clean up a small mercury spill.



You will need the following items:

1. 4 or 5 zipper-top plastic bags
2. trash bags (2 to 6 mm thick)
3. rubber, nitrile or latex gloves
4. paper towels
5. cardboard or squeegee
6. eye dropper
7. duct tape, or shaving cream and small paint brush
8. flashlight
9. powdered sulfur (optional)

Step 3: Cleanup spill.



- Put on rubber, nitrile or latex gloves.
- Pick up any broken pieces of glass and place them on a paper towel. Fold the paper towel, place it in a zipper-top bag, and seal the bag.
- Clean up the beads of mercury. Use a squeegee or cardboard to slowly roll the beads onto a sheet of paper. An eye dropper can also be used to collect the beads. Slowly squeeze mercury from the eye dropper onto a damp paper towel. Put the paper towel, paper, eye dropper, or anything else that has mercury on it, into a zipper-top bag, and seal the bag.

Step 3: continued

- After you remove larger beads, put shaving cream on top of a small paint brush and gently blot the affected area to pick up smaller hard-to-see beads. You can also use duct tape or masking tape to collect smaller hard-to-see beads. Place the paint brush or tape into a zipper-top bag.
- It is OPTIONAL to use commercially available powdered sulfur to absorb beads that are too small to see. The sulfur does two things: (1) it makes the mercury easier to see since there may be a color change from yellow to brown, and (2) it binds the mercury so that it can be easily removed, and it helps to keep mercury that may have been missed during the cleanup from vaporizing into the room.

Mercury spill kits that contain sulfur can be purchased from laboratory, chemical and hazardous materials response supply manufacturers. Read and understand how to use the cleanup kit before using.

Note: Powdered sulfur may stain fabrics. Also, when using powdered sulfur, avoid breathing in the powder as it can be moderately toxic.

Step 4: Look for mercury that may have been missed during the cleanup.



- Take a flashlight, hold it at a low angle close to the floor in a darkened room, and look for additional glistening beads of mercury that may be sticking to the surface or in small cracks. **Note:** Mercury can move surprising distances on hard and flat surfaces, so be sure to carefully inspect the entire room when you are searching.

Step 5: Remove contaminated carpet and throw away.



- Place outside the house in a safe place until household trash is picked up.

Step 6: Remove mercury from shoes, clothing, and skin.



- If mercury had touched your skin, shoes or clothing, remain still and have someone bring you a plastic trash bag and wet paper towels. Wipe off any visible beads of mercury with the wet paper towels and then put them into the trash bag. Remove contaminated shoes and clothing and place them in a trash bag. Seal that bag and place it in another bag.

Step 7: Properly dispose of contaminated cleanup materials.



- Place all materials used in the cleanup, including gloves, in a trash bag. Place the zipper-top bags that contain mercury and other objects into the trash bag. Close and seal the trash bag and place it in a safe place outside your house. Label the bag as directed by your local health or fire department.
- Contact your local health department, municipal waste authority, or your local fire department for proper disposal in accordance with local, state and federal laws.

Step 8: Determine if additional action needs to be taken following cleanup of spill.



- Keep the area well ventilated to the outside (i.e., windows open and fans in exterior windows running) for at least 24 hours after cleaning up the spill. Continue to keep pets and children out of the cleanup area. If anyone gets sick, call your doctor or the **Poison Control Center** at **(888) 222-1222** immediately.
- You may want to hire a contractor who has monitoring equipment to screen for mercury vapors. Consult your local environmental or health agency to inquire about contractors in your area.
- If young children or pregnant people are in the house, seek additional advice from your local or state health or environmental agency.

What to Do for Mercury Spills Greater Than the Amount in a Thermometer, Thermostat or Compact Fluorescent Light Bulb

Mercury is heavy. Just two tablespoons weigh nearly one pound. If more than the amount of mercury in a thermometer or thermostat or a compact fluorescent light bulb is spilled in your house, be sure to follow these steps:



- Have everyone else leave the area; **don't** let anyone walk through the mercury on their way out.
- Open all windows and doors to the **outside**.
- **Turn down** the heater in winter and **turn up** the air conditioner in summer.
- Shut all doors to other parts of the house, and leave the area.
- Call your local or state health or environmental agency for help.

- If more than two tablespoons of mercury are spilled, it is mandatory to call the National Response Center (NRC), available 24 hours a day, 1-800-424-8802.
- If you have health-related questions about mercury, call the Agency for Toxic Substances and Disease Registry (ATSDR) at 800-232-4636 or TTY: 888-232-6348, or by email to cdcinfo@cdc.gov.
- If you have questions about cleaning up a mercury spill of any size, call US EPA at 202-564-3850.



C
Li
C

CLEANLIGHTINGCOALITION.ORG