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strategies for a better environment

Shedding Light on Mercury in Fluorescents

A Workbook for Design Professionals

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Introduction: A New Look at Lighting

The energy-related environmental impacts of generating light, on a lumen by lumen basis,[1] have steadily decreased over the last century. Still, 22 percent of all the electricity consumed in the US is used for lighting. Americans spend nearly $58 billion a year to light their homes, places of business, and streets.[2] Many commercial consumers are responding to the high cost of lighting by purchasing the most energy-efficient technologies available, creating intense competition among lighting manufacturers.

Early incandescent lamps were extremely inefficient, losing nearly 95 percent of their energy as heat. Incandescent lighting is still the least efficient lighting technology available, producing a mere 10 to 20 lumens per watt of electricity consumed. In contrast, fluorescent, light-emitting diode (LED), and other of today's cutting-edge technologies produce light at far higher efficiencies, significantly reducing the costs and environmental impacts of lighting. The most energy-efficient fluorescent lamps can produce up to 90 lumens per watt,[3] and generally consume only a quarter of the energy per lumen of standard incandescent and tungsten halogen lamps.[4]

The increasing adoption of energy-efficient, cost-cutting lighting systems does have a downside, however. Many of these lamp technologies, including standard linear fluorescent, compact fluorescent, and high-intensity discharge (HID) lamps, rely on mercury to produce light.

What's Wrong with Mercury?

Mercury is a ubiquitous environmental contaminant and potent neurotoxin that can cause irreversible damage to the developing brain of the fetus and small children. Exposure to mercury at levels that cause no apparent harm to a pregnant woman can affect her fetus to the point of retarding development, leading to problems with walking, talking, learning, and behavior as the child grows. According to an analysis from the Centers for Disease Control and Prevention (CDC), close to 8 percent of women of childbearing age in the US have mercury blood levels that exceed the US Environmental Protection Agency's (EPA's) current safe upper limit for fetal risk of 5.8 micrograms (µg) per liter.[5] Recent studies indicate that mercury is actually more concentrated in the bloodstream of the fetus than of the mother, exposing the fetus to almost twice the mercury concentration of the mother's blood.[6] This means that the EPA's "safe" upper limit may significantly underestimate the number of children at risk. Based on these new findings, the agency now estimates that as many as 630,000 US children per year (one out of six newborns) could be at risk for developmental delays associated with mercury exposure.[7]

Mercury exposure can also affect adults, causing fine motor tremors, hair loss, vision problems, damage to vital organs, and confusion.[8] In addition, recent research indicates that high levels of fetal exposure are associated with difficulties with heart rate regulation later in life, apparently because of autonomous nervous system deficits.[9] Several other studies have also shown correlations between mercury in the blood of adults and rates of heart disease.[10]

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1 A lumen is a measure of light flow; the higher the lumens, the more light is produced.

2 US Dept. of Energy, Building Technologies Program, "Lighting Research and Development," http://www.eere.energy.gov/buildings/research/lighting/index.cfm.

3 *Ibid.*

4 National Electrical Manufacturers Association, "Alternatives to Mercury-containing Light Sources," http://www.imsasafety.org/journal/mayjun/mj7.pdf.

5 S.E. Schober *et al.*, "Blood mercury levels in US children and women of childbearing age, 1999-2000," *Journal of the American Medical Association,* Vol. 289, No. 13, 1667-74.

6 Kathryn R. Mahaffey, US. Environmental Protection Agency, "Update on Recent Epidemiologic Mercury Studies," presentation at the National Forum on Contaminants in Fish, San Diego, CA, January 25-28, 2004.

7 *Ibid.*

8 Agency for Toxic Substances and Disease Registry, Public Health Statement for Mercury, March 1999, http://www.atsdr.cdc.gov/toxprofiles/phs46.html.

9 Philippe Grandjean *et al.*, "Cardia autonomic activity in methylmercury neurotoxicity: 14 year follow-up of Faroese birth cohort,"*Journal of Pediatrics,* Vol. 144, Issue 2, February 2004.

10 J.T. Salonen *et al*., "Intake of mercury from fish, lipid peroxidation, and the risk of myocardial infarction and coronary, cardiovascular and any death in eastern Finnish men," *Circulation,* 91, 1995, 645-55; E. Guallar *et al.*, "Mercury, fish oils, and the risk of myocardial infarction," *New England Journal of Medicine,* Vol. 347, No. 22, 2002, 1747-54.

Mercury is also highly persistent in the environment and in living things. Because it does not degrade, small amounts of mercury released over time can eventually build up to dangerous levels. In addition, mercury is bioaccumulative, meaning that it builds up in living tissue, increasing in concentration as predators moving up the food chain ingest the accumulated mercury in prey animals. As a result, animals (including humans) may contain mercury concentrations thousands to millions of times higher than those of the surrounding environment. The EPA has placed mercury on its list of priority persistent, bioaccumulative toxins (PBTs) currently being addressed under a high-priority initiative aimed at reducing and eventually eliminating releases of these dangerous substances.

Because our environment is already contaminated with mercury to such a degree that thousands of children are at risk of harm, regulatory and health agencies have focused their efforts on reducing or eliminating all additional avoidable releases.

Mercury in Lamps

Linear fluorescent, compact fluorescent, and HID lamps produce visible light when the mercury they contain is electrically energized and emits ultraviolet radiation.[11] Mercury vaporizes readily at room temperature and, depending on many factors, may present an exposure hazard if a lamp breaks indoors. In addition, discarded lamps broken before or in the course of disposal in landfills or incinerators release their mercury content to the environment.

Some lamps contain very little mercury. For instance, small T5 linear fluorescents can contain as little as 1.4 milligrams (mg) mercury, and none of the major manufacturers makes a modern-generation T5 with more than 5 mg mercury.[12] However, differing proprietary technologies and manufacturing methods mean that the mercury content of interchangeable lamps can vary widely. Thus, functionally identical linear fluorescent lamps can contain from 4.4 to 15 mg of mercury.[13] Similarly, some models of compact fluorescent lamps that are direct replacements for standard incandescent lamps contain as little as 2 mg, while other models contain as much as 15 mg.[14] In contrast, large fluorescent tubes can contain up to 60 mg mercury,[15] and HID stadium lamps used in outdoor sports venues can contain 225 mg or more.[16] Even so-called low-mercury lamps that qualify for disposal as ordinary solid waste vary from 3.4 mg to 9 mg of mercury.[17]

These wide variations in mercury content can have significant consequences in terms of the amount of mercury used and potentially released at end of life. For example, 1000 linear fluorescent lamps in a modest commercial building may contain as little as 1.4 grams or as much as 30 grams of mercury, depending on the model used. A household installing a compact fluorescent lamp with the highest mercury content will use (and dispose of) almost three times more mercury than it would if the lowest-mercury-content lamp were chosen instead. Yet most building professionals and other consumers are unaware of the variability of the mercury content of lamps, and no systematic information on mercury levels is available to inform their decision-making.

Building standards are only beginning to address the importance of reducing the mercury in lighting products. The challenge is coming up with a whole-building approach that does not interfere with design flexibility or local lighting codes. The US Green Building Council's Leadership in Energy and Environmental Design in Existing Buildings (LEED-EB) rating standard, which is now undergoing pilot testing, contains a section limiting the average amount of mercury allowable per lamp.[18] In addition, version 1.0 of the Green Guidelines for Healthcare Construction contains mercury limitation language (which INFORM assisted in drafting) that requires

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[11] Ecos Consulting, "Mercury in Fluorescent Lamps: Environmental Consequences and Policy Implications for NRDC," May 30, 2003, http://www.nwalliance.org/resources/reports/NRDCMercury.pdf; US Dept. of Energy, Energy Efficiency and Renewable Energy Clearinghouse, "Energy-Efficient Lighting," December 1996, http://www.eere.energy.gov/consumerinfo/pdfs/eelight.pdf.

[12] Private communiction, Paul Walitsky, Manager, Environmental Affairs, Philips, February 20, 2003.

[13] *Ibid.;* private communications, Bob Horner, Product Group Manager, Sylvania, March 3, 2003; Joe Howley, Environmental Marketing Manager, GE Lighting, February 24, 2003.

[14] New Jersey Dept. of the Treasury, Division of Purchase and Property, Notice of Award, T-0192, Lamps Incandescent, HID, Fluorescent, Including Low-Mercury, October 21, 2003, http://www.state.nj.us/treasury/purchase/noa/contracts/t0192.shtml.

[15] Private communications, Paul Walitsky, Bob Horner, Joe Howley.

[16] Private communication, Paul Walitsky, April 1, 2003.

[17] Private communications, Paul Walitsky, February 20, 2003; Bob Hormer; Joe Howley.

[18] US Green Building Council, Leadership in Energy and Environmental Design, *Green Building Rating System for Existing Buildings Operations and Upgrades (LEED-EB)*, USGBC Public Comment Draft, February 23, 2004, http://www.usgbc.org/Docs/LEEDdocs/PublicCommentDraftLEED-EB20040223.pdf.

facilities to "verify that high-intensity discharge lamps are purchased with the lowest mercury content, providing that all other performance specifications are met."[19]

Mercury Releases from Discarded Lamps

While the amount of mercury contained in an individual fluorescent lamp is small — the average is around 10 mg for a common fluorescent tube[20] — the volume of lamps used and discarded in the US each year is enormous. According to the National Electrical Manufacturers Association (NEMA), only 20 percent of used fluorescent lamps is recycled, with the remainder being discarded with ordinary municipal waste.[21] According to NEMA's estimates, 680 million lamps containing 13 tons of mercury will enter the US waste stream in 2004.[22] (One ton of mercury is sufficient to contaminate over 1.3 billion 3-pound fish to the point that they are unsafe to eat.) This estimate, based on the average current content of mercury-containing fluorescents, may well underestimate the actual amount of mercury discarded in lamps, since many units disposed of today are older models that generally contain much larger quantities of mercury.[23]

Both the EPA and the state of Florida estimate that 100 percent of lamps disposed of in standard municipal waste break during transport to and handling at incinerators and landfills, releasing all the mercury vapor they contain.[24] However, exactly how much mercury is released when lamps break is disputed. According to some estimates, as much as 40 percent of a lamp's mercury content is released in the first two weeks after breakage.[25] Predictions made by the EPA in 1997 of potential mercury releases to air and water from lamps discarded in 2004 ranged from 200 to 3000 pounds, depending on the manner in which the lamps were handled after disposal.[26] More recently, various researchers have estimated that between 0.3 and 4 tons of mercury from lamps are released directly to air and water each year, with most of the remainder ending up in landfills.[27]

The conditions of individual landfills and incinerators and the pollution control technologies used, among other factors, can affect releases and make it difficult to precisely model the fate of the mercury contained in this waste. The movement of mercury within a landfill is not well understood and estimates of releases vary widely. However, at least one study indicates that mercury in landfills may be transformed into methyl mercury (the form that accumulates in living organisms) before being released to the environment, thus increasing the toxicity potential of such releases.[28] In recent years, mercury emissions from large incinerators have diminished thanks to increasingly stringent federal regulations that went into effect in 1995. However, mercury contained in the ash and particulates captured by pollution control devices must still be disposed of.

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[19] Sponsored by the American Society for Healthcare Engineering, the Green Guidelines for Healthcare Construction is "a metric tool for evaluating health and sustainability of building design, construction, maintenance and operations for the healthcare industry." See Green Guidelines for Healthcare Construction, Version 1.0, Draft for Public Comment, December 2003, http://www.gghc.org.

[20] National Electrical Manufacturers Association, "Fluorescent Lamps and the Environment," January 2000, http://www.nema.org/lamprecycle/nemafluorfinal.pdf.

[21] National Electrical Manufacturers Association, "Lamp Recycling Outreach Program," May 2003, 1, http://www.nema.org/lamprecycle/docs/Lamp-Recycling-Outreach-Program-1-1.pdf.

[22] National Electrical Manufacturers Association, "Environmental Impact Analysis: Spent Mercury-Containing Lamps," 2000, http://www.nema.org/papers/enviimpact.doc.

[23] In addition, since laws reducing or eliminating mercury in batteries took effect in the 1990s, the proportion of mercury in the solid waste stream from lamps has increased markedly. According to one study, the proportion of mercury contributed by electric lighting to Florida's waste stream rose from 3.2 percent to more than 16 percent between 1988 and 2000, while the amount from batteries declined from 88 percent to 24 percent in the same period. See Florida Dept. of Environmental Protection, "Mercury Management. Quantifying Mercury in Florida's Solid Waste," http://www.dep.state.fl.us/waste/categories/mercury/pages/sources_and_quantities.htm.

[24] US EPA, *Mercury Emissions from the Disposal of Fluorescent Lamps: Revised Model*, final report, March 31, 1998, http://www.epa.gov/epaoswer/hazwaste/id/merc-emi/merc-pgs/emmrpt.pdf.

[25] Ecos Consulting, "Mercury in Fluorescent Lamps: Environmental Consequences and Policy Implications for NRDC"; Michael Aucott *et al.*, "Release of Mercury from Broken Fluorescent Bulbs," *Journal of the Air & Waste Management Association*, Volume 53, February 2003, http://www.awma.org/journal/ShowAbstract.asp?Year=2003&PaperID=1012.

[26] US EPA, *Mercury Emissions from the Disposal of Fluorescent Lamps*, final report, June 30, 1997, http://www.epa.gov/epaoswer/hazwaste/id/merc-emi/merc-pgs/merc-rpt.pdf.

[27] US EPA, *Mercury Study Report to Congress*, EPA-452/R-97-004, December 1997, http://www.epa.gov/oar/mercury.html; US EPA, *Mercury Emissions from the Disposal of Fluorescent Lamps: Revised Model*; Michael Aucott *et al.*, "Release of Mercury from Broken Fluorescent Bulbs."

[28] S.E.Lindberg, *et al.*, "Technical Note: Methylated Mercury Species In Municipal Waste Landfill Gas Sampled In Florida, USA," *Atmospheric Environment*, Vol. 35, 2001, 4011-15.

It is important to point out that the use of energy-efficient mercury lamps contributes to overall reductions in the demand for electricity, and thus has the potential to reduce mercury emissions from power plants. These facilities are currently responsible for an estimated 48 percent of anthropogenic releases of mercury in the US.[29] In contrast, the disposal of spent lamps accounts for perhaps 1.1 percent of total anthropogenic releases of this toxin.[30] Despite this comparatively small amount, mercury from discarded lamps is considered a sufficiently significant threat to the environment to warrant action by the EPA.[31]

Disposal of Fluorescent Lamps

The EPA has tried to limit the number of mercury-containing lamps that enter the municipal waste stream. Before 1998, agency regulations classified spent lamps as hazardous waste. However, complicated storage, tracking, and transport requirements proved a disincentive for many businesses to comply with the regulations. In 1998, in an effort to reduce these end-of-life handling costs and encourage recycling, the EPA reclassified spent lamps as "universal waste." Universal waste consists of hazardous materials generated by households and small businesses that present only low-level hazards or can be easily managed with proper handing.

This initiative has streamlined storage, tracking, and transport requirements for discarded lamps, greatly reducing the costs involved in delivering them to recycling facilities or acceptable disposal sites (where they must still be treated as hazardous waste). However, under the Universal Waste Rule, a whole class of "conditionally exempt small quantity generators" — homes and small facilities that dispose of less than 100 kilograms of lamps per month — are not required to handle this waste in any special fashion. As a result, many fluorescent lamps are being thrown out in the trash to await collection with ordinary waste, and many of these get broken before disposal, releasing their mercury to the environment.

Despite the reclassification of fluorescent lamps as universal waste, recycling rates are still quite low. In 2002, the EPA initiated a mercury-added lamp outreach program intended to increase the recycling rate from the 2002 level of 20 percent to 40 percent by 2005 and 80 percent by 2009.[32] (For more information on proper lamp disposal procedures in your community, see http://www.epa.gov/epaoswer/hazwaste/mercury/live.htm.)

Mercury Trends in Lighting

In response to environmental concerns and public pressure, manufacturers have been working hard to decrease the mercury content of fluorescent lamps. The overall amount of mercury used by the lighting industry has been going down since the mid-1980s: compared to 57 tons in 1984, only 32 tons of mercury were used in lamps in 1997, and the amount continues to decline. In terms of individual lamps, the average mercury content of a 4-foot lamp went from about 48 mg in 1985 to under 23 mg in 1994 to less than 12 mg in 1999.[33] In addition, manufacturers are having some success with fluorescent lamps that contain no mercury. For example:

- Sylvania has developed a mercury-free backlighting bulb for flat-panel (LCD) applications that works with xenon gas and has a rated life[34] of 100,000 hours.[35]
- Mercury-free high-pressure sodium lamps are available for HID lighting applications[36] through Osram Sylvania.
- Mercury-free low-pressure sodium lamps (available from numerous manufacturers) are available for outdoor lighting.
- A Swedish company, LightLab, has demonstrated a mercury-free energy-efficient fluorescent lamp.[37]

However, most of these lamps have yet to reach the market and none is fully competitive with mercury-added lighting technologies. Sylvania's mercury-free flat-panel

[29] Ecos Consulting, "Mercury in Fluorescent Lamps: Environmental Consequences and Policy Implications for NRDC."

[30] *Ibid.*

[31] US EPA, Outreach Effort to Increase Recycling of Mercury-Containing Lamps, http://www.epa.gov/epaoswer/hazwaste/id/univwast/lamp.htm.

[32] *Ibid.*

[33] National Electrical Manufacturers Association, "Fluorescent Lamps and the Environment."

[34] The rated life is the average amount of time a lamp will function before failing.

[35] Osram Sylvania, "LCD monitors benefit from new Osram lamp that is used to screen backlighting," press release, May 18, 1999, http://www.sylvania.com/press/990517d.html.

[36] National Electrical Manufacturers Association, "Alternatives to Mercury-containing Light Sources."

[37] See http://www.lightlab.se/arkiv/eko/LightLab%20AB%20Q1%20report%20for%20Jan%201-%20Mar%2031,%202001.doc.

bulb is less efficient than mercury-added flat-panel backlights, so it trades reduced mercury content for potentially higher mercury emissions. Osram Sylvania's high-pressure sodium lamps are produced only in low wattages, and the low-pressure sodium lamps — though they produce as much light as mercury-added versions — do not have the same color rendering ability and do not meet outdoor lighting specifications in many jurisdictions.

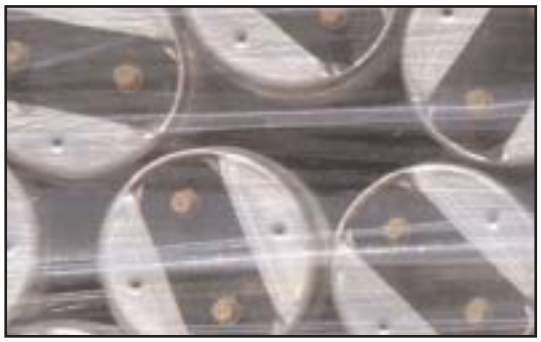
* * *

The growing adoption of energy-efficient lighting technologies is a beneficial development, contributing to reduced power consumption and potential reductions in mercury emissions from power plants. However, the increased use of these lamps is putting more mercury into homes, workplaces, and schools, increasing the risk of exposure during use and after disposal. Since consumers are still largely unaware that fluorescent lamps contain mercury, and that this highly toxic chemical can be released and contaminate the environment when lamps are burned in incinerators and buried in landfills, strategies are needed to increase the market for truly low-mercury alternatives by educating building professionals about the importance of purchasing low-mercury models and reclaiming the mercury content of spent lamps.

Building owners can contribute to this effort by ensuring that mercury-reduction strategies are part of the planning and maintenance of their facilities. For example, they can require architects to incorporate mercury restrictions into the construction documents for new buildings and renovations, and construction managers can see to it that subcontractors adhere to architectural specifications. Facility managers have a role to play not only in the construction process but in how existing facilities are run and maintained, educating staff and building occupants about the proper handling of mercury-added products. Finally, suppliers are well positioned to run effective mercury recycling programs, since they can easily ship spent lamps to recyclers at the end of their useful life.

The materials in this workbook are intended to provide building professionals with basic information on the mercury content of some of the principal types of architectural lighting, the environmental and health effects associated with the use and disposal of these products, available lower-mercury models and technologies, representative specifications that can be used by those wishing to purchase these "greener" alternatives, and other recommendations for reducing the environmental impact of mercury-added lamps and other building materials.

As more and more organizations specify environmentally sustainable products and practices for existing and future facilities, manufacturers will be encouraged to make more and better "green" products available. Meanwhile, as more and more building standards begin to incorporate mercury-reduction requirements for lighting and other building materials, the costs and benefits associated with constructing and maintaining a sustainable building will become better defined, helping to move "green" into the mainstream. The materials contained in this workbook can help clarify some of these costs and benefits, while providing building professionals with the latest information on emerging low-mercury technologies.



The Lowdown on Mercury in Fluorescent Lamps

The Lowdown on Mercury in Fluorescent Lamps

Most government agencies, schools, hospitals, and businesses purchase fluorescent lamps for their facilities because they are more energy-efficient than incandescent lamps. Fluorescent lamps are in fact the best choice because of their energy efficiency, but they also contain mercury, a highly persistent and toxic chemical that is building up to dangerous concentrations in fish, wildlife, and human beings throughout the US. For this reason, INFORM recommends buying fluorescent lamps with the lowest mercury content possible, and ensuring that they are recycled at end of life to prevent the release of mercury to the environment.

What should purchasers look for when buying fluorescent lamps?

- Energy efficiency
- Long lamp life
- Lowest mercury content
- Vendor promotion of recycling

Why is it important to buy lamps with the lowest mercury content?

A single lamp contains only milligrams of mercury. However, the National Electrical Manufacturers Association estimates that 680 million lamps containing 13 tons of mercury will enter the US waste stream in 2004.[1] Although it is impossible to model exactly the fate of the mercury contained in this waste, it is estimated that between 0.3 and 4 tons of mercury from lamps are released directly to air and water each year, with most of the remainder ending up in landfills.[2] (Four tons of mercury are sufficient to contaminate over 5.3 billion 3 pound fish to the point that they are unsafe to eat.) It is unknown how much mercury escapes from landfills each year to contribute to air and water contamination.

Do lower-mercury lamps cost more?

Generally no. The cost of interchangeable models with higher or lower mercury content is usually the same or differs by a few cents. The cost of specific lamp models depends on several factors, including the volume of lamps purchased.

How do I know if a lamp is "low-mercury?"

Some lamps are advertised as "green" or environmentally preferable, but these claims do not ensure the lowest-mercury model. The only sure way to know if you are buying the lamp with the lowest mercury content available for your application is to ask vendors for the actual mercury content of their lamps and select the lowest-mercury lamp on the basis of that information.

What about lamps that pass the toxicity characteristic leaching procedure (TCLP)?

Lamps that pass the toxicity characteristic leaching procedure are called "TCLP-compliant." These lamps may or may not have the same amount of mercury as an equivalent non-TCLP-compliant lamp.

The TCLP is used by the US EPA to determine if something is a hazardous waste. The procedure is designed to simulate how much of a toxic chemical would *leach* from a product if the product were put into a landfill; it does not measure how much of the toxic chemical is actually *contained* in the product or how much may be released under non-landfill conditions.[3] Mercury leaching can be affected by the presence of other chemicals or metals in the product, and so is not an accurate indicator of a lamp's mercury content. For more information about the TCLP and its use in evaluating lamps, see "Mercury-Containing Lamps and EPA's Toxicity Characteristic Leaching Procedure (TCLP)."

How much mercury is in a typical fluorescent lamp?

The amount of mercury in fluorescent lamps varies widely, depending on the lamp. Some fluorescent lamps have as little as 3.5 mg mercury, but some have as much as 60 mg. Over the past 20 years, the mercury content of these lamps has declined steadily.

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[1] National Electrical Manufacturers Association,"Environmental Impact Analysis: Spent Mercury-Containing Lamps," 2000, http://www.nema.org/papers/enviimpact.doc.

[2] US EPA, *Mercury Study Report to Congress*, EPA-452/R-97-004, December 1997, http://www.epa. gov/oar/mercury.html; US EPA, *Mercury Emissions from the Disposal of Fluorescent Lamps*, final report, March 31, 1998, http://www.epa.gov/epaoswer/hazwaste/id/merc-emi/merc-pgs/emmrpt.pdf; Michael Aucott *et al.*, "Release of Mercury from Broken Fluorescent Bulbs," *Journal of the Air & Waste Management Association*, Vol. 53, February 2003.

[3] US EPA, Test Methods Frequently Asked Questions: TCLP Questions, June 28, 2002, http://www.epa.gov/epaoswer/hazwaste/test/faqs_tclp.htm.

INFORM contacted Sylvania, GE, and Philips in 2003 to ascertain the amount of mercury found in both their "standard" linear four-foot TCLP-compliant lamps and their equivalent non-TCLP-compliant lamps. Keep in mind that the particular lamp your fixture requires may not fall into the "standard" category.

2002 Mercury Content of "Standard" Four-Foot T8 Lamps[4]

Manufacturer	TCLP Compliant	Non-TCLP Compliant
Philips	3.5 mg (Alto)	Not manufactured
Sylvania	6 to 8 mg (Ecologic)	6 to 8 mg
GE	6 mg (Ecolux)	Not manufactured

2002 Mercury Content of "Standard" Four-Foot T12 Lamps[4]

Manufacturer	TCLP Compliant	Non-TCLP Compliant
Philips	4.4 mg (Alto)	Not manufactured
Sylvania	9 mg (Ecologic)	9 mg
GE	9 mg (Ecolux)	9 - 15 mg

In 2002, the state of New Jersey requested mercury dose information for lamps purchased through the state contract, which included many different types of lamps. See "Mercury Disclosure Requirements and the New Jersey Lamp Contract."

Are TCLP-compliant lamps safer to handle in the workplace than non-TCLP-compliant lamps?

There is no evidence that the chemicals or mechanisms used to prevent mercury from leaching in the TCLP would prevent mercury from volatilizing if the lamp were accidentally broken, exposing nearby workers. The best way to reduce risk is to buy lamps with the least amount of mercury and to implement handling and storage methods that minimize the risk of breakage.

Do TCLP-compliant lamps last as long and perform as well as non-TCLP-compliant lamps?

INFORM received some anecdotal claims that TCLP-compliant lamps, and particularly the Philips Alto, burn out faster than non-TCLP-compliant lamps. However, INFORM is aware of no records that substantiate these claims. All lamps are rated for average lamp life and should be replaced by the manufacturer if they do not meet the performance claims. Also, to function at their rated capacity, lamps must be used with compatible ballasts. Ask your vendors to help identify the lowest-mercury lamps compatible with your existing ballasts.

Is it OK to throw TCLP-compliant lamps in the trash?

No. INFORM recommends that facilities recycle *all* their fluorescent lamps, including TCLP-compliant brands. Although it is legal in some states to dispose of TCLP-compliant lamps as non-hazardous waste, this practice will send mercury to landfills or municipal waste incinerators and may subsequently contribute to mercury pollution.

What should we do with spent lamps?

INFORM recommends that facilities set up recycling contracts for mercury-containing lamps and require lamp vendors to promote recycling when lamps are purchased or delivered. INFORM also recommends that any contract specifying TCLP-compliant lamps include language prohibiting vendors from encouraging facility employees to dispose of these lamps as non-hazardous waste.

[4] Private communications, Paul Walitsky, Philips, February 20, 2003; Bob Horner, Sylvania, March 3, 2003; Joe Howley, GE Lighting, February 24, 2003.

Recommended Specification For Lamp Purchasing Contracts

To require mercury disclosure and prefer lowest-mercury lamps:

Contractors (vendors) must submit amount of mercury per lamp in milligrams, and hours of rated life, for each lamp type supplied.[This facility] will prefer fluorescent lamps with the lowest amount of mercury per rated hour, provided the lamps meet all other performance specifications.

If a lamp recycling contract is in place:

[This facility] currently has a mercury lamp recycling contract in place. Contractors (vendors) must provide information to purchasers on using this recycling contract with each delivery of fluorescent lamps.

To prevent promotion of lamp disposal as non-hazardous waste:

Contractors (vendors) may not promote to facility employees the disposal of mercury-containing lamps as non-hazardous waste, even if the lamps are legally designated as non-hazardous waste in this state. Contractors must instead promote the recycling of all mercury-containing lamps.

Actual specifications used by others

New Jersey requested mercury amount disclosure on its lamp contract. See "Mercury Disclosure Requirements and the New Jersey Lamp Contract" for specifications, mercury amounts for lamps purchased, and mercury information for contract announcement. Contract announcement is at http://www.state.nj.us/treasury/purchase/noa/contracts/t0192.shtml.

Massachusetts did not specify TCLP-compliant lamps in contracts for its agencies, but preferred vendors that promoted the state's lamp-recycling contract. Download the lamp contract specifications at ftp://ftp.comm-pass.com/Data/00391101.PDF.

Massachusetts recycling contract: Download specifications for the Massachusetts lamp and ballast recycling contract at ftp://ftp.comm-pass.com/Data/01351701.PDF.

Recommended language for contract announcement:

Mercury is toxic: *When mercury-containing lamps break or are landfilled or incinerated, mercury is released to our air and water, increasing the risk of exposure to humans and wildlife that eat contaminated fish. This has resulted in fish consumption advisories for water bodies in all 50 states. [Insert information about fish advisories in state where contract is issued.]*

Select lowest-mercury lamp: *Review the mercury content information provided by the vendors and select the lowest-mercury lamp compatible with your ballast and fixture.*

Recycle all lamps: *[This facility] has a contract in place to recycle mercury lamps. It is illegal to dispose of most mercury-containing lamps in the trash. All broken mercury-containing lamps are hazardous waste and should be recycled. [Insert information about using lamp recycling contract.]*

Check old ballasts for PCBs: *Fluorescent lamp ballasts manufactured before 1979 may contain PCBs, which are extremely persistent and toxic. When old fixtures are replaced, ballasts must be tested for PCBs or disposed of as hazardous waste. Ballasts manufactured without PCBs are generally labeled accordingly.*

For more information

Buying and disposing of fluorescent lamps and ballasts: http://www.buildinggreen.com/features/ds/disposal.html

Fluorescent lamp recyclers: http://www.nema.org/lamprecycle/recyclers.html.

EPA 1999 Final Rule on Management of Hazardous Waste Lamps: http://www.epa.gov/epaoswer/hazwaste/id/merc-emi/merc-emi.htm.

Mercury-Containing Lamps and EPA's Toxicity Characteristic Leaching Procedure (TCLP)

Mercury-Containing Lamps and EPA's Toxicity Characteristic Leaching Procedure (TCLP)

What makes waste hazardous?

Many products are classified as hazardous waste when they are disposed of at the end of their useful life. These products contain materials that are corrosive, flammable, or toxic. Some of the toxic chemicals that qualify products as hazardous, such as lead and mercury, are persistent and bioaccumulative, meaning they remain in the environment indefinitely and accumulate in and harm living things. When products containing these toxic compounds are disposed of in landfills, the toxic chemicals can leach into underground drinking water supplies.[1]

When does a product qualify as hazardous waste?

The US Environmental Protection Agency (EPA) has identified 40 toxic chemicals that can cause harm when products containing them are disposed of in landfills and the chemicals leach out. In order to determine the potential of specific wastes in a landfill to leach dangerous concentrations of toxic chemicals into groundwater, the EPA developed a protocol known as the toxicity characteristic leaching procedure (TCLP). Products containing one or more of the listed toxins are assessed using the TCLP to estimate how much of their toxic contents would be released into landfill leachate under ordinary conditions. If the amount of a particular chemical released under test conditions exceeds regulatory limits, the waste qualifies as hazardous and must be handled according to regulations governing hazardous waste, such as handling by certified disposal agents and recycling or disposal in specially designated landfills and incinerators. Products that do not leach toxic materials at levels exceeding regulatory limits are termed TCLP-compliant.[2]

What are the shortcomings of the TCLP?

The purpose of the TCLP is to simulate the "mobility" (leaching) of substances under very particular conditions in a typical landfill. The EPA uses this procedure to determine whether certain toxic substances are likely to move from a landfill into groundwater. The procedure does not, however, recreate actual landfill conditions, which vary widely. Nor does it simulate incineration, which can release product contents directly into the air. Finally, the TCLP does not provide any insight into the potential dangers posed by exposure to toxic chemical-containing products during use.

Do mercury-containing lamps qualify as hazardous waste?

Energy-efficient lamps, such as high-intensity discharge (HID), compact fluorescent, and standard fluorescent lamps, rely on mercury. Some lamps contain very little mercury. For instance, a compact fluorescent can contain as little as 1.4 milligrams. In contrast, HID stadium lamps used in outdoor sports venues can contain 225 milligrams or more.[3] Linear fluorescent lamps can contain as little as 1.4 milligrams of mercury in smaller models, but up to 60 milligrams of mercury in others.[4] Mercury vaporizes readily at room temperature, and depending on many factors, may present an exposure hazard if a lamp breaks indoors.

Many lamps pass the TCLP assessment, meaning the mercury they contain does not leach sufficiently under the specific conditions of the test to qualify them as hazardous waste. It should be noted, however, that these lamps may contain devices and chemical additives that reduce mercury leaching rates during the TCLP procedure, but may or may not prevent leaching over long periods under real landfill conditions. More important, although these lamps are often referred to as "low mercury," they may contain as much mercury as lamps that fail the TCLP. Thus, lamps not classified as hazardous waste are more accurately termed "TCLP compliant" than "low mercury." For more information on the amounts of mercury contained in fluorescent lamps, see "The Lowdown on Mercury in Fluorescent Lamps."

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[1] US EPA, *RCRA Orientation Manual, Section III: RCRA Subtitle C – Managing Hazardous Waste,* Chapter 1, Hazardous Waste Identification, III-23, http://www.epa.gov/epaoswer/general/orientat/rom31.pdf.

[2] *Ibid*.

[3] Personal communication, Paul Walitsky, Manager, Environmental Affairs, Philips, April 1, 2003.

[4] *Ibid.*, February 20, 2003; Bob Horner, Product Group Manager, Sylvania, March 3, 2003; Joe Howley, Environmental Marketing Manager, GE Lighting, February 24, 2003.

Where Does the Mercury Go During Lamp Use?

A fluorescent lamp requires only 50 to 55 micrograms of mercury to run. The rest of the mercury in the lamp is a reserve, to be drawn on as mercury becomes bound to the glass and other materials inside the lamp during use.[5] A representative of Philips Lighting Company told INFORM that Philips is able to add less mercury to some of its lamp models than other manufacturers because it uses an aluminum oxide coating that keeps the mercury from binding to the glass.[6]

California's Restrictions on Mercury Lamp Disposal

California has adopted tougher standards than the federal government on the disposal of mercury-added devices. At this time, almost all mercury-added lamps must be either recycled or managed as hazardous waste under the state's Universal Waste Rule. Beginning in 2004, all mercury-containing lamps are to be recycled or managed as hazardous waste in California, with exemptions for households and certain small-quantity generators. These exemptions will end in February 2006.[10]

Can TCLP-compliant lamps be disposed in the regular trash?

Although it is legal in many states to dispose of TCLP-compliant lamps as nonhazardous waste, this practice sends mercury to landfills or, worse, to municipal waste incinerators, and thus contributes to mercury pollution. Each year, an estimated 0.3 to 4 tons of mercury are released directly into the environment from mercury-containing lamps that enter the solid waste stream in the US.[7] In addition, one study indicates that mercury in landfills may be transformed into methyl mercury, the form that accumulates in living organisms, before being released to the environment, thus increasing the toxicity potential of such releases.[8] In order to reduce the quantity of non-TCLP-compliant consumer products sent to disposal facilities, the EPA has designated some of these items — including many mercury-containing lamps — as "universal waste," thus eliminating the requirement that certain hazardous waste handling procedures be used during the recycling of these products.[9]

Conclusion

The TCLP status of fluorescent lamps is not necessarily the best indicator of their potential environmental and health impacts. Consumers who wish to reduce the impact of their lamps on the environment will (1) select lamps that contain the lowest mercury content available for their particular use, and (2) recycle all lamps at end of life, regardless of their TCLP status.

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[5] Sylvania, "The Use of Mercury in Efficient Electric Lamps – An Update," http://www.sylvania.com/press/03132001.html; personal communication, Steve McGuire, Environmental Affairs Associate, Philips, April 22, 2003.

[6] Personal communication, Steve McGuire.

[7] US EPA, *Mercury Study Report to Congress*, EPA-452/R-97-004, December 1997, http://www.epa.gov/oar/ mercury.html; US EPA, *Mercury Emissions From the Disposal of Fluorescent Lamps*, final report, March 31, 1998, http://www.epa.gov/epaoswer/hazwaste/id/merc-emi/merc-pgs/emmrpt.pdf; National Electrical Manufacturers Association, *Environmental Impact Analysis: Spent Mercury-Containing Lamps*, 2000, http://www.nema.org/papers/enviimpact.doc; Michael Aucott *et al.*, "Release of Mercury from Broken Fluorescent Bulbs," *Journal of the Air & Waste Management Association*, Vol. 53, February 2003.

[8] S.E.Lindberg *et al.*, "Technical Note: Methylated Mercury Species In Municipal Waste Landfill Gas Sampled In Florida, USA," *Atmospheric Environment*, Vol. 35, 2001, 4011-15.

[9] US EPA, "Some Used Lamps Are Universal Wastes," fact sheet, EPA530-F-99-024, July 1999, http://www.epa.gov/epaoswer/hazwaste/id/merc-emi/merc-pgs/fs_lamps.pdf.

[10] California Environmental Protection Agency, Department of Toxic Substances Control, "Managing Universal Waste in California," June 2003, http://www.dtsc.ca.gov/PublicationsForms/HWM_FS_UWR.pdf.

High-Bay Lighting:
Opportunities for Mercury Reduction and Energy Efficiency

High-Bay Lighting: Opportunities for Mercury Reduction and Energy Efficiency

What is high-bay lighting?

High-bay lighting is used in high-ceiling areas to light surfaces more than 15 feet away. Common high-bay applications include industrial manufacturing, gymnasiums, warehouses, and warehouse-type retailers. All lamps typically used in high-bay applications contain mercury, although some varieties – most notably high-output T5s and induction fluorescents – offer opportunities for mercury reduction.

Why should I be concerned about the mercury content of lamps?

Mercury is a highly persistent and toxic chemical that is building up to dangerous concentrations in fish, wildlife, and human beings throughout the US. By choosing high-efficiency lamps that contain less mercury, you help reduce the environmental impacts and health risks of lamp breakage during use, transport, and disposal.

What types of lighting systems can be used in high-bay settings?

The light from a standard fluorescent tube or incandescent bulb is too diffuse to adequately light a surface at the distance required for high-bay applications. Therefore, high-bay lighting typically requires one of the following:

- Metal halide high-intensity discharge (HID) lamps
- High-pressure sodium HID lamps
- High-output linear fluorescent T5 (HO T5) lamps
- Electrode-less induction fluorescent lamps.

Metal halide HID lamps have historically been the most commonly used lamps in these applications.High-pressure sodium HID lamps have poor color rendering, and so are not used as frequently as other lamps and are not discussed below. When comparing HID, HO T5, and induction lighting, it is important to consider the costs and environmental impacts of the entire fixture (or "system"), not just the individual lamps, since each requires a different number of bulbs to produce equivalent levels of illumination.

Which systems contain less mercury?

When calculating the amount of mercury used in a high-bay lighting system, it is important to consider the rated lamp life and the number of lamps required to provide equivalent amounts of light. Using lamps with a higher rated life reduces the overall amount of mercury entering the waste stream, because the lamps are changed less frequently. The following table shows the amount of mercury used for every 20,000 hours of use per system. Keep in mind that rated life and mercury amounts per lamp can vary widely depending on lamp model and manufacturer.

Mercury Use in Three High-Bay Lighting Systems

Lamp Type	Mercury Use per Equivalent Lighting System[1]	Rated Lamp Life (hours)[2]	Mercury Use per 20,000 Hours of Lamp Use
HO T5 linear fluorescent (four lamps)	5.6 – 20 mg	20,000	5.6 – 20 mg
Induction (two lamps)	28 – 34 mg	100,000	5.6 – 6.8 mg
Metal halide (one 400 watt lamp)	40 – 65 mg	20,000	40 – 65 mg

HO T5 lamps use the least amount of mercury at any one time (5.6 to 20 mg per equivalent system), reducing the health risks related to lamp breakage during use. Induction lamps, however, because they are rated for 100,000 hours, are responsible for smaller amounts of mercury and lamp waste over time, reducing solid waste and the liability risks of lamp breakage during transport and disposal. For more information on mercury in lamps, see "The Lowdown on Low-Mercury Lamps."

To get an idea of the amount of mercury used by different lighting systems over time in a typical high-bay application, imagine a midsize retailer with 200 open-plan facilities. Each 10,000 square foot facility uses 24 fixtures operating 16 hours per day. Over a 10-year period,

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1 Personal communications, Pamela Horner, Osram Sylvania, August 27 and September 4, 2003; Paul Walitsky, Philips Lighting, April 1 and August 27, 2003.

2 David Bisbee, Sacramento Municipal Utility District, T5 Fluorescent High-Bay Lighting Systems, Customer Advanced Technologies Program Technology Evaluation Report, May 15, 2002, http://www.smud.org/education/cat/cat_pdf/T5.pdf; Osram Sylvania, ICETRON Inductively-Coupled Electrodeless Systems, http://www.sylvania.com/business/fluorescent/ icetron.htm; Fluorescent Product Specifications, http://www. sylvania.com/business/fluorescent/specs.htm#ice; *Lamp & Ballast Product Catalog*, February 2002, http://www.sylvania. com/catalog/pdfs/cat_full.pdf.

this retailer could reduce its mercury use from over 500 grams to 81 grams by switching from metal halide to HO T5 lamps. (100 grams of mercury can contaminate almost 75,000 fish to the point that they are unsafe for human consumption.)

Mercury Use Over 10 Years in Three High-Bay Lighting Systems

Lamp Type	10-Year Mercury Use per Facility	10-Year Companywide Mercury Use
HO T5 (four lamps)	0.40 – 1.4 grams	81 – 290 grams
Induction (two lamps)	0.67 – 0.82 grams	130 – 160 grams
Metal halide (one lamp)	2.9 – 4.7 grams	580 – 940 grams

What are the drawbacks of metal halide HIDs?

Metal halide HID lamps have several drawbacks, three of which are related to energy efficiency:

- HIDs require several minutes to warm up. During this "re-strike" period, the lamps consume electricity but produce no usable light.
- Energy-saving occupancy sensors, which automatically turn lights on when the area is occupied and off when the area is unoccupied, cannot be used with metal halide HIDs.
- Dimming systems for HIDs are on the expensive side and are not as efficient as those for fluorescent control systems, reducing the benefits of decreasing light levels during low-use periods to save energy.
- In addition to these energy-efficiency factors, HID lamps can contain larger quantities of mercury compared with HO T5s and induction fluorescents.
- Metal halide systems use one lamp per fixture. When a lamp fails it requires immediate replacement, since a failed lamp represents a 100 percent reduction in the illumination provided by that fixture. In an HO T5 system, there are four lamps, so when a lamp fails there is only a 25 percent reduction in illumination, allowing a facility to operate safely until it is convenient to change the failed lamp.

What are the benefits of high-output T5s and induction fluorescents?

Switching from HID lamps to HO T5 fluorescent lamps is now a common strategy for increasing energy efficiency in warehouses and other high-bay lighting situations. Both HO T5s and induction fluorescents:

- Are capable of instant-on and instant re-strike.
- Can be used with energy-saving occupancy sensors.
- Can be adjusted through dimming (with a dimmable ballast).
- Have lower average mercury content than metal halide HID lamps.

Do high-output T5 and induction fluorescents perform as well as metal halide HID lamps in high-bay applications?

Yes. Several attributes are used to compare lamp performance:

1. *Rated life* is the average amount of time a lamp will function before failing.
2. The *color rendering index* (CRI) indicates how accurately a light source renders colors. A CRI of 100 is equivalent to sunlight. Lower CRIs indicate poorer color rendering.
3. A *lumen* is a measure of light flow. The higher the lumens, the more light is produced by the lamps in the fixture.
4. The *lumen maintenance* is a function of the rated life, showing the percentage of original lumens present after a certain percentage of the rated life has passed. Lumens decrease over the life of most lamps, so a lamp that maintains its lumen output for a longer period is more desirable.
5. The *color temperature* describes the appearance of the light in terms of the red and blue tones. Light that we perceive as redder or warmer has a lower color temperature, light that we perceive as bluer has a higher color temperature. While the color temperature of fluorescent and induction fluorescent lamps is stable over the life of the lamp, metal halide lamps tend to shift color over their lifetime.

Are both high-output T5 linear fluorescent and induction fluorescent lamps appropriate for all high-bay applications?

No. Fluorescent induction systems are the best choice for very cold conditions because they retain their efficiency at extremes of temperature. Because of their exceedingly long life, they also make sense in applications where it is difficult or costly to change a spent lamp. T5s, however, are more energy-efficient at moderate temperatures

(25˚C to 35˚C) than induction lamps, so for locations that do not experience temperature extremes and where labor costs to change a spent lamp are not significant, HO T5s may be preferable.

Performance of Three High-Bay Lamp Types

Attribute	High- Output T5 Linear Fluorescent[3]	Induction Fluorescent[4]	Metal Halide HID[5]
Rated life (hours)	20,000	100,000	20,000
CRI	82	80	65
Lumen maintenance	93% @ 40% of life	70% @ 60% of life	65% @ 40% of life

Which high-bay lighting systems are more energy-efficient?

When calculating energy efficiency, it is important to consider the number of lamps contained in equivalent systems, as well as the number of watts per lamp. For instance, in the example in the table below, four HO T5 lamps or two induction fluorescent lamps are required to produce approximately the same amount of light as one metal halide HID lamp. The higher the lumens per watt, the less electricity is needed to produce equivalent light.

Energy Efficiency of Three High-Bay Lighting Systems

Lamp Type	Mean Lumens per System	Mean Lumens per Watt	Kilowatt-Hours per Year*
HO T5 linear fluorescent (four lamps)	16,544 – 18,600	70 – 79	1,060
Induction (two lamps)	17,760	57	1,380
Metal halide (one lamp)	24,440	54	1,980

*Assumes the lamps run 12 hours per day, 365 days per year.

3 Bisbee, T5 Fluorescent High-Bay Lighting Systems.

4 These numbers are based on the Sylvania ICETRON lamp. Osram Sylvania, ICETRON Inductively-Coupled Electrodeless Systems; Fluorescent Product Specifications; and *Lamp & Ballast Product Catalog*.

5 Bisbee, T5 Fluorescent High-Bay Lighting Systems.

The fewer the kilowatt-hours per year used by a lighting system, the less electricity a facility uses and pays for.

Which lamps are less expensive to purchase and run?

Comparative purchase prices can vary widely depending on volume purchased and location. Based on a small survey, metal halide systems are less expensive to purchase than either of the fluorescent systems, costing approximately 25 percent less ($150) than an equivalent four-lamp T5 system ($200). An equivalent two-lamp induction system costs about four times an equivalent T5 system ($800).[6]

"Payback time" is the period that elapses before an initial investment is recouped, in this case through savings in electricity, lamp replacement, and maintenance/disposal costs. Payback time varies based on the size of the lighting project, the electricity rate, the particular fixtures selected, and other variables. The Los Angeles Department of Water and Power has a payback calculator at http://www.ladwp.com/energyadvisor/PA_46.html where you can input your variables.

A variety of case studies have reported payback times of 1.8 to 29.9 years for HO T5 high-bay replacement projects.[7] One case study reported a five- to eight-year payback period for an induction fluorescent high-bay relighting project.[8]

Recommendations

- Facility owners, managers, and architects specifying high-bay lighting applications should choose the most energy-efficient system with the lowest mercury content appropriate for their construction and remodeling projects.

6 Personal communications, Randy Miller, 1st Source Lighting, August 27 and September 4, 2003; Patrick Lew, Lindy Lighting, August 28, 2003.

7 Bisbee, T5 Fluorescent High-Bay Lighting Systems; Federal Energy Management Program, "Waste Isolation Pilot Plant Finds Savings in Lighting Retrofit," *FEMP Focus Newsletter*, January/February 2001, http://www.eere.energy.gov/femp/newsevents/femp_focus/feb01_waste.html; Martin WU Kwok-tin, Hong Kong Electrical and Mechanical Services Department, Report of the Pilot High Output T5 Fluorescent Lighting Project at East Kai Tak Indoor Games Hall, www.emsd.gov.hk/emsd/e_download/pee/t5_ektigh.doc.

8 Martin WU Kwok-tin, Hong Kong Electrical and Mechanical Services Department, "Induction Lamps Installations at Kowloon Bay Indoor Games Hall," http://www.emsd.gov.hk/ emsd/e_download/pee/Induction%20lamps%20at%20kbigh.pdf.

- Retrofit projects should be analyzed carefully for payback and benefits such as improved color rendering.
- Before purchasing a lighting system, buyers should consult a lighting professional who can analyze the entire project for energy efficiency, lighting level, and appropriate color rendering. Tell your chosen professional that your organization would like to specify low-mercury alternatives wherever possible.
- Facilities should recycle all mercury-containing products, including all HID lamps, T5s, and induction fluorescents.

Characteristics of Three High-Bay Lamps and Lighting Systems

Attribute	T5 HO Linear Fluorescent[9] (25˚C/35˚C)*	Induction[10]	Metal Halide[11]
Rated life (hours)	20,000	100,000	20,000
CRI	82	55	65
Lumen maintenance	93% @ 40% of life	70% @ 60% of life	65% @ 40% of life
Re-strike time	Instant on	Instant on	10 Minutes
Number of lamps per equivalent system	4	2	1
System watts	234	314	452
System initial lumens	17,800/ 20,000	24,000	37,600
System mean lumens	16,544/ 18,600	17,760	24,440
Mercury in the system[12]	5.6 – 20 mg	28 – 34 mg	40 – 65 mg
Initial system cost (fixture and ballast)	$200[13]	$800[14]	$150[15]

* Lumens produced by HO T5 lamps depend on operating temperature.

9 Bisbee, T5 Fluorescent High-Bay Lighting Systems.

10 These numbers are based on the Sylvania ICETRON lamp. Osram Sylvania, ICETRON Inductively-Coupled Electrodeless Systems, Fluorescent Product Specifications, and *Lamp & Ballast Product Catalog*.

11 Bisbee, T5 Fluorescent High-Bay Lighting Systems.

12 Personal communications, Pamela Horner and Paul Walitsky. .

13 Personal communication, Randy Miller.

14 *Ibid.*

15 Personal communication, Patrick Lew.

For more information

- T5 Fluorescent High-Bay Lighting Systems: http://www.smud.org/education/cat/cat_pdf/T5.pdf
- Induction Lighting Systems: http://www.smud.org/education/cat/cat_pdf/Induction%20Lighting.pdf
- Induction Lamps Installations at Kowloon Bay Indoor Games Hall: http://www.emsd.gov.hk/emsd/e_download/pee/Induction%20lamps%20at%20kbigh.pdf
- Lighting: HID Versus Fluorescent for High-Bay Lighting: http://www.ladwp.com/energyadvisor/PA_46.html

Environmentally Preferable LED Exit Signs:

Saving Money and Protecting the Environment Through Energy Efficiency

Environmentally Preferable LED Exit Signs: Saving Money and Protecting the Environment Through Energy Efficiency

According to the US Department of Energy, there are more than 100 million exit signs in use in the United States. These signs are typically lit by incandescent lamps and are estimated to consume 30 to 35 billion kilowatt-hours of electricity annually.[1]

Newer models of exit signs replace incandescent bulbs with either high-efficiency light-emitting diodes (LEDs) or compact fluorescent lamps. By specifying new exit signs (or retrofitting existing incandescent-lit signs[2]) with LED technology, municipalities and facilities can conserve energy, save money, and reduce their exit signs' impact on the environment by eliminating fluorescent bulbs that contain mercury.

What factors should purchasers consider when specifying new exit signs?

Fixture design. Lighting technology, design aesthetic, and backup power requirements vary widely, as do the associated prices.

Energy consumption. Two-lamp exit signs use from 1 to 50 watts of electricity. LED, incandescent, and compact fluorescent lamps use dramatically different amounts of energy. Exit signs using LEDs typically use about 10 to 50 times less energy than those with incandescent bulbs.

Lamp life. The length of time a lamp lasts is a critical factor, since lamp replacement costs (including lamp and labor costs, as well as the administrative cost of ordering lamps) will be incurred more frequently when lamps have a shorter rated life. An LED exit sign can last for 10 years with no lamp change-outs. During this time, a fluorescent bulb may need to be replaced six or more times and an incandescent bulb up to 30 times.

Backup power source. Building codes require emergency exit signs to have a backup battery in case of power loss. Batteries found in standalone exit signs must be rechargeable and usually contain toxic metals (usually cadmium or lead) that require disposal as hazardous waste or recycling under the Universal Waste Rule, depending on local regulations.[3]

Are LEDs environmentally preferable compared to incandescent or fluorescent lamps?

Yes. Incandescent and compact fluorescent lamps use more power than LEDs, and that power may be generated by coal-burning power plants, which are the largest source of mercury releases in the US, according to the EPA.[4] The EPA estimates that, on average, 0.016 milogram (mg) of mercury is emitted for each kilowatt-hour of electricity used in the US.[5]

Though significantly more energy efficient than incandescent lamps, fluorescent lamps contain mercury, which can be released to the environment when lamps break, either during use or after disposal. Mercury is a potent neurotoxin that is not readily broken down in the environment and can cause serious damage to the developing brains of infants and young children. The fluorescent lamps in one exit sign can contain more than 10 mg of mercury.[6] Thus, by switching to LEDs, a facility with 20 exit signs can reduce mercury use over a 10-year period from more than 750 mg to zero, and mercury emissions related to power use from 450 mg to 30 mg. (750 mg of mercury can contaminate over 1,000 fish to the point where they cannot be eaten.[7])

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[1] Energy Star, "Exit Signs," http://www.energystar.gov/index.cfm?c=exit_signs.pr_exit_signs.

[2] Because of the high initial cost of LEDs, it may not be cost-effective to retrofit exit signs containing compact fluorescent bulbs with LEDs, even though LEDs are more energy efficient.

[3] For information on recycling rechargeable batteries at end of life, see http://www.rbrc.org.

[4] US EPA, *Mercury Study Report to Congress*, EPA-452/R-97-004, December 1997, http://www.epa.gov/oar/mercury.html.

[5] US EPA, *Mercury Emissions from the Disposal of Fluorescent Lamps: Revised Model*, final report, March 31, 1998, http://www.epa.gov/epaoswer/hazwaste/id/merc-emi/merc-pgs/emmrpt.pdf.

[6] New Jersey Purchase Bureau, "Lamps, Incandescent, HID, Fluorescent, Including Low Mercury," Notice of Award T-0192, August 1, 2003, http://www.state.nj.us/treasury/purchase/noa/contracts/t0192.shtml.

[7] Assuming a 3 pound fish and a consumption advisory level of 0.5 parts per million mercury.

What are the comparative life-cycle costs of incandescent, fluorescent, and LED lamps?

Even though the initial purchase price of LED exit signs can be significantly higher than that of incandescent or fluorescent lamps, their life-cycle costs are much lower. LED exit signs use less electricity and the lamps have a rated life five times longer than that of incandescent or fluorescent lamps, equal to the expected life of the fixture. Payback time for investing in new LED fixtures can range from three months to just over four years, depending on the fixture used and electricity costs. Use the Energy Star calculator at http://208.254.22.7/ia/business/bulk_purchasing/bpsavings_calc/Calc_Exit_Signs.xls to estimate your payback time.

Life-Cycle Cost Factors of Exit Signs[8]

Lamp Type	Fixture Cost	Wattage	Lamp Life
Incandescent	$20 – $100	30 – 50 watts	3,000 –19,000 hrs.
Compact fluorescent	$125 – $200	10 – 16 watts	13,000 hrs.
Light-emitting diode (LED)	$30 – $250	1– 3 watts	10 yrs.+ [9]

How much money can a facility save by using LED technology compared to incandescent or compact fluorescent?

The savings realized by a specific facility will vary depending on regional energy costs, labor costs associated with changing spent lamps, and the number of exit signs used. The following table compares life-cycle costs of the three lamp types, assuming that electricity costs $.08 per kilowatt-hour (kWh), that the cost of purchasing and changing a lamp is $10, and that there are no other maintenance requirements for any of the exit sign types.

Cost Comparison of Exit Signs Over 10 Years

Electricity Cost Per Exit Sign			
Incandescent	**Compact**	**Fluor-escent**	**LED**
Wattage	30 – 50 watts	10 – 16 watts	1 – 3 watts
Annual Energy Use (kWh)	263 – 438	88 – 140	9 – 26
Annual Energy Cost	$21 – $35	$7 – $11	$0.70 – $2
10-Year Energy Cost	$210 – $350	$70 – $112	$7 – $21
Lamp Replacement Cost Per Exit Sign			
Number of Replacement Lamps Used in 10 Years	4 – 29	6	0
Cost of Lamp Replacement	$40 – $280	$60	–
Total Maintenance and Electricity Cost Over 10 Years			
Per Exit Sign	$390 – $490	$130 – $172	$7 – $21

Can I retrofit my existing fixtures with LED lamps?

Numerous LED lamps are available to fit existing incandescent fixtures. Known as direct retrofit lamps, these can cost as little as $24 to almost $40 for a two-lamp fixture.[10] Basing calculations of cost on $.08 per kWh, $24 to $40 per fixture, and $10 for the labor to replace the lamp, retrofitting an existing incandescent fixture with a direct retrofit LED model will pay for itself in approximately two years. LEDs are incompatible with fluorescent ballasts, so retrofit kits for compact fluorescent exit sign fixtures are not available. Agencies wishing to replace exit signs containing compact fluorescents with LEDs must purchase new exit signs, which will have a longer payback period.

[8] Price, wattage, and lamp life ranges are from an informal survey of product information from vendors, manufacturers, and the Federal Energy Management Program, including Cooper Lighting at http://www.cooperlighting.com, Lithonia at http://www.Lithonia.com, and Grainger at http://www.grainger.com; personal communications with Jeff Samuels, Spectro Lume, Inc., July 2003, and Ralph Williams, SRB Technologies, July 2003; Federal Energy Management Program, "How to Buy an Energy-Efficient Exit Sign," http://www.eere.energy.gov/femp/procurement/exit_sign.html.

[9] Overall fixture life cannot be guaranteed beyond 10 years, so extended lamp life beyond 10 years is not relevant.

[10] Price information from Grainger, http://www.grainger.com, and Good Mart, http://www.goodmart.com/products/bulb_exit_sign_retrofit_kit.htm.

Are LED exit signs and retrofits widely available?

Yes. LED exit signs and retrofits are available from most major national lighting and building equipment vendors.

Can old exit signs be thrown in the trash?

Incandescent and LED lamps may be disposed of with ordinary solid waste. Compact fluorescent lamps contain mercury and lead and are best handled by recycling at end of life (to capture their mercury content) through a licensed hazardous waste handler. Emergency exit signs are also required by law to have rechargeable batteries or other backup systems in case of a power outage. Many rechargeable batteries used in exit signs contain cadmium, lead, or other metals that can make the batteries hazardous waste, so these should be recycled through the Rechargeable Battery Recycling Corp. (http://www.rbrc. org) or by a licensed hazardous waste handler.

What about tritium exit signs?

Some exit signs are powered by the radioactive element tritium in order to run without electricity. Since tritium is radioactive, the signs are regulated by the Nuclear Regulatory Commission (NRC).[11] INFORM recommends that tritium signs only be used in instances where power cannot be supplied. There are several issues regarding tritium signs that end users should be aware of:[12]

- Tritium is a colorless, odorless gas and may not disperse from enclosed areas.
- Few companies have a take-back program for these signs, and collection for disposal can cost up to $100 per lamp.
- Since a tritium exit sign can last up to 25 years, end users may not be aware that the lamp is a radioactive product or that it requires special handling at end of life if management, or even ownership, of the facility has changed.

Recommendations

- When purchasing new fixtures, select LED exit signs.
- When replacing incandescent lamps in existing fixtures, retrofit with LED lamps.
- Replace all fluorescent exit sign fixtures with LED fixtures if the payback period is acceptable.
- Recycle all fluorescent lamps with a licensed hazardous waste handler.
- Recycle all rechargeable batteries through the Rechargeable Battery Recycling Corp. (http://www.rbrc.org) or through a certified battery recycling facility.
- When specifying new buildings or fixtures, specify LED exit signs:

  All exit signs should utilize a light-emitting diode (LED) light source and should not use incandescent or fluorescent lamps.

For more information

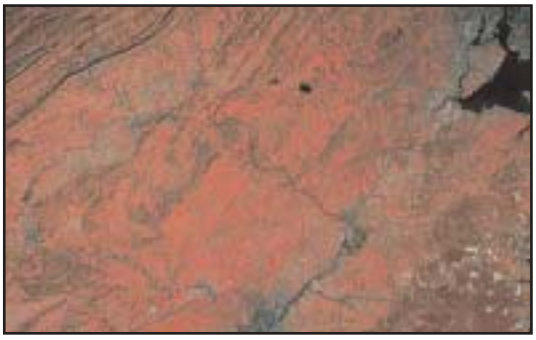
Lighting Research Center's Exit Sign Links
http://www.lrc.rpi.edu/programs/lightingTransformation/exits/exitlinks.html

Virginia DEQ Central Office LED Exit Sign Energy Saving Case Study
http://www.deq.state.va.us/p2/emsled.html

Energy Star Exit Signs
http://www.energystar.gov/index.cfm?c=exit_signs.pr_exit_signs

[11] For more information about regulatory issues with tritium exit signs, see US Nuclear Regulatory Commission, "Program-Specific Guidance About Licenses Authorizing Distribution to General Licensees," Appendix L, Guidance on Self-Luminous Exits (Q&As), NUREG-1556, Vol. 16, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1556/v16/#_1_56.

[12] Personal communication, Greg Morose, Product Stewardship Institute, University of Massachusetts at Lowell, August 5, 2003.



Mercury Disclosure Requirements
and the New Jersey Lamp Contract

Mercury Disclosure Requirements and the New Jersey Lamp Contract

New Jersey required vendors to disclose the amount of mercury in the mercury-containing lamps sold on its 2002 and 2003 contracts for incandescent, HID, and fluorescent lamps (contract T-0192). For the entire text of the 2003 bid document (not including price lines) for contract T-0192, see http://www.informinc.org/2003contractlang.txt. For the entire 2003 contract announcement, see http://www.state.nj.us/ treasury/purchase/noa/contracts/t0192.shtml. For more information on mercury in lamps, see The Lowdown on Mercury in Fluorescent Lamps.

Mercury Disclosure Language Used In New Jersey's 2003 Contract T-0192: Lamps, Incandescent, HID, Fluorescent, Including Low Mercury

New Jersey used the following language in its May 2003 lamp bid document. See the entire bid document at http://www. informinc.org/2003contractlang.txt.

Bidders must disclose the amount of mercury, in milligrams, for each mercury-added product bid. Space is provided on the pricing page for mercury content disclosure. Mercury-added products shall be defined as any device to which elemental mercury or mercury compounds are intentionally added.

Contractors may not promote to facility employees the disposal of mercury-containing lamps as non-hazardous waste, even if the lamps are legally designated as non-hazardous waste in this state. Contractors must instead promote the recycling of all mercury-containing lamps.

Contract Announcement Mercury Language for New Jersey's 2003 Contract T-0192: Lamps, Incandescent, HID, Fluorescent, Including Low Mercury

New Jersey used the following language to inform contract users regarding mercury in lamps. The full contract announcement is at http://www.state.nj.us/ treasury/purchase/noa/contracts/t0192.shtml.

When lamps break or are landfilled or incinerated with solid waste, mercury is released to our air and water, increasing the risk of exposure to humans and wildlife that eat contaminated fish. The US Environmental Protection Agency and Food and Drug Administration have warned children and women of childbearing age in all 50 states not to eat species of fish known to be contaminated with mercury.

"Low mercury" fluorescent tubes, offered by all of the major lighting manufacturers, are rated by manufacturers to last as long as "full dose mercury" lamps.

It is illegal to dispose of most end of life fluorescent and HID lamps in the trash.

All broken mercury containing lamps are hazardous waste, and must be disposed of properly.

Recommendations for lamp requesters:

In accordance with the recommendations of the New Jersey mercury pollution task force, a stakeholder group convened by the Department of Environmental Protection, the Purchase Bureau urges state agencies and agencies and departments using this contract under cooperative purchasing agreements to:

Purchase "low-mercury" fluorescent tubes, compact fluorescent, and high-pressure sodium lamps.

2003 Mercury Disclosure Requirements and the New Jersey Lamp Contract

New Jersey requires vendors who bid on New Jersey Contract T-0192 to disclose the amount of mercury in any mercury-added product on the contract. For full contract information, see http://www.state.nj.us/treasury/purchase/noa/contracts/t0192.shtml.

Mercury Content Information for Lamps Available on the New Jersey Contract T-0192

Please note: All fluorescent, compact fluorescent, low-pressure sodium and metal-halide lamps contain mercury. Some mercury-added lamps available through the contract are not listed here.

Brand	Model	Type	Length (Nom. inches)	Watts	Other Information	Mercury (mg)	Vendor	Line	Commodity Code Number	Unit Price
Philips	F96T12CW/EW/ALTO	T12	96	60	Linear fluorescent with med. bipin (G13) base	6.8	TAB	00014	285-50-052418	$.1.174
GE	F60T12/CW	T12	60	50	Linear fluorescent with med. bipin (G13) base	11-30	Graybar	00045	285-50-045140	$.1
GE*	F40XL/SPX41	T12	48	40	Linear fluorescent with med. bipin (G13) base	11-30	Rahway	00012	285-50-052416	$3.10
GE*	F40SPX41	T12	48	40	Linear fluorescent with med. bipin (G13) base	11-30	Rahway	00004	285-50-052404	$2.10
GE	F40BLB	T12	48	40	Black fluorescent with med. bipin (G13) base	11-30	Graybar	00043	285-50-052452	$5.77
Philips	F34CW/RS/EW/ALTO	T12	48	34	Linear fluorescent with med. bipin (G13) base	4.4	TAB	00011	285-50-052415	$.55
Philips	F34/CS/RS/WM/ALTO	T12	48	34	Linear fluorescent with med. bipin (G13) base	4.4	Billows	00001	285-50-052398	$0.54
Philips	F30T12/CW/RS/ALTO	T12	36	30	Linear fluorescent with med. bipin (G13) base	3.5	TAB	00046	285-50-045422	$.883
Philips	F30T12/CW/RS/ALTO	T12	36	30	Linear fluorescent with med. bipin (G13) base	3.5	TAB	00009	285-50-052413	$.883
Philips	F24T12/CW/HO	T12	24	35	Linear fluorescent with med. bipin (G13) base	15	Billows	00047	285-50-045423	$1.65
GE	F40/BL/U/3	T12	22.5	40	U-bent fluorescent with med. bipin (G13) base	11-30	Graybar	00044	285-50-052453	$2.71
Philips	FB40/CW/6	T12	22.5	40	U-bent fluorescent with med. bipin (G13) base	4.4	TAB	00017	285-50-052421	$1.984
Philips	FB40SPEC41/6/ALTO	T12	22.5	40	U-bent fluorescent with med. bipin (G13) base	4.4	TAB	00049	285-50-045351	$1.984
Philips	FB34CW/6/EW/ALTO	T12	22.5	34	U-bent fluorescent with med. bipin (G13) base	4.4	TAB	00016	285-50-052420	$1.89
Philips	FB34/WW/6/EW/ALTO	T12	22.5	34	U-bent fluorescent with med. bipin (G13) base	4.4	TAB	00018	285-50-052422	$1.98
Philips	FB34/CW/6/EW/ALTO	T12	22.5	34	U-bent fluorescent with med. bipin (G13) base	4.4	TAB	00048	285-50-045350	$1.89
Philips	F34/CW/RS/EW/ALTO	T8	48	32	Linear fluorescent with med. bipin (G13) base	4.4	TAB	00035	285-50-052445	$.55
Philips	F32/T8/TL735/ALTO	T8	48	32	Linear fluorescent with med. bipin (G13) base	3.5	TAB	00031	285-50-052441	$1.09
Sylvania	FO32/835/ECO	T8	48	32	Linear fluorescent with med. bipin (G13) base	7-10	Regency	00033	285-50-052443	$1.42
Sylvania	FO32/841/ECO	T8	48	32	Linear fluorescent with med. bipin (G13) base	7-10	Regency	00034	285-50-052444	$1.42
Philips	F32TL/TL741/ALTO	T8	48	32	Linear fluorescent with med. bipin (G13) base	3.5	TAB	00032	285-50-052442	$1.09
Philips	F25T8/TL/835	T8	36	25	Linear fluorescent with med. bipin (G13) base	3.5	TAB	00030	285-50-052440	$1.766
Sylvania	FO25/741/ECO	T8	24	25	Linear fluorescent with med. bipin (G13) base	7-10	Griffith	00008	285-50-052412	$1.43
Sylvania	FO17/741/ECO	T8	24	17	Linear fluorescent with med. bipin (G13) base	7-10	Griffith	00029	28-50-052439	$1.43
Sylvania	FO17/741/ECO	T8	24	17	Linear fluorescent with med. bipin (G13) base	7-10	Regency	00007	285-50-052411	$1.43
Philips	F15T8/CW/ALTO	T8	18	15	Linear fluorescent with med. bipin (G13) base	1.4	TAB	00006	285-50-052410	$.696
Sylvania	FBO31/835	T8	22.5	31	U-bent fluorescent with med. bipin (G13) base	6-9	Regency	00036	285-50-052446	$5.19
Sylvania	FBO31/841	T8	22.5	31	U-bent fluorescent with med. bipin (G13) base	6-9	Regency	00037	285-50-052447	$5.19
Sylvania	FBO16/841	T8	10.5	16	U-bent fluorescent with med. bipin (G13) base	6-9	Cooper	00039	285-50-045135	$5.20

Sylvania	FO17/741/ECO	T8	24	17	Linear fluorescent with med. bipin (G13) base	7-10	Regency	00007	285-50-052411	$1.43
Philips	F15T8/CW/ALTO	T8	18	15	Linear fluorescent with med. bipin (G13) base	1.4	TAB	00006	285-50-052410	$.696
Sylvania	FBO31/835	T8	22.5	31	U-bent fluorescent with med. bipin (G13) base	6-9	Regency	00036	285-50-052446	$5.19
Sylvania	FBO31/841	T8	22.5	31	U-bent fluorescent with med. bipin (G13) base	6-9	Regency	00037	285-50-052447	$5.19
Sylvania	FBO16/841	T8	10.5	16	U-bent fluorescent with med. bipin (G13) base	6-9	Cooper	00039	285-50-045135	$5.20
Philips	PL-L40W/835/RS/IS	T5	22.6	40	Linear fluorescent	1.4	Warshauer	00041	285-50-052450	$3.73
Philips	FC8T9/HL/CW	Circ. T9	8.25	22	4-pin circular fluorescent	15	Hughes	00038	285-50-052448	$1.15
GE	FC12T9/CW	Circ. T9	12	32	4-pin circular fluorescent	11-30	Rahway	00019	285-50-052423	$1.05
GE	MVR50/U	HID	5.5	50	Metal halide lamp, med. base	11-30	Graybar	00053	285-50-045355	$10.00
Lumenarc	MH70/7/MED	HID	n/a	70	Metal halide	8	Lumenarc	00054	285-50-045355	$10.97
Lumenarc	MH100/U/MED	HID	n/a	100	Metal halide	8	Lumenarc	00055	285-50-045355	$10.97
Lumenarc	MH100/CU/MED	HID	n/a	n/a	Metal halide, med. base	8	Lumenarc	00078	285-50-052425	$14.97
Philips	MH175/U	HID	8 5/16	175	Metal halide with mog. base	25.75	TAB	00079	285-50-052426	$6.732
Philips	MH250/U	HID	8 5/16	250	Metal halide with mog. base	34	TAB	00080	285-50-052427	$7.605
Philips	MH250/U	HID	8 5/16	250	Metal halide with mog. base	34	TAB	00056	285-50-045355	$7.605
Philips	MH400/U	HID	11.5	400	Metal halide with mog. base	49.5	TAB	00057	285-50-045355	$7.221
Philips	MH1000/U	HID	15 3/8	1000	Metal halide with mog. base	154	TAB	00072	285-50052454	$17.351
Philips	MH1000/U	HID	15 3/8	1000	Metal halide with mog. base	154	TAB	00058	285-50-045355	$17.444
Lumenarc	H43AV75/DXMED	HID	n/a	75	Mercury vapor	8	Lumenarc	00077	285-50-052424	$7.97
Lumenarc	LUA50/S55	HID	n/a	400	High-pressure sodium lamp	3-4	Lumenarc	00060	285-50-052397	$7.79
GE*	Q250CL/MC-EHT	HID	3.156	250	T type quartzline halogen with mini-cand base	1-10	Rahway	00052	285-50-052490	$2.75
GE	SOX 135	HID	30.5”	135	Low-pressure sodium lamps, T21, BY22d base	7-10	Graybar	00064	285-50-045358	$12.86
Philips	SOX180	HID	44 1/8	180	Low-pressure sodium with DC bay base		Turtle	00063	285-50-045357	$20.00
GE	F18DBX/SPX35 4P	CFL[1]	6.06	18	Compact fluorescent 4-pin EOL	11-30	Graybar	00028	285-50-052438	$1.17
Sylvania	CF26DD827	CFL	6.8	26	PL-C cluster 2-pin	13-18	Griffith	00020	285-50-052428	$2.99
Sylvania	CF15EL/830MED/1	CFL	5.5	15	Self-ballasted CFL with med. screw base	2-4	Griffith	00027	285-50-052437	$5.08
Sylvania	CF18DDE827	CFL	5.8	18	Dimmable, 4-pin base, double tube	2-4	Griffith	00050	28-50-045669	$2.99
Sylvania	CF15EL TWIST	CFL	5.125	15	Spiral CFL with med. screw base	10-14	Griffith	00075	285-50-052407	$4.47
Sylvania	CF20EL TWIST	CFL	5.5	20	Spiral CFL with med. screw base	10-14	Griffith	00076	285-50-052408	$4.47
Philips	PL-S 13W 827	CFL	7	13	Short fluorescent, 2GX7 base	1.4	Hughes	00026	285-50052436	$.95
Philips	PLS13/27	CFL	7	13	Compact fluorescent black light	5.5	TAB	00005	285-50-052409	$.841
GE*	F13BX/SPX27/827	CFL	7	13	Biax CFL with GX23 base	11-30	Rahway	00023	285-50-052431	$.72
Philips	PLS7W/27	CFL	n/a	7	Compact fluorescent	5.5	TAB	00013	285-50-052417	$.789
Philips	PLS7W/27	CFL	n/a	7	Short fluorescent	5.5	TAB	00024	285-50-052432	$.789
Philips	PLS9W/27	CFL	n/a	9	Short fluorescent	5.5	TAB	00025	285-50-052433	$.789
Philips	PL-L 40W/835/RS/IS	CFL	22 1/2	38	Long fluorescent with 4-pin base	4.4	Warshauer	00022	285-50-052450	$3.73
Sylvania	CFI5EL/TWIST	CFL	5.125	15	Spiral CFL with med. screw base	10-15	Jewel	00003	285-50-052448	$4.65

* Descriptions incompatible with item numbers

Additional Resources

Additional Resources

General Information on Persistent, Bioaccumulative Toxins (PBTs)

INFORM's Purchasing for Pollution Prevention program:
http://www.informinc.org/p3_01.php

EPA's Persistent Bioaccumulative and Toxic Chemical Program:
http://www.epa.gov/opptintr/pbt/

EPA fact sheet on PBTs:
http://www.epa.gov/opptintr/pbt/fact.htm

Priority PBTs currently addressed by EPA's PBT initiative:
http://www.epa.gov/opptintr/pbt/cheminfo.htm

General Mercury Information

EPA answers frequently asked questions about mercury:
http://www.epa.gov/mercury/information1.htm

Agency for Toxic Substances and Disease Registry, Public Health Statement for Mercury:
http://www.atsdr.cdc.gov/toxprofiles/phs46.html

National Academies Press, "Toxicological Effects of Methylmercury":
http://books.nap.edu/books/0309071402/html/1.html#pagetop

EPA instructions for cleaning up a mercury spill:
http://www.epa.gov/epaoswer/hazwaste/mercury/spills.htm

EPA list of products that contain mercury and how to handle them safely:
http://www.epa.gov/grtlakes/p2/mercpam.html

INFORM list of mercury-containing products and alternatives:
http://www.informinc.org/fsmercalts.pdf

Links to EPA regional and state mercury programs and legislation:
http://www.epa.gov/epaoswer/hazwaste/mercury/live.htm

EPA's Mercury White Paper:
http://www.epa.gov/ttn/oarpg/t3/memoranda/whtpaper.pdf

Erie County, PA, mercury audit form:
http://www.dep.state.pa.us/dep/deputate/pollprev/P3erie/Mercbroch.pdf

Energy Efficiency

Energy Star-rated products listed by type:
http://www.energystar.gov/index.cfm?fuseaction=find_a_product

Federal Energy Management Program, Energy Efficiency Calculator for compact fluorescent lamps:
http://www.eere.energy.gov/femp/technologies/eep_fluorescent_lamps_calc.cfm

Federal Energy Management Program, "How to Buy Energy-Efficient Fluorescent Tube Lamps":
http://www.eere.energy.gov/femp/pdfs/fluor_lamps.pdf

Federal Energy Management Program, "How to Buy Energy-Efficient Fluorescent Ballasts":
http://www.eere.energy.gov/femp/pdfs/ballast.pdf

Federal Energy Management Program, "How to Select Lighting Controls for Offices and Public Buildings":
http://www.eere.energy.gov/femp/pdfs/light_controls.pdf

US Department of Energy, "Energy Savers: Tips on Saving Energy and Money at Home":
http://www.eere.energy.gov/consumerinfo/energy_savers/

Lighting Research Center, Exit sign links:
http://www.lrc.rpi.edu/programs/lightingTransformation/exits/exitlinks.html

Natural Resources Defense Council, Overview of the organization's "green" offices:
http://www.nrdc.org/cities/building/foffice.asp

New York State Dept. of Environmental Conservation, Explanation of tax credit incentives for sustainable development available through the state's Green Building Initiative:
http://www.dec.state.ny.us/website/ppu/grnbldg/index.html

Lighting Retrofitters

Faith Technologies, Inc.:
http://www.faith-technologies.com/capabilties/lighting_retrofit.aspx

Trade Associations

National Electrical Manufacturers Association (NEMA):
http://www.nema.org/

American Society of Heating, Air Conditioning and Refrigeration Engineers (ASHRAE):
http://www.ashrae.org

International Association of Lighting Designers:
http://www.iald.org/index.htm

International Association of Lighting Management Companies:
http://www.nalmco.org/

Illuminating Engineering Society of North America (IESNA):
http://www.iesna.org

Northeast Energy Efficiency Partnerships:
http://www.neep.org

National Association of Energy Service Companies:
http://www.naesco.org/index.htm

National Association of Independent Lighting Distributors:
http://www.naild.org/home.asp?pagenumber=1

Manufacturers

General Electric:
http://www.ge.com/en

OSRAM Sylvania:
http://www.sylvania.com/home_us.htm

Philips Lighting:
http://www.lighting.philips.com/nam/

Lutron Electronics:
http://www.lutron.com/lutron/

Advance Transformer:
http://www.advancetransformer.com/

Johnson Controls:
http://www.johnsoncontrols.com/

Honeywell:
http://www.honeywell.com/

Government Agencies

US Dept. of Energy, Federal Energy Management Program:
http://www.eere.energy.gov/femp/

US Environmental Protection Agency, Mercury home page:
http://www.epa.gov/mercury/

New York State Energy Research and Development Authority:
http://www.nyserda.org/

Agency for Toxic Substances and Disease Registry:
http://www.atsdr.cdc.gov/

Centers for Disease Control and Prevention:
http://www.cdc.gov/page.do

Service Providers (Energy Efficiency, Facilities Consultants)

Alliant Energy Integrated Services:
http://www.alliantenergyisco.com/services.php

AMERESCO:
http://www.ameresco.com/

Consolidated Edison Solutions:
http://www.conedsolutions.com/

Conservation Services Group:
http://www.csgrp.com/

Custom Energy:
http://www.customenergy.com/

Energy Systems Group:
http://www.energysg.com/

Johnson Controls:
http://www.johnsoncontrols.com/

Honeywell:
http://www.honeywell.com/

NORESCO:
http://www.noresco.com/site/content/index.asp

Select Energy Services:
http://www.selectenergysi.com/

Sempra Energy:
http://www.sempra.com/

Siemens Building Technology:
http://www.sbt.siemens.com/bau/solutions/performance/

Southern Company Energy Solutions:
http://www.socoesco.com/

Trane:
http://www.trane.com/TraneHomePage.asp

Mercury Recycling/Reclamation

List of all US lamp recyclers:
http://www.nema.org/lamprecycle/

Thermostat Recycling Corp. facilitates the collection of mercury-added thermostats by HVAC wholesalers
http://www.nema.org/index_nema.cfm/664/

EPA's list of state and local mercury collection/ recycling/exchange programs:
http://www.epa.gov/epaoswer/hazwaste/mercury/collction.htm

Not-for-Profit and Educational Resources

Environmental Working Group:
http://www.ewg.org/

Natural Resources Defense Council:
http://www.nrdc.org/

Healthy Building Network:
http://www.healthybuilding.net/

INFORM, Inc.:
http://www.informinc.org

Alliance for Safe Alternatives:
http://www.safealternatives.org/modelpolicies2.html

Mercury Policy Project:
http://www.mercurypolicy.org/

Building Green.com:
http://www.buildinggreen.com/

US Green Building Council:
http://www.usgbc.org

Lighting Research Center:
http://www.lrc.rpi.edu/

National Lighting Bureau:
http://www.nlb.org/

Publications and Membership

Related Publications

Cleaning for Health: Products and Practices for a Safer Indoor Environment
Alicia Culver, Marian Feinberg, David Klebenov, Judy Muskinow, Lara Sutherland (2002, 86 pp., $20)

Expanding the Public's Right to Know: Materials Accounting Data as a Tool for Promoting Environmental Justice and Pollution Prevention
Steven Anderson, Alicia Culver, Mark Dorfman, Amy Hughes (2000, 40 pp., $20)

Joining Forces: Case Studies in Business and Environmental Integration
Mark Haveman and Mark Dorfman (1998, 34 pp., $30)

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