LIGHTING FUTURES

In this issue

Lamp disposal rules change

by Kathleen Daly

Beginning in January 2000, regulations governing the way large numbers of mercury-containing lamps are disposed eased. In July 1999, the U.S. Environmental Protection Agency (EPA) decided to change the lamps' classification in the hope that simplified disposal regulations would encourage recycling.

The EPA has been considering the change for several years, and its decision follows as many as 40 states that have developed their own regulations for lamp disposal (see "State regulations" below).

In its ruling, the EPA classified lamps containing mercury and other hazardous waste as universal waste, which is a subset of hazardous waste. The ruling streamlines federal regulations for lamp disposal or recycling, with the goal of reducing the number of lamps containing hazardous waste in municipal landfills and incinerators while increasing the number of lamps being recycled. Under the universal waste rule, anyone who disposes of or handles universal waste lamps in bulk (a "handler") can recycle or send them to a hazardous waste landfill without filing the extensive paperwork required for hazardous waste. The ruling includes fluorescent, high-intensity discharge, neon, mercury vapor, high-pressure sodium, and metal halide lamps.

The universal waste category applies to several common, widely dispersed hazardous wastes, including pesticides, batteries, thermostats, and now lamps. The EPA developed the category partly to encourage the growth of recycling programs so that even those disposing of small quantities might find more opportunity to recycle hazardous items than to dispose of them in municipal landfills.

Since 1994, the EPA has been considering whether to issue a conditional exclusion for lamps, which would have excluded them from hazardous waste regulations if they were disposed of by recycling or in a lined landfill, or to apply the universal waste rule. "Universal waste has been an option for lamps all along," said Marilyn Goode, specialist with the EPA Office of Solid Waste. Spent lamps have been considered hazardous waste since 1990, and the universal waste rule was first issued in 1995. "It took a while to listen to all the options and decide that universal waste was the best way to go."

Mercury is the primary reason spent fluorescent lamps are considered hazardous waste, although some lamps also contain lead. Mercury can cause kidney, nerve, and brain damage in adults, children, and developing fetuses if they are exposed to large amounts or are exposed over a long period of time (see "Mercury in lamps"). In its decision, the EPA referred to studies that show mercury from municipal landfills has in some cases leached into drinking water sources in amounts above the 2 parts per billion allowed by the EPA. Those studies included Superfund and other landfills that may include industrial waste and other hazardous material not commonly found in municipal waste landfills. In addition, lamps that go to municipal incinerators release up to 90% of the mercury they contain into the air, unless the incinerators have emission controls.

While hazardous waste regulations required that lamps disposed of in large quantities be recycled or sent to hazardous waste landfills, "we do have reason to believe that a lot of these lamps have wound up in municipal landfills," Goode said. "The point of putting them under universal waste is to streamline the requirements to bring about better management of these wastes." In other words, the EPA hopes that reducing paperwork and other regulations for lamps will lead to better compliance.

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Mercury in lamps

Fluorescent lamps require small amounts of mercury to operate – from less than 10 milligrams in new low-dose lamps to 23 milligrams in typical fluorescent lamps. As an arc of electricity passes through the lamp, the mercury vaporizes and emits ultraviolet radiation. The radiation activates the phosphor powder coating inside the lamp, allowing the radiation to become visible as light. Once the lamp switches off, the mercury condenses to a liquid state. As lamps age, different components absorb some of the mercury.

Mercury, a naturally occurring element, can cause serious health problems including damage to the kidney, brain, and developing fetuses. The Agency for Toxic Substances and Disease Registry, part of the U.S. Department of Health and Human Services, recently established a new, higher minimal risk level (MRL) for methyl mercury, the organic form of the element most frequently consumed by people when they eat fish. The new MRL of 0.3 micrograms per kilogram of body weight per day is 3 times the 0.1 microgram per kilogram per day MRL established in 1994. The agency defines an MRL as "an estimate of

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State regulations for lamp disposal

State waste disposal regulations take precedence over federal regulations if the state's are more stringent. In those cases, waste generators must follow state regulations. For example, two states require that all fluorescent lamps be recycled.

Anyone disposing of spent lamps should contact their state hazardous waste authorities to determine what regulations apply. Contact information for these state agencies is available at the EPA's Web site (www.epa.gov/regional/federal/envrolst.htm). Envirobiz International Environmental Information Network's Web site also contains state listings (www.envirobiz.com/searchmenu.htm, click on government regulatory agencies).

Earth's 911, a non-profit educational public-private partnership, provides recycling resources by zip code at its Web site (www.1800cleanup.org.) Earth's 911 can also be reached by calling 1-800-CLEANUP.

Questions about TCLP

By John D. Bullough

The lighting industry has criticized the test used to determine whether spent fluorescent and high-intensity discharge (HID) lamps are hazardous waste because of its variability.

The U.S. Environmental Protection Agency (EPA) in 1990 established the toxicity characteristic leaching procedure (TCLP) to measure the presence of toxic materials such as benzene, chloroform, lead, or mercury within waste products, including lamps, destined for landfills. Yet the EPA also presents information about potential variability of test results in its *Lighting Upgrade Manual*.

TCLP tests for mercury in a soluble form. Because fluorescent and HID lamps contain some soluble mercury at the end of life, they are potentially toxic waste and must be tested unless the generator is already aware of whether the lamps are hazardous waste through results of previous testing or manufacturer information. If the TCLP from a lamp sample results in a high enough concentration of soluble mercury, the lamp is considered hazardous waste and is subject to specific and often expensive disposal procedures.

Testing is an expensive process and so not all lamps are tested. TCLP costs about $140 per lamp, which means testing all spent lamps for mercury is not economically feasible. Yet one lamp passing TCLP is no assurance that other lamps in the same class and brand will pass. The National Electrical Manufacturers Association (NEMA) worked with the EPA in 1991 and 1992 to develop a series of laboratory tests to study problematic testing procedures, methodologies, and sampling.

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Lutron Electronics improves remote-controlled dimming

Lutron, manufacturer of the Spacer dimmer, has introduced the Spacer System handheld remote-controlled dimmer for areas such as executive offices, cafes, boutiques, small conference rooms, and home theaters. The system can change light levels or use different combinations of lights from a handheld remote or from the wall-mounted master control. Users can preset up to four lighting scenes and recall them later. The system uses standard wiring and is appropriate for incandescent and halogen lighting.

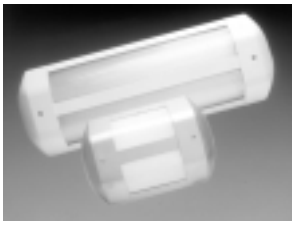
Lutron

Philips updates its MasterColor metal halides

Philips Lighting has replaced the traditional quartz arc tube technology in its MasterColor metal halide lamps with ceramic arc tubes. Philips has also removed lead from the glass and replaced lead in the solder with silver, resulting in lamps that pass the U.S. Environmental Protection Agency's toxic characteristic leaching procedure (TCLP) for hazardous waste. The line consists of screw-based ED-17s (replacements for standard and 3K metal halide lamps), reflector PARs, and single- and double-ended linear lamps for accent and floodlighting applications.

Philips Lighting Company

Vandal-resistant, ADA-compliant luminaires available from Morlite



Morlite Systems now has a line of fixtures—the LPL Sconce Series—that are suitable for public environments such as schools, parking garages, commercial workrooms, and sports facilities. The Sconce Series fixtures are wall luminaires that can be combined with an available battery pack to provide vandal-resistant emergency lighting. Illumination is provided by a choice of two 26-watt quad-tube compact fluorescent lamps or two 40-watt single-ended biax fluorescent lamps. A UV-stabilized, interlocking shock-resistant polycarbonate lens with linear prisms is available in optically clear or translucent opal with additional lens and housing protection. The luminaires are UL and CUL listed and ADA compliant.

Morlite

Uni-Form metal halide offers high lumens in small package

Venture Lighting's new ED17 200-watt Uni-Form metal halide lamp is designed for new and retrofit applications where energy-efficient, high-lumen lamps are required. This 200-watt medium-base lamp can fit in a smaller fixture than a standard 250-watt lamp. Venture says the lamp produces 21,000 lumens, has a performance life of 12,000 hours, a color temperature of 4000K, and a CRI of 65. The ED17 is also available with a mogul base of 15,000 hours. Venture has designed metal halide ballasts for the ED17, including low-current crest factor ignitor constant-wattage autotransformer ballasts in Quad-Tap, Tri-Tap, and 480-volt versions and a 277-volt controlled-current reactor ballast with ignitor starting.

Venture Lighting International

Sportlite announces energy-saving alternative to HID

An alternative to HID fixtures, Sportlite's LX800 Series high-bay fixtures with 42-watt compact fluorescent lamps have multiple lamps to reduce glare. The LX800 Series has AMP snap-lock electrical connectors and spring-clip secured ballasts for ease of installation and maintenance. Four-level stepped dimming is available. The LX800 Series comes in four styles

Sportlite

The Future of *Futures*

For four years, *Lighting Futures* has brought you and thousands of other readers timely information about the future of technologies and systems for lighting our homes, offices, and roadways. Through feature articles, columns, and departments, *Futures* has provided a glimpse of what we can expect from the lighting we use – in terms of energy, environmental impact, human factors, even beauty and aesthetics. Working with the sponsor of *Lighting Futures*, the U.S. Environmental Protection Agency, *Lighting Futures* is evolving in the near future. After the next issue, *Futures* will continue to provide timely and insightful news and information about new and forthcoming developments in lighting, but will do so through a medium that itself is evolving – the World Wide Web. Yes, this may change the way you read *Futures*, and while it would be easy to say that this is being done only to save paper (although this is a nice benefit!), this transition also offers opportunities for *Futures* to provide new kinds of information about lighting technologies and applications. What kinds of information, you ask? Stay tuned – next issue, the last *Futures* as you know it, will give you more details about what to expect. We hope that you will join us for the ride.

John D. Bullough,
Future *Lighting Futures* Editor

futurespast: **Who turned on the lights?**

by Marilyn R.P. Morgan

The fluorescent lamps that light our stores, schools, and offices were, only 64 years ago, exotic creations from the lab making their debut at an Illuminating Engineering Society of North America (IESNA) convention. The beginning of these ubiquitous lamps was less auspicious, dating to ancient times and fueled by people's fascination with natural phosphorescence.

In 980 A.D., the emperor of China heard of a picture on which an ox mysteriously appeared each evening. When he examined the picture, he discovered that the artist had painted the ox with a luminous paint containing oyster shell. Six hundred years later a shoemaker in Bologna, Italy, discovered that a rock called heavy spar was luminous after exposure to strong light. After another century the story continues, again with oyster shells, when an Englishman heated the ground shells with sulfur to make luminescent calcium sulfide. The German poet Goethe also experimented with naturally luminous substances.

In the 19th century, researchers discovered that they could vary both the intensity and duration of a material's phosphorescence by adding small amounts of copper and bismuth. In 1859, Becquerel described his experiments with tubes of luminescent materials and rarified air. Edison, inventor of the first practical incandescent lamp, also invented a fluorescent lamp in 1896 that used X-rays to excite fluorescent radiation in calcium tungstate on the inside walls of a vacuum chamber (a glass bulb). Unlike his incandescent lamps, this lamp was not practical. He discontinued work on the project after his assistant suffered severe burns from the X-rays

The search went on for the right combination of ultraviolet source and fluorescent material, with mercury becoming first choice as the source. French and German experiments in the early 1930s showed promise, and in 1934 work began in the U.S. as well. Attendees at the IESNA convention in Cincinnati in September 1935 saw the first public exhibition in the U.S. of a practical low-voltage fluorescent lamp.

The new lamps provided decorative lighting for the 100th anniversary celebration of the U.S. Patent Office in 1936 and at the two world's fairs in 1938 and 1939. In April 1938, fluorescent lamps were offered commercially in three sizes and seven colors. They produced colored light at 200 times the efficiency of the older filament lamps with filters, according to advertising of the day, and for a time it seemed that providing colored lighting for special purposes would be the fluorescents' main use.

By 1947, a 40-watt white lamp gave about six times the lighting value of a similar 1938 fluorescent lamp. Improvements including two-lamp ballasts, instant starting, and the availability of circline lamps brought increasing public acceptance of fluorescents. Recent improvements in technology to reduce hum and flicker, the availability of easy-to-install screwbase compact fluorescent lamps, and new luminaire designs that look less industrial and more home-like have accelerated this trend as fluorescents continue to make their way into U.S. homes.

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GE exhibited fluorescent lamps at the 1939 New York World's Fair.

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Questions about TCLP

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NEMA has published five new standards for TCLP sample preparation after years of research and testing. The NEMA Web site, www.nema.org, contains information about the standards.

Why soluble mercury?

The EPA developed TCLP as a way to determine if a waste is hazardous, and it tests for a variety of hazardous materials besides mercury, said Greg Helms, environmental protection specialist with the Office of Solid Waste. EPA staff determined that the way to do this was to simulate the highest risk – and likeliest disposal – for those materials, he said. They chose a municipal solid waste landfill.

"We thought a municipal solid waste (MSW) landfill was plausible and probably the highest risk scenario," Helms said. "That was because MSW landfills can generate acidic conditions which can mobilize metals like mercury, lead, and cadmium. We postulated that as plausible worst case management."

The EPA's main concern at the time was groundwater contamination, he said. "If you put waste X in a landfill, how much bad constituent would leach out and reach drinking water wells and how much (water) would be unusable? Drinking water standards were used as a reference value," Helms said. "We tried as best we could to simulate (the) aggressiveness and conditions of an MSW landfill."

How TCLP works

The EPA Publication SW846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Method 1311, "Toxicity Characteristic Leaching Procedure," gives the precise details of TCLP. For solid materials such as lamps, a sample of the material weighing at least 100 grams is broken into pieces small enough to meet one of the following criteria:

- the narrowest dimension of every piece must be smaller than 1 centimeter
- the surface area of the material must be at least 3.1 square centimeters per gram of material

One way to assure meeting the first criterion is by passing the material through a 9.5-millimeter standard sieve. Once the material is prepared, it is placed in a vessel where an extraction fluid consisting of an acetic acid solution is added. After the material is mixed in this solution continuously for 18 hours, the liquid is extracted. The test for mercury requires that the concentration of soluble mercury in this liquid be less than 0.2 milligrams per liter for the material to be regarded as non-hazardous. Lamps may also contain mercury that is not soluble and so does not show up on the test.

TCLP questions

Peter Bleasby, director of industry relations and standards for OSRAM SYLVANIA, points out that "TCLP only determines how much mercury is soluble. TCLP doesn't quantify the amount of mercury in products."

Joe Howley, GE Lighting environmental marketing manager, agreed that TCLP results depend on several variables, such as which lamp parts are tested or a lab's testing procedures. He advocates standardizing the TCLP for lamps.

TCLP tests for a variety of toxins, and therefore is somewhat less precise than it might otherwise be. "I think TCLP in general does a decent job as a screen," Helms said. "It was never intended to be a quantitative predictor of leaching under all circumstances. If people want a more precise test, then they have to be willing to deal with a regulatory system or a test system that is going to be more complex."

Mercury poses particular problems in that it is very volatile and is liquid at room temperature, Helms said. However, he noted that soluble mercury is more likely to migrate than metallic mercury. "I guess the bottom line on TCLP is if we are doing the test for general use, it's not going to be perfect," he said. "It's a screening test. It's not going to be extremely precise. In general I think TCLP has worked pretty well in identifying substances that are hazards."

The EPA Green Lights Program's 1995 *Lighting Upgrade Manual* (EPA 430-B-95-003) identifies several factors that can contribute to inconsistent test results, including:

- Lamp age. Mercury concentrations in fluorescent lamps remain relatively stable throughout the life of a lamp. However, the relative amount of soluble mercury tends to increase as the end of life approaches. Because of this, the same lamp that could pass the TCLP test when new might fail the test when spent. If samples submitted for the TCLP are new lamps, they might not accurately predict soluble mercury concentrations of spent lamps destined for landfills.
- Laboratory procedures. The TCLP, as outlined by the EPA, leaves room for significant variations in laboratory procedures. The size of the pieces tested, for example, can vary considerably. As pointed out by Science Applications International Corporation and reported by Paul Walitsky, manager of environmental affairs for Philips Lighting, in *ECON Magazine*, January 1996 ("Shedding Light on Fluorescent Waste"), following the TCLP might result in a loss of mercury before the mercury concentration is measured. Sample consistency is also important. Two samples from the same lamp may give different results with the TCLP. A 4-foot T8 fluorescent lamp weighs about 200 grams; a T12 fluorescent lamp of the same length weighs about 300 grams. NEMA recommends that the entire lamp be tested, not merely a 100-gram sample of lamp material.

One important qualification about the TCLP is that it is designed to estimate potential leaching of toxic substances from landfills into adjacent ecosystems. However, many fluorescent lamps are disposed of via incineration. Incineration releases 90% of lamp mercury, whether soluble or insoluble, directly into the air unless incinerators have the proper filtering equipment. New regulations for emission control will take effect this year.

When the EPA developed TCLP in the early 1990s, air pathways were not considered, Helms said, but that is changing. The EPA recently released a new study of risk from waste by releases to the air, and is reviewing its mercury waste treatment standards for an update, he said.

TCLP, however, has not predicted the release of mercury from lamps into the environment as a whole. It can be useful only as a predictor of the potential for a lamp to leach mercury into the ground.

trade in flux

Lighting certification

By Devki RajGuru

What is a lighting professional? The National Council on Qualifications for the Lighting Professions – or NCQLP – is trying to answer that question. The NCQLP is not alone. Other organizations, such as the Illuminating Engineering Society of North America (IESNA) and the International Association of Lighting Designers (IALD), have also been working for years to raise the bar for lighting practice. NCQLP developed as an independent organization to establish and then maintain a set of requirements that would become a necessity to practice as a professional in the realm of lighting.

As stated in promotional literature, "The NCQLP is a non-profit independent certifying body founded in 1991 by practitioners in the lighting industry." Composed of volunteers from within the industry, the NCQLP's goal is to ensure effective and efficient lighting practice. So far, 798 people have earned lighting certification.

Three years ago, the NCQLP unveiled the Lighting Certification (LC) program. A three-step program, it involves work experience, a comprehensive exam, and a system of continuing education. Candidates for the LC program are not required to have an educational degree in the field of lighting, nor is the LC credential at present required by any agency to practice in the field of lighting. Currently, the portion of this program attracting the most attention is the exam.

Applied Measurement Professionals (AMP), an independent organization, administers and scores the exam, which it conducts annually at various sites around the U.S. and Canada. "The exam has been very carefully and precisely created to test a person's knowledge on three cognitive levels: recall, application, and analysis and evaluation," said Christopher Cuttle, LC, a former member of the NCQLP Test Committee.

The four-hour exam is divided into two sections: 100 multiple-choice questions and four simulation problems. Multiple- choice questions test knowledge, while the simulations test skills gained through experience. The test covers six specific areas of lighting practice, each weighted according to its importance. "The exam is meant to be comprehensive, covering a broad curriculum," said Russell Leslie LC, associate director of the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute.

Many of the initial takers were longtime professionals, Cuttle said. "The aim of LC is to raise standards of practice, and as this happens, it can be expected that the exam will increase in difficulty as well," Cuttle said. The pass rate for the most recent exam, given in 1999, is 80%.

Anyone considering taking the exam should read the pamphlet from NCQLP that clearly sets out eligibility, exam format and content, as well as the application form. Contact the NCQLP directly at (301) 654-2121, or email to info@ncqlp.org for a copy.

Why Test?

If the LC is not required, why should anyone spend the time to study and money to take the exam? Industry members agree that the exam is comprehensive and a good start to ensuring that a practitioner knows the basics, but it does not guarantee ability or excellence in the field.

Mark Godfrey of Pacific Lightworks in Portland, Oregon, took the 1998 exam. "I believe that this is a positive way to ensure to my clients that I am qualified," he said. His

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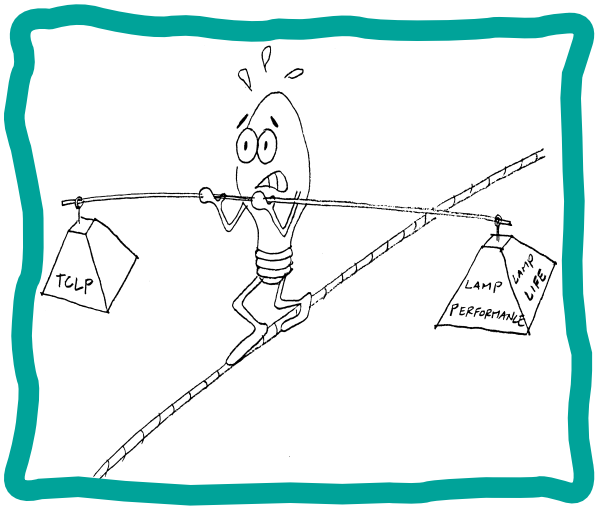
the lighter side



Javier Ten 2000

Mercury: a careful balancing act...

Mercury in lamps

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the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure."

The U.S. Food and Drug Administration limits the amount of methyl mercury in fish to 1 part per million, and recommends that consumers limit their consumption of large predatory fish with levels at or near 1 part per million to 7 ounces per week. For drinking water, the U.S. Environmental Protection Agency (EPA) has established a mercury limit of 2 parts per billion.

Mercury from lamps can get into the environment through breakage, which can release both mercury and mercury-contaminated phosphors. Incineration releases both soluble and non-soluble mercury into the atmosphere and accounts for 90% of the mercury released into the atmosphere from fluorescent and HID lamps. In its 1997 *Mercury Study Report to Congress*, the EPA estimates that mercury emissions from landfills in 1994-95 from all sources was less than 0.1 tons; the mercury emissions from fluorescent lamp recycling was also less than 0.1 tons for the same year.

Lamp disposal rules change

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The EPA estimates that 1% of the 158 tons of mercury released into the environment by human activity in the United States in 1994–95 came from spent mercury-containing lamps, compared with 87% from combustion sources such as incinerators and coal-burning power plants.

Paul Abernathy, executive director of the Association of Lighting and Mercury Recyclers, said the hazardous waste regulations for lamps were largely ignored.

"Historically there has been widespread non-compliance with the rules that have affected lamp management. About 88% of lamps have been thrown into the garbage," Abernathy said. Much of that non-compliance may be the result of ignorance, he said, noting that many businesses and building owners do not know they have been violating hazardous waste regulations by sending their lamps to the municipal landfill.

"We also think because there's been wholesale non-compliance for years and because EPA hasn't formally resolved the issue until this year, there's been little pressure (on) local governments to add fluorescent lamps (to their waste recycling programs)," he said. With EPA's support for recycling through the universal waste ruling, that may change. For example, municipal solid waste facilities began offering recycling for batteries after they were declared a universal waste.

Many lamps, however, are exempt from disposal regulations. Residents, exempt in most states from lamp disposal regulations, dispose of 15% of mercury-containing lamps, while 40 states also exempt some small businesses from regulations, similar to the federal regulations' conditionally exempt small quantity generators, said Ric Erdheim, senior manager for government affairs for the National Electrical Manufacturers Association.

Joe Howley, GE Lighting environmental marketing manager, said the universal waste ruling may increase recycling. "Before, they would have to use these full hazardous waste regulations to recycle (lamps), and this was sort of a disincentive to recycle because these people weren't normally familiar with the regulations, didn't want to deal with them, or weren't familiar with how to deal with them," Howley said. "This may make it simpler. It also would make it simpler for EPA to go in and encourage people to recycle. Instead of saying, 'Now you have to follow several pages of regulations,' (EPA) could say, 'Now you should recycle,' and get them to recycle in a very simple manner without a lot of paperwork."

In the years during which the EPA delayed its decision, the agency allowed states to add spent fluorescent lamps to their own universal waste programs, resulting in a patchwork of regulations for lamp disposal across the country. As a result, more stringent state regulations will supercede the new federal regulations (see "State regulations" page 1).

The mercury cycle

A naturally occurring element, mercury is a part of our world. Present in air, earth, and water, mercury has many forms. It travels through air, water, and soil and shifts forms depending on its location and circumstances. For humans, large amounts of mercury pose serious health risks including neurological disorders and birth defects. Yet the amount of mercury in the world never actually changes. What changes is the amount of exposure humans have to mercury and the form of the element at the time of exposure.

Released by natural forces – a volcano, for example – or by human activity such as, fossil fuel combustion, mercury enters the air. It can travel substantial distances, falling miles from its point of origin.

In water or in earth, inorganic mercury can become organic mercury through contact with bacteria and other substances. Methyl mercury, one of the more common and more toxic forms of organic mercury, is the form of mercury often present in water and fish.

Humans encounter mercury every day. According to the Agency for Substances and Disease Registry of the U.S. Food and Drug Administration, the air we breathe typically contains about 2.4 parts of mercury per trillion parts of air. Humans can ingest mercury through contaminated water and fish, breathe

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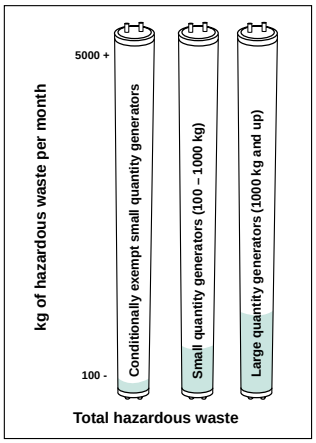
The old regulations

Under the federal Resource Conservation and Recovery Act (RCRA), spent lamps are determined to be hazardous waste based on the toxicity characteristic leaching procedure (TCLP). The test estimates how much hazardous material such as mercury would potentially leach from the product if the material were placed in a landfill (see "Questions about TCLP" page 1). Those lamps that come through the TCLP with a mercury concentration of 0.2 milligrams per liter or greater are considered hazardous waste.

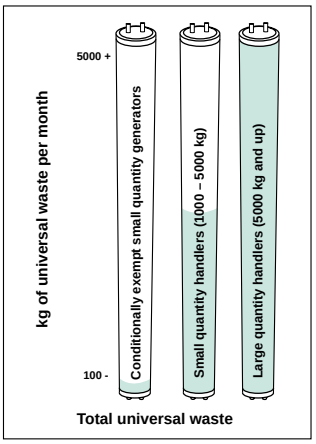


Until lamps became universal waste in January, RCRA labeled anyone disposing of lamps that fail TCLP a "hazardous waste generator," with three classifications. Conditionally exempt small quantity generators dispose of less than 100 kilograms of hazardous waste in a month and are exempt from RCRA requirements. A small quantity generator disposes of more than 100 kilograms of hazardous waste (approximately 300 to 350 4 - foot T12 lamps) in a month and must follow substantial record-keeping, transportation, and storage regulation. Even more rigorous regulations apply for large quantity generators who dispose of more than 1000 kilograms of hazardous waste a month.

Before the universal waste ruling, large and small hazardous waste generators were required to dispose of their lamps in a hazardous waste landfill or recycle them; register with the EPA; fill out the hazardous waste manifest, a complex, multi-part form with multiple copies; and use a hazardous waste transporter to bring their waste to appropriate recycling or disposal facilities. Any generator of a hazardous substance can be held liable for releases of that substance into the environment under the Comprehensive Environmental Response, Compensation, and Liability Act.

The new regulations

Federal universal waste regulations apply to two categories of "handlers." A small quantity handler accumulates up to 5000 kilograms of total universal waste at one time, while a large quantity handler accumulates more than 5000 kilograms. Conditionally exempt small quantity generators of hazardous waste are exempt from federal universal waste regulations.



Under federal universal waste regulations, large quantity universal waste handlers are required to notify the EPA that they are handling universal waste, obtain an EPA identification number, and keep records for three years of incoming and outgoing shipments of universal waste. These rules, however, are less demanding than those for hazardous waste. In addition, while some transportation rules will be in place, federal rules no longer require handlers to use hazardous waste transporters to bring their lamps to a recycler or hazardous waste landfill. Federal storage regulations are also eased, allowing longer storage periods for universal waste than are allowed for hazardous waste. Small quantity generators generally do not have to inform the EPA regional office about their universal waste or keep records of universal waste shipments, but state requirements may be more stringent.

Some states require that all fluorescent lamps be recycled, while others have more limited exemptions than allowed under federal regulations. To avoid violating state regulations, people disposing of fluorescent or HID lamps should contact their state hazardous waste authority to find out specific requirements (see "State regulations" page 1).

The recycling option

One way to reduce the amount of mercury circulating in the environment is through recycling.

Philips Lighting supports recycling. Paul Walitsky, manager of environmental affairs for Philips Lighting, acknowledges that recycling may seem costly, but the issue goes beyond cost.

"You are not paying for recovering mercury as a commodity when you recycle. What you are paying for is keeping mercury out of the ecosystem," Walitsky said. "How much is that worth? I cannot judge."

Howley of GE Lighting takes the middle road on recycling, supporting the concept while noting its drawbacks.

"I think recycling is a beneficial way to deal with the disposal of the lamps. There are situations where it doesn't make sense. There are still a lot of technical and economic hurdles associated with it," he said. "It costs (the recyclers) a lot more to collect and separate the materials of the lamp than (they) can get on the open market for the recovered materials."

Abernathy of the Association of Lighting and Mercury Recyclers and the EPA disagree with concerns that the cost of recycling will prevent people from retrofitting their lighting systems with lamps that are more energy-efficient. According to the EPA's 1998 *Lighting Upgrade Manual*, fluorescent recycling costs range from $0.06 a foot to $0.15 a foot, with an average of $0.10 a foot. A 4-foot, 40-watt T12 lamp costs approximately $0.40 to recycle, according to the manual, while putting lamps in a hazardous waste landfill costs about $0.25 to $0.50 per 4-foot lamp. The EPA estimates that the energy savings from an energy-efficient retrofit will offset any increased costs for recycling.

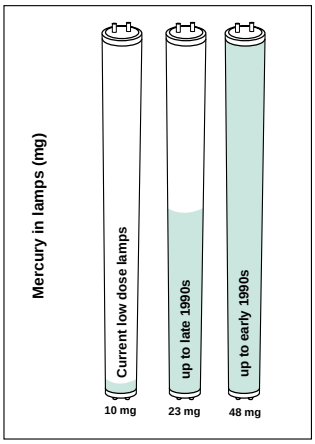
The appeal of fluorescent lamps

While mercury is an environmental and health concern, fluorescent lamps are responsible for only a very small amount of the element being released into the environment. At the same time, their energy efficiency means they are responsible for far less mercury entering the environment through coal-powered energy generation than that which would be released with incandescent lamps at the same lighting level.

While most commercial and industrial settings already use fluorescent lamps, a retrofit to fluorescent lamps that are more energy-efficient would increase efficiency and further reduce mercury emissions. Because incandescent lamps are found in homes, the opportunity for further energy efficiency exists if more residential users begin to use energy efficient light sources such as compact fluorescent lamps designed for residential

fixtures or hardwire residential fluorescent lighting systems into their homes. Each kilowatt-hour saved through energy efficiency prevents 0.04 milligrams of mercury emissions, the EPA estimates.

The lighting industry has taken significant steps to reduce the amount of mercury they use in lamps already. fluorescent lamps contained as much as 48 milligrams of mercury through the early 1990s. The amount has decreased to 23 milligrams, and new "low-dose" lamps have less than 10 milligrams. Compare that to a paperclip, which weighs about 1 gram. Further, many low-dose lamps pass the TCLP test and so are exempt from hazardous waste and universal waste regulations. The EPA, however, encourages recycling for all fluorescent lamps.



While reducing mercury in lamps is a significant accomplishment, the EPA universal waste decision for lamps is designed to keep the mercury from waste lamps out of municipal landfills and incinerators. The EPA predicted in the 1997 report *Mercury Emissions from the Disposal of fluorescent Lamps* that the universal waste rule could reduce mercury in the environment by more than 600 kilograms this year. It is unlikely that the debate about mercury in lamps and lamp disposal will end with this ruling; manufacturers and environmentalists may never agree on how much mercury is acceptable in lamps or in the country's disposal system. One thing is clear: the element mercury will not disappear from the environment or from a variety of energy-efficient lamps.

Low-dose mercury lamps

Manufacturers are lowering mercury content in lamps and advertising that the low-dose mercury lamps will pass the test that determines whether a substance classifies as a hazardous waste. Manufacturers have developed ways to reduce the soluble mercury in lamps without changing the total mercury content. To pass the toxicity characteristic leaching procedure (TCLP), a lamp must test with no more than 0.2 milligrams of soluble mercury per liter (see "Questions about TCLP" page 1).

"The traditional (4-foot) fluorescent lamps made through the 1980s and 1990s typically contained 45 to 50 milligrams of mercury, so the fact that the industry has gotten them down to less than 10 milligrams (per lamp) is a pretty significant achievement in terms of minimizing our use of this metal," said Joe Howley, GE Lighting environmental marketing manager.

While reducing mercury is a benefit at disposal time, manufacturers must balance that with lamp performance. Mercury dosages have to be calculated precisely in the range of tenths of milligrams, because a mercury dose that is too small will shorten lamp life or cause the lamp to fail, while too large a dose means the lamp may fail TCLP.

"Obviously, we have issues with removing all of the mercury because it's mercury that creates the ultraviolet energy that makes the lamp efficient," Howley said. "If we drop the mercury levels too low, we have concerns about lamp performance and lamp life. Once you drop below 10 milligrams, you have to be very careful in how you design the lamp to assure that it performs the way the old lamps performed and achieves the same lifetimes."

Low-dose lamps allow a variety of disposal options because the lamps pass TCLP. They can be discarded in municipal landfills or incinerated, which releases most of the lamps' mercury into the atmosphere. Low-dose mercury lamps can be recycled even if not classified as hazardous waste by state and federal regulatory agencies.

The mercury cycle

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mercury, and even absorb it through the skin if they come in contact with it. Federal agencies have established levels of mercury exposure that are deemed acceptable, though debate on those levels continues (see "Mercury in lamps" page 1).

In the *Mercury Study Report to Congress* issued in 1997, the U.S. Environmental Protection Agency estimated that approximately 5500 tons of mercury are released into the atmosphere each year from all sources, including anthropogenic, natural, and oceanic emissions. Of that, approximately 3% came from sources in the United States in 1995. Combustion sources accounted for 154.7 tons of the 158 tons of anthropogenic emissions from the United States, while lamp breakage accounted for only 1.5 tons. That figure is low, yet the National Electrical Manufacturers Association has argued that it is too high. The numbers are derived from a model that cannot accurately represent the emissions from broken lamps, said Ric Erdheim, NEMA senior manager for government affairs. "Only recently has data been available" that would allow an accurate model to be developed, he said.

making contact

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Lighting certification

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employer agrees. Pacific Lightworks paid the examination fee and helped Godfrey study for the exam. All designers in the firm who are eligible now have the LC.

Marianne Maloney, of Fisher Marantz Stone in New York, started out as an architect, but discovered lighting design just out of school. She has a degree in a related field that requires its own rigorous examination. "I feel that taking the exam matters as a benchmark," she said. "It establishes a baseline of knowledge, similar to a rite of passage, that states I am not a beginner anymore."

Burr Rutledge, a graduate of the LRC's MS in Lighting program and a lighting designer with H.M. Brandston and Partners Inc., is still considering taking the exam. "There is no outward perceived advantage, other than, as a young professional, it adds another layer of credibility," he said. Time to study and cost of examination fees are important deciding issues for young lighting professionals, he said.

"It looks good on a resume, a show of commitment to the profession," said Patty Glasow, principle at Auerbach+Glasow in San Francisco. "But when hiring for a small firm, a person's personality can be just as important as their skills and experience." As a firm policy, Auerbach+Glasow supports the NCQLP exam by paying the fee and purchasing study materials for employees. The LC credential gives them confidence in a person's level of basic knowledge, but does not replace experience, she said.

OSRAM SYLVANIA considers the test sufficiently important for its employees that 16 have so far earned the right to put LC on their business cards, including several in top management, said Pamela Horner, LC, manager of general lighting education with the lamp manufacturer.

"I would say that the NCQLP Lighting Certified program shows our total commitment to all aspects of lighting, not just to maufacturing," Horner said. "Furthermore, the credential is important in order to demonstrate our knowledge and our leadership to our customers, especially in three areas: in sales, in product management, and in education."

The program fits into the company's existing commitment for employee training, she said, so that many people use their professional improvement benefits to study for and take the exam. The company also showed its support by featuring the 16 LC employees in the internal newsletter.

"We've publicized it internally, so people are aware that it exists, and we put LC on our business cards," she said.

Diarmuid McSweeney, LC, director of industrial marketing for Holophane and a former NCQLP board member, continues to support the program.

"I believe that a minimum level lighting qualification is necessary to raise the bar in our industry," McSweeney said. "For companies such as Holophane, I believe it's important for our sales and marketing representatives to show that they have the necessary expertise to be helpful to their customers."

Holophane encourages employees to attend courses to prepare for the LC exam and reimburses them their costs when they pass it. As many as 25 employees have earned LC, earning Holophane recognition at LightFair 1999 for having the most employees with LC, McSweeney said.

While the exam establishes a basic knowledge level, it also requires continuing education to maintain certification, he noted. "After three years you have to renew to show that you are still current," he said, through some of the many possible methods of accruing lighting education units (LEUs), such as attending trade shows and courses, writing papers, giving lectures, and reading approved lighting articles.

Another issue that has arisen is one involving who is eligible to take the exam. Again, unlike engineering or architecture, an LC candidate does not necessarily need to be working in a lighting practice. Lighting is such a broad industry that manufacturers, sales representatives, and electricians are included as "related fields" and can take the exam.

How does this affect international lighting professionals? In this day of global economies and blurred boundary lines, many lighting practices have gone worldwide, opening offices on far-off continents. Should lighting designers in other countries take an exam that is currently written only for North America? The NCQLP lists reference sources on which the exam is based, and these relate only to North American practice. They make no reference to practices in other countries or to documents issued by international bodies.

"The official position of the IALD is that lighting practice is in a state of transition, and there are no finite answers to these questions. As an international organization, we must represent the rights of our non-American members," said Morag Fullilove, executive director of the IALD. "The IALD has always believed in, and supported, the importance of upgrading the quality of services." More than 100 IALD members have the LC credential, but until these issues can be resolved, the IALD will not require this credential for its members.

Regardless of how lighting practice gets there, lighting professionals are determined to achieve a level of professionalism and credibility similar to that of the engineering and architecture professions. The general feeling throughout the industry is positive. The LC creates a comprehensive base, and in the future, more precise and specialized requirements may emerge to work in conjunction with the LC for specific areas of lighting practice.