DANGEROUS MERCURY IN CFLs?

ONE BIG FISH STORY

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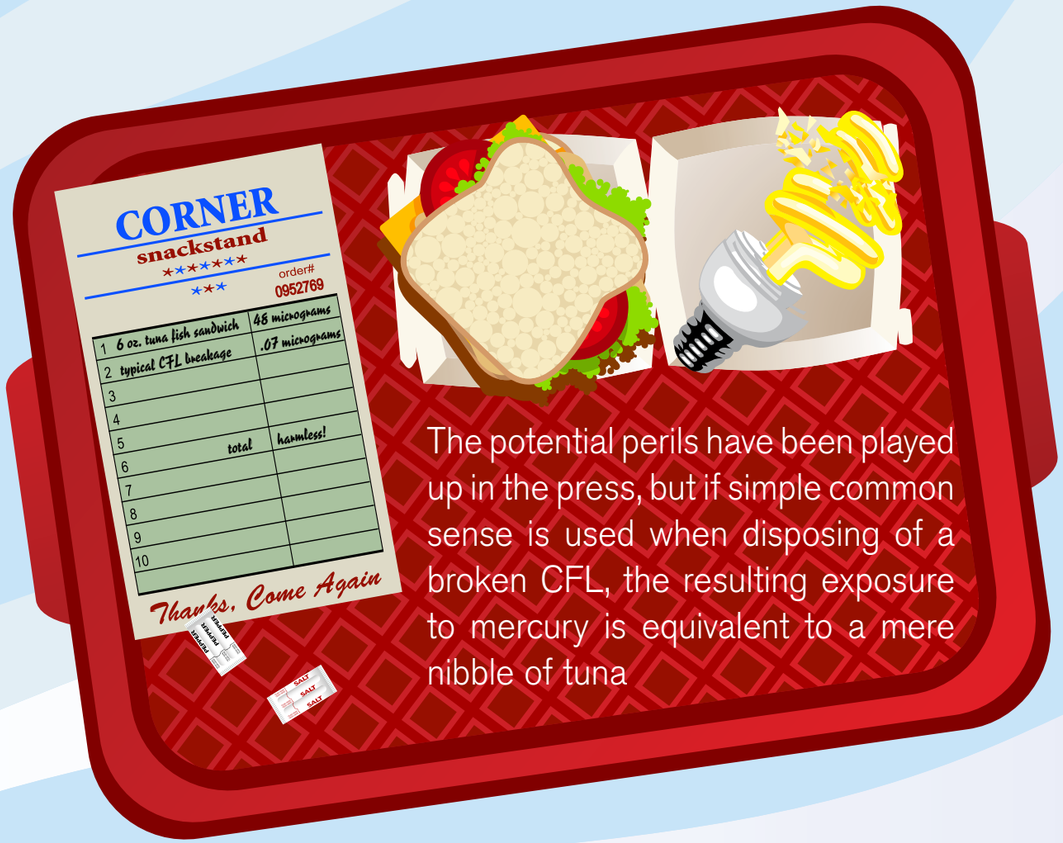

Lighting professionals are presumably aware that used CFLs are supposed to be recycled, and not just sent to landfills, because of the small amount of toxic mercury they contain. But what do you advise your clients when they break a lamp? And just how dangerous is the mercury inside?

You may have heard that clean-up costs are exorbitant and that the mercury vapor concentration from a broken lamp is unsafe. Actually, the amount of mercury that you are likely exposed to after breaking a lamp is no more than you subject yourself to when eating a bite of tuna. In this paper, we review the concerns, describe why we believe that the fish comparison is valid and show that the real risk is negligible.

Let's start with the reports of exorbitant clean-up costs and dangerous mercury vapor levels. In April 2007, Brandy Bridges accidentally broke a CFL in her daughter's bedroom and was left wondering what to do next. [1] After several referrals, she phoned the Maine Department of Environmental Protection (MDEP), which sent a specialist to her home a day later. Airborne concentrations of mercury were generally low, but measurements in two areas–a 1-ft area around the breakage and a nearby bag of toys where some lamp fragments had fallen–exceeded the state's air quality standard. When Bridges expressed concern about long-term exposure, she was referred to a commercial clean-up contractor; the estimate for a professional clean-up was $2,000.

This incident was quickly seized upon as an argument against the use of CFLs. Why should consumers bear the risk of introducing a potential safety hazard into their own homes just to save a little energy? Against health concerns and clean-up costs on this scale, a lower utility bill and the satisfaction from a little environmentalism seem meager encouragement. In response to public outrage, especially in the blogosphere, MDEP posted a reply documenting its assurances to Bridges that, in her case, "potential mercury exposure would be very low and likely of negligible health concern." Unfortunately, this assurance is apparently true only as long as broken CFLs are "properly cleaned up."[2] These responses are hardly less alarming. Would exposure be potentially hazardous under different circumstances? And what does proper clean-up entail?

MDEP couldn't find the information to actually answer these questions, so they ran a study which examined 45 different breakage/clean-up scenarios.[5] They found that altering the ventilation conditions, cleaning methods and equipment, sample CFL, and breakage conditions and surface (e.g., hardwood floor versus carpet), resulted in average first-hour mercury vapor concentrations that varied by a factor of 600. Many of these concentration levels exceeded the state air quality standard, and the report concluded that "…homeowners consider not utilizing fluorescent lamps…where they could easily be broken, in bedrooms used by infants, small children or pregnant women…" and, should a lamp be broken over a carpet, that "…homeowners consider removal of the area of the carpet where the breakage occurred as a precaution, particularly in homes with infants, small children, or pregnant women." This is not much better than the $2,000 clean-up, and, if taken seriously, is likely to discourage a lot of people from considering CFLs at all.

A QUESTION OF EXPOSURE

Those of us who remember mercury thermometers, which contained 100 or more times the amount of mercury in a CFL, may well wonder how we ever survived. In fact, the use of the state air quality standard to determine the acceptable level for a one-time or infrequent exposure is extremely conservative. The state standard is based on an estimate of the No Observable Adverse Effects Level (NOAEL) for continuous (lifetime) exposure. The MDEP justifies using this ambient air quality (AAQ) standard for a single exposure because of a lack of information on the effects of prenatal exposure: "An important issue for which there are no data is the relative importance of a short spike in exposure versus a longer-term lower exposure in producing toxicity. The U.S. EPA considers that a single exposure may be sufficient to produce effects in a developing organism because of the recognition of potential critical windows of vulnerability." Based on this logic, a short spike in exposure

could be as short as a single breath. MDEP, without any discussion of the issue, confines its analysis to situations where the average level exceeds the AAQ for one hour.

The problem with applying this principle to air concentrations is that exposure is not directly proportional to the current air concentration. Human beings are continually exposed to mercury–from inorganic mercury salts in food and water, elemental mercury in air (from natural and anthropogenic sources), and organic mercury, such as methylmercury, in fish. Mercury becomes bound within tissues in the body, and is only gradually released over time. Prenatal exposure actually results from the combination of mercury from the environment and any mercury remaining in the bloodstream from a history of exposure.

While the various forms of mercury appear to have similar mechanisms of toxicity, methylmercury is the most dangerous for the prenatal or young infant; it readily crosses the placental and blood-brain barriers and is much more likely to be bound to the developing brain.[4-6] Comparing the mercury dose from a meal of fish, or even a past history of eating fish, to the dose from a broken CFL therefore becomes a useful, while conservative, exercise in understanding the real danger posed by CFLs.

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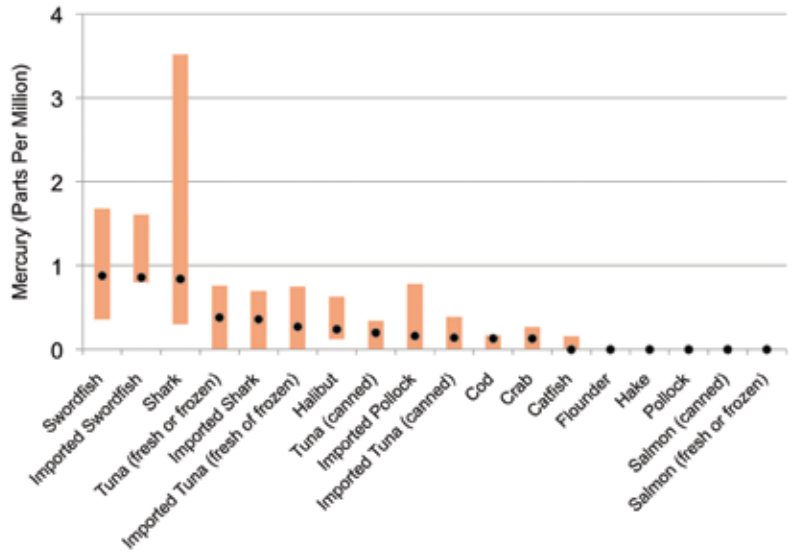
For those following an "average" diet, fish is one of the most common sources of mercury that we are exposed to in everyday life. The amount of methylmercury that accumulates in fish varies according to how high the fish is on the food chain (**Figure 1**)[4]. The FDA encourages people, including pregnant women, to eat fish, but recommends that they eat no more than one 6-ounce meal per week of fish such as Albacore tuna, which is relatively high in mercury content. Albacore tuna is one of the most commonly consumed fish.

Figure 2 shows the key comparisons between mercury exposures from breaking a CFL, and the methylmercury exposures from eating Albacore tuna. The top bar, showing the tiny mercury dose (0.068 micrograms) calculated from the median of the 45 breakage scenarios, is compared to the dose absorbed by breathing air contaminated at the state air quality standard for one hour (0.153 micrograms) and eight hours (1.22 micrograms). (Eight hours is an approximate upper limit on the time it takes to digest and absorb the mercury from a meal.) Most important in this comparison is the bar showing the dose from eating a single (6-ounce) meal of Albacore tuna (48 micrograms of mercury), which is roughly equal to the very worst CFL breakage case measured by the MDEP. The

Figure 1 : Methylmercury concentrations in 18 types of commonly consumed fish, showing average (black dots) and range (orange bars).[7] Source: U.S. Dept. of Health and Human Services and U.S. Environmental Protection Agency, "Mercury Levels in Commercial Fish and Shellfish."

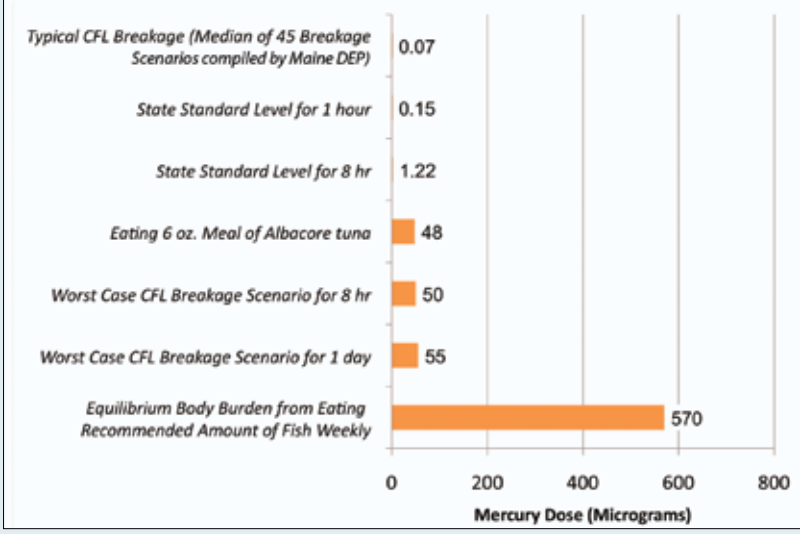


last, and by far the largest, of the bars is the steady state body burden that would result if the recommended amount of fish is regularly consumed on a weekly basis.

DIGESTING THE DATA

So what do all these comparisons mean? First, they show that if simple common sense is used in disposing of the broken CFL, the resulting exposure to mercury is equivalent to about 1/50th of an ounce–a single nibble–of Albacore tuna! Second, when we account for the fact that methylmercury appears to be more hazardous than an equivalent amount of mercury vapor, they suggest that the state air quality standard (which is only marginally higher than a nibble of tuna) is an inappropriately conservative standard for a single short-term exposure. Third, even the most extreme CFL breakage scenario measured by the MDEP only equaled the approximate exposure from a single meal of fish. Fourth, the equilibrium body burden that would result from long-term consumption of the recommended amount of fish is about 10 times larger than the very worst case CFL breakage scenario. The incremental dose from a single meal is only a fraction of the total dose due to long-term exposure. The FDA explicitly bases its recommendations on fish consumption with this in mind: "One week's consumption of fish does not change the level of methylmercury in the body much at all. If you eat a lot of fish one week, you can cut back for the next week or two. Just make sure you average the recommended amount per week."[8].

Figure 2: Dose of mercury from listed exposures.



Note that the worst case scenario was truly designed as the worst of worst cases. It yielded 800 times the median dose, and five times the dose of the second worst case (data not shown in Figure 2). There were two main factors that contributed to this case. First, every effort was made to force the mercury into the air. Although the bulk debris was picked up, it was disposed of in a trash can, in the room. A vacuum cleaner, with a beater attachment, was then used on the carpet where the lamp had been broken and then left in the room. Second, entrances to the room were shut, and heating vents and windows sealed, leaving little chance for the mercury to disperse. The important point here: all of these factors are easily avoidable.

It is an unfortunate fact of life that people are exposed to many toxins, sometimes with tragic consequences. We found an immense number of cases from overdoses of aspirin and other household medicines, as well as many household chemicals. We found fewer cases of mercury poisoning from paint, from broken thermometers or medical equipment, and from people attempting to refine gold or extract silver from dental fillings. We found only one case involving mercury from lamps, and that resulted from the breakage of *an entire carton* of older 8-ft lamps. An infant playing for several months in a shed where the lamps were broken developed acrodynia, a condition primarily characterized by irritability, anorexia and pain in the extremities.[9] The condition cleared up after the infant was removed from exposure to the mercury spill. This case was not equivalent to the breaking of one, or even several, CFLs. Old 8-ft lamps contain 10 to 50 times as much mercury as new CFLs, so the amount of mercury released in this case was several hundred to 1,000

times more than would be released by a single broken CFL.

WHAT DO YOU SAY?

So your client is concerned about what might happen if they break a CFL. What do you tell them? You can tell them that if they follow the steps described below a broken CFL poses about as much of a health risk as a bite of tuna.

1) Ventilate the area where the lamp is broken with outside air,

2) Promptly clean up and remove any visible debris to a ventilated (preferably outdoor) area,

3) Vacuuming forces mercury into the air and should be avoided if possible. (Any vacuuming should be limited to one or two minutes, and the vacuumed space should be vacated, while ventilating, for one to two hours. In addition, the vacuum cleaner should be emptied, then used and stored in ventilated areas until it has been used several more times.)

If they have already broken the lamp and vacuumed it up and are worried, you can tell them that they have been exposed to about as much mercury as they would get from eating the FDA recommended amount of fish per week. They can reduce any potential risk to a prenatal infant by limiting their fish intake over the next couple of weeks.

And no, they shouldn't call for HazMat.

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Jack Howells is currently an undergraduate in English at UC Berkeley and is also a student assistant at Lawrence Berkeley National Laboratory.

[1] "Fluorescent Bulb Break Creates Costly Hassle," The Ellsworth American, April 12, 2007: http://ellsworthmaine.com/site/index.php?option=com_content&task=view&id=7446&Itemid=31

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[3] Maine Compact Fluorescent Lamp Study, February, 2008: http://maine.gov/dep/rwm/homeowner/cflreport.htm

[4] Toxicological Profile for Mercury, U. S. Department of Health and Human Services, March 1999: www.atsdr.cdc.gov/ToxProfiles/tp46.html

[5] Ministry of the Environment, Government of Japan, Minimata Disease The History and Measures www.env.go.jp/en/chemi/hs/minamata2002/ch3.html

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[7] U.S. Department of Health and Human Services and U.S. Environmental Protection Agency, "Mercury Levels in Commercial Fish and Shellfish," Last updated Feb. 2006 www.cfsan.fda.gov/~frf/sea-mehg.html

[8] What You Need to Know About Mercury in Fish and Shellfish, 2004 EPA and FDA Advice For: Women Who Might Become Pregnant, Women Who are Pregnant, Nursing Mothers, Young Children: www.cfsan.fda.gov/~dms/admehg3.html

[9] Tunnessen WW Jr, McMahon KJ, Baser M. "Acrodynia: Exposure to Mercury from Fluorescent Lightbulbs." Pediatrics 79 (5): 786-9. (1987) PMID 3575038.