

# Fluorescent L a m p s a n d t h e Environment

**Mercury Use**

**Environmental Benefits**

**Disposal Requirements**

# Lamps & Mercury

Over the past few years, state and federal regulations concerning fluorescent lamp disposal have become increasingly complex, affecting a wide range of US businesses. Fluorescent lamps and high intensity discharge lamps contain a small quantity of mercury. Concerns over mercury releases to the air and water are driving stricter disposal regulations.

The National Electrical Manufacturers Association (NEMA), whose members include virtually all of the lamp manufacturers in the United States, has produced this brochure to educate our customers, the public, and decision-makers on the role of mercury in lamps and on appropriate approaches to ensure that spent lamps are managed in an environmentally responsible way.

This brochure provides answers to the following questions:

## **Lamp Technology**

- Why do lamps need mercury?
- How much mercury do lamps contain?

## **Environmental Concerns**

- What are the energy and environmental benefits of fluorescent lamps?
- How do generators (users) dispose of spent lamps?
- How much mercury is released to the atmosphere from fluorescent lamp disposal?

## **Industry Efforts**

- What is the lighting industry doing to reduce mercury use?

## **Regulatory Efforts**

- How are fluorescent lamps regulated?

- What are the current federal government regulations?
- What are state regulatory options?

NEMA believes a common understanding of these issues will lead to sensible and protective policies for lamp management.

# Lamp Technology

## Why Do Lamps Need Mercury?

Mercury is an essential ingredient for most energy efficient lamps. Fluorescent lamps and high intensity discharge (HID) lamps are the two most common types of lamps that utilize mercury. Fluorescent lamps provide lighting for most schools, office buildings, and stores. HID lamps, which include mercury-vapor, metal halide, and high-pressure sodium lamps, are used for street lights, floodlights, and industrial lighting.

A typical fluorescent lamp is composed of a phosphor coated glass tube with electrodes located at either end. The tube contains mercury, of which only a very small amount is in vapor form. When a voltage is applied, the electrodes energize the mercury vapor, causing it to emit ultraviolet (UV) energy. The phosphor coating absorbs the UV energy, causing the phosphor to fluoresce and emit visible light. Without the mercury vapor to produce UV energy, there would be no light.

A four-foot fluorescent lamp has an average rated life of at least 20,000 hours. To achieve this long life, lamps must contain a specific quantity of mercury. The amount of mercury required is very small, typically measured in milligrams, and varies by lamp type, date of manufacture, manufacturing plant, and manufacturer.

If lamp life is shortened, more lamps must be purchased to achieve the same length of service, and the number of lamps that generators must dispose will increase.

## How Much Mercury Do Lamps Contain?

Based on a 1999 NEMA survey, the average four-foot fluorescent lamp contains about 11.6 milligrams (mg) of mercury. This number has been steadily declining as lamp manufacturers work to reduce mercury content to the minimum amount technically feasible without reducing lamp life. The average four-foot lamp today contains over 75% less mercury than the same lamp would have contained in 1985.

According to the U.S. EPA, total global natural and manmade emissions to the environment are 5,500 tons.<sup>1</sup> Manmade sources in the U.S. released 158 tons of mercury in 1995. For comparison, all of the lamps sold in the United States in 1999 *contain* only an estimated 13 tons of mercury, of which only a fraction will be released as an air emission. Proper lamp disposal or recycling will result in keeping almost all of this mercury out of the environment.

# Environmental Issues

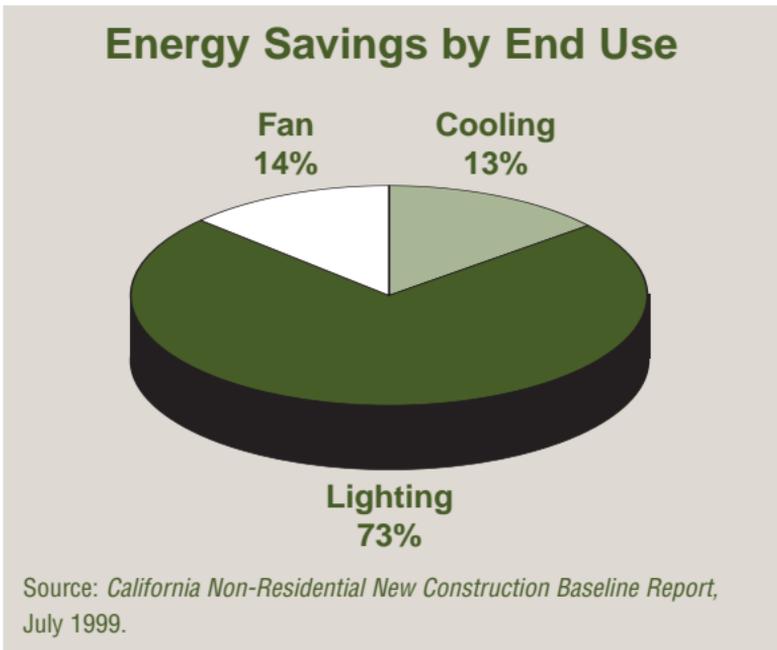
## What Are the Energy and Environmental Benefits of Fluorescent Lamps?

Both fluorescent and HID lamps are typically *three to four times more energy efficient* than incandescent lamps.

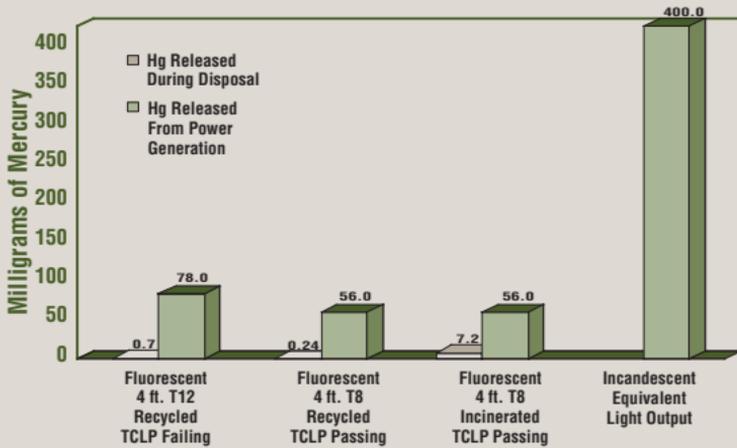
Through their Green Lights, Energy Star Buildings, Rebuild America, and Federal Energy Management programs, the U.S. Environmental Protection Agency (EPA) and the

Department of Energy actively promote the conversion to more energy efficient lighting, such as modern fluorescent lamps. In addition, utilities promote energy efficient lamp conversions through demand side management programs. The use of energy efficient mercury-containing lamps can play a significant role in the nation's energy consumption. A study, recently published in California, concerned the efficiency of newly constructed non-commercial buildings. Lighting was identified as the single most important contributor to energy efficiency (at 73% of the total energy savings by end use).

The use of energy efficient lighting reduces the amount of coal, oil, and gas burned in power plants, as well as the amount of air pollutants released from power plants. Mercury is a common pollutant emitted from power plants burning coal, oil, or gas. Because of the significant energy savings, using high efficiency fluorescent lamps to replace incandescent lamps or older fluorescent lamps results in a net *reduction* in mercury emissions. EPA estimates that full implementation of the Green Lights program nationwide would result in a reduction of close to 10 tons of mercury per year due to reduced power generation.<sup>2</sup>



## Lifetime Hg Emissions



*Hg from fluorescent lamp disposal is small compared to the Hg released from power generation required to operate the lamp*

*Incandescent lamps contain no mercury but result in the highest Hg emissions*

Source: "Environmental & Health Aspects of Lighting," *Journal of the Illuminating Engineering Society*, Summer 1994.

Additionally, EPA estimates that full implementation of the Green Lights program would also reduce carbon dioxide emissions (global warming) by 202 million tons, sulfur dioxide emissions (acid rain) by 1.3 million tons, and nitrogen oxide emissions (a component of smog) by 0.6 million tons.

## How Are Fluorescent Lamps Managed After Being Used?

After a fluorescent lamp or other mercury-containing lamp is used it is either:

- Disposed of in a municipal or hazardous waste landfill;
- Recycled to recover mercury and other lamp materials; or
- Placed in a municipal waste incinerator.

All of these disposal and management options have different environmental and economic costs.

## What Are the Environmental Impacts of Different Management Methods?

**Recycling:** Recycling has the advantage of reusing certain raw materials from fluorescent lamps, including mercury. Studies indicate that mercury releases into the air from well-managed lamp recycling equipment and facilities are relatively low. However, the reclaimed glass often contains a small amount of residual mercury which can be released as the glass is distributed through commerce and processed at high temperatures to make new products.<sup>3</sup> While recycling capacity is increasing, there are areas in the United States where there are still only a limited number of recycling operations. In addition, the market value of the reclaimed materials from lamps is negligible, such that lamp recycling is never economically self-sufficient and waste generators or government programs must pay for the recycling.

**Landfills:** Landfilling has been the traditional means of disposing of spent lamps (see page 13). Due to their extremely low mercury content, lamps have historically accounted for only 3.8 percent of all the mercury deposited in municipal landfills.<sup>4</sup> Although there have been numerous mercury studies during the past 10 years, none has shown that lamps disposed of in landfills pose a human health or environmental risk. EPA's own studies have demonstrated that mercury is rarely detected in landfill leachate. When it is detected, mercury levels in landfill leachate rarely exceed the standards for drinking water. These studies have also shown that air releases of mercury from landfills are also negligible. The conclusion to these studies is that 99.99% of the mercury in a landfill is safely retained.

Both properly regulated landfilling and recycling are environmentally protective options for managing spent lamps. Because landfilling in modern, permitted landfills is a safe method of disposing of mercury-containing lamps, it is

an important option that should remain available to those disposing of spent lamps. It provides a low-cost disposal alternative that does not substantially increase the cost of upgrading to more efficient and environmentally beneficial fluorescent lighting systems.

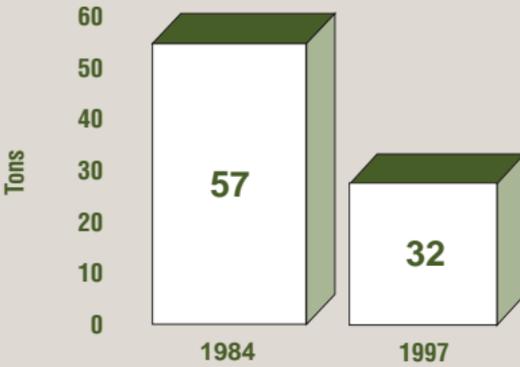
**Incineration:** Until recently, most municipal waste incinerators did not have special controls to reduce mercury emissions. The incineration of mercury-containing lamps, therefore, released up to 90% of the mercury to the air.<sup>4</sup> By the end of the year 2000, most incinerators will have added stringent new EPA-mandated mercury controls, dramatically reducing the amount of mercury that incinerators release from any mercury-containing product. NEMA believes that generators should divert spent lamps from incinerators to other management methods.

**Crushing:** Crushing lamps prior to transportation reduces the volume of waste by approximately 80%. High quality crushers utilize mercury filters and other technology to limit mercury emissions. All crushers must comply with OSHA air quality standards. Crushing can significantly reduce transportation and storage costs for generators. It also eliminates the chance of lamps releasing mercury to the air when accidentally broken during storage and transportation.

## **What is the Lighting Industry Doing to Reduce Mercury Use?**

The amount of mercury used to manufacture lamps has steadily declined over the last 15 years. According to data from the U.S. Department of the Interior, the lighting industry has reduced its use of mercury from 57 tons in 1984 to 32 tons in 1997. This represents almost a 50% reduction in mercury usage despite increasing use of mercury containing lamps.

## Mercury Used In Lighting Industry 1984 vs. 1997

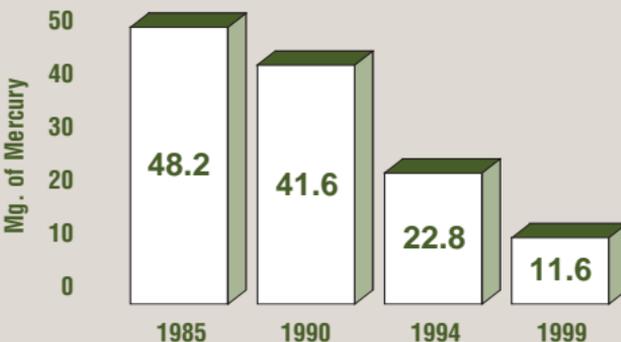


Source: U.S. Department of the Interior

Lamps do not contain all of the mercury used in the manufacture of fluorescent lamps. A survey of NEMA's members indicated that lamps actually contained 17 tons of the mercury used in 1994 to manufacture lamps. NEMA estimates that lamps manufactured in 1999 contained approximately 13 tons. Mercury used in the manufacturing process that is not contained in the lamps is returned to mercury distillers for purification and reuse. Currently, less than 50% of the mercury that lamp manufacturers use is contained in lamps. All the mercury used is recycled mercury.

The lighting industry has made significant investments in manufacturing processes and new lamp designs to continue

## Mercury Contained in Four Foot Fluorescent Lamp— Industry Average



to drive down mercury content in lamps. These investments have reduced the average mercury content of a four foot lamp from 48.2 mg in 1985, to 41.6 mg in 1990, to 22.8 mg in 1994, and to 11.6 mg in 1999.<sup>5</sup>

It is unlikely that an energy efficient mercury-free fluorescent lamp will be commercially available in the near future. The lamp industry and the research community have not found a substitute that has mercury's unique energy efficient properties. Research shows that a fluorescent lamp made without mercury would consume approximately 3 times more energy than a mercury-containing lamp to produce the same light output.

# Regulation of Spent Lamps

## How Are Fluorescent Lamps Regulated?

The goal of any regulatory effort should be to control releases of mercury from spent lamps while not driving the costs of lamp disposal so high that businesses and homeowners are reluctant to use energy efficient lighting or that they dispose of lamps improperly.

## What Are the Current Federal Regulations?

For many years, EPA considered mercury-containing lamps to be ordinary municipal solid waste that generators would dispose of along with everyday garbage. In 1990, EPA revised the test it uses to identify a hazardous waste (the Toxicity Characteristic Leaching Procedure or "TCLP" test). Under this new test, many spent mercury-containing lamps failed and were classified as hazardous waste.

In response, the industry has developed many lamp types with reduced mercury that pass the TCLP test and are, therefore, not classified as hazardous wastes. Federal law exempts households and conditionally exempts small quantity generators (“CESQGs”—facilities that generate less than 100 kg of total hazardous waste per month) from handling spent lamps that do not pass the TCLP test as hazardous waste. Most states apply these exemptions. A few states ban the disposal of all lamps in solid waste.

When a waste is classified as hazardous, a large quantity generator of the waste is subject to a uniform set of stringent regulations, including burdensome paperwork requirements. For most fluorescent lamps, these regulations preclude the use of state-of-the-art municipal landfills and municipal waste incinerators and require the use of treatment and disposal or recycling technologies.

These federal regulations, which generally classify spent lamps as hazardous wastes unless the spent lamp can pass the existing toxicity test, provide potential disincentives to upgrading lighting systems. The increased costs and liabilities associated with hazardous waste disposal may discourage companies from switching to new, energy efficient lamps.

EPA, along with companies that manufacture lamps and others, recognized that the regulation of spent mercury-containing lamps as traditional hazardous wastes was inappropriate. EPA designed hazardous waste regulations to control the management of highly toxic industrial wastes, not widely dispersed, low-risk wastes. These stringent requirements are not fully needed to manage lamps properly. Moreover, the requirements impose new costs on the millions of businesses, schools, and other organizations that use and dispose of mercury-containing lamps.

In 1999, EPA enacted a regulation that allows generators to manage lamps under a new set of modified hazardous waste regulations EPA developed for other commonly generated wastes such as certain types of batteries and thermostats. These modified regulations, known collectively as the “Universal Waste” rule, significantly reduce transportation, storage, collection, and record keeping requirements for hazardous wastes that are recycled.

The “Universal Waste” regulation allows users of fluorescent lamps to:

- Characterize spent lamps using the TCLP test to determine hazardous waste classification for appropriate disposal,
- Process spent hazardous waste lamps at a lamp recycler under a significantly reduced set of regulations, or
- Dispose spent hazardous waste lamps in hazardous waste landfills under full hazardous waste regulations.

In 1995, EPA decided in its final generic Universal Waste rule that it would allow states the option of adding additional wastes, such as mercury-containing lamps, to their Universal Waste program through a petition process. Several states have added lamps to their State Universal Waste Program before EPA did in 1999. These state requirements may vary from the EPA rule. Other states have adopted the EPA rule without amendment. Almost all states have taken or plan to take action to add lamps to their universal waste rule. As of mid-2000, state disposal regulations vary greatly. **NEMA recommends that generators contact their state authorities to determine the spent lamp management requirements applicable to them. Generators can obtain information about state lamp management requirements at [www.lamprecycle.org](http://www.lamprecycle.org).**

# Recommended Policies for State Management of Spent Lamps

The changing status of mercury-containing lamps creates a confusing environment for generators of spent lamps.

States that have received authority from EPA to run their waste programs may not enforce regulations that are less stringent than those EPA has adopted. However, many states have not strictly enforced the EPA rules. Other states have adopted their own rules for lamps, many of which are inconsistent with the federal regulations. Some states have not added lamps to their universal waste rule. Most, but not all, states have adopted the Federal rules that exempt lamps that pass the TCLP test or lamps from households or conditionally exempt small quantity generators from hazardous waste disposal requirements.

NEMA believes there are actions states can take to facilitate the safe, efficient, and cost-effective collection and management of spent lamps.

## **States can:**

- Remind generators that only lamps failing the TCLP test are subject to hazardous waste or universal waste regulations, but that all fluorescent lamps should be managed in well designed disposal facilities;
- Adopt the EPA Universal Waste rule for lamps without amendment;
- Allow on-site crushing of lamps before disposal if the crusher has a mercury filter, meets the definition of a “treatment tank” under the hazardous waste rules, and complies with OSHA air quality standards for mercury;

- Clarify to lamp generators that lamps that are removed from service but will be reused by another user are not considered a waste;
- Remind households and conditionally exempt small quantity generators, if applicable, that they are exempt from hazardous waste regulations;
- Encourage that household hazardous waste facilities, where they exist, should be open to conditionally exempt small quantity generators;
- Regulate mercury-containing lamps under the universal waste rules or the hazardous waste management regulations known as Subtitle C.

## Conclusion

NEMA and its members continue to promote the use of energy efficient lighting to reduce mercury emissions from power generation. NEMA members continue to reduce the amount of mercury used in lamps. Research has shown that both properly regulated landfilling and recycling can be environmentally protective. NEMA believes the best way to minimize mercury emissions to the environment is to:

- Increase the use of energy efficient lamps,
- Continue to reduce the amount of mercury used in energy efficient lamps,
- Increase the recycling of lamps, and
- Prohibit their incineration.

## REFERENCES

1. EPA Mercury Report to Congress: Volume I, Executive Summary, December 1997, pp. O-1, O-2.
2. *Federal Register*, July 27, 1994, Vol. 59, p. 38289, col. 3.
3. NEMA, "Mercury Content of Residues from Lamp Reclamation," September 1994.
4. Truesdale, Beaulieu, and Pierson, Research Triangle Institute, "Management of Used Fluorescent Lamps: Preliminary Risk Assessment," May 1993.
5. NEMA, "Environmental Impact Analysis: Spent Mercury-Containing Lamps," January 2000 (Fourth Edition).
6. *Federal Register*, July 6, 1999, Vol. 64, pp. 36466-36490.



The lamp section of the National Electrical Manufacturers Association prepared this brochure. The section's members include:

EYE Lighting International  
GE Lighting  
OSRAM SYLVANIA, Inc.  
Philips Lighting Company  
SLI Lighting  
Ushio America  
Venture Lighting International  
Voltarc Technologies

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