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(FORM UPDATED: 08/11/2010)

WISCONSIN STATE LEGISLATURE ... PUBLIC HEARING - COMMITTEE RECORDS

2009-10

(session year)

Senate

(Assembly, Senate or Joint)

Committee on Environment...

COMMITTEE NOTICES ...

- Committee Reports ... **CR**
- Executive Sessions ... **ES**
- Public Hearings ... **PH**

INFORMATION COLLECTED BY COMMITTEE FOR AND AGAINST PROPOSAL

- Appointments ... **Appt** (w/Record of Comm. Proceedings)
- Clearinghouse Rules ... **CRule** (w/Record of Comm. Proceedings)
- Hearing Records ... bills and resolutions (w/Record of Comm. Proceedings)
 - (**ab** = Assembly Bill) (**ar** = Assembly Resolution) (**ajr** = Assembly Joint Resolution)
 - (**sb** = Senate Bill) (**sr** = Senate Resolution) (**sjr** = Senate Joint Resolution)
- Miscellaneous ... **Misc**

* Contents organized for archiving by: Stefanie Rose (LRB) (September 2013)

Senate

Record of Committee Proceedings

Committee on Environment

Senate Bill 629

Relating to: the sale, disposal, collection, and recycling of mercury-added lamps and making an appropriation.

By Senators Jauch, Lehman, Miller, Taylor, Robson, Risser and Cowles; cosponsored by Representatives Zepnick, Pope-Roberts, Pasch, Berceau, Black, Sinicki, Dexter, Benedict, Roys and Hebl.

March 18, 2010 Referred to Committee on Environment.

March 23, 2010 **PUBLIC HEARING HELD**

Present: (5) Senators Miller, Jauch, Wirch, Kedzie and Olsen.

Absent: (0) None.

Appearances For

- Bob Jauch, Poplar — Senator, 25th Senate District
- Ann Coakley, Madison — DNR
- Lisa Brosseau, Minneapolis — Herself
- Peder Larson, Bloomington — Mercury Waste Solutions
- John Reindl, Madison — Council on Recycling
- Amber Meyer Smith, Madison — Clean Wisconsin

Appearances Against

- Mark Kohorst, Rosslyn — National Electrical Manufacturers Association
- Joseph Howley, Cleveland — GE Lighting
- Scott Thibodeau, Port Washington — Veolia
- Phillip Pitter, Port Washington — Association of Lighting and Mercury Recyclers

Appearances for Information Only

- Lynn Morgan, Milwaukee — Waste Management
- Josh Zepnick, Milwaukee — Representative, 9th Assembly District

Registrations For

- Mickey Beil, Madison — Dane County
- George Meyer, Madison — Wisconsin Wildlife Federation

- Jennifer Giegerich, Madison — Wisconsin League of Conservation Voters

Registrations Against

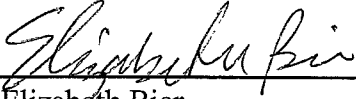
- Scott Tyre, Madison — Capitol Navigators
- Scott Manley, Madison — Wisconsin Manufacturers & Commerce
- Peter Christianson, Madison — Veolia Environmental Services
- Peter Christianson, Madison — General Electric

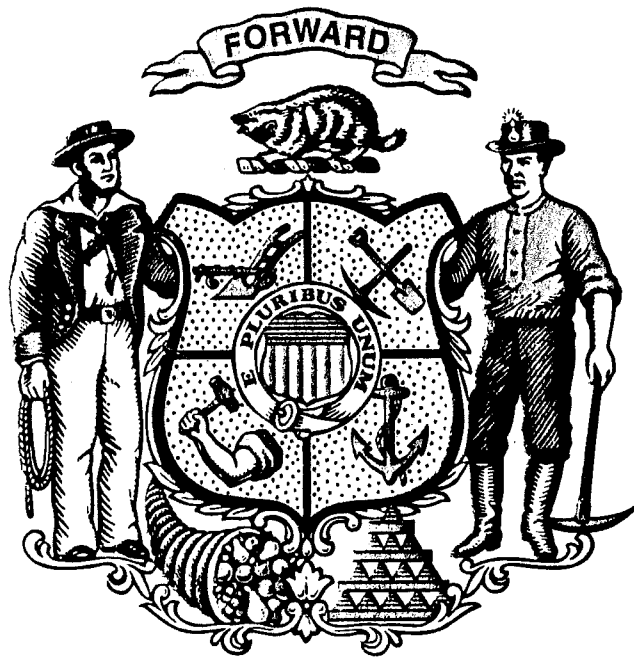
Registrations for Information Only

- None.

April 22, 2010

Failed to pass pursuant to Senate Joint Resolution 1.


Elizabeth Bier
Committee Clerk



**Hearing Notes
March 23, 2010**

Call Public Hearing to Order and ask Clerk to call the roll

- ROLL CALL

SB 364/AB 544, relating prohibiting the installation, sale, and distribution of wheel weights and other wheel balancing products that contain lead

- Sen. Coggs/Rep. Black

SB 632, relating to control of nonpoint source water pollution in certain areas with carbonate and granting rule-making authority

- Sen. Hansen

SB 629, relating to the sale, disposal, collection and recycling of mercury-added lamps and making an appropriation

- Sen. Jauch

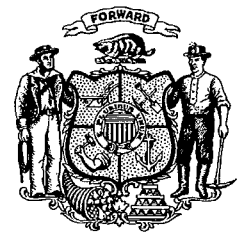
SB 620, relating to groundwater management, water conservation, and granting rule-making authority

- Sen. Miller/Rep. Black

Public Hearing concludes, adjourn meeting



WISCONSIN STATE LEGISLATURE





Association of Lighting and Mercury Recyclers

A non-profit organization representing members of the recycling industry
www.almr.org

March 15, 2010

Office of State Senator Bob Jauch
Room 118 South
State Capitol
P.O. Box 7882
Madison, WI 53707-7882

Via email: Sarah.Barry@legis.wisconsin.gov

RE: 3096/2 Comments of the Association of Lighting and Mercury Recyclers

Senator Jauch,

Thank you for the opportunity to provide comments on the pre-introduction draft of your bill. There are portions of the bill we support and we want to encourage you to proceed, but there are other portions that we cannot support because they will have a negative impact on the lamp recycling industry and could increase costs so much as to become a deterrent to recycling. We know that is not your intention, so we hope you will incorporate our comments as you proceed.

The Association of Lighting and Mercury Recyclers (ALMR) is a national non-profit organization representing members of the mercury recycling industry. ALMR represents the majority of the mercury lighting recycling firms in Wisconsin and throughout the U.S., operating from 58 locations in 25 states, serving the entire United States. These companies process and treat mercury containing wastes specifically to remove the mercury and prevent it from entering the environment or impacting human health. The ALMR serves as an educational and informational resource to government, business and the public regarding proper mercury reclamation and disposal. An important part of our mission is to promote programs, policies, and practices that divert mercury-bearing wastes from the solid waste stream and the environment. Thus, we have always been a supporter of any policies that promote and encourage recycling.

First, we support Section 4 of your bill. This is long overdue and will close several exemptions in the federal policy that allow people to break mercury lamps in the garbage. When more states adopt the level of stringency that you are proposing we will see less confusion and more compliance, both of which are needed to see recycling rates increase.

Our concerns about the bill have to do with onerous requirements placed solely on manufacturers, and not on others, that places them squarely into the commerce of lamp recycling and interfering with this ongoing commerce. Lamp recycling is a hazardous waste activity and manufacturers cannot bear the total financial responsibility and liability or take the risks for compliance under the regulations without interfering with RCRA responsibility, CERCLA liability or contract law.

To elaborate, the ALMR supports producer responsibility, but not when financial controls forced on producers have the potential to undermine the commerce of lamp recycling. States should avoid any policies that could have the effect of removing free market forces or imposing requirements on manufacturers that would result in manufacturer "control" of an already competitive and highly regulated industry. Additionally, producers do not have the leverage to force a collection system over retailers or local government agencies.

The terms producer responsibility, manufacturer responsibility, and product stewardship are sometimes used interchangeably. We do not think this responsibility should be forced only on the manufacturer and we agree with the USEPA when it comes to sharing this responsibility. (See <http://yosemite.epa.gov/R10/owcm.nsf/1e9059fc4619cec588256500005b5e90/8f48c35059713a1988256848007594c7!OpenDocument>). According to EPA:

"Product Stewardship (otherwise known as Extended Product Responsibility or EPR) is a principle that directs all actors in the life cycle of a product to minimize the impacts of that product on the environment. Product stewardship means that all parties who have a role in designing, producing, selling or using a product assume responsibility for the environmental impacts of that product throughout its life. What is unique about product stewardship is its emphasis on the entire product system in achieving sustainable development.

"Product Stewardship extends manufacturers' responsibility for products to the disposal and recycling stages. This shift in responsibility provides an incentive for manufacturers to think differently about resources and materials so that toxicity reduction, reuse and recycling are considered at the product design stage.

"Under product stewardship, all participants in the product life cycle -- designers, suppliers, manufacturers, distributors, retailers, users, recyclers and disposers -- share responsibility for the environmental effects of the products. Product Stewardship is an umbrella under which familiar environmental strategies exist: Design for the Environment, greening the supply chain, Pollution Prevention, resource conservation, take-back, product to service transition. These are but a few of the strategies that embody the principle of product stewardship."

Section 5 of the draft bill contains a new requirement: that containers used for shipping lamps be approved by the Department. We oppose any state-specific requirements for containers, packaging or shipping lamps that are different than the federal regulations. Our industry has been collecting and transporting used lamps for over 20 years. There are existing packaging and shipping requirements in the federal codes, both from the EPA¹ and the Department of Transportation². Wisconsin also has adopted the EPA requirements in the Universal Waste Rule³. Fed Ex, UPS and the US Postal Service also have specific packaging requirements for lamps that apply throughout the nation. Since packaging for a product or a waste is an integral part of the interstate commerce it is not appropriate for any state to develop unique standards. Disparity among states will interfere with commerce and likely add costs. Generators could ship out of state for disposal and avoid packaging and out-of-state generators could not be forced to use WI-specific packaging. Since there is the potential for creating anti-trust and interstate commerce issues, combined with the absence of any criteria in the state for the department to use to approve or deny packaging, we suggest you delete Section 5. (3) 5. from the bill, or revise it to establish a procedure for the delivery of mercury-added lamps derived from households in containers and ensure that

¹ See 40 CFR 273.13 and 273.33 sub para (d) *Lamps*. A small quantity handler of universal waste must manage lamps in a way that prevents releases of any universal waste or component of a universal waste to the environment, as follows:

(1) A small quantity handler of universal waste must contain any lamp in containers or packages that are structurally sound, adequate to prevent breakage, and compatible with the contents of the lamps. Such containers and packages must remain closed and must lack evidence of leakage, spillage or damage that could cause leakage under reasonably foreseeable conditions.

(2) A small quantity handler of universal waste must immediately clean up and place in a container any lamp that is broken and must place in a container any lamp that shows evidence of breakage, leakage, or damage that could cause the release of mercury or other hazardous constituents to the environment. Containers must be closed, structurally sound, compatible with the contents of the lamps and must lack evidence of leakage, spillage or damage that could cause leakage or releases of mercury or other hazardous constituents to the environment under reasonably foreseeable conditions.

² See 49 CFR 173.164 (c) (3) (3) Electron tubes, mercury vapor tubes and similar tubes must be packaged as follows: (i) Tubes which are packed in strong outer packagings with all seams and joints sealed with self-adhesive, pressure-sensitive tape which will prevent the escape of mercury from the package, are authorized up to a total net quantity of 450 g (15.9 ounces) of mercury per package; (ii) Tubes with more than 450 g (15.9 ounces) of mercury are authorized only when packed in strong outer packagings, having sealed inner liners or bags of strong leakproof and puncture-resistant material impervious to mercury which will prevent escape of mercury from the package irrespective of its position; (iii) Tubes which do not contain more than 5 g (0.2 ounce) of mercury each and which are packed in the manufacturer's original packagings, are authorized up to a total net quantity of 30 g (1.1 ounces) of mercury per package; (iv) Tubes which are completely jacketed in sealed leakproof metal cases are authorized in the manufacturer's original packagings. (4) A person offering for transportation electron tubes, mercury vapor tubes, and similar tubes shall indicate the quantity of mercury therein on the shipping paper.

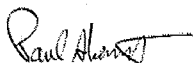
³ See the requirements of NR 673.13(4), Wis Adm. Code or NR673.33(4) Wis. Adm. Code.

collectors comply from collection locations to a recycler within the framework of existing federal and state codes referenced here. This also eliminates the need for rulemaking by the agency.

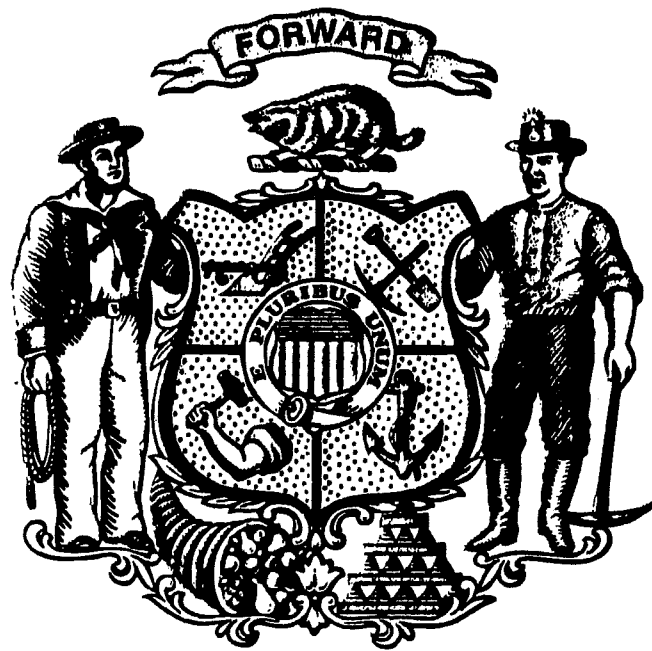
We agree that to get consumers (households) to participate, convenient take-back programs are needed, but producers cannot force retailers or others to participate. There are already a large number of drop-off locations in Wisconsin that more people should be encouraged to use. See <http://www.epa.gov/wastes/hazard/wastetypes/universal/lamps/where/region5.htm>

The ALMR and its members remain committed to promoting policies that promote lamp recycling, and we are available to work with you at any time to develop a measure that accomplishes that objective and does not adversely impact our industry.

Sincerely,



Paul Abernathy
Executive Director





Matthew Williams
Government Relations Leader
Americas

GE Healthcare

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GE Lighting

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March 22, 2010

Wisconsin Bill LRB – 3096/2

GE POSITION - OPPOSE

1. FAILS TO INCLUDE ALL STAKEHOLDERS

A successful Compact Fluorescent Lamp (or CFL)-recycling program needs to include all stakeholders in the state to achieve a high recycling rate. However, this bill appears to place almost all of the responsibility on manufacturers, who are least positioned to collect and recycle lamps. Such stakeholders include household hazardous waste collection facilities, retailers, recyclers, efficiency programs, local governments, and the State DNR. Individual manufacturers have very few physical locations in the state to collect lamps, and manufacturers do not own or manage lamp-recycling operations.

2. BILL IS TECHNICALLY DIFFICULT

The bill requires calculation on a recycling rate based on the total weight of products available for recycling in a specific year. Most lamps available for recycling today were sold from 5 to 15 years ago. These products were sold by dozens of manufacturers, some US-based like GE, and many foreign based. Some are no longer in business and some may have only sold products for one or two years. None of these companies tracks, or has ever tracked, lamp weight. Lamp weight information for the products available for recycling is unknown and unknowable. This serious technical flaw makes it impossible for DNR to calculate a recycling rate as proposed.

3. PUTS UNSUSTAINABLE REQUIREMENTS ON MANUFACTURERS

The bill requires manufacturers to:

- a) establish hundreds of recycling locations for free CFL recycling even though manufacturers currently own and operate very few locations in the state;
- b) ensure that collectors comply with all environmental codes even though this is typically the function of the DNR;
- c) develop public education campaign without any assistance or support from others especially efficiency programs which heavily promote these products;
- d) establish a procedure to deliver recovered products to recyclers even though recyclers have already developed such systems currently operating at retailers or Household Hazardous waste collection centers; and
- e) annually report unknown or unknowable information, such as the weight of mercury-added lamps derived from households.

It is important to note that the bill does not ensure that consumers will recycle their mercury-containing lamps at a rate that is higher than the current independent lamp recycling systems being operated in the state at many stores or community collection centers.

4. FAILS TO PROVIDE A SUSTAINABLE FUNDING MECHANISM

As proposed, manufacturers are acquiring substantially more requirements and costs to sell a very competitive, low-cost, low-margin product, while there is no visible or sustainable funding mechanism contemplated by the bill structure. We are concerned that the impact of complying with a multitude of new difficult regulations would be much higher prices for energy-efficient lamps, which will reduce energy conservation in homes producing increasing consumer electricity use and costs.

5. SETS UNREALISTICALLY HIGH RECYCLING RATE of 70%

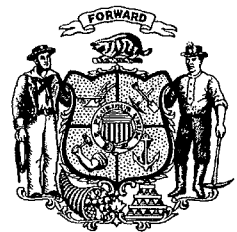
Typical recycling rates for common recyclables, that are just as easy to “throw-away,” usually range from 20 to 40%, and almost always less than 50%. Past experience suggests that a 70% recycling rate for this type of product, while laudable, is unlikely to ever be achieved.

Summary

GE supports CFL recycling, but we believe this bill would benefit from stakeholder discussions that would help get the state closer to meeting the goals of the legislation. We oppose the bill in its current form because it will dramatically increase consumer and producer costs without creating the appropriate conditions for sustained, increased lamp recycling.



WISCONSIN STATE LEGISLATURE





Mercury Policy Project

1420 North St., Montpelier, VT 05602 ~ www.mercurypolicy.org ~ 802.223.9000

MEMORANDUM

To: Wisconsin State Legislators
From: Michael Bender, Director, Mercury Policy Project
Subject: 2010 Senate Bill 629
Date: March 23, 2010

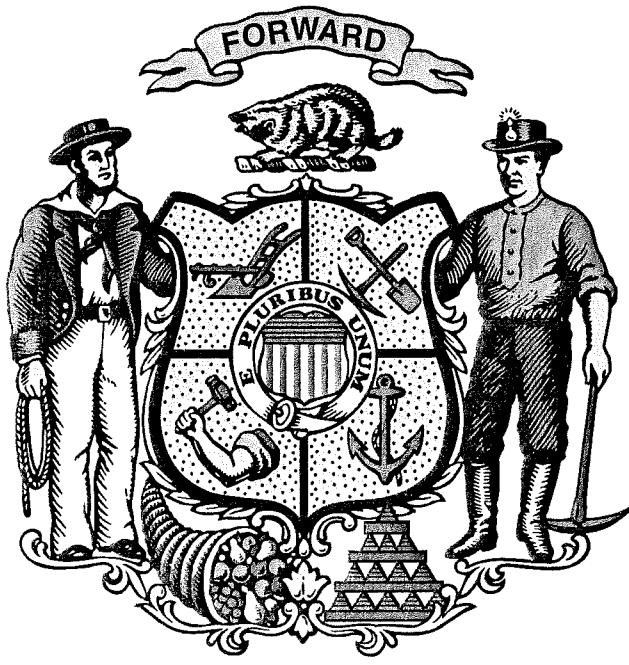
For over the past decade, the Mercury Policy Project has worked to promote policies to eliminate mercury uses, reduce mercury exposure and promote collection of mercury product discards. Today, we are writing in support of Senate Bill 629. This legislation is an important step forward to promote a more comprehensive broad based recycling infrastructure for light bulbs.

Upon enactment, Senate Bill 629 will establish a manufacturer-financed program for collecting and recycling mercury-containing lamps. There are several advantages for Wisconsin to expand their product stewardship approach to mercury-containing light bulb, which include:

- **Dedicated and sustainable funding.** Producers who profit from selling lighting products that contain mercury are responsible for funding the recycling program, and can internalize that cost in the product price. So consumers essentially purchase the recycling service when they purchase the product. The cost of the recycling would be spread over all mercury-containing lighting sold in the state, and inexpensive incandescent lights will be phased out, so prices of fluorescent lighting will be competitive.
- **Provides financing that could fund any and all collection methods.** A variety of different existing and new collection methods could be used including existing retailer take-back and recycling depots programs, or other appropriate methods. Collectors can choose to participate and must be fairly compensated for their services by lighting producers.
- **A private sector recycling program promotes cost effectiveness, reducing costs to residents and local governments.** Manufacturers have an incentive to keep costs low and operate the program efficiently within the performance and convenience requirements of the law. A statewide program would have economies of scale. Creation of many new government-run programs is avoided; costs to local governments and ratepayers are reduced.

In addition, there is increasing precedence for producer-provided recycling of mercury-containing lights:

- Producer-provided recycling of fluorescent lights is required throughout the European Union, with programs already implemented in many countries.
- In British Columbia, producers are scheduled to implement their program next year.
- Last year, the state of Maine has enacted a law requiring a producer-provided recycling program which will start in January 2011.
- Most recently, Washington State just enacted a law creating a producer-financing recycling program to start in January 2013.



March 23, 2010

Testimony from Lisa M. Brosseau, ScD, CIH, Associate Professor, University of Minnesota, School of Public Health, Division of Environmental Health Sciences

Public Hearing, Committee on Environment, Senate Bill 629 Relating to: the sale, disposal, collection, and recycling of mercury-added lamps and making an appropriation.

While it is important to ensure that mercury-added lamps do not end up in landfills and are recycled in a manner that prevents mercury release into the environment, it is also important to keep in mind that once a lamp is broken, much of the mercury will be released as vapor into the air. A bill that addresses the proper management of mercury-added lamps should include a requirement for the use of vapor-tight packaging that does not allow release of mercury into the environment.

Many different people could be directly exposed to airborne mercury vapor from broken lamps (used or new) – employees of shippers to retail facilities, retail employees and customers, employees of shippers to recycling facilities, customers of recycling shippers. The general public may be at risk of exposure, as well, if they are near broken lamps in any of these situations.

It only takes 5 broken 4-ft low-mercury lamps to exceed the California OSHA exposure limit, 10 lamps to exceed the limit set by Minnesota OSHA and other states¹ and 18 lamps to exceed the Federal OSHA limit. A single lamp can release mercury vapor over a period of weeks.² Inhaled mercury can lead to neurologic damage in adults, children and fetuses.

Better packaging standards are needed for mercury-containing lamps. The 2005 additions to the universal waste packaging standards required packages that prevent the escape of mercury into the environment by volatilization – **but mercury-containing lamps were excluded**. The recycling of mercury-containing lamps is governed by the 1999 version of the universal waste packaging standard, which does not address the release of vapor.

Research in my laboratory has demonstrated that most commercially-available packages used to transport used lamps to recycling facilities do not adequately prevent the release of mercury vapor from broken lamps. Since it is impossible to prevent lamp breakage during shipping, it should be assumed that every lamp in a package will break. Retailers involved in re-lamping programs may use boxes that contain more than 100 bulbs – and multiple boxes are often combined on pallets for shipping. For a typical commercial shipping vehicle holding approximately 30,000 lamps, we estimate airborne concentrations would exceed 40 times the

¹ Alaska, Hawaii, Michigan, New York, North Carolina, Oregon, Vermont and Washington

² Aucott et al. Release of Mercury from Broken Fluorescent Bulbs. JAWMA 53:143-151 (2003).

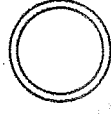
OSHA exposure limit and 160 times the California OSHA exposure limit and ACGIH recommended guideline, if only 5% of these lamps were to break.³

We found that there are several important aspects to packaging designs that prevent release of mercury vapor into the environment. First – the lamps must be contained within a well-sealed vapor-resistant bag. Second, damage to the bag must be prevented – the best design involved two cardboard boxes – one internal and one external to the vapor-resistant bag. The internal box protects the bag from abrasions or cuts from broken glass. The external box provides integrity to the overall package.

In summary, I strongly recommend the addition of language to this bill that will ensure that packaging is used that prevents the release of mercury vapor to the environment both to prevent its transport into water and the food chain and to protect anyone in the immediate vicinity from airborne exposure.

³ T.T. Glenz, L.M. Brosseau, R.W. Hoffbeck: Preventing Mercury Vapor Release from Broken Fluorescent Lamps During Shipping. J. Air & Waste Manage. Assoc. 59:266-272 (2009).

Preventing Mercury Vapor Release from Broken Fluorescent Lamps During Shipping

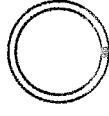


LISA M BROSSAU, SCD, CIH
SCHOOL OF PUBLIC HEALTH
UNIVERSITY OF MINNESOTA

Who Might be Exposed to Mercury Vapor from Broken Bulbs?

- **Many different groups may be exposed to potentially high levels of mercury vapor from broken used and new mercury-containing fluorescent lamps:**
 - Employees of shippers to retail facilities
 - Retail employees
 - Retail customers
 - Employees of shippers to recycling facilities
 - Customers of recycling shippers
 - General public

Mercury Vapor Release from Broken Bulbs



- Airborne mercury vapor concentrations from single broken 4-ft fluorescent bulbs:
 - 0.0029 – 0.016 mg/m³ for new low-mercury lamps
 - 0.013 – 0.052 mg/m³ for used high-mercury lamps
 - 0.0087 – 0.024 mg/m³ for used low-mercury lamps
- **No difference in mercury vapor concentrations from new and used low-mercury lamps**

Number of Broken Used 4-ft Low-Mercury Lamps Needed to Exceed Workplace Limits?

- **18 broken lamps > Federal OSHA Permissible Exposure Limit (PEL) of 0.1 mg/m³**
- **10 broken lamps > Minnesota OSHA PEL of 0.05 mg/m³***
- **4.5 broken lamps > California OSHA PEL of 0.025 mg/m³**

*Other states with this level include Alaska, Hawaii, Michigan, New York, North Carolina, Oregon, Vermont and Washington.

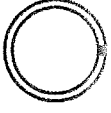
Environmental Fate of Airborne Mercury



- Mercury can be released from broken lamps for weeks when lamps break during handling, storage and disposal*
- Mercury can be inhaled or absorbed through the skin, leading to neurologic damage in adults, children and fetuses
- Mercury does not degrade in the environment
- Airborne mercury finds its way into water, where biological processes convert it to methyl mercury, which can enter the food chain through fish.
- Methyl mercury causes central nervous system damage and is a possible human carcinogen.

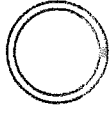
* Aucott et al. Release of Mercury from Broken Fluorescent Bulbs. JAWMA 53:143-151 (2003).

Sources of Mercury in the Environment



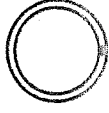
- Human activity causes 2/3rds of mercury in global atmosphere.
- In the U.S., anthropogenic sources release 100 tons of mercury each year.
- Mercury-containing products account for approximately 35 tons of mercury released into the environment each year.

Sources of Environmental Mercury



- Models suggest that mercury-containing lamps are responsible for 1 ton of air emissions from products
- Higher releases occur during waste lamp transport than in disposal processes
 - Measurements of mercury emissions from dumpsters and during transfer station activities corroborate that transport is a significant source of airborne mercury during landfill disposal.
- Air release of mercury vapor could be lowered by 30% if recycling were increased to 50% AND if improvements in handling were made to lower losses from breakage.

Universal Waste Packaging



- 1999 - Lamp packaging rules do not specifically address mercury vapor
 - Structurally sound
 - Adequate to prevent breakage
 - Compatible with contents of the lamps
 - No leakage, spillage or damage that could cause leakage of mercury
- 2005 – new requirement for mercury-containing devices (**lamps are excluded**)
 - Must be reasonably designed to prevent the escape of mercury into the environment by **volatilization** or any other means

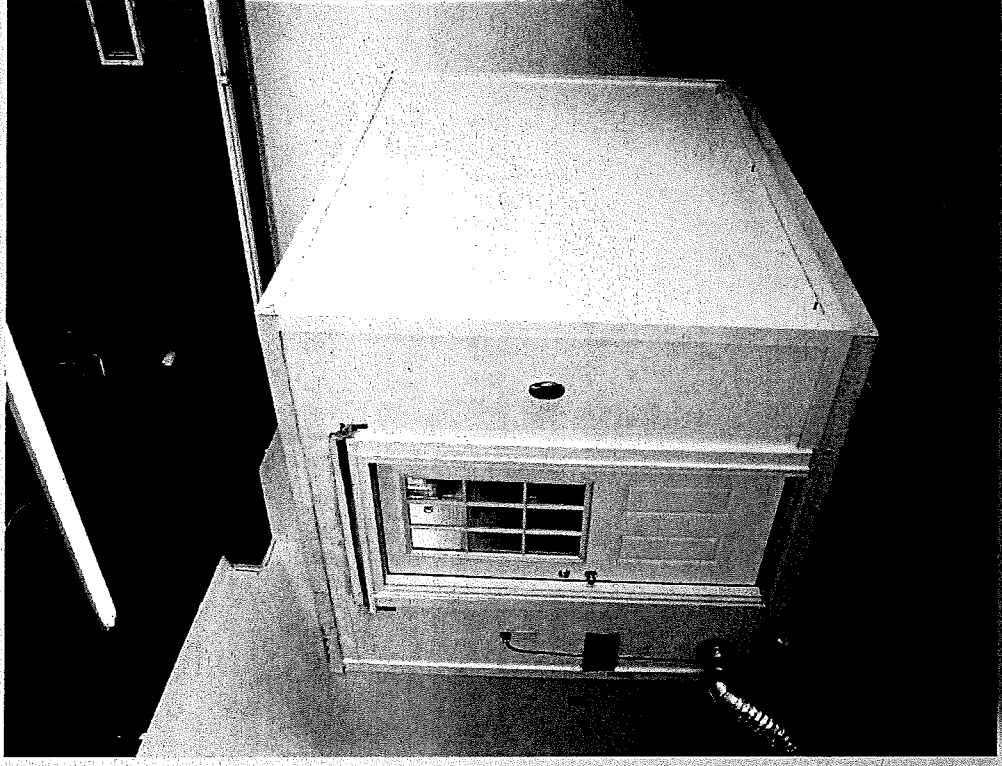


How well do boxes prevent the release of mercury vapor from broken fluorescent light bulbs during shipment to recycling facilities?

Test Chamber

640 ft³ chamber

- 10 ft x 8 ft x 8 ft
- Lined with foil-faced foam board/foil tape
- Ceiling fan for mixing
- Supply and exhaust ventilation
- Two programmable heaters
- Internal/external thermometer (83 +/- 2 F)
- Six external sampling ports

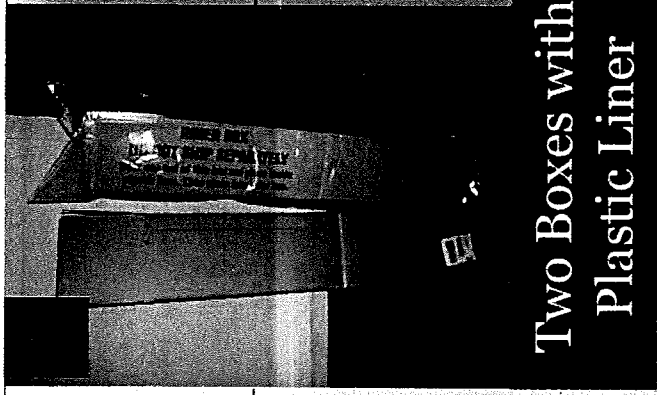


Test Boxes

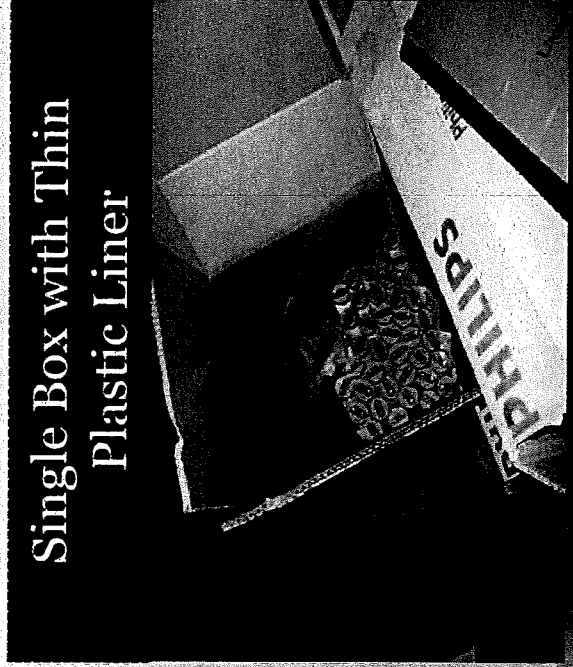
- Designed for 4-ft linear lamps
- Representative of boxes used to ship used lamps to recyclers
- Approximately same capacity



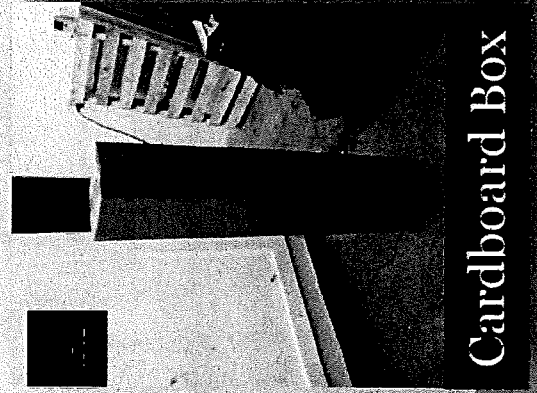
Single Box with Heavier Plastic Liner



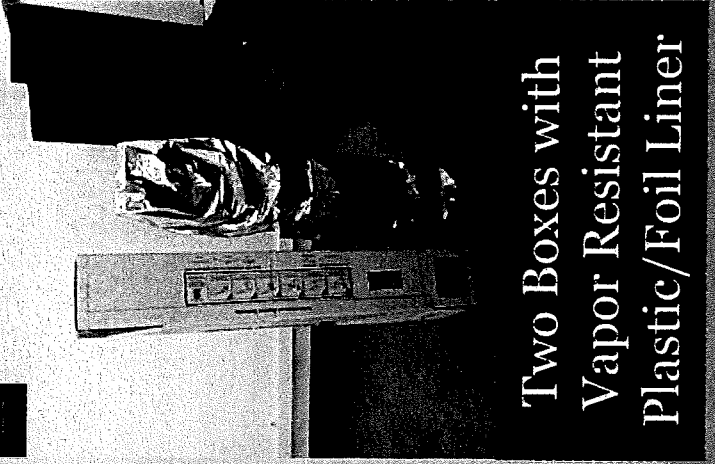
Two Boxes with Plastic Liner



Single Box with Thin Plastic Liner



Cardboard Box



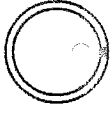
Two Boxes with Vapor Resistant Plastic/Foil Liner

Lamp Selection

- Low mercury Phillips
ALTO Energy
Advantage lamps
- Single retail
department store
company
- 21,235 hours average
burn time
- Separated into 80
boxes of 30 lamps
each



Test Procedure



- 40 randomly-selected lamps in box
- Boxes loaded and sealed following recycler's instructions
- 10 replications of 5 recyclers' boxes

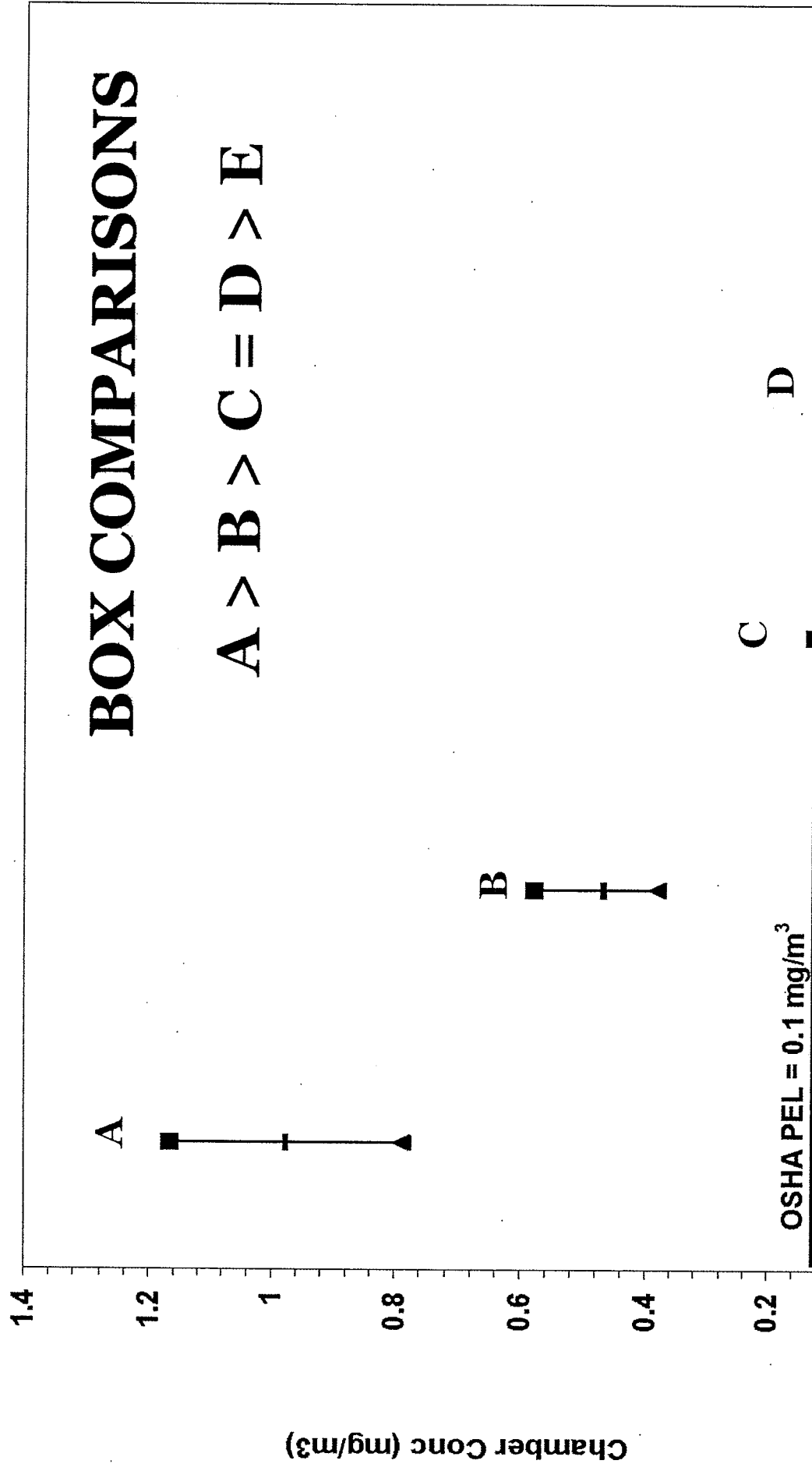
Test Procedure



- Start overhead mixing fan & two heaters
- Purge chamber until zero reading on direct-reading instrument
- Close inlet and exhaust and allow chamber to heat to 83 ± 2 F
- Start sampling pumps
- Drop and shake test box to break all lamps
- Close chamber and run test for 6 hr
- Note condition of box and lamps

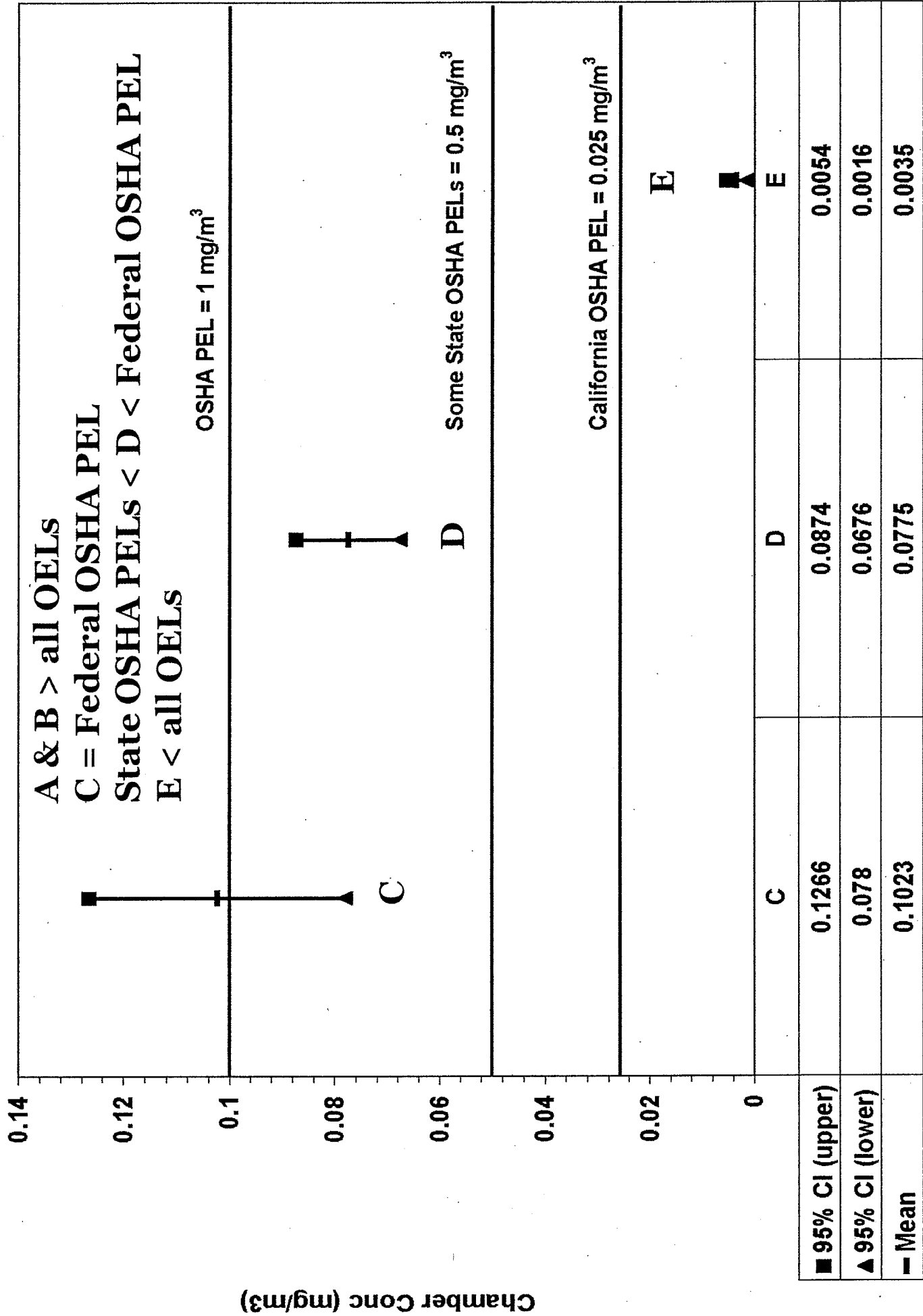
BOX COMPARISONS

$A > B > C = D > E$



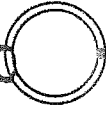
	A	B	C	D	E
■ 95% CI (upper)	1.166	0.5795	0.1266	0.0874	0.0054
▲ 95% CI (lower)	0.788	0.3815	0.078	0.0676	0.0016
— Mean	0.977	0.4688	0.1023	0.0775	0.0035

Box



Box

Mercury Vapor Containment Compared to Single Cardboard Box



Type of Box	Efficiency
Single Box with Thin Plastic Liner (not sealed)	50%
Single Box with Heavier Plastic Liner (sealed with tape)	90%
Two Boxes with Inner Plastic Liner (sealed with tape)	92%
Two Boxes with Vapor Resistant Plastic/Foil Liner (sealed with zipper lock)	99.7%

Research Conclusions



- **Quality of box and liner plays important role in containment of vapors**
 - Dents in boxes were common
 - Liners in boxes D and E intact after each test, but liners in boxes B and C were frequently cut and torn
- **Method of sealing box may also be significant**
 - Unsealed liner in box B slipped down
 - Liner in box E worked even when not fully sealed

Policy Implications



- Standards should include requirement for demonstrating that packaging prevents mercury vapor release.
- Our results suggest that an effective packaging design should include:
 - Well-sealed vapor resistant liner bag
 - Inner box to limit damage to liner
 - Outer box for support