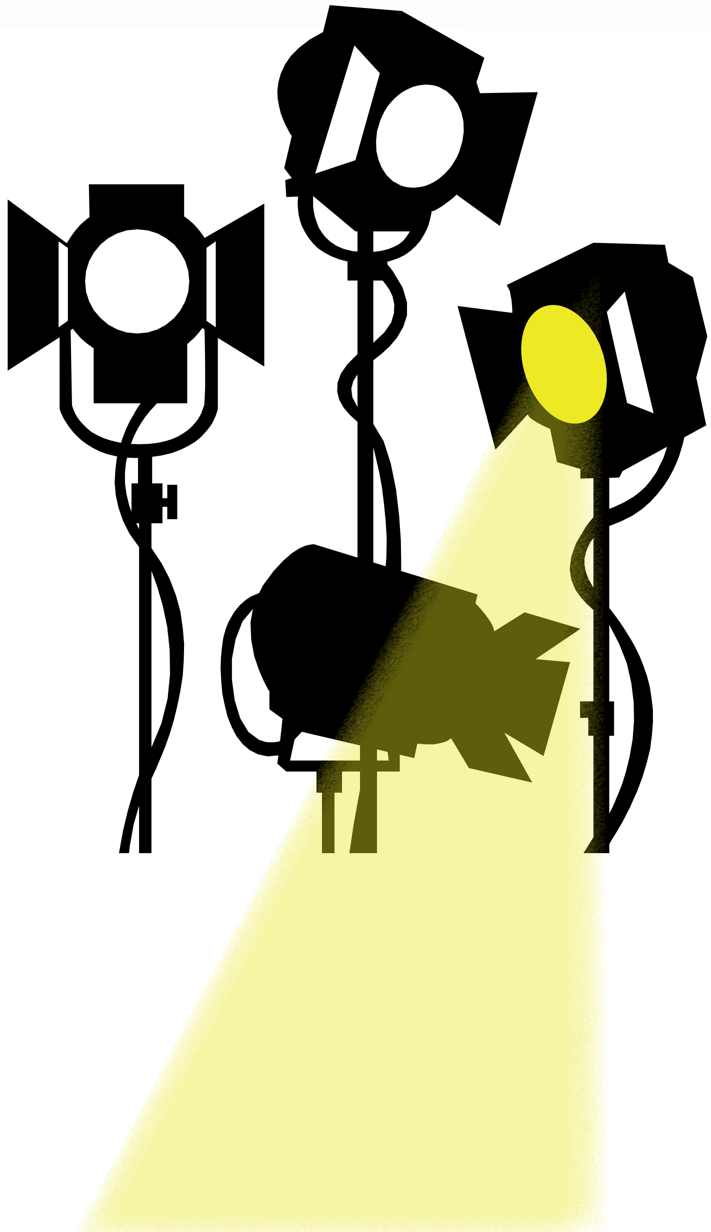

Shedding Light on Mercury Risks from CFL Breakage

Prepared by Edward Groth, PhD
For
The Mercury Policy Project
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This report is available on the world wide web at: www.mercurypolicy.org

Mercury Policy Project
1420 North St.
Montpelier, VT 05602
www.mercurypolicy.org

Summary: ***Compact fluorescent lights (CFLs) are important energy-savers and are being widely substituted for less-efficient incandescent light bulbs. But CFLs also contain small amounts of elemental mercury. Much of this mercury is released when a CFL is broken. Several studies of mercury releases from broken fluorescent bulbs suggest that, under certain conditions, CFL breakage can pose a health risk, especially to an infant or young child who spends time near the site of the breakage. While this risk raises valid public-health concerns, there is no reason for consumers either to avoid using CFLs or to panic if one is broken. However, parents should consider avoiding using CFLs in situations where breakage is likely, especially in infants' or toddlers' rooms. To prevent breakage and to increase recycling of CFLs at the end of their useful life, consumers need more and better information about risks posed by broken lamps, clear and consistent instruction on safe clean-up and disposal of a broken CFL, and guidance to help find energy-efficient light bulbs with minimal mercury content.***

CFLs help reduce the emissions coming from coal-fired power plants

Introduction: Risks and Benefits of CFLs, An Overview

CFLs convert power into light more efficiently and last longer than incandescent bulbs do. They are therefore widely promoted as an important energy-conservation technology. Indeed, greatly expanded use of CFLs will reduce carbon dioxide emissions, a major contributor to global warming, and other air pollution, including mercury emissions, from coal-fired power plants. Consumers are appropriately being encouraged by governments, utilities, and public-interest organizations to buy and use CFLs.

However, CFLs also contain realtively small amounts of mercury. Some may contain as much as 30 milligrams (mg), others as little as 1 mg of this toxic metal element. The amount of mercury in some CFLs is less than in the past, and the lighting industry continues to work toward reducing it further (NEMA 2007). Some US manufacturers have pledged to use 5 to 6 mg or less of mercury in their CFLs, and a few companies are now offering bulbs they claim contain only 1 mg. The current limit in Europe is 5 mg, and a proposed Green Seal standard for the U.S. calls for 3 mg or less.

A mercury-free CFL is not possible with current technology; some mercury is required for the lights to work. Mercury vapor inside the tube is excited by electric current and emits ultraviolet light, which excites compounds painted on the inside of the glass, making them emit visible light. Alternative energy-efficient lighting technologies, such as light-emitting diodes (LEDs), are very long-lasting and contain no mercury. LEDs are not yet practical choices for many lighting applications, but their use is growing as they become more available and prices drop.

The presence of mercury in CFLs (and in more traditional, linear fluorescent light tubes) raises several risk issues. Workers may be exposed to mercury when manufacturing, transporting, installing, recycling or disposing of fluorescent lights. While no mercury is released during normal operation, consumers can be exposed to mercury if a fluorescent tube or CFL is broken. And as the number of fluorescent lights in use grows, so does the amount of mercury that can be accidentally released in homes and can enter the waste stream.

The National Electrical Manufacturers Association (NEMA) estimated that 670 million used fluorescent bulbs were disposed of in 2003, and the number has doubtless continued to grow since then. While a small fraction are recycled, most end up in landfills or trash incinerators, where they are almost certain to be broken (if they haven't been broken earlier in the disposal process). Broken fluorescent lights release an estimated 2 to 4 tons of mercury vapor into the environment each year in the U.S. (Aucott et al. 2004)

This report focuses on the emerging risk issues associated with CFL breakage in the home. Wider environmental impacts of CFLs throughout the product life cycle, analyses of alternative energy-efficient lighting choices, and strategies for addressing such broader issues are generally outside the scope of this paper. Many of these issues have recently been addressed by the Sierra Club (2008), among others (see Appendix for the Sierra Club Guidelines, and Resources section for further information).

Can a Broken CFL Create a Household Health Hazard?

CFLs, like other light bulbs, tend to be fragile; most designs use relatively unprotected, thin glass tubes. Given normal human foibles, some CFLs will be broken. People may drop a CFL or apply too much force when installing or removing it. Lamps occasionally get knocked over, especially in homes with children and pets. And when a CFL's useful life is over and it is thrown away, it may get broken in the trash before it even leaves the house.

The mercury in a broken CFL can escape and contaminate the site of the breakage. Most of the mercury in a CFL is in vapor form; some may be adsorbed onto surfaces inside the lamp, and a small amount may exist as tiny liquid droplets. Mercury vapor, which is readily dispersed in air and absorbed through the lungs, is the most immediate health concern. But liquid mercury, especially if it is absorbed into a carpet or an upholstered surface, can remain in place and vaporize over time, contributing to ongoing indoor exposure.

Different CFL designs may be more or less prone to breakage and can contain different amounts of mercury.

Critical issues in a risk assessment for this potential mercury exposure include:

- Who is likely to be exposed to airborne mercury after a CFL breaks?
- Who is most vulnerable to possible harm?
- What adverse effects could this mercury exposure have on household residents?
- What is a "safe" level of mercury in indoor air, as defined by expert agencies?
- Can CFL breakage produce air mercury levels above those safety limits?
- If so, how high are the levels and how long do elevated air mercury levels persist?

We will attempt to answer each of these questions below. One obvious conclusion is that much remains uncertain and unknown; there are not yet clear scientific answers on many of the issues. However, enough is known to support concerns about the nature and general magnitude of the risks, and to offer common-sense advice to consumers.

(1) Why are children at greatest risk from mercury vapor?

When a CFL breaks, anyone in the household may be exposed to mercury vapor. But the public health concern is currently focused on circumstances where infants, small children or pregnant women can inhale mercury vapor. This concern is based on strong scientific evidence that the very young and the fetus are much more sensitive than older groups in the population are to the potential toxic effects of mercury.

During fetal development and early childhood, up to the age of six years or so, the human brain grows and changes rapidly. This dynamic developmental process is vulnerable to the disruptive effects of toxic exposures. Young children, infants and fetuses have been shown to be highly susceptible to developmental effects associated with methylmercury in fish in their (and their mothers') diets (Debes et al., 2006). There is no comparable body of epidemiological evidence on the effects of mercury vapor in the very young, but an analogous hypersensitivity of the developing brain to damage from elemental mercury has been well documented in animal studies.

Babies and other small children are also more vulnerable to airborne mercury exposures, because their small body sizes and more rapid respiration rates give them a larger dose of mercury than an adult gets from inhaling air with the same mercury concentration. Mercury vapor is heavier than air, and mercury concentrations in indoor air tend to be higher near the floor. Infants and toddlers who crawl, sit, walk, play and breathe on or close to the floor are thus likely to be most heavily exposed to the mercury vapor from a broken CFL.

Historically, a specific form of mercury poisoning called acrodynia has occurred in some children who inhaled mercury vapor, often when a device that contained mercury such as a thermometer or a thermostat was broken. Acrodynia is characterized by loss of appetite, irritability, sensitivity to light, profuse sweating that often produces a rash, and reddened, peeling skin on the hands and feet. Acrodynia has also been associated with mercury vapor emitted into indoor air from certain latex paints that historically contained mercury fungicides (Hirschman et al. 1963, Agocs et al. 1990).

One published clinical report has described a case of acrodynia in a toddler who played in a shed where a box of fluorescent light tubes had been broken five months earlier (Tunnessen et al. 1987). In that case, the affected child had two older siblings who played in the same mercury-contaminated area. Like the patient, both siblings had elevated urinary mercury levels, indicating substantial exposure to mercury vapor. But neither sibling developed acrodynia. The authors noted that historically, only a small fraction of thousands of children exposed to mercury vapor have actually developed acrodynia. They suggest that acrodynia may be an allergic or hypersensitivity reaction to mercury toxicity in highly susceptible individuals (Tunnessen et al. 1987).

Acrodynia can take weeks or months after initial exposure to develop, which makes it difficult or impossible to determine exposure levels that caused the disease. The medical literature does not include adequate measurements of the airborne mercury concentrations to which children with acrodynia from inhaling mercury vapor were exposed. We do not know what level of mercury in air causes acrodynia, or conversely, the highest level that poses no risk of causing this effect. It is not possible to estimate how many children might fall into a sensitive subgroup that could develop acrodynia if exposed to mercury vapor, and there is no basis to predict which children might be susceptible, if acrodynia is indeed a hyper-sensitivity reaction. These all remain critical uncertainties.

Finally, although acrodynia is the best known and best documented effect of exposure to elemental mercury in children, it is not necessarily the one we should be most concerned about. Toxic effects on the developing brain may well occur at lower mercury doses than any that can cause acrodynia, but such neuro-developmental effects are difficult to observe and to associate with exposure. Because of justified concern about potential developmental effects, the issue of short-term spikes of exposure, discussed in Section 3, below, takes on added importance.

(2) What is a "safe" level of mercury vapor in air?

Mercury concentrations in rural, unpolluted ambient air are typically about 1 to 2 ng/m^3. (The units are nanograms, or billionths of a gram, per cubic meter of air.) By contrast, the lowest levels that are currently of health concern are about 100 times greater than this background level.

Two federal agencies and several states have developed guidelines for "safe" chronic (long-term) exposure to mercury vapor in air. The US Environmental Protection Agency (EPA) has established a Reference Concentration (RfC) of 300 ng/m^3 (Rice 2007). The Agency for Toxic Substances and Disease Registry (ATSDR), a branch of the Centers for Disease Control, has adopted a Minimal Risk Level (MRL) of 200 ng/m^3 (ATSDR 2006). Some states have adopted the EPA RfC, while others have developed their own MRLs. Notable among the latter is California's chronic Reference Exposure Level (REL) of 90 ng/m^3 (California DTSC 2002).

These guidelines describe levels of exposure to mercury vapor that are believed to pose no appreciable health hazard, even if a person were exposed to that level for an extended time. Both federal guidelines are based on a study that measured adverse effects of inhaled mercury on the nervous system of adult men exposed in the workplace. The California REL aims to prevent mercury damage to the developing brain, and is based on animal toxicity data.

Several states have also adopted guidelines for acute (short-term) exposure to mercury vapor (Rice 2007). California's acute REL, for example, is 1,800 ng/m^3, averaged over one hour. There is no federal acute RfC for mercury vapor. However, the ATSDR has set a "reoccupancy level" (a guideline for when it is safe to let people re-enter a building that has been contaminated with mercury) at 1,000 ng/m^3.

Each of these guidelines includes an "uncertainty factor" (for example, 30-fold in both the EPA's RfC and the ATSDR's chronic MRL), which provides a margin of exposure between a level of mercury vapor in air that had clear-cut adverse effects in the studies on which the limit is based, and the permitted exposure level

(3) Is exposure to mercury vapor at levels above these guidelines harmful?

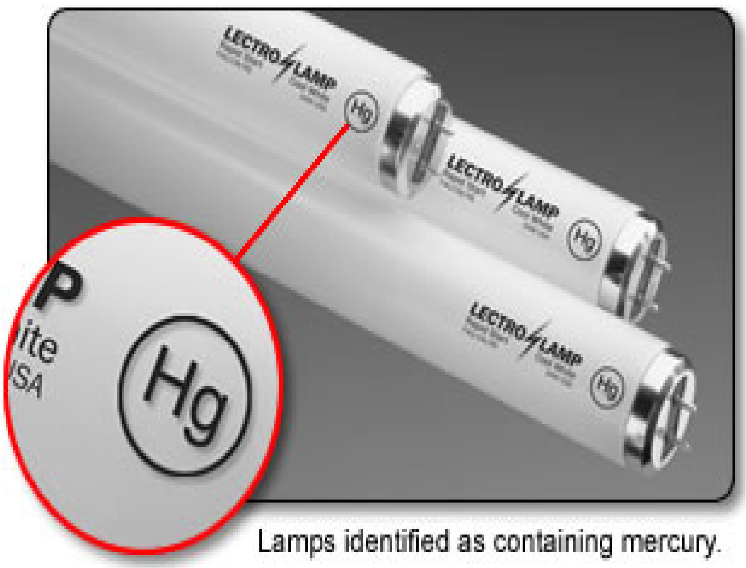
Not necessarily, but it could be. As just explained, the various guidelines all provide a margin (e.g., 30-fold, in the federal chronic guidelines) between the acceptable level and higher levels that are known to cause adverse effects. When a person is chronically exposed to airborne mercury at levels higher than, say, 90 to 300 ng/m^3, but still below levels that have caused detectable harm, all that is certain is that the margin between their actual exposure and the harmful level has been reduced.

What is less clear is the level of exposure at which harm, especially subtler effects than those that occurred in workers or heavily-exposed rats, might begin to occur. Even within a sensitive subgroup like young children, some individuals are much more susceptible to toxic effects than the average person is. It is far from certain that the margins of exposure built into the various guidelines provide adequate safety for such sensitive individuals.

Further uncertainties arise when people are exposed to mercury vapor concentrations moderately greater than the guideline levels, for periods of a few minutes to a few hours. Scientists classify this as acute or subacute exposure. In theory, brief exposure should pose smaller risks than long-term exposure, because less mercury should be absorbed. The guidelines for acceptable acute exposure to mercury vapor are generally designed to prevent adverse effects that become obvious soon after exposure; just as for the chronic guidelines, acute limits include uncertainty factors.

However, here too, there are large knowledge gaps. Acute exposure can have delayed or chronic effects. In particular, a short-term "spike" or series of spikes of exposure might affect key developmental processes, if a child or fetus were exposed during a crucial developmental phase, producing long-term damage to the brain and learning ability, for instance. The relative hazards of chronic versus spike exposures have not been well characterized by toxicology in general, and this lack of basic knowledge limits our ability to precisely assess mercury exposure risks. It is therefore not possible to conclude confidently that even brief exposure to mercury vapor levels above current guidelines poses no significant health risks.

Among the most important uncertainties is the lack of adequate information on the level of mercury in indoor air that is safe for infants, children, or pregnant women. All of the studies that have associated adverse human health effects with specific levels of mercury in air have involved adults, mostly men. There is essentially no good epidemiological evidence on mercury effects on the sub-populations believed to be at highest risk.



Lamps identified as containing mercury.

Some might argue that the margins in current federal and state guidelines for exposure to mercury vapor are wide enough to protect everyone, including fetuses, babies and other children. In the absence of well-designed studies measuring the effects of mercury vapor exposure on those specific populations, that argument rests on faith more than on science.

(4) What level of mercury vapor exposure can result from a broken CFL?

Several factors can affect the amount of mercury released by a broken CFL, including the brand (manufacturer), when it was made (newer bulbs generally have less mercury), and how much it has been used (mercury vapor levels decline with use). The more time that passes between breakage and clean-up and the higher the temperature where the breakage occurs, the more mercury will be released, other things being equal. When breakage occurs on a carpet, a rug or upholstered furniture, liquid mercury that escapes can be absorbed by textile fibers. This mercury can later vaporize if the textile items are agitated by being walked on, swept, brushed or vacuum-cleaned.

The amount of mercury in a typical CFL is small. However, magnitude is relative, as this illustrative example shows. Chandrasekhar (2007) modeled the dispersal of mercury in the air in a room after a CFL is broken. He made some reasonable assumptions: That a broken CFL contains 5 mg (5,000,000 ng) of mercury vapor; that the volume of air in the room is about 33 m^3; that all the mercury in the lamp is in vapor form, and that it all escapes on breakage and diffuses through the air in the room within a few minutes. With those starting points, he calculated that the mercury vapor concentration in the room a few minutes after a CFL was broken could exceed 150,000 ng/m^3.

Aucott et al. (2004) at the New Jersey Department of Environmental Protection took a more experimental approach. They broke fluorescent tubes in a 32-gallon plastic barrel, then periodically removed and replaced the barrel's cover (simulating normal use of a garbage can), and measured mercury levels in the air inside the closed barrel to estimate the rate of mercury release. They found that 17 to 40 percent of the mercury in a broken bulb was released into the air within two weeks after breakage, and one-third of the total release occurred during the first 8 hours. Higher temperatures led to more rapid and greater releases of mercury. The release rate declined over time, and a significant amount of mercury remained adsorbed on surfaces of the broken tubes.

Aucott et al.'s results suggest a smaller total mercury vapor release than that predicted by Chandrasekhar's "worst case" model. With the same assumed 5 mg of mercury vapor and the same size room as in Chandrasekhar's model, the NJDEP data suggest that a broken fluorescent light could produce air mercury levels in the range of 8,000 to 20,000 ng/m^3 within 8 hours after breakage, if the room were not ventilated and the broken bulb were not removed. These projected levels are high enough to justify public health concerns about potential exposure of residents to mercury vapor from broken fluorescent lights.

The State of Maine became interested in this problem when a resident who had broken a CFL on a carpet in her home sought assistance from the state government (Maine DEP 2007). A toxic-spill investigator visited the home two days after the CFL breakage had occurred (and two days after the consumer had cleaned up the broken bulb) and found a mercury concentration of 1,939 ng/m^3 in the air directly above the spot on the carpet where the bulb had broken. On a second visit, two months later, the investigator found no levels above Maine's state RfC of 300 ng/m^3 anywhere in the home, even at the site of the breakage.

The initial reading of 1,939 ng/m^3 and the likelihood that CFL breakage occurs fairly often spurred the Maine agencies involved to seek better data on potential exposure to airborne mercury following such breakage. They carried out a study in which CFLs were broken under controlled conditions and mercury levels in air in the room where the bulbs were broken were measured. The results are consistent with the two studies just described and reinforce the conclusion that a broken CFL can produce mercury vapor levels well in excess of current state and federal guidelines, at least for brief periods (Rice 2007). It appears that in Maine's judgment, these elevated mercury levels represent a public-health concern, especially for households with infants or young children.

...a broken CFL can produce mercury vapor levels well in excess of current state and federal guidelines, at least for brief periods.

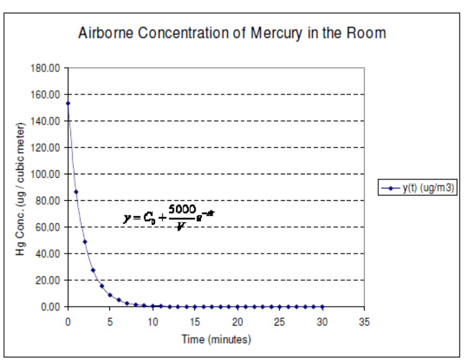
A technical report on Maine's breakage tests is about to be published, but was not available when our report was being written. Based on the growing body of evidence that CFL breakage may pose risks to health under certain conditions, several other states will also address these risk issues. Readers may wish to check the states' web sites in coming weeks for the most current advisories on the subject (see Resources section for links.)

What Should I Do If I Break a CFL in My Home?

Although it should go without saying, an important strategy is to avoid breaking a CFL in the first place. For example, when installing or removing a CFL, turn it by gripping the base; where possible, don't twist the glass tubes. Also, be aware of the risks of breakage when a CFL's useful life is over and it is ready for disposal. A CFL that is simply thrown in the trash can easily break—in an indoor wastebasket, for example, which could result in household exposure to mercury vapor. Recommendations for proper end-of-life disposal appear at the end of this report. This section focuses on cleaning up after a more typical accidental breakage.

The advice given here is based on guidance offered by various state and federal agencies (Weiss 2007, Chandrasekhar 2007) and by the US EPA (2007). The advice is evolving as better data are developed, and the EPA has stated that it intends to update its advice frequently. This report synthesizes current advice; if you have further questions, we suggest you contact your state health department or environmental agency or visit their web sites (see Resources section for examples).

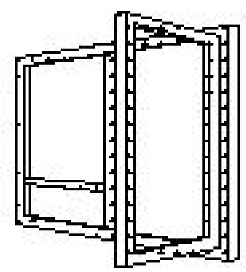
It makes sense to anticipate that you may break a CFL now and then, and to keep clean-up guidelines handy, just in case.



Chandrasekhar (2007) showed that opening a window and using a fan can reduce mercury vapor to safe levels in about 12 minutes

The three most important points are: (1) Don't panic; (2) Ventilate the area; and (3) Clean up the breakage promptly, but do not use a vacuum cleaner, broom or dustpan.

First, don't panic. While there is some risk from exposure to the mercury vapor a CFL breakage can release, the risk is comparatively small, and promptly and properly cleaning up the broken bulb can greatly reduce or eliminate the risk.



Second, ventilate the breakage area immediately. Open a window, or all the windows, in the room and let the air flow out, taking mercury vapor with it. If the air is cold, heating the room will increase the rate at which mercury vaporizes and speed its removal. But if you have a forced hot air furnace, use plastic bags and duct tape to cover the vents in the room, to keep air flow from spreading mercury vapor throughout the building. Use a table fan or pedestal fan to blow air out the window. If the room has only one window, keep the door open a crack, to let clean air in to replace the contaminated air flowing out. If the room where the breakage occurred has multiple windows, open them all, and close the door to keep air flow from spreading mercury to other rooms.

Most expert agencies say to ventilate for at least 15 minutes. Chandrasekhar's modeling exercise (2007) found that with even a minimally effective fan to increase air flow, this strategy should reduce mercury vapor levels to below the ATSDR MRL within 12 minutes, and to background levels after 20-25 minutes.

He suggested that ventilating for longer times could provide an additional margin of safety, but no more than 45 minutes was needed in any case.

Third, once you have begun ventilating the area, clean up the debris from the broken CFL promptly. If you are pregnant, or think you might be pregnant, though, we recommend opening a window, then leaving the room, closing the door, and asking someone else to carry out the rest of the clean-up steps described below.

Children, pets and other family members should be kept away from the area where the breakage occurred until it has been cleaned up, to avoid exposure to mercury and to keep them from tracking mercury into other parts of the house. Pick up broken glass pieces and other debris, using disposable rubber gloves (sold in supermarkets) if you have them. You can also use tweezers to pick up glass shards, or they can be gently swept onto a stiff piece of paper or cardboard, using another piece of paper or similar disposable object.

DO NOT USE A VACUUM CLEANER. Vacuuming the spill site will vaporize any liquid mercury present and spread it through the air in the room. It can also contaminate the vacuum cleaner, which could then disperse mercury in other parts of your home. For the same reason, don't clean up with a broom, a brush, a dustpan or a mop, which could also get contaminated and transfer mercury to other surfaces. Use disposable objects to sweep up the smaller pieces.

When pieces that can be gathered up by the methods described above have been collected, pat the carpet or floor with duct tape or masking tape (wrapped around a piece of cardboard, sticky-side-out), to pick up small particles. When you have removed all visible particles, wipe the affected area down carefully with a moist paper towel or commercial wet-wipe.

Place the pieces of the broken CFL in a container that can be tightly sealed, such as glass or plastic jar with a screw-on lid. Items that won't fit into a jar and don't have sharp edges (such as used gloves, paper towels and tape-wrapped cardboard) can be sealed inside a pair of zip-lock plastic bags, one inside the other. Wash your hands (and any tweezers or other tools you may have used) thoroughly, with soap or detergent.

In most areas, the debris from a single broken CFL, in its sealed container(s), can safely be disposed of in the household trash (but make sure this is allowed under your state's laws). If you have multiple broken bulbs, or if state law requires it for even a single bulb, take the debris to a local hazardous-household-waste collection site.

If the breakage occurred on a carpet, a rug or upholstered furniture, avoid subsequent vacuuming of the spill area, which is likely to retain mercury for some time. If the contaminated textile item is is in a child's or pregnant woman's room, consider removing or replacing it, or if that is not feasible, moving the person's sleeping and play areas to another room.

This advice errs on the side of caution, which is appropriate, given the large scientific uncertainties involved in assessing this risk. Remember, the risk is relatively small to begin with, and if you follow these clean-up procedures, you should feel confident that you have reduced the risk substantially or virtually eliminated it.

Recommendations

These recommendations are for consumers who face potential risks from CFL breakage in their homes, and for others concerned with that problem. Additional recommendations on wider issues like making progress toward low mercury and mercury-free energy-efficient lighting technologies and improving the availability of environmentally sound disposal and recycling of spent CFLs, can be found on linked sites listed in the Resources section.

Consumers should:

- Choose CFLs as energy-saving devices without fear of the mercury they contain, while informing themselves about the nature of risks involved and the appropriate cautions and countermeasures to follow when breakage does occur.
- Avoid using a CFL in a lamp that is reasonably likely to fall down or be knocked over, especially if such a lamp is in a child's room.
- Handle CFLs with care to avoid breakage, including when disposing of spent bulbs.
- Keep guidelines for cleaning up a broken CFL handy, just in case one breaks.
- Try to buy CFLs with the lowest mercury content, which currently is about 1 mg. If those are not locally available, look for bulbs made by companies that have pledged to keep mercury content below 5 mg (see NEMA link in Resources).
- Choose CFL designs that are less likely to break, e.g., those where the fluorescent tube is enclosed inside a plastic shield.
- Demand that manufacturers and retailers provide information on mercury content of CFLs, on labels, at the point of sale and on web sites.
- Take advantage of available local CFL recycling options offered by manufacturers or retailers in your area, and work with government, utilities and others to expand the availability of CFL recycling.
- Where CFL recycling is not available, try to dispose of CFLs in an environmentally responsible manner. Specifically, do not throw CFLs down trash chutes (in apartment buildings), do not put them out with other glass objects for local recycling pick-ups, and find out whether local law permits them to be put in the trash, or requires them to be taken to a hazardous household waste pick-up site. When they are put in the trash, try to protect them from breakage (say, by putting them inside a sturdy container.)

The lighting industry should:

- Continue its efforts to develop lower-mercury, longer-lasting CFL technologies, and get their products certified by Green Seal and other independent third parties.
- Test the comparative breakage resistance of different CFL designs, make the results public, and phase out designs particularly prone to breakage.
- Continue its efforts to make high-efficiency, mercury-free lighting systems such as LEDs more widely available and more price-competitive for a wider range of lighting needs.
- Pursue a long-term goal of phasing out

CFLs in favor of more sustainable lighting technologies.

- Include information about the mercury content of their fluorescent lamp products, at the point of sale, on packaging, and on web sites.
- Insert information about possible mercury exposure from breakage and about safe clean-up procedures in CFL packages.
- Collect and disseminate up-to-date information and advice in several languages for consumers about the risks from CFL breakage and proper clean-up methods, via brochures, web sites, poison-control centers, and other media.
- Ensure that all CFL giveaways include information on breakage, safe clean-up procedures and recycling programs.
- Collaborate with government and academic researchers to collect more extensive data on potential exposure to mercury vapor from CFL breakage.
- Work with their distributors to develop an industry-financed recycling system for spent fluorescent bulbs.

Governments and electric power utilities should:

- Collect and disseminate up-to-date information and advice in several languages for consumers about the risks from CFL breakage and proper clean-up methods, via brochures, web sites, poison-control centers, and other media.
- Develop consistent advice to the extent possible on these issues, to avoid consumer confusion.
- Develop incentives to promote adoption of the lowest-mercury, most breakage-resistant and longest-lasting CFL designs, through government purchasing or large-scale utility CFL-distribution programs.
- Adopt guidelines for CFL-giveaway programs that include strong environmental standards.
- Require CFL giveaways to include information on breakage, safe clean-up procedures and recycling programs.
- Consider requiring the phase-out of mercury-containing CFLs as more acceptable alternative high-efficiency lighting technologies become available and affordable.
- Collaborate with the lighting industry and others on research to develop better data for exposure assessments related to breakage of CFLs and other fluorescent lamps, in homes and in trash processing.

Environmental NGOs and the public-interest community should:

- Pursue long-term energy-saving lighting strategies that minimize toxic releases throughout product life cycles, minimize resource consumption, emphasize recycling over disposal, promote closed-loop processes for end-of-product life issues and manufacturer- or retailer-funded recycling programs.
- Develop and disseminate consumer information on risk-benefit trade-offs of CFL use, and promote increased community involvement in energy choices.
- Consider adopting and encourage other organizations and utilities involved in CFL giveaway programs to adopt the Sierra Club's Guidelines for Environmentally-Preferable Light Bulbs (appended to this report).

Image credits:

p.1 Eric Uram - Headwater Consulting 2005

p.2 http://www.maine.gov/dep/rwm/homeowner/fluorescent.htm

p.3 http://www.123rf.com/photo_715631.html

p.4 Jim Gathany - CDC 2003

p.5 http://upload.wikimedia.org/wikipedia/commons/thumb/a/ae/Question_mark_3d.png/310px-Question_mark_3d.png

p.6 http://www.mercvt.org/images/hglamp.jpg

p. 8 http://www.dep.state.fl.us/waste/quick_topics/publications/shw/mercury/Mercury_CFL_Dynamics-final.pdf

p. 10 http://www.mercvt.org/dispose/lamprecycleproject.htm

Resources

If you have further questions, we suggest you contact your state health department or environmental agency or visit their web sites

Gov't Advice on CFL Safety and Clean-Up

Maine www.maine.gov/dep/rwm/homeowner/fluorescent.htm

Massachusetts www.mass.gov/dep/toxics/stypes/hgres.htm#dispose

Minneapolis www.ci.minneapolis.mn.us/environment/fluorescent.asp

Minnesota www.pca.state.mn.us/waste/lightbulbs.html

Vermont www.mercvt.org/PDF/cflampfactsheet.pdf

Florida www.dep.state.fl.us/waste/categories/mercury/

California www.ciwmb.ca.gov/WPIE/HazSub/Mercury.htm

USEPA www.epa.gov/mercury/spills/index.htm#flourescent

Information on Recycling Programs for CFLs:

www.zerowaste.org/publications/CFL/CFL_case_studies.htm

www.savingcivilization.org/recycling-light-bulbs.html

www.ikea.com/ms/en_US/about_ikea/social_environmental/environment.html

www.epa.gov/epaoswer/hazwaste/id/univwast/lamps/index.htm

www.nema.org/lamprecycle/recyclers.html

www.tcpi.com/recycle.aspx

www.almr.org/

Third-Party Certification Programs for Energy-Efficient Lighting:

http://www.greenseal.org/certification/gs-5proposed_revised_standard.pdf

www.greenerchoices.org/eco-labels/productIndex.cfm

www.greenseal.org/index.cfm

www.gen.gr.jp/index.html

home.howstuffworks.com/fluorescent-lamp2.htm

www.epa.gov/epaoswer/hazwaste/id/univwast/lamps/lamps.htm

www.govpro.com/Issue/Article/38657/Issue

http://www.ecologo.org/en/seeourcriteria/details.asp?ccd_id=239

General Information on Energy-Efficient Lighting Choices:

www.energystar.gov/index.cfm?c=cfls.pr_cfls

http://www.lrc.rpi.edu/

www.bulbamerica.com/Indoor-Reflectors-429-cat.htm

http://www1.eere.energy.gov/femp/procurement/eep_fluor_tips.html

www.wattmanledlamp.com/index.php?main_page=index&cPath=73

sev.prnewswire.com/oil-energy/20080219/AQTU01019022008-1.html

www.popularmechanics.com/blogs/home_journal_news/4217864.html

www.informinc.org/fact_P3fluorescentlamps.php

www.newdream.org/consumer/cfl.php

US NGO Information Resources on CFLs:

www.sierraclub.org/policy/conservation/cfl-guidelines.pdf

www.responsiblepurchasing.org/purchasing_guides/lighting/

blogs.consumerreports.org/home/2007/06/qa_are_there_an.html

blogs.consumerreports.org/home/2007/03/a_darker_side_o.html

blogs.consumerreports.org/home/2007/10/cfl-recycling.html

www.environmentaldefense.org/page.cfm?tagid=609

Lighting Manufacturers' Statements:

www.nema.org/gov/ehs/committees/lamps/cfl-mercury.cfm

www.tcpi.com/corp

www.gelighting.com

www.osram.com

www.lighting.philips.com

www.lightsofamerica.com/

European Programs Related to CFLs and Mercury Risks:

www.elcfed.org/documents/070420_ELC_Q&A_on_Domestic_Lighting.pdf.

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0095:EN:HTML

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Appendix 1

Sierra Club CFL Guidelines for Selecting, Distributing and Recycling Environmentally-Preferable Light Bulbs During Mass Giveaways

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Guidelines for Selecting, Distributing and Recycling Environmentally-Preferable Light Bulbs During Mass Giveaways

Many chapters and groups of the Sierra Club plan to or have engaged in community-based programs to distribute energy-efficient compact fluorescent lamps (CFLs). These efforts help educate consumers about easy and important ways to reduce energy consumption. Three times more efficient than standard incandescent light bulbs, CFLs significantly reduce mercury, greenhouse gases and other toxic emissions coming from coal-fired power plants. At the same time, concerns have been raised because all CFLs contain mercury and some models contain lead. The vast majority of CFLs ends up in landfills or trash incinerators where these hazardous substances can get released into the environment.

These Guidelines seek to balance and advance the Sierra Club's goals of climate protection, toxics reduction and zero waste. The primary purpose of these Guidelines is to help Sierra Club chapters and groups optimize environmental benefits of energy-efficient lamp distribution programs in their communities. The intention is to design distribution programs that pressure corporations to provide less-toxic lamps, and create producer-funded retail recycling opportunities that make it as easy for customers to recycle CFLs as it is to buy them. These guidelines advocate some actions that go beyond the capacity of individual consumers; however, recommendations have been included that will help individuals select the best lamps when making their purchases at retail stores.

Summary Checklist: Specifying CFLs for Distribution Programs

- Require ENERGY STAR–qualified CFLs (www.energystar.gov) with a minimum rated life of 10,000 hours, and with the highest efficiency (lumens per watt). Look for the Energy Star logo on the packaging.
- Require companies to disclose mercury content (in milligrams - mg) and any lead in solder and/or glass.
- Specify lamps with 5 mg of mercury or less and favor ones with less than 3 mg.
- Choose lead-free whenever available (usually labeled as such).
- Choose manufacturers and distributors offering private-sector-financed collection and recycling programs.
- Include local recycling information with lamps. Encourage consumers to use local retail and other private collection systems when available. Publicly-funded collection should be promoted as transitional to the creation of private collection opportunities.
- Prepare consumer-friendly fact sheets and other materials that respect local traditions, culture and language.

- Include instructions about what to do (and not do) if a CFL breaks (see below).
- Distribute in cooperation with community leadership, consistent with Environmental Justice protocols.

Recommendations for Individuals Purchasing CFLs

- Whenever available, choose CFLs in an ENERGY STAR–labeled package. This will help ensure you buy a more energy efficient and higher performing product.
- Choose the CFL that meets your needs and has the longest rated life. Look for products that last at least 10,000 hours. This information is almost always printed on the package.
- Choose the most energy-efficient model with the fewest watts to give you the light output you need. (CFLs tend to

Sierra Club Headquarters: 85 Second St., Second Floor • San Francisco, CA 94105 • (415) 977-5500
Sierra Club Washington, D.C. Office: 408 C St. NE • Washington, DC 20002 • (202) 547-1141 • *www.sierraclub.org/policy*

fade over their life; so pick one slightly brighter than the incandescent lamp you are replacing.)

- Choose lamps made by companies pledging to keep mercury content below 5-6 mg by going to www.nema.org/gov/ehs/committees/lamps/cfl-mercury.cfm.
- Choose CFLs that manufacturers advertise as lead-free.
- Choose retailers that offer to collect spent CFLs (and other fluorescent lamps). While Ikea is the only U.S. retailer that recycles burned-out CFLs consumers bring back to stores, a retailer-financed lamp "take-back" program has been established in Europe. Encourage manufacturers/retailers in your community to set up on-going recycling programs for their customers.

Background and Rationale

1. Use energy efficient, long-lasting bulbs

Sierra Club commits to distributing only ENERGY STAR-qualified lighting products, including CFLs and Solid State Lighting (SSLs-including light-emitting diodes (LEDs).

The ENERGY STAR program, which is jointly run by the US Department of Energy and the US Environmental Protection Agency (EPA), qualifies CFLs, SSLs and other energy-efficient lighting products that meet minimum performance standards for efficacy, lamp life, and light quality. Qualified lighting products are listed on the ENERGY STAR website at www.energystar.gov. CFLs chosen for mass distribution programs should offer the highest efficiency, which is measured in lumens per watt. CFLs tend to fade over time, so it is important to specify models that emit about 20-30 percent more initial lumens than the incandescent it is replacing.

The ENERGY STAR program has set a minimum rated life of 6,000 hours for all qualified CFLs but the program's website indicates that nearly 1,000 models have a rated life of 10,000 hours or more. The ENERGY STAR criteria for LEDs was released in September 2007. As LEDs become more available and affordable, the Sierra Club should include them in their distribution programs since they are longer-lasting and mercury-free. ENERGY STAR-qualified LED lights must have a rated life of at least 25,000 hours.

The specification and distribution of long-lasting CFLs and LEDs minimizes environmental impacts by reducing the number of light bulbs that need to be manufactured, transported, and ultimately recycled, as well as the number that may end up in the trash. It also drives innovation by supporting companies that have invested in high-performance technology.

2. Use least-toxic bulbs

Sierra Club commits to distributing light bulbs that have the least mercury and lead.

While all CFLs currently contain mercury, the amount they contain can vary from 1-30 milligrams (mg), depending on manufacturer and model. Several major manufacturers (including some members of the National Electrical Manufacturers Association, www.nema.org/gov/ehs/committees/lamps/cfl-mercury.cfm.) have agreed to cap mercury at 5 mg in most models, but some CFLs are available with as little as 1 mg of mercury. Sierra Club distribution programs should specify CFLs with a maximum of 5 mg of mercury and give preference to CFLs with less than 3 mg of mercury.

Similarly, many CFLs (and other light bulbs with screw-in bases) are made with lead in the solder and glass. Lead-free CFLs are becoming increasing available in the marketplace as lead solder is being banned from other electronic and electrical applications in Europe and elsewhere. Sierra Club encourages its members to distribute lead-free CFLs whenever they are available and meet other performance and environmental criteria. In addition, LEDs (which are mercury-free but may contain some other heavy metals) should be evaluated for toxicity and considered for inclusion in Sierra Club's distribution programs when they are determined to be efficient, environmentally preferable and cost-effective for specific applications.

The specification of low-mercury, mercury-free, and lead-free lamps protects workers manufacturing these products, consumers (especially if the light bulbs accidentally break), and the environment. Workers are further protected whenever fluorescent lamps are manufactured with encapsulated mercury dosing technologies—such as pellets, pills or amalgam – rather than traditional liquid-mercury dosing methods. Mercury is a toxic heavy metal that persists in the environment, concentrates in the food chain, and causes nerve and brain damage, heart disease and cancer. Lead, like mercury, is a persistent, bioaccumulative and toxic chemical known to cause serious, long-term health damage, particularly to children's brains.

Sierra Club encourages manufacturers to label their lamps and packaging with information on mercury and lead content for each model. Mercury content should be labeled as a maximum per lamp, not an average or range. In addition, Sierra Club should consider distributing CFLs/LEDs with separate ballast/transformers, when available, just as in fluorescent tube lamps. This will decrease the amount of materials in CFLs and LED lamps requiring disposal, help retain longer-lived components during their entire useful life (like solid-state circuit boards and transformers), and decrease purchase, recycling and disposal costs for manufacturers and consumers alike.

These actions are consistent with toxics use reduction, right-to-know and pollution prevention/zero waste principles in Sierra Club's Environmental Justice Policy as well as in its Environmentally Hazardous Substances Policy, which discourages use of hazardous substances that persist in the environment and tend to become concentrated in living organisms.

3. Promote recycling take-back by retailers, vendors and producers.

Sierra Club commits to promoting effective recycling programs and assisting local governments by supporting recycling take-back by retailers, vendors and producers.

When the Sierra Club engages in CFL distribution programs, we have a responsibility to inform consumers of the mercury in fluorescents and potential lead in both incandescents and fluorescents, and the consequent urgency to recycle them at end of life. However, public collection infrastructure (household hazardous waste collection centers and events) are not equipped to sustainably address this problem. Only about 2% of household fluorescent lamps are recycled in the U.S. (Association of Lighting and Mercury Recyclers, 2004). Local governments currently pay exorbitant sums to collect a small portion of all retired lamps. Where local government collection is the only option, simply telling consumers "Please Recycle" is both misleading to consumers and frustrating to underfunded and ineffective public sector programs.

Ultimately, it should be as easy to recycle CFLs as it is to purchase them. This requires development of convenient private sector collection and recycling opportunities. Sierra Club chapters and groups should aggressively support local government efforts to develop retail and vendor take-back programs for mercury- and/or lead-containing lamps, preferably through producer-funded programs. Distribution programs should give preference to using wholesalers or retailers who provide take-back services. Recycling information provided during distribution should direct consumers to use local retail and other private sector collection sites and methods, in preference to taxpayer-funded collection programs. The Sierra Club supports and will work towards enforceable producer responsibility standards for collecting and recycling hazardous lighting products (see model criteria below).

All Sierra Club CFL distribution programs must include instructions for recipients about what to do, and not do, if a CFL breaks—such as ventilating the room but not vacuuming. A US EPA fact sheet available at www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf . It should be given to all volunteers working on the distribution program so that they know what to tell people if they ask that question. In addition, the Club calls upon EPA to carefully evaluate its cleanup methods to determine their effectiveness on all surfaces including carpets.

4. Serve low-income communities

Sierra Club volunteers involved in energy-efficient lighting distribution programs should make a good faith effort to build bridges with low-income communities where appropriate, in line with Environmental Justice principles and protocols. The Sierra Club should provide versions of materials that respect local traditions and language. Working with community leadership will make distribution efforts more welcome. Reaching out to low-income populations will increase the use of energy-efficient products in neighborhoods where residents may be the least likely to afford them on their own.

Model Policy Language for Producer Responsibility as it Relates to Hazardous Material Recovery from Consumer Lighting

Every manufacturer of general purpose lights sold in ____ state and containing hazardous materials shall be responsible for all of the following:

(a) On and after [date], ensuring that a system is in place to provide for the collection and recycling of any end-of-life general purpose lights generated in this state.

(b) On or before [date], submitting a plan (the plan) to the [State department] for the collection, recycling, and proper management of end-of-life general purpose lights generated in this state.

(c) The plan shall include all of the following:

(1) The methods to be used by the manufacturer to collect and properly manage spent devices generated in xxxx state.

(2) The number and frequency of collection(s).

(3) The methods to be used to educate consumers about the opportunities presented in the plan.

(4) The funding mechanism(s) to accomplish the plan originate from the manufacturer(s).