Land & Water Resources Council

Labeling and Collection of Mercury-Added Products

Report to the Joint Standing Committee on Natural Resources, 119th Maine Legislature
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A report to the Maine Legislature by the Land & Water Resources Council

I. Introduction

This report is required under section 5 of *An Act to Reduce Mercury Use and Emissions*[1] (the mercury bill) passed by the Maine Legislature last April. Section 5 requires the Land and Water Resources Council to submit a report, together with implementing legislation, on the following:

- Establishment of a collection system through which mercury-added products offered for sale in the State can be returned for recycling to the manufacturer;

- Labeling of mercury-added products sold at retail, including thermostats, thermometers, electrical switches or other electrical devices, lighting devices, batteries and medical or scientific instruments, to inform the user that the product contains mercury and that the manufacturer is required to recycle the product; and

- Imposition of a fee on the sale of mercury-added products in the State, with an evaluation of options for the use of revenues from the fee, including: reimbursing resource recovery facilities for the expense incurred to meet mercury emissions limits; research and public education on reducing the sale of mercury-added products in the State; and research on the release of mercury as a result of the combustion of wood or wood chips.

The mercury bill was enacted in response to legislative consideration of a report titled *Mercury in Maine* that was submitted by the Council in January 1998. The latter report, among other things, documents unhealthy concentrations of mercury in the Maine environment, identifies disposal of mercury-added products as a source of mercury emissions, and recommends action to reduce the use of mercury in products and to divert mercury-added products from the solid waste stream.

The requirement for a report on mercury-added products was included in the mercury bill at the request of the Mid-Maine Waste Action Corporation (MWAC),

[1] Public Laws 1997, chapter 722, effective July 9, 1998.

operator of a solid waste incinerator in the City of Auburn. Auburn Mayor Lee Young, testifying before the Legislature's Natural Resources Committee, supported the goal of reducing mercury emissions from waste incineration, but urged the Committee not to rely on incinerator stack controls as the solution. The solution, Mayor Young said, "is found on the first rung of the State's hierarchy of waste management tools."[2]

The State solid waste management hierarchy is a legislatively-adopted statement of policy that gives preference to waste reduction, reuse and recycling over incineration and landfilling.[3] The Legislature acted in accordance with this policy when it adopted the MWAC-sponsored report requirement and asked the Council to report on manufacturer collection as a strategy to avoid disposal of mercury-added products.

In asking the Council to look specifically at collection by manufacturers, the Legislature raised the issue of who should bear primary responsibility for diverting mercury-added products from the solid waste stream. Manufacturers know their product best. They know how to deliver the product to consumers. For these reasons, they presumably are in a better position than consumers and municipalities to address the logistical and technological challenge of collecting mercury-added products. Sections II and III of this report examine the case for manufacturer take-back.[4]

II. Mercury-Added Products in Maine Solid Waste

Mercury is used in many products for many different reasons. A study conducted by the State of Minnesota identified at least 140 mercury-added products, from ice fishing tip-up lights to eye liner.[5] Many of these products, such as cosmetics in which the mercury serves as a fungicide, contain very small amounts of mercury. Others such as flow meters at water treatment plants and dairy barn manometers for measuring vacuum in milking machines can contain up to a pound or more of mercury per device. Some products are widely used; others have specialized and limited application.

Mercury-added products in use in Maine are estimated to contain between 14 and 23 tons of mercury.[6] The useful life of such products varies widely, from button cell batteries that last only a few weeks to fluorescent lamps that last 5 years on average to thermostats that can remain in use for 30 years or more. Assuming an average product life span of 20 years and no recycling, 1,400 to 2,300 pounds of mercury are discarded each year.

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[2] Young, Lee, in testimony on LD 2269 (118th Legislature 1998) before the Joint Standing Committee on Natural Resources, March 18, 1998.

[3] Title 38, Maine Revised Statutes Annotated, section 2101.

[4] This report does not explore the need for collection of mercury-added products. The need for action is documented in the Council's 1998 report *Mercury in Maine*.

[5] Gilkeson, John, *Mercury Products Study*, Minnesota Pollution Control Agency, April 1996 (revised August 1998).

[6] Bastey, *Mercury-Added Products in Maine's Solid Waste*, December 1998, p. 5. See Appendix 2 of this report.

The products that appear to account for the highest percentages of mercury in Maine solid waste are thermostats, thermometers, fluorescent lamps, tilt switches and batteries.[7] Manufacturer take-back for these products is examined below.

A. Thermostats

The mercury in thermostats serves to connect two electrodes, thereby completing an electrical circuit that triggers heating and air-conditioning units to turn on. Non-mercury thermostats are available, but the U.S. Environmental Protection Agency estimates 83% of all thermostats contain mercury. Each thermostat contains two to three grams of mercury in a glass ampoule, with some thermostats having more than one ampoule. Each year, an estimated 123 pounds of mercury ends up in Maine's solid waste stream from disposal of mercury-switch thermostats.[8]

In 1996, following passage of a law by the State of Minnesota requiring manufacturers to provide incentives to ensure that mercury in thermostats is reused or recycled when removed from service,[9] the Thermostat Recycling Corporation (TRC) was formed by manufacturers Honeywell, General Electric and White Rodgers as a private corporation to recycle thermostats. The thermostat industry decided to establish TRC rather than switch to non-mercury thermostats because non-mercury thermostats have disadvantages compared to mercury switch thermostats, and because the characteristics of the product make it amenable to recycling. The glass ampoule containing the mercury is small, removable and protected by a sturdy metal casing that minimizes breakage. TRC enjoys the economy of being able to pack and ship 100 ampoules in a single collection box.

TRC uses the existing product distribution infrastructure (manufacturer to wholesaler to contractor) to recover the ampoules. Specially designed collection boxes are provided to wholesalers for a $15 deposit. When the collection boxes are full, they are shipped to a processing facility and an empty container is shipped to the wholesaler. According to TRC executive director Ric Erdheim:

> "The program requires virtually no effort or cost to contractors or wholesalers. Contractors only need to bring old thermostats to participating wholesalers. Wholesalers only pay a $15/container fee and maintain a relatively unobtrusive container in their stores. TRC pays shipping costs from

[7] Ibid.
[8] Bastey, p. 15.
[9] Minnesota Statutes, chapter 116, subdivision 5.

> the wholesaler to the TRC mercury ampoule clipping facilities . . . . Wholesalers use the program as a marketing tool to bring contractors into their stores."[10]

TRC will accept any brand mercury-switch thermostat, but operates only through wholesalers on the premise that most thermostats are installed by heating and air conditioning contractors. This use of an existing and relatively cooperative infrastructure limits the number of people with whom TRC interacts and keeps administrative costs relatively low. TRC estimates the cost of capturing a pound of mercury through its program is roughly $50 to $75.[11]

TRC has established collection programs in 9 states: Florida, Illinois, Indiana, Iowa, Michigan, Minnesota, North Dakota, Ohio and Wisconsin. It has offered to extend its program to Maine and other northeastern states provided the states allow TRC to follow the federal Universal Waste Rule.[12] The Universal Waste Rule was promulgated in 1995 to encourage reclamation and recycling of three "universal" hazardous wastes—batteries, thermostats and pesticides—by setting storage and transportation requirements specifically tailored to management of those wastes.

The Maine Department of Environmental Protection (DEP) has begun proceedings to incorporate the universal waste concept into the state Hazardous Waste Management Rules. Pending adoption of a final rule, the DEP has authorized TRC by letter to operate its program consistent with universal waste requirements.

Observations and conclusions: Manufacturer take-back has worked for thermostats. It was a simple matter of making the product distribution system work in reverse. State legislation in Minnesota appeared to provide the impetus. The thermostat industry formed a third party corporation to fulfill the take-back responsibility of all manufacturers collectively.

B. Thermometers

The mercury in thermometers is in a glass tube calibrated to give a precise measurement of temperature. Mercury is used because a slight change in temperature causes it to increase or decrease in volume. A fever thermometer contains about one half gram of mercury. Laboratory thermometers contain about 3 grams of mercury on average. The mercury-containing glass tube is fragile and susceptible to breakage. Thermometer breakage and disposal is estimated to contribute 155 pounds of mercury to Maine's solid waste stream

[10] Erdheim, Ric, National Manufacturers Association, in memorandum to John James, Maine Department of Environmental Protection, October 23, 1998.
[11] Ibid.
[12] Federal Code of Regulations, Title 40, Part 273.

each year.[13]

There are numerous alternatives to mercury thermometers including digital and alcohol or "red bulb" thermometers, although these alternatives are higher priced. At least two thermometer vendors of laboratory and commercial thermometers—A & M Thermometers Corporation and H-B Instrument Company—will accept intact mercury thermometers via mail from customers purchasing a mercury free thermometer.

Not much attention has been focused on diversion of mercury thermometers from the solid waste stream.[14] Minnesota and Vermont prohibit disposal of mercury thermometers in solid waste, and Minnesota also prohibits medical facilities from routinely distributing mercury-containing thermometers[15] However, no state requires manufacturer take-back.

Observations and conclusions: The relatively small size of thermometers makes them amenable to collection and diversion from the solid waste stream. The primary issue is breakage. Manufacturers are perhaps in the best position to design a collection system that minimizes breakage as they already must deal with this issue in marketing the product.

A prohibition on retail sale of mercury thermometers could be considered in conjunction with mandatory take-back. Such a prohibition would increase use of alternative non-mercury thermometers and enable manufacturers to focus take-back efforts on wholesalers and institutions.

C. Fluorescent lamps

Mercury is an essential component in fluorescent lamps and high intensity discharge (HID) lamps used in streetlights and floodlights. Fluorescent lamps contain mercury in vapor form and in the phosphor coating on the lamp tube. The mercury vapor is energized to emit ultraviolet light.

Lamp manufacturers are working to reduce the mercury content of fluorescent lamps to the minimum amount technically feasible without reducing lamp life. The average four foot fluorescent lamp made today contains less than 23 milligrams of mercury, down 50 percent from levels in lamps manufactured in 1985.[16] Although elimination of mercury altogether is not feasible, at least two manufacturers—General Electric and Philips—make a line of lamps in which mercury levels are reduced to the point that the lamps do not qualify as

[13] Bastey, p. 16, 22.

[14] NESCAUM, Northeast States and Eastern Canadian Provinces Mercury Study, prepared by the Northeast States for Coordinated Air Use Management, Northeast Waste Management Officials Association, New England Interstate Water Pollution Control Commission and the Canadian Ecological Monitoring and Assessment Network, February 1998, p. VII-7.

[15] Minnesota Statutes, chapter 116.92, subdivision 6.

[16] National Electrical Manufacturers Association, "Fluorescent Lamps and the Environment," November 1996.

hazardous waste.

Despite these steady reductions in mercury content, disposal of fluorescent lamps continues to be a source of mercury emissions during waste handling and disposal. Disposal of fluorescent lamps is estimated to contribute about 126 pounds of mercury to the Maine solid waste stream.[17]

No state requires manufacturer take-back of lamps, although Vermont requires manufacturer labeling to inform users that the lamp contains mercury and may not be placed in solid waste. The responsibility for collection of waste lamps falls primarily on the product user under state and federal hazardous waste law. Most fluorescent lamps qualify as hazardous waste when removed from service and, as such, are prohibited from disposal in the solid waste stream. The exceptions are waste lamps generated by households, which are exempt from hazardous waste requirements, and the low-mercury lamps that do not meet the definition of hazardous waste.

A recycling infrastructure involving lighting contractors, recycling companies and hazardous waste transporters has developed to collect lamps from users and enable them to comply with hazardous waste management requirements. An estimated 10 percent of the fluorescent lamps used by businesses and institutions are diverted from the solid waste stream through this recycling infrastructure.[18] The Maine DEP adopted a Mercury-Containing Lamp Policy in 1996 to increase participation. Much like the Universal Waste Rule, the policy seeks to promote a higher rate of recycling by tailoring waste management requirements specifically to storage and transport of waste lamps.

Two states—Minnesota and Vermont—have banned disposal of all fluorescent lamps in solid waste, including lamps that do not meet the definition of hazardous waste.[19] In these states, responsibility for collection of the lamps from households and small businesses rests with local government and, in Minnesota, with Northern States Power, the state's largest electric utility.

Minnesota requires Northern States Power to both encourage use of fluorescent and HID lamps and to establish reasonably convenient locations for collecting spent lamps. This was done because fluorescent and HID lamps, even though they contain mercury, remain a good choice from the standpoint of mercury emissions reduction. They use significantly less energy than incandescent bulbs. The use of fluorescent lamps, especially in large commercial, industrial and institutional settings, reduces the demand for electricity from fossil fuel burning power plants, which are themselves a significant source of mercury emissions.

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[17] Bastey, p. 13.
[18] Ibid.
[19] Minnesota Statutes, chapter 115A.932, subdivision 1; Vermont Statutes Annotated, title 10, section 6621d.

Minnesota law also requires vendors who sell mercury-added lamps for use in industrial, commercial, office or multi-unit residential buildings to clearly inform the purchaser in writing that the lamps contain mercury, a hazardous substance regulated by state and federal law, and that they may not be placed in solid waste. In addition, contractors who remove mercury-added lamps from such buildings must disclose, in writing, the arrangements made for management of the mercury in the removed lamps.[20]

Observations and conclusions: In the absence of manufacturer take-back, a third party collection system for waste lamps has developed to serve hazardous waste generators. Participation in the system is low in Maine,[21] and appears to depend largely on user knowledge of, and willingness to comply with, hazardous waste management requirements that prohibit disposal in solid waste. The collection system does not directly serve household users, who are exempt from regulation under Maine hazardous waste rules and who therefore may legally place fluorescent lamps in the solid waste stream.[22]

There are no apparent obstacles to manufacturer take-back of mercury-added lamps. Manufacturers could meet take-back requirements through contractual arrangements that allow use of the existing third party collection infrastructure. A manufacturer take-back requirement would give manufacturers incentive to design the lamps to minimize the costs of collection and recycling.

Manufacturers suggest that a take-back requirement for fluorescent lamps would increase the initial purchase price of lamps by as much as 50¢ on average and might be a disincentive to use of energy efficient lighting. Analysis of this concern by the U.S. Environmental Protection Agency and others appears to disprove any such trade-off. EPA found, among other things, that the cost of lamp recycling is one to two percent of total lighting costs, that the recycling cost is minor compared to the energy savings associated with lighting upgrades, and that lamp recycling costs were never mentioned as a reason for not participating in EPA's Green Lights Program, an outreach program that promotes conversion to energy efficient lighting.[23]

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[20] Minnesota Statutes, chapter 116.92, subdivision 7.

[21] Bastey, id., p. 23.

[22] Some used fluorescent lamps generated by homeowners are collected as part of annual household hazardous waste collection days in several Maine municipalities. Residential use is estimated to account for less than 10 percent of all mercury emissions from fluorescent lamps. A study of the greater Milwaukee, Wisconsin region puts the figure at about five percent. Obenauf, Patrick and Skavroneck, Steven, *Mercury Source Sector Assessment for the Greater Milwaukee Area*, September 1997, p. 11, 52.

[23] Office of Solid Waste, U.S. Environmental Protection Agency, *Mercury Emissions From Disposal of Fluorescent Lamps: Final Report,* June 30, 1997.

D. Tilt switches

Mercury, because it is a liquid at normal temperatures and because it is an excellent electrical conductor, is used in electrical switches that operate by tilting. Mercury tilt switches are used for convenience lighting in car trunks and hoods and chest freezers. As the hood or lid is lifted or lowered, the mercury in the switch completes or breaks the electrical connection that turns the light on and off.

According to 1995 estimates, about 2.2 million mercury convenience switches are installed in new cars each year. Each switch on average contains 0.8 grams of mercury for a total equivalent to 18,700 pounds of mercury per year. Maine's share of that total on a per capita basis is about 87 pounds.[24]

About 90 percent of all automobiles, when taken out of service, are dismantled to remove reusable parts and the hulk is then shredded for metal recovery. About 75 percent of the vehicle is recycled in the dismantling and shredding operations. The remainder usually is disposed of in landfills in the form of shredder residue or fluff. The mercury in tilt switches presumably ends up in the fluff, although some may be released during shredding and some may end up as a contaminant in the metals recycling process.

The Society of Automobile Engineers has developed a draft procedure for safe removal of convenience light switches from vehicles at end of life. The procedure, when finalized, will be disseminated to auto dismantlers and recyclers. In the meantime, General Motors, Ford and Chrysler have independently committed to eliminate mercury switches where feasible. Non-mercury switches are available, but cost about 9¢ more per switch and are "less robust" than mercury switches according to a 1995 industry white paper. Chrysler has eliminated mercury switches from all convenience lighting in its 1998 models.

About 25 percent of chest freezers manufactured today have a mercury switch to activate an interior light. Some new pilot light gas ranges also use a mercury-containing switch to ensure no gas escapes when the oven is turned off. These two applications are estimated to contribute a total of about 9½ pounds of mercury to Maine's waste stream each year.[25] Some clothes washers manufactured before 1972 also had mercury switches, but likely are no longer in use.

When large appliances such as these are taken out of service, they become part of the white goods waste stream. Most white goods are collected at municipal solid waste facilities, usually a transfer station, and then taken to a recycling facility where they are shredded. As is the case for auto recycling,

[24] Bastey, id., p. 15.
[25] Bastey, pp. 18, 19.

some mercury in appliance switches likely is released during shredding, some becomes a contaminant in the metal recycling process and the rest ends up in shredder fluff that is landfilled.

The State of California requires removal of mercury-containing components of appliances prior to shredding. The California Integrated Waste Management Board has developed an Appliance Recycling Guide to assist those who process and recycle appliances. The guide identifies the mercury switches that must be removed, provides removal instructions, and sets forth California's requirements for management of the switches once removed.

The Association of Home Appliance Manufacturers (AHAM) has called upon suppliers of appliance components to eliminate mercury in components, but acceptable alternatives that do not compromise safety and reliability have not been found.[26] AHAM has joined with the Institute of Scrap Recycling Industries, the Steel Recycling Institute and the American Plastics Council to form the Major Resource Management Alliance (MARMA). MARMA studies and reports on advances in appliance recycling.

Observations and conclusions: Neither automobile nor appliance manufacturers are required to ensure that mercury switches are removed from their products prior to shredding. Manufacturers could provide for switch removal by working with automobile and appliance recyclers. This third party collection infrastructure captures most end-of-life appliances and automobiles. A manufacturer take-back requirement for mercury tilt switches or other mercury-added components will not require this existing system to be duplicated, but will require it to be adapted to accomplish removal of those components.

E. Batteries

Maine law prohibits the sale of most mercury-added batteries[27] and, in fact, most batteries manufactured today do not have mercury added during the manufacturing process. There are two exceptions—mercuric oxide and button cell batteries.

Mercuric oxide batteries are used in medical devices and other applications where a stable current and long lasting service life is essential. The mercury, which is used as one of the battery electrodes, accounts for about 40 percent of the battery weight and cannot be reduced without reducing the energy content. Alexander Technologies, Inc., the only U.S. manufacturer of mercuric oxide batteries, has established a collection and recycling system as required

[26] Moorhead, Tracey, American Association of Appliance Manufacturers, in letter to John James, Maine Department of Environmental Protection, November 19, 1998.
[27] Title 38, Maine Revised Statutes Annotated,,section 2165(6).

under Maine law.[28] Users of mercuric oxide batteries are prohibited from disposing of the battery except through that system.[29]

Manufacturers still use small amounts of mercury in button cell batteries. Button cells, so-called because they are the size and shape of a button, are used in hearing aids, wristwatches and other products. The small size of the battery required for these applications demands use of a tightly compacted electrolyte. The mercury serves this purpose. Maine law restricts the mercury content of button cell batteries to no more than 25 milligrams of mercury. Disposal of button cell batteries is estimated to contribute 20 pounds of mercury to Maine's solid waste stream each year.

Observations and conclusions. Batteries represent a manufacturer take-back success story. Take-back systems are in place for mercuric oxide batteries as mentioned above and also for rechargeable nickel cadmium (Ni-Cd) batteries.

Maine is one of 8 states that enacted take-back requirements for Ni-Cd batteries.[30] The others are Connecticut, Florida, Iowa, Maryland, Minnesota, New Jersey and Vermont. Prior to passage of these laws, few Ni-Cd batteries were recycled. State legislation spurred industry to establish a collection recycling infrastructure. Battery manufacturers set up a corporation, the Rechargeable Battery Recycling Corporation (RBRC), to physically administer the collection and recycling system.

A case study by Bette Fishbein of the non-profit group Inform, Inc. identifies the RBRC program as a model for take-back programs that involve many companies and are handled by a third party.[31] Fishbein writes:

> "The structure of RBRC and its licensing system could be adapted to other industries. In multi-company take-back systems, license fees can provide a method of allocating financial responsibility when it is not feasible for each company to take-back only its own products. The licensing arrangements provide a mechanism for allocating the costs across many companies in an equitable and efficient manner."

Maine also requires take-back of lead acid batteries.[32] Retailers and wholesalers of lead-acid batteries must accept used lead-acid batteries from customers who purchase a new battery. To encourage return of used batteries, the retailer is required to collect a $10 deposit on the new battery if a

[28] Ibid., section 2165(4).
[29] Ibid., section 2165(2)
[30] Ibid., sections 2165, 2166.
[31] Fishbein, Bette, "Industry Program to Collect Nickel-Cadmium (Ni-Cd) Batteries," *Extended Product Responsibility: A New Principle for Product-Oriented Pollution Prevention*, U.S. Environmental Protection Agency, June 1997, chapter 6.
[32] Title 38, Maine Revised Statutes Annotated, section 1604.

used one is not exchanged at the time of sale. No empirical data has been collected on the success of the exchange program, but anecdotal information from Maine's waste-to-energy incinerators and other solid waste facilities indicates that few lead-acid batteries are observed in the solid waste stream.

III. Product Stewardship

A. Extending manufacturer responsibility

As is clear from the forgoing discussion, manufacturer take-back does not necessarily mean the manufacturer must physically repossess the product. It means the manufacturer assumes responsibility for ensuring a system is in place to capture the mercury at the end of the product life. No single approach to manufacturer take-back will work for all mercury-added products. It is up to the manufacturer to determine how best to carry out this responsibility.

The concept that manufacturers should bear responsibility for the environmental impacts of their products throughout the product lifecycle is referred to as "product stewardship" or "extended producer responsibility" (EPR). As applied to the issue of mercury emissions, EPR means that the primary responsibility for collection and disposal is shifted from the consumer and municipalities to producers who purposefully add mercury to a product during its formulation or manufacture.

In placing responsibility for the waste management impacts of mercury-added products on the producer, manufacturer take-back and other forms of EPR focus on the actor in the product life cycle with the greatest leverage over environmental improvement.[33] By being required to take responsibility for disposal of their product, manufacturers of mercury-added products will more aggressively incorporate environmental considerations in product design. A manufacturer who must pay to recapture a product because it contains mercury has a strong incentive to design for recyclability, or to avoid the use of mercury altogether.

Manufacturer take-back also avoids the need for municipal collection and recycling efforts that are, in effect, a form of government subsidy to the manufacturer. Maine's municipal solid waste infrastructure is not currently adapted to segregate mercury-added wastes for special handling. This could be done, but at what cost and who should pay?

With manufacturer take-back, financial responsibility rests with the producer, who then presumably "internalizes" the collection and waste management

[33] Lifset, Reid, "Extending Producer Responsibility in North America: Progress, Pitfalls, and Prospects in the Mid-1990s," *Proceedings of the Symposium on Extended Producer Responsibility,* November 14-15, 1994, p. 38.

costs in the product price paid by the consumer. This better ensures the availability of adequate funding than a system that relies on public, taxed-based financing. The essence of EPR is who pays for, not who physically operates the waste management system.[34] Municipalities could continue their traditional role as handlers in waste collection, though now as contractors.

Manufacturers presumably will use their product knowledge and entrepreneurial ingenuity to keep collection costs as low as possible. They have the expertise as designers, marketers and distributors that government lacks, and, as a consequence, they likely will be more efficient than government in finding the most inexpensive approach to capture of mercury-added products. In this sense, manufacturer take-back is a form of performance standard.[35] The manufacturer must provide a collection system for end-of-life management of the product, but is free to innovate and choose the particular means of doing so.

Manufacturer take-back is a market-oriented approach to the problem of mercury-added products. It brings market forces to bear on the problem by shifting responsibility for post-consumer product management from the government to the manufacturer. This presumably will drive innovation in product design, in recycling technologies and in collection systems, perhaps giving incentive to eliminate use of mercury altogether in those cases where it is feasible to do so. That market incentive and ingenuity are missing in a system that relies primarily on government subsidized waste collection.

B. The politics of extending manufacturer responsibility

Although the case for manufacturer take-back of mercury-added products is sound, support is not universal:

> As proposals to extend producer responsibility multiply around the globe, the justification for this policy strategy has come under increasing scrutiny...American business interests are especially active and concerned because there is little EPR in the United States at this time—the new environmental obligation is not fait accompli—and because many companies feel that European EPR initiatives will become especially onerous when transplanted to the U.S. regulatory climate.[36]

Several U.S. companies have formed the Shared Product Responsibility Group to argue against EPR initiatives and in favor of the status quo, which they call Shared Product Responsibility (SPR).[37] Unlike EPR, which seeks to extend responsibility to producers for the latter stages of a product lifecycle, SPR looks

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[34] Organization for Economic Cooperation and Development, *Extended and Shared Producer Responsibility: Phase 2*, May 1998, exec. sum., p. 5, 6.

[35] Lifset, Reid, "Take it Back: Extended Producer Responsibility as a Form of Incentive-based Environmental Policy", *Journal of Resource Management and Technology*, Vol. 21, No. 4, December 1993, pp. 163-175.

[36] Lifset, Reid and Lindhqvist, Thomas, "Getting the Goal Right: EPR and DfE," *Journal of Industrial Ecology*, vol. 2, no. 1, p. 6.

[37] Ibid.

to each actor along the product life cycle to properly manage environmental performance.[38]

SPR advocates challenge the EPR notion that producers are in the best position to influence environmental performance throughout the product lifecycle. They concede this may be true at the design and production stage, but contend it is not necessarily accurate for environmental issues associated with distribution, use and disposal when other actors have physical possession of the product. They view EPR as a significant departure from the traditional concept of linking control over a product and its effect to the actor in possession when the effects occur. This departure from current accepted practice could unsettle business relationships and have broad unforeseen implications beyond the environmental arena.[39]

If SPR sounds familiar, that is because it describes the prevailing approach to responsibility for end-of-life product management in the United States. Most manufacturers are able to pass product disposal costs down the distribution chain, to be paid by the product user in the form of disposal fees, by municipalities in their solid waste budgets or, in the case of mercury-added products, to be borne in the form of adverse health impacts from mercury deposition in the environment. No group in society wants to bear costs they can avoid. Manufacturers of mercury-added products are no different. They enjoy a substantial subsidy in the form of avoided disposal costs and are unlikely to assume this cost in the absence of a legislative mandate.

States can play a major role in changing the current disposal paradigm and extending producer responsibility. As mentioned, battery legislation in eight states, including Maine, was a driving force behind the establishment of an industry program to collect Ni-Cd batteries and led to the passage of national legislation.[40] State legislation also provided the impetus for establishment of a collection program by the only U.S. manufacturer of mercuric oxide batteries, and Minnesota has enacted laws requiring manufacturer collection for two other mercury-added products—thermostats and displacement relays.[41] However, legislative initiatives by Minnesota and Vermont to extend producer responsibility to a wider range of mercury-added products, including fluorescent lamps, have not been successful to date.

Manufacturers can be expected to continue to participate in legislative debates on manufacturer take-back, and to insist on well-reasoned responses to their reservations about such initiatives. The National Electrical Manufacturers Association (NEMA), for example, suggests that policy makers, before

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[38] Lewis, Cynthia, *Improved the Environmental Performance of Products: A Shared Responsibility*, a paper submitted to the OECD International Workshop on Extended Producer Responsibility, Ottawa, Canada, December 2-4, 1997, p. 1.

[39] Ibid., p. 3.

[40] Fishbein, id., p. 6-22.

[41] A displacement relay is an electric flow device in which a plunger, when energized, moves into a pool of mercury, displacing the mercury sufficiently to create a closed electrical circuit. Displacement relays are used in high voltage applications such as deep fat fryers. About ¾ million are sold in the U.S. each year.

implementing a system of manufacturer take-back for the full range of mercury-added products, undertake a product-by-product analysis that:

- Quantifies the amount of mercury contributed by the product to the waste stream;
- Identifies where the product goes upon entering the waste stream (i.e., whether to a landfill, incinerator or recycling facility) and the consequences;
- Examines the effects of manufacturer reformulations on future mercury flows into the waste stream; and
- Examines the different ways in which the product might be prevented from entering the solid waste stream, including the effectiveness, cost and disadvantages of each.

Under this approach, the decision on whether to proceed with manufacturer take-back then would be made based on a balancing of these factors.[42]

NEMA further suggests that manufacturer take-back may not be warranted where manufacturers already have and continue to reduce their use of mercury in the absence of legislative mandates. This argument was made by a representative of the Philips Lighting Company, a NEMA member, at a meeting of this Council on December 17, 1998. Philips has reduced the mercury content of 80 percent of the lamps it manufactures to levels where the lamps no longer qualify as hazardous waste. The company expects to increase that percentage to over 90 by the end of 1999.

Because these low-mercury lamps do not meet the definition of hazardous waste, they may legally be placed in the solid waste stream. Philips suggests that placing these lamps in the trash is an environmentally safe practice if waste incinerators are equipped with state-of-the-art emissions controls. Philips further suggests that capture of mercury from low-mercury lamps through incinerator emissions controls is more economically efficient than a manufacturer take-back program to divert the lamps from the solid waste stream.[43]

Others disagree on whether low mercury lamps may be safely placed in the trash for collection with other municipal solid waste. They applaud the success of Philips and other lamp manufacturers in reducing mercury content, but observe that the reduced use of mercury per lamp has been largely negated by

[42] Erdheim, Ric, National Electrical Manufacturers Association, in letter to John James , Maine Department of Environmental Protection, December 7, 1998.
[43] Walitski, Paul, in comments to the Land and Water Resources Council, December 17, 1998.

an increase in the number of lamps in use.[44] The lamps still contain small amounts of mercury and, cumulatively, represent a significant source of mercury in the waste stream. The fact that mercury content has been reduced to the point where it is now legal to dispose of the lamps in the solid waste stream could actually increase the flow of mercury to disposal facilities.

Most European nations,[45] and a few U.S states that have closely examined the issue, continue to promote recycling of all fluorescent lamps, including the low mercury lamps made by Philips and others. Philips Lighting has adjusted to this political reality in Europe by marketing a line of fluorescent lamps touted for their recyclability. The advertising for these lamps says they are recyclable "to minimise the end-of-life disposal problems and environmental burden."

We do not single Philips out to characterize its concerns about manufacturer take-back as unfounded. Other manufacturers of mercury-added products have voiced concerns during the compilation of this report. Automobile manufacturers, for example, are concerned that, under an EPR approach, they could be held liable for the failure of auto dismantlers and recyclers—third parties over which they have little control—to remove mercury tilt switches before the automobile is shredded. Still others, including NEMA and the Association of Home Appliance Manufactures, suggest that manufacturer take-back is inappropriate for mercury-added products destined for disposal in landfills because most studies show that landfills are a relatively minor source of mercury emissions to the environment compared to emissions from incinerators.

Although most of these manufacturer groups were represented on an advisory group convened to provide input to this report, at least one industry group has complained their concerns were ignored. Further, the draft report submitted to this Council was not available sufficiently in advance for meaningful review and comment by manufacturers. The perception that manufacturer groups have not been heard could slow or block efforts to extend producer responsibility for mercury-added products. At a minimum, concerns about procedural fairness will hinder a frank discussion of the merits of manufacturer take-back. Legislative action on establishment of collection system for manufacturer take-back of mercury added products should be delayed pending further consideration of manufacturer objections.

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[44] Eaton, Gordon, U.S. Geological Survey, "Mineral Industry Surveys: Mercury," June 1997, p. 2.

[45] Most European nations belong to the Organization for Economic Cooperation and Development (OECD), a Paris-based organization composed of 29 member nations from among the world's leading industrial countries. The OECD is in the midst of a multi-year program to develop guidance documents for member nations interested in product take-back and initiatives to extend producer responsibility. OECD polices often become national policies in member states. Product stewardship policies enjoy strong support in European nations, several of which have mandated product stewardship for packaging, batteries and other products.

IV. Product Bans

The use of mercury in some products, such as toys and games, is clearly non-essential or frivolous. In such cases, the responsible course is for the producer to eliminate the mercury component or discontinue production altogether. Where the producer does not do so voluntarily, a statutory ban may be appropriate.

The State of Minnesota has banned the sale of toys or games that contain mercury and sale of clothing that contains a mercury switch.[46] The ban on toys and games was enacted in 1992, following introduction of a mercury-containing toy called Maze. The ban on mercury switches in clothing has been in place since 1994, and was in part a response to the use of a mercury-added light switch in the soles of sneakers made by LA Gear.

Minnesota also has banned the use of mercury manometers on dairy farms.[47] The manometers are used to measure vacuum pressure in milking machines. Each manometer contains about ¾ pound of mercury and needs to be replaced periodically due to contamination of the mercury with milk and debris. A 1994 study identified dairy barn manometers as a significant source of mercury emissions in Minnesota. The state Legislature subsequently decided to phase them out given that non-mercury vacuum pressure gauges are available. The Legislature funded a buy-back program in conjunction with the phase out; $100 was allocated for each of the estimated 2000 manometers in the state.

The legal viability and overall effectiveness of a state ban on non-essential mercury-containing products depends on the product targeted. Minnesota's ban on manometers, for example, likely was very effective in reducing mercury emissions given the number of manometers in use, the relatively high amount of mercury used in each one, and the need for periodic replacement. In Maine, a ban may be unnecessary given estimates that only about 25 dairy barns still have mercury manometers. A targeted education and outreach effort, with modest funding for manometer buy-back, should suffice.

Minnesota's ban on mercury in toys and sneakers might be viewed as relatively ineffective if measured only against total emissions from mercury-added products. However, such bans increase public awareness of the need to reduce mercury emissions and have an immeasurable educational value that likely enhances their overall effectiveness.

As to the legal viability of a product ban, the constitutional issues have been

[46] Minnesota Statutes, chapter 116.92, subdivision 8.
[47] Ibid., subdivision 8a.

addressed by Gerald Reid, an assistant attorney general with the Maine Department of Attorney General.[48] Mr. Reid set forth several principles of constitutional law that might be implicated by such legislation:

The Commerce Clause. Any state legislation that has a significant impact on interstate commerce runs the risk of violating the Commerce Clause. The general rule in Commerce Clause cases is explained by the United States Supreme Court in Pike v. Bruce Church. That case suggests a four-part inquiry:

1. Does the legislation regulate even-handedly?

   The question here is whether a product ban discriminates against out-of-state interests. A ban is not a problem in this regard because it imposes an equal burden on in-state and out-of-state manufacturers.

2. Does the product ban have a legitimate local purpose?

   A product ban clearly serves a local purpose. Courts give great deference to a state's right to regulate for protection of health, safety and welfare. An effort to control mercury emissions would be entitled to this deference.

3. Are the effects of the ban only incidental?

   A reviewing court likely would find a ban to have at least an incidental effect on interstate commerce. However, that alone does not lead to a constitutional problem; it simply means that it's necessary to continue the analysis with the next question.

4. Is the burden on interstate commerce clearly excessive in relation to the local benefits? Could the local interest be promoted with a lesser impact on interstate commerce?

   These are questions of degree. A product ban could be drafted in a way to pass this test. The key is to minimize the impact on interstate commerce while tailoring the legislation to closely accomplish its purpose of reducing mercury pollution.

Preemption. State statutes can be subject to invalidation on the grounds of federal preemption under a variety of circumstances. The most obvious problem is with state laws that are in clear conflict with federal law. Preemption also can occur when Congress expressed its intent to occupy

[48] Reid, Gerald, Maine Department of Attorney General, in memorandum to John James, Maine Department of Environmental Protection, September 17, 1998.

the entire field of regulation in a given area, as well as when a particular subject matter requires uniformity or regulation (the latter could be an argument against state labeling requirements). The "Mercury-Containing Rechargeable Battery Management Act," 42 U.S.C § 14301, et seq., may pose preemption issues for any attempt to further restrict the sale of mercury-added batteries. Preemption otherwise does not appear to pose an obstacle to the banning of mercury-added products.

Due process considerations. The constitutional concept of due process requires any law to be sufficiently specific and clear so that people of ordinary intelligence are able to ascertain its meaning and comply with its provisions. If, rather than banning specific products such as toys and games, Maine were to, for example, prohibit the sale of "any product in which the use of mercury is frivolous or non-essential," it obviously would be necessary to provide specific definitions in the law of the terms "frivolous" or "non-essential." It also would be desirable to base the definitions on some empirical data in order to avoid arguments that the law's standards are without a rational basis.

V. Product Labeling

Although the manufacturer has the greatest ability and, thus, the greatest responsibility, to reduce the impact of its product, all actors along the product chain, including the consumer, share responsibility for proper management of the product.[49] Manufacturer take-back will be successful as a strategy for diverting mercury-added products from the municipal solid waste stream only if the consumer knows that an alternative collection system is available and uses it. To ensure this happens, disposal of mercury-added products in solid waste must be banned and the product must labeled.

The label on a mercury-added product should have two purposes. First, it should inform prospective purchasers that the product contains mercury. This enables the consumer to shop for alternatives. Labeling for this purpose will be most effective in conjunction with education and outreach efforts that inform the public of environmental issues associated with mercury emissions and promote understanding of the connection between environmental impacts and product choices.[50]

The second purpose of the label is to inform the product user of the end-of life management system established for the product. As an incentive to use this system, the label also should inform the user of the prohibition on placing the

[49] Davis, Gary and Wilt, Catherine, *Extended Product Responsibility*, U.S. Environmental Protection Agency, June 1997, p. 1-1.

[50] Goldberg, Terri and Guillemin, Robert, Northeast Waste Management Officials Association, in memorandum to NEWMOA Directors, June 4, 1998, p. 6.

product in the trash for disposal as solid waste.

Minnesota and Vermont have enacted legislation requiring labeling of certain mercury-added products. In Minnesota, the specific products targeted for labeling are:

- thermostats and thermometers;
- electric switches, individually or as part of another product other than a motor vehicle;
- appliances;
- medical or scientific instruments; and
- electric relays or other electrical devices.

Vermont has targeted the same products for labeling, but does not exempt switches in automobiles. In addition, Vermont requires labeling of mercury-containing lamps.

In both states, the label language and placement have been a key concern in stakeholder discussions and rulemaking. Trade associations have played a large role in that debate. To avoid fragmented, state-by-state labeling requirements that frustrate commerce and confuse consumers, Maine should be consistent with the labeling approaches taken by Minnesota and Vermont.[51]

Staff from the Northeast Waste Management Officials Association (NEWMOA) suggest that label options developed by RBRC for Ni-Cd batteries may work well for mercury-added products. The logos and toll free numbers championed by RBRC may be especially effective.

> "Logos offer a simple and versatile way to identify mercury in a wide range of products and components. This is especially important in cases where components are too small for text. For example, button batteries have already been exempted from mercury labeling laws. Although labels still need to be placed on button battery packaging, this situation foreshadows the labeling difficulties introduced by small product components such as switches and relays."[52]

A toll free number can be used on the label as the vehicle to inform the user about the end-of-life management system established for the product.

Research by NEWMOA staff also suggests the importance of label placement. Placement of the label on the packaging where it can be clearly viewed at the

[51] Ibid., p. 6.
[52] Ibid., p. 5.

point of sale is critical to helping consumers make educated purchasing decisions. When products are discarded, labels on the product itself provide the most reliable method for informing consumers about proper disposal.

VI. Fees

A fee could be imposed on mercury-added products to shift economic responsibility for waste management to the manufacturer and product consumer. Such fees, often called advance disposal fees (ADFs), embody the principal of extended producer responsibility.[53] ADFs could be assessed to provide revenues for educational outreach and research related to diversion of mercury-added products from the solid waste stream, or to fund so-called "clean-sweep" collection programs for orphaned mercury-added products not likely to be captured through manufacturer take-back programs. The legislative directive for this report also asks the Council to consider using revenues from such a fees to reimburse incineration facilities for the expense of meeting mercury emission limits and to conduct research on the release of mercury from wood combustion.

One ADF option is a fee based on the mercury content of the product. This would provide incentive to manufacturers to reduce mercury content, but, unlike manufacturer take-back, it would not provide an incentive to design for product recyclability. However, the added product cost as a result of the fee could discourage purchase of mercury-added items and create a buying preference for non-mercury alternatives.

The Mid-Maine Waste Action Corporation has suggested a content-based fee of $2000/lb ($4.40/gm) based on the projected cost of capturing mercury through tailpipe mercury controls at its incineration facility. Assuming 3000 pounds of mercury enters Maine each year through sale of new products,[54] this fee rate would raise $6 million/year in revenue.

An alternative approach (option 2) would be to set the fee rate to achieve a specific revenue goal. For example, if $300,000 is budgeted annually for state agency initiatives related to mercury-added products, the required fee would be $100 per pound (22¢ per gram). The table below compares added cost per product of this option and option 1.

[53] Davis and Wilt, id., p. 2-5.

[54] This estimate is extrapolated from a Minnesota study estimating that 12,000 pounds of mercury enter that state each year through products sold in the state. See Minnesota Pollution Control Agency, *Options & Strategies for Reducing Mercury Releases*, October 20, 1998, p. 168.

Product	Mercury Content	Fee (option 1)	Fee (option 2)
Thermostat	3 grams	$13.20	$0.66 (66¢)
Fever thermometer	0.5 gram	$2.20	$0.11 (11¢)
4-foot fluorescent lamp	20 milligrams	$0.09 (9¢)	$0.005 (½¢)
Hood light tilt switch	0.8 gram	$3.52	$0.18 (18¢)
Button battery	9 milligrams	$0.04 (4¢)	4¢ per 100

Some argue that a product fee or tax to raise revenue for proper handling of mercury-added products will be a more direct and meaningful pricing signal than "internalization" of such costs in product prices. Internalization of disposal costs though manufacturer take-back requirements shifts disposal costs from the taxpayer to the consumer, but provides little meaningful information to consumers who wish to base their purchasing decision on environmental factors such as disposal costs. This is because the product price reflects numerous other factors and inputs, including the cost of materials, labor and marketing. The disposal cost message is too attenuated to be effective.[55]

The main drawback to imposition of a fee on the sale of mercury-added products is the added administrative burden to the state and to the manufacturers or retailers who collect the fee. The administrative costs could be paid from the revenues or requested from the state General Fund. However, retailers can be expected to oppose fees due to the added collection and record-keeping burden, and because of concern that revenues may be diverted to uses not directly related to the purpose of the fee.

The experience of the Maine Waste Management Agency is instructive. Part of that agency's funding formula was a $5 advance disposal fee on the sale of new appliances, furniture items, mattresses and bathtubs, and a $1 fee on new tires and lead acid batteries. All of those fees, except the fee on lead-acid batteries and tires, were repealed in response to pressure from retailers and manufacturers, and the agency itself abolished.

VII. Findings

- Maine should take steps to divert mercury-added products from disposal in the solid waste stream. Manufacturers are reducing mercury levels in products but voluntary reductions are not happening fast enough given that mercury persists in the environment for long periods, becomes more concentrated as it moves up the

[55] Lewis, id., p. 4.

food chain, and can cause serious health problems in humans and wildlife.

- Manufacturers of mercury-added products appear to be in the best position to ensure that appropriate, practical and cost-effective systems are available for end-of-life management of their products. Maine should consider adopting legislation that extends manufacturer responsibility to the waste management stage. Before adopting such legislation, manufacturer objections to extended product responsibility should be further explored.

- If Maine adopts legislation requiring manufacturers to provide for end-of-life collection of mercury-added products, the state also should prohibit disposal of the products in the municipal solid waste stream.

- Consumer education through product labeling is critical to success of any effort to divert mercury-added products from the solid waste stream. At a minimum, all mercury-added products should be labeled to inform the user that the product contains mercury. If Maine adopts legislation requiring manufacturers to provide for the end-of-life collection of mercury-added products, the product also should be labeled to inform the user of the alternate collection system and that disposal in the municipal solid waste stream is prohibited.

- The Department of Environmental Protection should review its hazardous waste management rules to ensure the regulatory framework governing handling of mercury-added products does not unnecessarily impede their collection and recycling. The department should initiate proceedings to revise or amend the rules as determined appropriate to remove any such impediments and to promote environmentally sound management of mercury-added products.

- Maine should ensure that its legislative and regulatory initiatives regarding mercury-added products are consistent, to the extent appropriate, with mercury product laws in effect in the States of Vermont and Minnesota, and with regional efforts to address the issue of mercury in products. Maine should follow Minnesota's lead in banning the sale of toys, games and clothing that contain mercury, and should also consider extending the ban to the retail sale of mercury-added thermometers.

VIII. Implementing Legislation

Appendix 1 sets forth proposed legislation based on the findings and conclusions of this report.

Appendix 1

Proposed Implementing Legislation

An Act to Reduce Mercury in Products

Be it enacted by the People of the State of Maine as follows:

Sec. 1. 38 MRSA c. 13-D, is enacted to read:

Chapter 13-D

MERCURY EMISSIONS CONTROL

§1391. Definition

The term "mercury-added product" as used in this chapter means a product into which elemental mercury or mercury compounds are intentionally added during its formulation or manufacture and in which the continued presence of mercury is desired to provide a specific characteristic or to perform a specific function.

§1392. Disclosure of mercury content

After July 1, 1999, a manufacturer or wholesaler may not supply a mercury-added product for sale in this state without first notifying the commissioner in writing of the amount of mercury in the product and the purpose that the mercury serves.

§1393. Labeling

After July 1, 2000, a manufacturer or wholesaler may not sell and a retailer may not knowingly sell a mercury-added product unless the product is labeled in a manner to clearly inform a purchaser or consumer that mercury has been added to the product. The department may adopt rules regarding labeling placement and content. The rules must give preference to placement of the label on the product and product packaging.

§1394. Mercury-containing lamps; large use applications

1. A person who sells fluorescent or other lamps that contain mercury to the owner or manager of an industrial, commercial, office or multi-unit residential building, or to any person who replaces or removes from service outdoor lamps that contain mercury, shall clearly inform the purchaser in writing on the invoice for the lamps, or in a separate writing, that the lamps contain mercury, a hazardous substance that is regulated by federal or state law, and that they should not be placed in solid waste.

2. A person who contracts with the owner or manager of an industrial, commercial, office, or multi-unit residential building, or with a person responsible for outdoor lighting, to remove from service fluorescent or other lamps that contain mercury shall clearly inform, in writing, the person for whom the work is being done that the lamps being removed from service contain mercury and what the contractor's arrangements are for the management of the mercury in the removed lamps.

§1395. Elemental mercury

1. Sale. A person may not sell mercury to another person in this state without providing a material safety data sheet, as defined in United States Code, title 42, section 11049, and requiring the purchaser to sign a statement that the purchaser:

A. Will use the mercury only for a medical, dental, instructional, research, or manufacturing purpose;

B. Understands that mercury is toxic, and will store and use it appropriately so that no person is exposed to the mercury unknowingly; and

C. Will not place, or allow anyone under the purchaser's control to place, the mercury in the trash for disposal as solid waste or in a wastewater disposal system.

2. Use. A person who uses elemental mercury in any application may not place, or deliver the mercury to another person who places residues, particles, scrapings or other materials that contain mercury in solid waste or wastewater, except for traces of materials that may inadvertently pass through a filtration system during a dental procedure.

§1396. Ban; toys, games, and apparel

A person may not sell for resale or at retail in this state a toy or game that contains mercury, or an item of clothing or wearing apparel that contains an electric switch that contains mercury.

Sec. 2. Report; manufacturer responsibility for collection of mercury-added products. The Land and Water Resources Council shall prepare a report that identifies and responds to arguments against extending manufacturer responsibility to the collection of mercury-added products from users. The report must address the following issues:

- Whether mercury-added products that do not meet the definition of hazardous waste may safely be placed in the municipal solid waste stream;

- Whether it is more cost effective to recover mercury from mercury-added products through incinerator emissions controls than by collection and recycling of the product;

- Whether manufacturer take-back should be universal for mercury-added products;

- Whether a manufacturer funded take-back program for fluorescent lamps, by increasing the purchase price of the lamp, will cause lamp users to abandon fluorescent lighting in favor of a less energy efficient alternative; and

- Whether disposal of mercury-added products in solid waste landfills is an environmentally sound practice, and, if so, whether it is possible to establish a collection system for mercury-added products that captures only those products destined for incineration.

The council shall submit the report, together with recommendations to implement a system for ensuring that disposal of mercury-added products does not contribute to mercury emissions to the environment, to the joint standing committee of the Legislature having jurisdiction over natural resources matters by January 15, 2000.

Mercury-Added Products in Maine's Solid Waste

December 1998

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Table of Contents

I. INTRODUCTION

The Maine Department of Environmental Protection (MDEP), on behalf of the state Land and Water Resources Council, prepared this report on mercury-added products as required in *An Act to Reduce Mercury Use and Emissions, PL 1997, c. 722.* Section 5 of the act requires the council to report on the following:

- Establishment of a collection system through which mercury-added products can be returned for recycling to the manufacturer;

- Labeling of mercury-added products to inform the user that the product contains mercury and that the manufacturer is required to recycle the product; and

- Imposition of a fee on the sale of mercury-added products, with an evaluation of options for use of revenues from the fee.

The report must be submitted to the Legislature's Joint Standing Committee on Natural Resources by January 1, 1999.

The MDEP retained John Bastey, an environmental consultant, to collect and compile information needed to complete the report. Specifically, Mr. Bastey was asked to identify mercury-added products in Maine's municipal solid waste stream and collect information related to the feasibility and practicality of diverting such products from the waste stream by returning the product to the manufacturer.

This report is an effort to put some numbers to the amount of mercury disposed of in the solid waste stream. Mr. Bastey found that little data is available within or about Maine. As a result, information was gathered from existing sources and interviews were conducted with state and federal regulators and industry representatives, industrial associations and representatives of non-governmental agencies (NGAs).

Of most assistance were two very recent reports in particular, the *Major Source Sector Assessment for the Greater Milwaukee Area* and two mercury studies performed by the Minnesota Pollution Control Agency (MPCA), one issued in first draft as late as September 11, 1998 and under initial consideration on November 20, 1998. Without the help of these reports, and the dozens of interviews granted by more than 35 mercury specialists across the country, it would not have been possible to write this report in five weeks.

On November 20, 1998, at a meeting hosted by the MDEP in Portland, Maine many of the primary sources for this report further assisted the MDEP.

A. Executive Summary

Mercury arrives in Maine along two primary pathways, long-range airborne transport and imported mercury-containing products. The MDEP's Bureau of Air Quality Control, working with the North East States for Coordinated Air Use Management (NESCAUM), is studying long-range air transport issues. This report looks at the commercial products that are disposed of at the waste facilities in the state.

Imported mercury-added products are transported to Maine through commerce with other states and countries. At the end of their useful lives those products end up in Maine's solid waste stream. In 1995 Maine disposed of 1,339,352 tons of solid waste. Of that 41.5% was recycled, 39.4% was incinerated, 12.5% was landfilled, 5.6% was exported (primarily to Turn Key landfill in New Hampshire), and .8% was used as fuel in other than municipal waste incinerators. Of the 695,123 tons of waste disposed of in Maine that year, 76% was incinerated and the remaining 24% was landfilled.

It must be assumed that about 70% of any mercury that is incinerated in Maine is emitted to the air, the balance being trapped in fly ash and landfilled. The mercury products that are landfilled may be sequestered in a properly designed and operated landfill (good leachate control, regular daily cover) although recent studies in Florida indicate that some mercury compounds may escape in landfill gases. The rate of emissions from Florida landfills is very low (estimated at 2 lbs./year statewide by one source) and would be lower in Maine given our colder temperature regime.

Table I

Sources of mercury in Maine's solid waste stream

Product Type	Amount to Waste/Yr. (lb.)	Amount in Stock (lb.)	Level of Confidence
Batteries	See sec. III	8915	Medium
Blood pressure cuffs (med. Offices)	23.7	2374	Medium
Chest freezers	1.4	28	High
Dairy manometers	1.6	25	High
Fever thermometers	155	Unknown	Medium
Fluorescent lamps	126	685	Medium
Laboratory thermometers	0.5	5	Low
Pilot light gas stoves	8	152	High
Thermostats	123	4310	Medium
Vehicles	87	867	Medium
Total	526.2	17361	

Table I shows the products estimated to contribute the largest amounts of mercury to Maine's to Maine's waste stream. Estimates are explained in Section III of this report.

The numbers in the table are estimates of the amount of mercury contributed to Maine's solid waste stream from the named sources. "Amount to Waste (Lbs.)" is the amount estimated to go to the waste stream each year from Maine homes and businesses.

"Amount in Stock (Lbs.)" is the amount of mercury in mercury-added products estimated to be in use across the state.

A note on the accuracy of the numbers in this table: The term "Level of Confidence" is a qualitative descriptor meant to convey an idea of the level of accuracy in the assumptions on which the numbers in the table are based. It must be remembered that the sources of data for the calculations of the different kinds of products listed above is far from perfect or complete. The numbers used are at best educated guesses based on hours of phone calls and hundreds of pages of reports, letters, articles and data sheets collected in September and refined in November of 1998. The products listed in the Table do not account for all mercury in the waste stream. Dozens of other mercury-added products are sold in the state. The limited time available for this investigation did not allow the gathering of detailed data on each of them.

In talking with other environmental specialists involved in tracking mercury in other states and Canada, in industry and national programs, the same problem, a lack of hard data, was repeatedly identified.

Recent estimates from the Region V office of the EPA, however, indicate that nationwide there are some 3,000 to 5,000 metric tons of mercury installed in the U. S. Since Maine represents 0.46% of the U. S. population, using the EPA estimates, Maine may have between 13.8 and 23 tons of mercury installed and in use in its businesses, industries and homes. Of that amount this report attempts to account for only that fraction disposed of in the waste stream each year.

It is certain that the actual amount of mercury in the Maine waste stream is somewhat higher than detailed above. Bearing that in mind the committee should look at this report as providing a floor, not a ceiling, in regard to the amount of mercury disposed of in the state. It is a valuable first step to give the committee enough information to make some basic decisions, but that is all it is.

While this report has not been peer reviewed, many of the numbers were reviewed by telephone with primary contributors to the other studies and have been significantly modified over the past several months as new information was presented. As a result, this final draft document is quite different from the working draft released in September and any assumptions made based on the earlier draft should be reexamined.

It should also be noted that Maine has a very significant 41% recycling rate, made up of such things as appliances and other large metal goods as well as bottles and cans, so some mercury-containing waste is neither landfilled nor incinerated in the state.

B. Format

The major sections of the report are Section III, where the amounts of mercury contributed by different products are analyzed, and Sections IV and V, concerning reduction strategies and benefits of and barriers to those strategies.

The information in Section III is organized by product type and based on reports, letters, conversations and interviews from and with specialists at the EPA, various state agencies and NGAs in the northeast and midwest. The strategies in Section IV come from research into methods used to reduce the amount of mercury in other states. The draft *Minnesota Source Reduction Feasibility and Reduction Strategies* report is a "must read" for committee members as it lays out in detail many options and strategies for reducing the amount of mercury in that state. The Milwaukee report was used to compare the results of this study with a jurisdiction of similar size and geographical placement to determine if amounts of mercury being reported in Maine were within the bounds of common sense.

C. Sources of Information

In early September, 1998, both the *Minnesota Source Reduction Feasibility and Reduction Strategies Committee Report* and the *Greater Milwaukee Area Mercury Reduction Project Report* became available. These reports discuss the amounts of mercury in their respective waste streams. The Minnesota report is very recent. The Milwaukee report is a final draft document. Both reports deal with northern states with industrial bases and climate regimes similar to Maine's, and, in the case of Milwaukee, a comparable population. The Milwaukee report represents a single region of Wisconsin, not the whole state. The Minnesota report concerns the entire state, an area much larger than Maine in size and population. Nevertheless, many of the issues discussed are the same for all three jurisdictions.

Information in the Northeast States/Eastern Canadian Province's *Mercury Study,* EPA's *Mercury Study Report to Congress,* the American Hospital Association *Becoming A Mercury Free Facility: A Priority to be Achieved by the Year 2000* and many other studies, reports, letters, fact sheets, Internet pages and other sources of written and electronic information were reviewed.

Interviews, often multiple, were conducted with specialists from many state and federal government offices, industrial representatives, members of non-governmental agencies and individuals across the northeast and the nation. A list of contacts and interviewees is attached.

II – MERCURY-ADDED PRODUCTS IN MAINE'S WASTE STREAM

What kinds of products contain mercury?

Fluorescent lamps, old flashlight batteries, fever thermometers, blood pressure cuffs, electrical switches in homes, switches, relays, cars and appliances, thermostats, hospitals and laboratories, to mention a few of the dozens.

The *Mercury Products Study* by John Gilkeson, of the Minnesota Office of Environmental Assistance (MOEA), includes an excellent list of mercury-containing products. The list is quoted in the appendix with permission from that department. The list is quite long and determining the amounts of mercury added to the Maine solid waste stream based on a list of that length is beyond the scope of this report.

In reading the list it should be noted that in some devices the mercury serves a function that is different from the main purpose of the device. For example, in DC watt hour meters, the mercury serves primarily a mechanical function as a low friction bearing. In a conventional thermostat, the mercury serves an electrical function in a tilt switch and has no thermometric function. In a mercury and glass thermostat, the mercury serves both thermometric and electrical functions. Many of these devices and products are used in educational institutions, as well as in commercial applications.

Mercury is contained in many products and is used for many purposes. Most of the products listed either use mercury in very small amounts (e.g. eye cosmetics), have been discontinued over the past several years (e.g. pesticides), or are not currently issues of importance in Maine (e.g. gold mining).

In reviewing the Minnesota list and other information in the reports, it appears that the products listed in Section III are likely to contain the bulk of the mercury in the Maine solid waste stream. In calculating that impact the amount of mercury in each product or component was determined using available data from national sources. Only in the cases of chest freezer light switches, pilot light gas ranges and dairy manometers was the data specific to Maine. Amounts were arrived at by dividing the national number by the US population, then multiplying the result by the Maine population.

That method of calculating the amount of mercury in Maine has obvious problems as it is likely to over represent or under represent Maine's actual use of the products. However, the method was discussed with other researchers, specifically at EPA's Washington DC Office of Pollution Prevention, EPA's Region V Pollution Prevention office and the MDEP. Given the kinds of information available and the time constraints a better method could not be found. The researcher at the Minnesota Pollution Control Agency used the same methodology where specific Minnesota numbers were not available.

III – DETERMINING AMOUNTS OF MERCURY IN THE WASTE STREAM

1. Batteries

Mercury is added to batteries to assist in the delivery of electricity. It prevents gas buildup within the cell and allows battery components to be compacted more tightly. While manufacturers stopped using mercury in all round and prismatic batteries in 1993, small amounts of mercury continue to be used in button cell batteries.

For example, the button cell batteries used in hearing aids, wristwatches and other products that require a very small energy source contain mercury because the size of the cell requires that the electrolyte be compacted tightly to give the battery any useful life. Because hearing aid batteries only last a few weeks their usage rate is so high that they are generally purchased in packs.

According to the National Electronics Manufacturers Association (NEMA) button cells contribute about 20 lbs./year to the Maine waste stream. That is not captured in the United States Geological Survey (USGS) chart below so 20 lb. Of mercury has been added to the USGS total, even though it means a small amount of double counting.

When current delivery must be absolutely stable, as in various hospital and military applications, mercury is used in the battery electrodes. Imagine a heart lung machine during a power outage with a battery whose current fluctuates. A secure supply of voltage is vitally important. Likewise in military procurement some equipment requires a dependable and steady current source that can only be supplied by high mercury batteries.

American battery manufacturers began phasing mercury out of their batteries in the late 1980s and stopped using mercury in round and prismatic alkaline manganese and zinc carbon batteries altogether in 1993. The 1996 federal Mercury Containing and Rechargeable Battery Management Act bans the sale of any alkaline manganese or zinc carbon battery, other than button cells, that contains mercury. Nevertheless, mercury containing batteries remain in the waste steam and these batteries cannot be readily differentiated from zero mercury added batteries. However, average mercury levels in batteries have already declined significantly and, according to NEMA, will reach near zero by between 2005 and 2008.

In the US only the Alexander Battery Company still uses mercury to make specialty batteries for hospitals, the military, and others who need the special properties that mercury gives to a battery. Alexander Battery has a return program for its high mercury batteries so they can be returned for recycling, as is required under existing Maine law (Title 38 of the Maine Revised Statutes Annotated Section 2165(4)).

A significant amount of the mercury emitted by waste incinerators continues to come

from old batteries as there are millions of high mercury batteries, long since used and dead, stockpiled in desk drawers, old flashlights and broken toys in home attics, garages and businesses across the country.

In addition some sources suggest that there are foreign batteries in the waste stream that contain high levels of mercury. Laws in Japan, Germany and the rest of Western Europe are similar to US law so only those countries that have not adopted stringent mercury content laws are a risk. It is doubtful that America is a dumping ground for high mercury batteries, although some may find their way into the country.

Information from the Department of the Interior, United States Geological Survey, concerning mercury use in making batteries is presented below. This information was collected from battery manufacturers.

Table II

Mercury use by U. S. battery manufacturers from 1984
(Data from the U. S. Geological Survey in pounds/year)

Year	Amount in United States	Amount in Maine	Percent Reduction (running total)
1984	2257200	10472	0
1985	2099272	9742	7
1986	1654064	7272	27
1987	1175112	5453	47
1988	987012	4580	56
1989	55152	2558	76
1990	233700	1084	90
1991	39672	183	98
1992	28652	132	98
1993	22040	102	99
1994	13224	61	99.4
1995	1064	5	99.95
1996	1064	5	99.95
1997	1064	5	99.95
1998	1064	5	99.95

This table shows the reduction in mercury use by American battery companies based on the reduction in the amount of mercury purchased by the industry. It does not include button cells, which are estimated to add 20 lbs. Of mercury per year to the Maine waste stream by themselves.

Since the data from the U. S. Geological Survey (once the U. S. Bureau of Mines) shows that little mercury now goes into new American made batteries the issue becomes how much mercury is contributed to the Maine waste stream in old batteries, which depends on the length of time Maine people keep old batteries. One might

suspect that the widespread power outages from the January 1998 ice storm served to flush out many older, mercury-containing batteries. The MDEP conducted a one-time collection effort to capture old batteries that might have otherwise gone to incinerators. 13.6 tons of batteries were collected and landfilled as a result. The Massachusetts DEP suggests this theory may not be supported and there is little scientific data to show how many old batteries were turned out during the ice storm, however based on the authors experience, no old batteries were left after fourteen days without electric power.

The battery industry is surveying battery disposal trends in Florida, New Jersey and Minnesota, and those studies show that the mercury content in the stock of recycled batteries drops by about fifty percent every two years. They will be re-surveying the study sites again in October, 1998 and will have more information later in the year or early next year.

The Massachusetts Department of Environmental Protection contends that the amount of mercury from batteries contributed to that state's waste stream represents the highest total amount from any source, but recognizes that the share of mercury in the waste stream is dropping as older batteries are thrown out. The MPCA suggests that the amount of mercury in the waste stream in Minnesota is higher than the NEMA studies show but they are not certain by how much. Currently there appears to be no data to support this suggestion so when the latest Hennepin County survey results become available both the PCA and NEMA will be analyzing the data closely.

The MPCA feels that a battery collection program is effective in that state given its history of local recycling efforts and the Massachusetts DEP suggests that a collection system targeted at older batteries, including button cells, is warranted in Massachusetts.

The Milwaukee area report puts the total releases as a result of batteries at 53 lb./year but this seems to be a low estimate based on a two year turn-over rate. Conversations with other state mercury managers in Minnesota and New Jersey indicate that a longer turn-over rate may be more accurate.

NEMA's position is that a majority of batteries end up in the waste stream within two years after they are purchased. Using that assumption, in 1997, the last full year, there was only would only be 10 lbs. Of mercury left in all the batteries in Maine's waste stream plus 20 lbs. From button cells for each year for a total of 50 lbs. (5 lbs. From 1996 + 5 lbs. From 1997 + 40 lbs. From button cells from both years).

No other state agencies or NGAs agree with the two year disposal cycle but none suggests a specific longer life span. With no survey data for Maine and conflicting information from sources outside of the state two additional "life spans" were calculated and used to estimate the amount of mercury contained in batteries currently in the use/waste stream in Maine, one for a five-year and one for a ten-year span.

If batteries stay in the waste stream for five years there should currently be about 278 lbs. Of mercury in batteries in Maine, an amount arrived at by adding the USGS amounts from January 1993 to December 1997 (the last full year) from the above table and adding an additional 20 lbs. For each year for button cells. If they stay in the waste

stream for 10 years, 1988 to 1997, the amount becomes 8,915 lbs.

Both numbers were arrived at in the manner noted above, each years USGS data was increased by 20 lbs. The results are presented below.

Using a two year model:

Standing Stock = 50 lbs.

Using a five year model:

Standing Stock = 278 lbs.

Using a ten year model:

Standing Stock = 8,915 lbs.

How much of the standing stock ends up in the waste stream and is disposed of in landfills and incinerators is a guess. NEMA's analysis is that the amounts are decreased by 50% every two years. Others do not agree but have no better information. The New Jersey Department of Environmental Protection explains that they are seeing a one third reduction every two years rather than a one-half reduction.

All do agree, however, that there is very little mercury in batteries today and no one disagrees that the amount of mercury disposed of in the waste stream is decreasing. The differences of opinion arise concerning the actual amounts in the waste stream. The policy decision that springs from using the two, five or ten year calculation drives whether a battery collection program is needed or not.

2. Fluorescent Lamps

Fluorescent lamp bulbs use mercury to create ultraviolet light which excites the phosphor coating on the inside of the tube to create visible light. When current is applied to the lamp a small amount of mercury is vaporized. There is no alternative to this process but the lamp industry has greatly reduced the amount of mercury in each lamp over the past ten years. In the 1980s lamps contained about 48 mg of mercury each. By 1994 each four-foot lamp contained 23 mg of mercury, more than a 50% reduction. By 2000 NEMA estimates the mercury content of a four-foot lamp will be less than 12 mg.

In states with a large commercial sector, recycling lamps is the norm for large industrial and commercial users. Lamps are replaced in a regular rotation and those collected are manifested as appropriate and shipped to out-of-state recyclers. The recycling fee alone for this service is said to be about $0.50/bulb and is built into the purchase/maintenance/removal fees charged by the lighting contractor.

The average useful life of a lamp is 20,000 hours. Because most industrial and commercial users have the lamps lighted for ten to twelve hours/day, five or six days a week, the average life of a lamp may be about five years. However, some businesses

re-light on three or even two year intervals in order that none of the lights burn out. One recycler explained that losing a bulb in a product display area shows up almost immediately in lost sales so retailers are conscious that good and constant lighting is important to their profitability.

Useful lamp life is likely to be much longer for small commercial facilities and homeowner as the lamps are not used as much. It would not be unusual for a lamp in the basement to be used for eight to ten years. Home owners and small commercial businesses are more likely dispose of burned-out lamps in the trash.

Joseph Howley, Manager, Environmental Marketing, General Electric Company, Cleveland, Ohio, explains that 80% of the fluorescent bulbs are used by large commercial and industrial facilities and that about 20% of the lamps are used in homes and small commercial environments.

According to NEMA, when a lamp is broken, as is likely to be the case when disposed of in the trash, any mercury in the vapor phase (about .04 mg according to NEMA) is immediately released. Much of the remaining mercury slowly vaporizes as long as it is exposed to the air but a small percentage remains tied up in the bulb components and does not easily vaporize. Since mercury does not vaporize easily at ambient temperatures loss to the air is slow. Mr. Smith at the Massachusetts DEP explains that during waste handling a significant amount of mercury is released. All agree that when lamps are incinerated without controls to reduce mercury emissions all of the mercury is vaporized and most (about 70%) becomes airborne, the remaining 30% being caught in the fly ash. No Maine incinerators have such controls.

In addition to tube lamps of two, four-foot and eight-foot lengths, high intensity discharge lamps (HIDs) are used throughout Maine. The numbers in this section only include commercial sized four-foot lamps and two-foot lamps. The HID market is smaller but significant, about 4 % - 5% of the market.

Modern bulb recycling is done in equipment like the Photon-V. Bulbs are shipped to the recycling facility intact and placed in the recycling machine. There the mercury and phosphor dust are removed through a heat process. The glass and aluminum end caps are recycled and sold and the mercury in the phosphor dust is distilled. Finally the phosphor dust and mercury are marketed. The phosphor is used by hazardous material clean-up sites as an absorbent. The equipment is said to be very clean and suggestions that, as one Florida report said, 2% of the mercury might be lost to the air, were received by one recycler with the comment that flue gases at their facility were tested regularly and the level of mercury was below detection limits. Older recycling facilities may emit more mercury to the atmosphere.

Calculations: NEMA suggests calculating the mercury in lamps as follows:

Since lamps last an average of five years, lamps disposed of in 1999 will be related to mercury used in lamps in 1994. The USGS says that mercury purchased by the lamp industry since 1994 has been 30, 33, 32 and 32 tons. It would be fair to use 32 tons as an estimate of mercury purchased by the lamp industry. Only about 50% of the mercury

actually goes into a lamp. The other portion of mercury is used in the manufacturing process and returned to mercury distillers for purification. That means about sixteen tons or 32,000 pounds of mercury is in lamps that will be disposed in 1999.

The Maine population (1,242,051) is roughly 0.0046 of the US population (267,636,000). Based on population, and using the 16 ton level, mercury levels from lamps would be 147 pounds. A second estimate confirms this result. The average lamp manufactured in 1994 contained slightly less than 23 mg of mercury. This is the lamp on average that will be disposed of in 1999. Multiplying 23 mg by the number of lamps sold in Maine (roughly the Maine population times two) or 2.5 million equals 57,500,000 mg of mercury. Dividing by 454,000 mg per pound results in 127 pounds of mercury. So mercury levels in lamps disposed of in Maine in 1999 will contain between 127 and 147 pounds of mercury or 137 lbs., on average.

This means that if lamp manufacturers did not reduce mercury levels in lamps since 1994, the standing stock is 5 times 137 or 685 pounds. Lamp manufacturers have reduced mercury levels in lamps but the specific data is not available so the above number for standing stock will be used.

Recycling numbers for Maine have not been collected in a manner in which they can be readily used for this report; however national bulb recycling estimates indicate that about 10% of the bulbs sold are recycled. Large businesses account for 80% of bulb use and also for nearly 100% of the recycling effort. It is not likely that many small businesses or homeowners recycle their fluorescent bulbs. (137 lbs. X .80% use) X 10% recycling = 10.96 lbs. Recycled, leaving 126 lbs. Disposed of in the waste stream each year.

Standing Stock = 685 lbs.
Waste Stream = 126 lbs./year

3. Thermostats

The operation of a mercury thermostat is based on two physical phenomena of metals:

1. A bimetallic strip bends or straightens when heated or cooled as the two metals expand and contract differentially; and,
2. Mercury is a liquid metal that conducts electricity.

These two characteristics make the mercury thermostat an excellent control mechanism for home heating. As a building cools the bimetallic strip in the thermostat relaxes, rotating an ampoule of mercury attached to it. When the temperature preset by the homeowner is reached the strip has moved enough to allow the mercury to flow to the electrodes at one end of the ampoule and complete an electrical circuit that turns on the furnace.

In Maine almost every home and business establishment has one or more thermostats. EPA estimates that 83% of these thermostats contain mercury. Most homes have only

one zone but newer homes, and especially electrically heated homes, may have many.

Most bimetallic mercury thermostats contain three grams of mercury in a single ampoule but some contain more than a single ampoule.

Calculations: In calculating the amount of mercury in thermostats many assumptions are made. It should be noted that in the Milwaukee study many of the same assumptions were used.

1. Assume 1.5 thermostats per household;
2. Assume 1.25 thermostats per business establishment;
3. 83% of thermostats contain mercury (EPA);
4. Each mercury thermostat contains a singe 3 gm ampoule of mercury; and
5. A thermostat is replaced at between 20 and 50 years.

The US census counts 465,312 households in Maine and 67,986 businesses.
(465,312 homes X 1.5) + (67,986 businesses X 1.25) = 785,950 thermostats in Maine
83% of homes use mercury thermostats so 785,950 X 83% = 652,339 thermostats.
3 gms per thermostat = 1,957,016 gms of mercury divided by 454 gms/lb. = 4,310.6 lb.
In the standing stock of homes and businesses in Maine.

Assuming the life of a thermostat is 35 years (NEMA says unit life ranges from 20 to 50 years) each year 1/35th of the thermostats in Maine are replaced due to malfunction, system replacement or demolition.

Disposal is piecemeal by job so inoperative thermostats might be returned to a heating company or just be thrown into the trash at the place of removal. In either case they are likely to end up in an incinerator or a landfill. If they are incinerated the mercury is vaporized to the atmosphere. If they are landfilled the ampoule may or may not be broken. Fred Wingate, president of Wingate Lathe, a heating oil firm in Hallowell, Maine, explains that they replace about 20 thermostats a year. If the TRC program were implemented in Maine his firm would take advantage of it.

Standing Stock = 4,310 lb.
Waste Stream = 123 lb./year

4. Automotive Convenience Lights

Cars and trucks in the United States contain several sources of mercury, most insignificant. The largest source by far, accounting for about 85% or more of the mercury in a vehicle, is found in switches used to activate lights in trunks and under hoods. Information from North East Waste Management Officials Association (NEWMOA) is that 12.2 million mercury switches were placed in vehicles in 1997 and about 8.5 metric tons of mercury were used to manufacture these switches.

Assuming that a car or truck in Maine must be replaced 10 years after purchase and the

replaced vehicle is sold for scrap.

Calculations:
One metric ton = 2,200 lbs., so 8.5 metric tons = 18,700 lb. of mercury.
Per capita in the US: 18,700 lb. ÷ 267,636,000 = 0.0000698 lbs./person.
Per capita in Maine: 0.0000698 lbs./cap X 1,242,051 Maine population = 86.7 lbs. of mercury in 1997 cars and trucks sold in Maine.

If a Maine vehicle lasts for ten years there may be as much as 867 lb. of mercury in the standing stock of vehicles in Maine with 86.7 lb. per year taken off the road and sold out of state, recycled or parked in backyards across the state.

While a significant part of the mercury in Maine cars that are disposed of each year leaves the state before entering the waste stream, there is no clear way to determine how much. As a result this report assumes that it stays in Maine and enters the solid waste stream.

Standing Stock = 867 lb.
Waste Stream = 87 lb./year

5. Fever Thermometers

Fever thermometers are small glass tubes containing mercury that are calibrated to give precise measurements of body temperature.

Assuming that fever thermometers are used in households, doctor's offices, nurses stations, infirmaries and dozens of other settings across the state where the temperature of a patient might be taken, the number of individual thermometers is very high. Most fever thermometers contain about .5 gms of mercury although some may contain as much as 3 gms. They are fragile instruments so care must be taken by the user to insure that children do not come in contact with liquid mercury. The medical literature discusses a few cases where mercury vapor from broken fever thermometers was deemed causative in the serious illness of children and death in geriatric patients. In the cases involving children the mercury was ground into carpeting and inhaled over time as the mercury vaporized in the home.

Alternatives such as digital electronic thermometers, glass/alcohol thermometers, glass/gallium-indium-tin thermometers (galinstan), ear canal thermometers and flexible forehead thermometers are readily available and, while somewhat less exact in the hands of a person not trained in medicine, should be adequate for normal household use.

Estimates using the EPA's nationwide totals discarded to the waste stream are the best available at this time. Estimates of the standing stock based on guesses using the number of homes, thermometer life, and assumed number of thermometers in each home have not been attempted as they were deemed too variable to be of use.

Calculation based on EPA data:
According to the EPA 16.85 tons of mercury or .000125 lb./person is discarded each year in fever thermometers. In Maine that equals about 155 lb. of mercury per year added to the waste stream.

Standing Stock = Unknown
Waste Stream = 155 lb./year

6. Large Appliances

Large or major appliances include clothes washers and dryers, refrigerators/freezers, chest freezers, dishwashers, ranges/ovens, microwave ovens, room air conditioners, and dehumidifiers. Portable appliances include irons, hair dryers, toasters, blenders, food processors, portable heaters, coffeemakers, and such. For the purposes of this report water heaters, furnaces, central air conditioning systems, and sump pumps are not considered large appliances.

Taking the appliance waste stream as a whole, including appliances that may be 25, 30 or even 50 years old, there are numerous sources of mercury. For example, chest freezers with lid-top lights and old automatic washing machines with an "automatic-stop" function often use or used mercury switches. Anecdotal evidence in a letter from the Appliance Recycling Corporation of America Inc. (ARCA) suggests that some very old automatic washing machines may have several mercury switches for different functions (while not a manufacturer of appliances ARCA, in years past, recycled appliances to the used appliance market or the scrap metal market on the east coast and is still active on the west coast). Likewise, some "auto-off" irons have mercury switches and the tip-over safety switches in space heaters may contain mercury. Finally, sump pumps with float switches often use mercury.

Short of calling every single manufacturer of every variety of appliance, a task impossible under the time constraints of this project, it is not possible to determine how much mercury is in the waste stream from these sources. The amount arrived at in this brief overview is less than exists in the commercial and residential environment.

The Association of Home Appliance Manufacturers (AHAM) explains that washing machines have not used mercury switches for 26 years and suggests that we assume that those products have already been disposed of as the average life of a washing machine is 20 years. In addition, AHAM reports that space heaters with the "safety off" tip-over feature and a "very few" irons are manufactured today contain mercury.

Data specific to Maine concerning the sale of "chest freezers" and "pilot light gas ranges" was provided by the Association of Home Appliance Manufacturers and is considered highly accurate. AHAM states that these are the only two kinds of major appliances that contain mercury.

Chest Freezers. Because of the temperatures at which a freezer operates, AHAM explains, their manufacturers feel that only mercury switches can *reliably* be used to activate an interior light. Of all the chest freezers made only 25% contain interior lights and mercury switches. The mercury is located in an ampoule in the light switch. When the top of the freezer is opened the mercury switch activates the chest light. Each freezer contains one switch and each switch contains .035 oz of Mercury.

Assuming:

1. The average life expectancy of a chest freezer is 20 years (industry data);
2. Sales have been more or less flat for the last 20 years;
3. 25% of freezers sold have interior lights with mercury switches;
4. 2,600 freezers were sold in 1997, and
5. A light switch contain 0.035 oz of mercury.

Calculations: 2,600 (sold in 1997) freezers X .035 oz/freezer X 25% with lights = 22.75 oz = 1.42 lb./year.

If 2,600 units were sold each year for the past 20 years, as assumed, then 28.4 lb. of mercury exists in freezers throughout Maine. If, after reaching saturation, more or less the same number are disposed of as are purchased each year then 1.42 lb. of mercury is discarded each year in appliances.

Standing Stock = 28 lb. of mercury
Waste Stream = 1.4 lb./year

Pilot Light Gas Ranges: A "diostat switch" in pilot light gas ranges insures that no gas escapes into the room when the oven is turned off. It is a safety device and not likely to be replaced by manufacturers with a non-mercury alternative. Each diostat contains .07 oz of mercury and 28% of the gas ranges produced use a diostat. Other types of ranges uses a "glow bar" to control gas flow. A glow-bar is more expensive and produces a finer temperature control but requires electricity to operate. Generally the ranges using diostats are not connected to electricity.

Assuming:

1. The average life expectancy of a chest freezer is 19 years (industry data);
2. Sales have been more or less flat for the last 19 years;
3. 28% of gas ranges sold have diostats containing mercury;
4. 6,500 freezers were sold in 1997; and
5. A diostat contains 0.035 oz of mercury.

Calculations: 6,500 (sold in 1997) units sold in Maine of which 28% use mercury diostats = 1,820 units X .07 oz of mercury/ diostat = 8 lb. of mercury each year. The life of a pilot light range is 19 years = 152 lb. of mercury in the existing stock of gas ranges in Maine.

If 6,500 units were sold each year for the past 19 years, as assumed, then 152 lbs. of mercury exists in freezers throughout Maine. If, after reaching saturation, more or less

the same number are disposed of as are purchased each year then 8 lbs. of mercury is discarded each year in appliances.

Standing Stock = 152
Disposed Stock = 8

7. Medical Offices

Medical offices include doctor's offices and hospitals. Hospitals use high mercury batteries for certain kinds of equipment, sphygmomanometers to measure blood pressure and dozens of pieces of medical equipment (see list in appendix). Maine hospitals are represented by the Maine Hospital Association (MHA), an affiliate of the American Hospital Association (AHA). The MHA is currently working with the Office of Pollution Prevention to carry out the terms of a nationwide agreement between the AHA and the EPA concerning mercury reduction and elimination. The EPA initiative was signed in June of this year and initial organizational steps are underway at the MHA. At this point, since the hospitals are working toward a goal of being mercury free by 2005, and because each hospital has a mercury spill plan and detailed instructions on disposal, further inventory of the mercury in this sector was not performed. All sources agree that hospitals represent a significant reservoir of mercury.

Doctor's offices
The number of doctors in Maine, and therefore the number of offices they use, is difficult to determine. The Maine Medical Association has about two thousand doctors who are members. The State Board of Medical Registration contains the names of more than 4,704 licensed doctors in Maine. The difference in the numbers is caused by a variety of factors. Retired doctors continue to be registered, many doctors are licensed in several states, and some doctors do not join the Maine Medical Association.

For this study I have chosen to use the Medical Board of Registration number with some corrections suggested by Dr. John Garofalo, a past president of the Maine Medical Association, who was interviewed concerning the number of sphygmomanometers or "blood pressure cuffs" in Maine, potentially a significant reservoir of mercury which might end up in the solid waste stream.

Dr. Garofalo explained that the mercury manometer is the most accurate way to measure blood pressure and that if he switched to non-mercury devices he would keep a mercury "cuff" to calibrate the non-mercury manometers. He added that his practice now uses digital thermometers almost exclusively but when he needs to know the temperature of a patient precisely he uses a mercury thermometer kept in reserve for that purpose.

James Baum, Vice President of Baummanometer in Copiague, New York, provided information about sphygmomanometers. He noted that there are several types of blood pressure cuffs made by his firm in general use, wall-mounted, desk and wheeled. The wall mounted and desk cuffs contain about 4.07 oz of mercury and the wheeled

versions contain about 4.35 oz of mercury (wheeled manometers contain more mercury because they may be placed on a surface with up to 20% grade and still read accurately). Since it is not possible to know how many of each kind are used in individual offices it is assumed that hat all are of the larger wheeled type containing 4.35 oz of mercury, an assumption that means some over counting.

Sphygmomanometers are lifetime instruments, according to Mr. Baum. He explains that they are seldom thrown away because they are valuable ($150/unit) and don't fail. His firm tracks serial numbers back to the 1920s and is able to and does repair even the oldest of the manometers sold in the last 70+ years. Baumanometer recycles blood pressure cuffs to "needy" applicants for free and will accept old cuffs in trade for new ones. Broken cuffs can be returned to Baumanometer for repair or replacement.

The following assumptions have been made about sphygmomanometers in medical practices in Maine.

1. There is likely to be a cuff in each examining room;
2. Each doctor's office, on average, will have 2.5 examining rooms;
3. Of those registered only about 70% actually practice in Maine;
4. Assume 1% of cuffs go to the solid waste stream each year; and
5. Cuffs in other settings such as factory infirmaries, college campuses, school nurses stations contribute about 500 cuffs.

Calculation:

4,704 registered doctors X 70% activity rate = 3,293 practicing doctors in Maine.
3,293 doctors X 2.5 examining rooms = 8,232 blood pressure cuffs in Maine,
4.35 ozs/manometer X 8,732 cuffs = 37984 ozs of mercury ÷ 16 oz/lb. = 2,374 lb. of mercury.

Standing Stock = 2,374 lb.
Disposed Stock = 23.7 lb.

8. Dairy Manometers

There are 501 Maine dairies. Each dairy uses a manometer or vacuum pressure gauge of some sort to set the vacuum of its milking machines. Conversations with Dr. Donald Hoenig, a dairy veterinarian with the Maine Department of Agriculture, indicate that, unlike Minnesota where a dairy manometer exchange program is underway, Maine dairies are smaller and few use mercury manometers. Dr. Hoenig estimates that about 25 Maine dairies have a mercury instrument and that it will probably be replaced with a spring or digital instrument when retired from service. While information from Minnesota indicates that as many as one third of their dairies use mercury manometers, Dr. Hoenig explains that for a number of reasons that is not the case in Maine.

Mercury used to fill dairy manometers is generally sold in one pound containers, based

on information contributed at the November 20, 1998 meeting in Portland, so for the calculations below it is assumed each installed manometer uses one pound of mercury.

Calculations: Each dairy manometer contains about .78 lb. of mercury but the mercury is shipped in 1.0 lb. containers. There 501 dairies, of which 25 have mercury manometers.

25 manometers X 1.0 lb. each = 25 lb. of mercury in dairy manometers.
Disposed of manometers may be on the order of one or two each year = .78 to 1.56 lb./year

Standing Stock = 25 lb.
Waste Stream = 1.6 lb./year

9. Laboratory Thermometers

No data exists on the use of lab thermometers in Maine. Assuming, however, that each lab thermometer contains about 3 gms of mercury and that there might be 750 lab thermometers in the businesses, laboratories, colleges and on the university campuses of Maine 750 gms of mercury exists in this source category. If ten percent are broken each year about 0.5 lbs. enters the waste stream from this source.

Calculations: 750 thermometers X 3 gms/thermometer = 750 gms ÷ 454 gms/lb. = 5 lb.
If 10% are broken each year = .5 lb. disposed of into the waste stream.

Standing Stock = 4.9 lb.
Waste Stream = 0.5 lb.

IV – REDUCTION STRATEGIES

There are many ways to reduce the amount of mercury in the solid waste stream in Maine. They involve innovations by government and businesses to capture and recycle or properly dispose of the element. The Minnesota Source Reduction Feasibility and Reduction Strategies Committee has studied this issue at great length. Their draft report on Options and Strategies for Reducing Mercury Releases is as good a list of ways to reduce mercury in the environment as exists. The final report was released in early October.

Manufacturer reverse distribution systems exist for some mercury-added products. The Thermostat Recycling Corporation recycles thermostats, although not in Maine. The Alexander Battery Company makes provision for the recycling of its batteries by hospitals, its primary market in Maine. The Ni-Cad take-back program for rechargeable batteries is another program that exists, although it doesn't involve mercury added batteries. In addition, Maine's history as a bottle recycling state dating from the late 1970s shows that recycling to manufacturers can be accomplished.

A. Recycling Programs

1. Thermostats

TRC is a corporation organized by three thermostat manufactures, White-Rogers, General Electric and Honeywell, to administer a national program to recycle mercury-containing thermostats. The program is in operation is nine states as of June 26, 1998, including Florida, Illinois, Indiana, Iowa, Michigan, Minnesota, North Dakota, Ohio and Wisconsin.

The program collects all brands of used wall-mounted, mercury-containing thermostats. The thermostats are placed in specially designed boxes located at participating heating, ventilation and air conditioning wholesalers. TRC then arranges for transport of the boxes to a removal site where TRC removes the mercury containing bulbs. The mercury is then recovered and recycled. All costs are born by the TRC except for a one-time $15.00 fee charged by TRC to participating firms.

TRC has expressed its interest in expanding its program into 13 northeastern states, including Maine. Maine is currently working with TRC to establish a collection program. However, TRC will not begin collecting until agreements are reached with all 13 states.

2. Appliances

As far as can be determined appliance manufacturers have not established any recycling programs to recover mercury from their products. The Appliance Recycling Corporation of America, Inc. (ARCA), a non-profit corporation that is not part of the appliance manufacturing community, is involved in the removal and

recycling of mercury from major appliances. The service they provide in other parts of the country, primarily on the west coast, is to remove and recycle mercury containing components from many types of major household appliances. AHAM explains that it is aware of no appliance manufacturers that currently use mercury but that older washers, dryers and irons did use mercury switches in the past and there are likely to be older appliances in use that still contain mercury switches.

ARCA does not operate in Maine or on the east coast. In lieu of this service options for capturing mercury from appliances include requiring Maine appliance retailers or used appliance dealers to remove mercury containing switches from major appliances as they are discarded from the home when new appliances are delivered.

It is possible that landfill managers could be trained to find and remove mercury switches before appliances are put in the "white goods" areas of municipal landfills. A small fee for the cost removal would pay for any training needed. Then, with adoption of the Universal Waste Rule the landfill might become a collection point for any mercury capsules thus removed.

ARCA suggests that the California Integrated Waste Management Board be contacted for instructions printed for landfill operators on how to remove mercury switches.

3. Lamp Recycling

Maine has revised its hazardous waste management rules concerning the storage and transport of mercury-containing lamps in order to better facilitate recycling of the mercury they contain (see DEP Mercury-Containing Lamp Policy, October 25, 1996).

Currently about 10% of fluorescent lamps used in major businesses in Maine are recycled from firms like Shaws and Central Maine Power Company and others who have large offices or workspaces in Maine. Generally they hire a lighting contractor to replace and recycle their lamps on a regular basis. The contractors are required to report how many lamps are recycled each year to the MDEP.

Once lamps are removed from the fixture in the building they become hazardous waste and are subject to the requirements of state and federal law concerning storage, transport and disposal. A growing percentage of lamps are not hazardous wastes at the end of their useful lives. The generator of the lamps is ultimately responsible for the proper disposal of the waste in an environmentally acceptable manner.

Lamps are trucked to out-of-state processors who sort, crush and recycle the glass, aluminum and mercury contained in the lamps.

4. Dairy Manometers

Minnesota has initiated a first in the nation dairy manometer exchange program. Under this program the state purchases the existing mercury manometer from the dairy and allows some additional expense for the purchase of a new non-mercury manometer. The total cost per manometer is about $250.

The Minnesota program was discussed briefly with Dr. Hoeing, of the Maine Department of Agriculture. He agreed that mercury manometers could be easily replaced with non-mercury alternatives but since he estimated that there were only about 25 mercury manometers in the state's 501 dairies the program would capture much less mercury than it does in Minnesota.

5. Medical Batteries

The Alexander Battery Company is the only manufacturer of "high" mercury batteries in the United States. It has a recycling program that involves re-packaging spent batteries for returning the company for recycling. As part of the AHA and EPA mercury free hospital initiative, Maine hospitals will be advised in more detail about the program.

B. Advance Disposal Fees

One method of providing funds to cover the cost of mercury recycling is to institute a system of advance disposal fees on items not otherwise recycled such as lamps or thermostats. Under such a system a fee is added to the cost of a product containing the mercury. The fee is non-refundable and goes to an account held by the State dedicated to costs associated with recovering and disposing of mercury from the products on which the fee is placed. Maine has some background in this area in automotive battery and tire disposal fees.

C. Product Labeling

1. Minnesota

As has been acknowledged elsewhere in this report, of all the states Minnesota is the leader in tackling the thorny issues of mercury use and reduction. Because they have been at it longer, have better data and are, therefore, more aware of the impacts of mercury to their environment they have been more active in the legislature as well. Minnesota enacted a Mercury Prohibition law that includes a labeling provision for certain products containing mercury. The products regulated by the law are thermostats and thermometers, electric switches other than in motor vehicles, appliances, medical and scientific instruments and electric relays or other electrical devices. The label must tell the consumer that there is mercury in the

product and that the it cannot be placed in the garbage until the mercury has been removed and reused, recycled or otherwise managed to ensure that it does not become part of the solid waste or wastewaters of the state.

A synopsis of the Minnesota Law:

- Manufacturers of thermostats must provide incentives to insure that the mercury is reused or recycled when the thermostat is taken out of service.

- Manufacturers of displacement relays are responsible for the costs of collecting and managing the relays to insure that they do not become part of the solid waste stream. They must provide incentives to insure that the consumer does not dispose of the relay in the solid waste stream. The manufacturer or an organization of manufacturers may participate in projects to collect relays A displacement relay is defined as an electric flow control device having one or more poles containing metallic mercury and a plunger which displaces mercury enough to create a closed circuit.

- Medical facilities may not routinely distribute mercury thermometers.

- The person selling fluorescent and HID lights to industrial, commercial, office or multi-unit residential dwellings must notify the buyer that the lamps contain mercury, that they must not be disposed of in solid waste and that they are regulated my state and federal law. Likewise, a person who contracts to remove fluorescent or HID lamps must inform, in writing, the person for whom the work is being done that the lamps contain mercury as well as what the contractor intends to do with the old lamps.

- The use of mercury in toys, games and apparel is banned.

- Mercury manometers used in the dairy industry may not be sold or installed in Minnesota and all manometers currently in use must be removed from service and recycled by January 1, 2000.

2. Vermont

In the northeast, Vermont holds a place much like Minnesota in the Midwest. New ideas and stringent environmental rules often start there and are adopted by other northeastern states. In 1998 the state of Vermont passed a law concerning the labeling of mercury-added products.

Synopsis of the Vermont law:

- As in Minnesota, a mercury-added product cannot be sold unless it is labeled as to its mercury content and so as to inform the consumer that it may not be disposed of in the waste stream until the mercury is removed and reused, recycled or otherwise managed. Products regulated by this law are similar to

those in the Minnesota law; thermostats or thermometers, switches, medical and scientific instruments, electric relays or other electrical devices, lamps and batteries sold to the public, except for button batteries.

- In addition, everyone who discards solid waste in Vermont must separate labeled mercury-added products from the regular solid waste.
- Collection of the labeled waste will occur at a designated collection area.
- By December 1, 1998, solid waste implementation plans for every solid waste management district or municipality must be amended to provide for an information effort to advise the public about labeled mercury-added waste products and to provide a collection program for the mercury-added products.

V. – BENEFITS AND BARRIERS

1. Product Labeling

Benefits:

- Public Information - Labeling products containing mercury can be seen as a benefit because it make the public aware of the mercury content in some of the products used in everyday life and causes the consumer to make an educated choice between mercury containing and non-mercury containing products. A labeling effort will likely carry over to non-labeled mercury containing products applying pressure to reduce or eliminate mercury in those products as well.

- Reduced Use - The environmental benefit derived is based on the assumption that a knowing consumer may not purchase mercury containing products if they understand the potential damage the element can cause to the environment. In addition the consumer can weigh the time and effort recycling will cause when the product is worn out and must be replaced compared to some less onerous replacement effort when a non-mercury containing produce must be replaced.

Barriers:

- Stigmatization - Product labeling can stigmatize a product and reduce its market share, even if, in a long view, the product is better for the environment than alternatives. NEMA makes this argument concerning fluorescent bulbs which use less energy thereby demanding less power be produced for lighting needs. Power generation is a major source of atmospheric mercury pollution.

- Inefficient - The process of creating and distributing labeled products on a state-by-state piecemeal basis is inefficient for manufacturers. They will argue that they will just stop shipping to Maine if a labeling law is passed.

As a matter of history that occurred when the Waste Management Agency instituted a ban on Ni-Cad batteries. If fact, while some manufacturers pulled out of the Maine market others did not and there was an ample supply of properly labeled Ni-Cad batteries in the marketplace.

Note: Because the two laws currently in place are very new there are no figures available on whether labeling has had any impact on the use of mercury containing products.

2. Third Party Buy-Back Programs

As far as can be determined there is only one "buy-back" program, the thermostat program initiated by the Thermostat Recycling Company.

Benefits:

- When instituted in Maine the TRC reverse-distribution program can remove as much as 123 lb. of mercury from the Maine environment each year, almost 25% of the identified mercury product load.

- The program has proven to be somewhat effective in the states which are currently members.

- Public education of the effort will alert Maine people to the hazards represented by mercury in the waste stream.

Barriers:

- Homeowners may replace their own thermostats in many homes in Maine. They will need to be made aware of the program when they purchase the replacement unit.

- Aggregating mercury in any facility poses some level of danger although it must be assumed that heating, ventilation and air conditioning firms are best equipped to deal with the problem and will exert the proper level of care

- Public attention to the issue of mercury in the waste stream may cause consumers to purchase non-mercury thermostats, a barrier to the manufacturers of these devices that is likely balanced by the fact that they make non-mercury devices as well.

3. Clean Sweep Programs

Benefits:

- Clean sweep programs, like those in Wisconsin, can be seen as a public education effort with lingering effects concerning all mercury containing products into the future.

- These programs gather at least a portion of mercury containing products from the environment in each pass, reducing the amount wasted to landfills and incinerators.

Barriers:

- Public education costs money and will be relatively expensive per pound of mercury removed.

- By its nature this is an effort that must be undertaken by state or municipal governments, already hard pressed to find staff hours to do their everyday jobs. Running a Clean Sweep program will require several staff people spread across the state. While the tasks might be set up as part time jobs for staff with other duties, in sum it will require payroll expenditures as well as public education expenditures from already tight state and municipal budgets.

- Once collected in a single site the mercury containing products will have to be disposed of properly or recycled. Improper disposal after collection, while not a high probability, is a possibility that should be guarded against. For example, if any of the mercury containing products were disposed of in an incinerator after collection the potential for a public outcry would be significant.

4. Manufacturer Buy-Backs

This strategy is discussed in the Minnesota Options and Strategies Report. As envisioned there it would involve a deposit system much like Maine's bottle bill.

Benefits:

- Such a program would shift some of the administrative and cost burden to manufacturers although a significant amount would remain for public entities to subsidize in terms of collection and enforcement.

- A buy-back program would remove some of the mercury containing products from the waste stream by giving them some value in the market place.

Barriers:

- Manufacturers could be expected to lobby long and hard to prevent adoption of such a program. Those who remember the bottle bill battles of the late 1970s well remember the constant barrage of television ads from the bottling industry.

- Buy-back, Take-back or other systems that provide for product return to the manufacturer arguable pose health and safety issues as citizens collect and store mercury containing products in their homes, saving enough for a trip to the recycling center or other collection point. While there would be little threat from old batteries, storing liquid mercury in the home could lead to the kind of remediation effort that was undertaken last year when mercury was found in an abandoned building in Waterville. This concern must be weighed against health and safety issues associated with the current absence of a collection system for mercury-containing products in the home.

5. Advance disposal fees

This strategy is used currently on some Maine products such as tires and automotive batteries. At one time it was also part of the funding formula for the Waste Management Agency but, disposal fees for most products were removed by the legislature after pressure from retainers and manufacturers.

Benefits:

- The State of Maine would collect a funding source to be spent on removing mercury containing parts from products that contain them. The fund would be used to collect and dispose of the mercury in an environmentally sound manner.

- As a result of lower mercury contamination in the waste stream, the cost of operating waste to energy plants could be decreased.

Barriers:

- Businesses would be forced to collect another fee for the state.
- The price of Maine products would rise compared to other states, a particular problem along the New Hampshire border
- Creating and managing the fund would cost the state and the fund a small part of the money raised.

6. The Universal Waste Rule

Hazardous wastes generated by households (such as thermostats) are exempt from Resource Conservation and Recovery Act (RCRA) Sub. C requirements (because of the regulatory burden their disposal would cause). However, when materials that would otherwise be classified as hazardous under RCRA Sub. C are collected by commercial establishments, industrial facilities or other non-exempt generators, the collected waste falls under RCRA Sub C and the business is required to comply with the Sub C manifesting and waste management requirements. Many companies felt this was burdensome and EPA recognized that gains could be made in recycling some hazardous materials generated at the household level if a new rule could be written. It responded by promulgating the Universal Waste Rule in 1995. The rule allows for alternative management structures and streamlined collection requirements for batteries, mercury-containing thermostats and certain pesticides.

Specifically the rule eliminates most manifest requirements, allows for the collection of "universal wastes" for up to a year, allows off-site consolidation of wastes and prohibits the shipment of universal wastes to solid waste landfills or incinerators.

As was noted above, Maine currently operates under policies such as the Mercury Containing Lamp Policy which implement the underlying concept of reduced hazardous waste manifest requirements designed to facilitate recycling.

APPENDICES

1. List of Mercury Containing Products from Minnesota Study

Uses of mercury for its mechanical properties as a high-density, low-friction fluid

- telescope mirrors
- Canter Tube: 6' tube used in medical procedures to trace GI tract
- Bougie Tube: used in medical procedures for esophageal dilation
- lighthouse lamp bearing
- waste water treatment plant pivot arm bearing
- archery as a bow stabilizer; two models: 6" 8 oz.; 10" 11 oz. (Neutralizer®)
- DC watt hour meters (no longer made but may still be in use)
- bubbler or trap used in laboratories to seal reaction vessels for monitoring gas evolution
- weights and counterweights in grandfather clocks

Pressure and flow rate measurement and control devices (manometers), tube type and well type
Note: devices in this category have extensive application in the natural gas industry

- sphygmomanometers (blood pressure "cuffs")
- laboratory manometers (pressure measurement devices)
- commercial-industrial manometers (many types and uses)
- dairy barn manometers (tube type, measures milking system vacuum)
- barometers - atmospheric pressure (well type, climatology and meteorology uses)
- gas meter pressure safety device (tube device, likely no longer made but in use)
- permeter - used to measure permeability of sand mass to flow of air (foundry application)
- air flow measurement devices using a Pitot Tube and manometer (foundry and other applications; may also be called an airway controller)
- mercury diffusion pump (laboratory/educational use)

Temperature measurement and sensing devices

- Mercury in glass thermometers, (ASTM and laboratory)
  - cup case (for tank sample temperature testing)
  - tapered bulb thermometers (armored)
  - sling psychrometer (for measuring relative humidity)
  - mason's hygrometer (stationary, for measuring relative humidity)
  - oven temperature control (home and commercial)
  - candy/deep-fry thermometers (home and commercial)
  - weather measurement thermometers (home, commercial, scientific)
  - minimum/maximum thermometers (home, commercial, scientific)
  - fever thermometers (home, commercial, veterinary)
  - other specialty uses, e.g., Clerget sugar test, blood bank, incubator/water bath, dairy
- Mercury flame sensor/mercury safety valve (stainless steel bulb, capillary tube, and bellows control device) used for 'unsupervised burners' in certain gas fired devices with standing pilot or electronic ignition pilot , e.g., residential and commercial 0vens/ranges, commercial griddle with concealed pilot, unit heaters, some light industrial oven applications, furnaces, infrared heaters, 'cycle pilot' devices)
- Mercury thermostat sensors (w/stainless steel capillary tube) (used in gas ovens operating up to 750°F (not used in self-cleaning ovens), discontinued in 1970's. Currently produced devices use oil or sodium-potassium mixture.)

Thermo-electric devices (mercury movement opens and closes an electrical circuit at a preset or adjustable set point)

- thermostats (1, 2 or 4 glass tubes of mercury are used in conjunction with relay control device); mercury-thallium models are used for temperatures to neg. 60°C
- thermal switch with integral or remote mounted solid state control (similar to a thermostat)
- thermoregulator (an adjustable mercury in glass device with an electrical output dependent on the position of the mercury column)

Electrical properties (switches, relays, sensors)

- cathode in mercury-cell chloralkali production facilities
- dropping mercury electrode (DME) technique for polarography and analytical chemistry
- displacement or plunger relays (generally for high current, high voltage applications, e.g., resistance heating, welding, lighting, power supply switching, and industrial process controllers
- wetted reed relays (printed circuit board mount)
  primarily used in test, calibration, measurement equipment where stable contact resistance over the life of the product is necessary. One industry source states that 90% of market is for specialized equipment produced in quantities of 10-200 units per year; mass production applications do not need mercury-wetted reed relays
- telecommunications industry switching equipment and boards used in central facilities
- tilt switches (including SPST, SPDT, NO, NC, wide angle, omni-directional, circuit board mount)
  - temperature control (mounted on bimetal coil or attached to bulb device)
  - pressure control (mounted on bourdon tube or on diaphragm)
  - fluid level control (mounted in float, on lever arm, on diaphragm or on plunger)
  - airflow/fan limit controls (mounted to vane in airflow)
  - pneumatic tube communication systems
  - 'man down' alarms
  - swimming pool alarms
  - safety shut off
    - steam irons
    - electric space heaters (may have been discontinued by early 1995)
    - outboard motors
    - limit switches for industrial machinery
  - automobile hood, trunk, vanity mirror, glove box, emergency brake lights
  - automobile automatic roll bar
  - automobile 'ride control' automatic leveling suspension
  - automobile security systems (tilt and trembler devices)
  - building security systems (tilt and trembler devices)
  - 'silent' wall switches, single pole and three-way; identifiable by "top" mark on one end of switch (discontinued by GE in 1991; Leviton only other reported manufacturers)
  - commercial popcorn poppers
  - film editing equipment
  - greenhouse louver positioning devices
  - washing machine spin cycle shut-off (believed to be no longer in production)
  - chest freezer lid light
  - security system applications (various, including automobile, computer lockdowns, and other applications where movement of a 'momentary contact' switch can trigger an alarm)

    - anti-tamper device in gas meters and pay phones (unable to confirm gas meter application with major gas meter manufacturer)
    - automatic car washes (Ryko: treadle on/off switch and detection of top brush position)
    - Ice fishing tip-up lights
    - fishing lure (manufactured in Canada possibly for tip-ups)
    - lawn tractor/riding mower fuel level indicator
    - electric organs - non-keyboard controls such as tone
    - fire alarm box switch
    - marine auto-pilot
    - level and rotation sensors and controls (automobile, aircraft, and defense applications)
    - laptop computer - screen shutoff when cover closed
    - portable phone mute/privacy switch when phone is in horizontal position
    - cameras (still, video, film); overridable position sensor to protect from sunlight damage
- proximity sensors, magnetically activated, applications unknown
- g-sensors
    - automobile ABS sensors (used to pulse system and disengage auto 4wd)
    - some older automobile air bag sensors
    - auto seat belt mechanisms (electrically activated inertia lock)
    - security system applications
- rectifiers, oscillators, phanatrons, thyratrons, ignitrons, excitrons, cathode tubes; inverters
- switches or relays in some remote reading devices for utility meters, purpose unknown

Electrical Discharge Properties/Lighting

- fluorescent lamps: general purpose straight, U-bent, circline, compact high output, bilirubin blue, blacklight, "bug-zapper" devices
- high intensity discharge
    - mercury vapor lamps
    - high pressure sodium lamps
    - metal halide lamps used in automobile headlights (new use, xenon-mercury-halide)
    - 'CS - compact source mercury lamps' (photographic, lab uses)
    - 'Special mercury lamps' (UV properties)
- neon lamps (most colors except red, orange, pink)
- spectral lamps - monochromatic light source for laboratory and research applications
- cold cathode lamps for illumination
- germicidal lamps (hot cathode, cold cathode, slimline)

Electronic Properties/Semiconductors

- mercury-cadmium telluride semiconductors/infrared sensors
  Extensive defense and satellite uses; no substitute with comparable performance for many applications. One researcher estimates annual mercury consumption for this use at 100 pounds. Includes photovoltaic and photoconductive cells.

Medical, pharmaceutical, cosmetic/human contact

- vaccines and other biologic products
- homeopathic medications (at least 17 compounds used, many applications)
- over-the-counter (OTC) nasal sprays (preservative)
- OTC ophthalmic and contact lens products (preservative)
- eye-area cosmetics (up to 65 ppm mercury) (preservative)

- hemorrhoid ointments and creams (preservative, discontinued early 1995)
- OTC disinfectants: Mercurochrome® [merbromin], tincture of merthiolate
- merbromin solution used in plastic reconstructive surgery as disinfectant and marker
- mercuric chloride peritoneal lavage in cancer surgery (Great Britain)
- skin bleaching creams (OTC discontinued in US by early 1970s)
- diuretic (mersalyl and salts are still manufactured, extent of use unknown)
- traditional Chinese medicine (including herbal balls)
- spiritist use
- tattoo pigments (discontinued in US, likely in 1970's)

Medical and laboratory/no human contact (active ingredient or preservative)

- tissue fixatives for pathology, histology (e.g., Zanker's, B5)
- tissue stains (Harris hematoxylin stain may be mercury-free)
- Hayem diluting fluid for red blood cell count) contains mercuric chloride
- reagents for various diagnostic and laboratory tests:
  - arsenic-calcium reagent (260 ppm)
  - Precision reagent (240 ppm)
  - CPK reagent (2.7 ppm)
  - colorimetric chloride analysis (mercuric thiocyanate or mercuric nitrate titration)
  - Nessler's Reagent/Channing's Solution (mercury potassium iodide); used for total Kjeldahl nitrogen (no apparent alternate method) and nitrogen ammonia (USEPA accepted/approved).
  - Millon's Reagent (mercury-nitric acid solution, for albumin)
  - salinity (mercuric nitrate titration)
- Radiometer (brand) blood gas analyzer reference electrode
- ESA (brand) Model 3010B Lead Analyzer electrode (used for testing blood lead levels)
- preservative in various products such as pregnancy test kits and possibly in similar diagnostic products
- thimerosal used as preservative for sucrose buffers in disc electrophoresis

Veterinary medicine and other veterinary/livestock uses:

- vaccines for cattle, swine, and dogs
- other medications:
  - Dip-A-Way (contains merbromin, mfd. by Universal Aquarium System)
  - Wound Control (contains merbromin, mfd. by Universal Aquarium System)
  - RX ICK Control (contains merbromin, mfd. by Wardley Corp.)
  - Aqueous Red Mercury Blister (contains mercuric iodide; mfd by QA Laboratories and P.C. Laboratories)
  - Phillips Corona Ointment antiseptic dressing for horses and other animals
- udder wash with thimerosal - discontinued many years ago

Pesticides

- food uses canceled in 1969 and US pesticide registrations canceled by early 1995. Last four uses to be canceled were as a turf fungicide, a mildewcide for fresh cut wood, a fungicide and preservative in latex paint, and outdoor fabric treatment
- marine anti-fouling paint (discontinued in 1970's)

Pigments (reds and oranges)

Used in engineering plastics where high temperature stability is required. Past uses included many automotive parts, vinyl, ABS, polycarbonate. The only remaining manufacturer is

SLMC in France; one US auto manufacturer reports recently discontinuing a mercury-containing color concentrate used in plastic component manufacturing.

Catalysts (primarily for urethane and vinyl)

- polymer curing
- monomer production
- acetylene production (probably no longer used)
- vinyl and anthraquinone production (unconfirmed)
- Battery electrodes (mercuric oxide battery, mercury-cadmium battery)

Other uses

- battery anti-gassing (zinc anode coating in alkaline, carbon zinc batteries)
- fireworks (no longer used by US manufacturers but may be used elsewhere)
- Explosives: mercury fulminate, apparently no longer manufactured
- School laboratory experiments and demonstrations
  Note: this use is prone to mismanagement and release, and generates hazardous non-recyclable waste; chemical principles and phenomena can be demonstrated with less toxic or non-toxic substances.

Amalgamating properties and amalgams

- dental
- gold mining/extraction (used in small scale artisanal' mining, large scale mining reportedly uses other chemical or mechanical processes)
- mirror silvering (discontinued about 1900)
- gold porcelain paint (availability and use in US unconfirmed)
- gun cleaning: mercury is poured into the barrel and then removed, reportedly to remove lead, copper and brass residues

Home uses that have resulted in documented mercury poisoning (a sampling)

- fabrication of fishing sinkers with mercury, lead, copper, and solder (heating)
- gold smelting (heating)
- recovery of silver from dental amalgam (heating)
- recovery of mercury from products such as batteries (heating)
- use of interior latex paints with high mercury preservative levels
- vapor exposure from spilled mercury and broken products such as thermometers
- consumption of treated grain or meat from animals fed treated grain
- fluorescent lamp breakage/acrodynia in 2 year old (ingestion/inhalation)
- use of 'folk' medicines containing mercury (ingestion/inhalation/dermal contact)
- use of a beauty cream containing calomel (mercurous chloride)
  Note: mercury poisoning from use of the cream ("Crema de Belleza' made in Mexico) was documented in individuals in California, New Mexico and Texas in 1995 and 1996. Total mercury content of the cream was 6 to 8%.

2. List of Interviewees

Name	Affiliation	Phone
Andrews, Carol	Minnesota Pollution Control Agency	651-296-6300
Arienti, Mark	Regional Waste Systems	207-773-1738
Baum, James	W.A. Baum Co. Inc.	516-226-3940
Bender, Mike	Mercury Consultant	802-223-9000
Bray, Andy	Northeast Waste Mgmt Officials Association	617-367-8558
Brown, Larry	Holtrachem	207-825-3341
Cavanaugh, Brian	MDEP	207-287-2811
Clark, Paula	MDEP	207-287-2651
Clerk	Maine Medical Association	207-622-3374
Davey, Kathy	USEPA Headquarters	202-262-2290
Doering, Ellen	MDEP	207-287-2437
Dow, Sharon	Nurse Manager, Maine General Hospital	207-626-1000
Dugal, Dionne	American Hospital Association	202-626-2284
Dunn, Dr. James	Augusta Dental Arts	207-622-3144
Dyer, Janet	Central Maine Power Co.	207-626-9679
Erdheim, Eric	National Electrical Manufactures Association	703-841-3249
Garofalo, Dr. John	Past President, Maine Medical Association	207-623-5902
Gilkeson, John	Minnesota Office of Environmental Assistance	612-215-0199
Glasgow, James	MDEP	207-287-2651
Guerra, James	Tri-County Solid Waste Management	207-785-2323
Hall, Chris	Maine Chamber of Commerce and Industry	207-623-4568
Hanson, Rolf	Minnesota Chamber of Commerce	651-292-4668
Harnar, James	Maine Hospital Association	207-622-4794
Hoenig, Dr. Donald	Maine Department of Agriculture	207-287-3701
Howe, Robert	Howe Associates (representing dentists in Maine)	207-622-4466
James, John	MDEP	207-287-7866
Jones, Glennis	Appliance Recycling Corp.	916-442-8895
Kane, Alexis	USEPA Region V	312-886-7018
Karp, Hildy	Greening	213-245-0510
Kazar, Joseph	Mid Maine Waste Action Corp.	207-783-8805
Ladner, Stacy	MDEP	207-287-2651
McGregor, James	Maine Merchants Association	207-623-1149
Miller, John	Vermont Agency for Natural Resources	802-241-3472
Mirabile, Gerry	Central Maine Power Co.	207-621-4417
Moorhead, Tracey	Association of Home Appliance Manufacturers	202-434-7477
Morris, Wayne	Association of Home Appliance Manufacturers	202-434-7477
Pierce, Sterling	MDEP	207-287-4868
Roberts, Douglas	North Carolina Dept. of Environmental Protection	919-733-4998
Smith, Mark	Mass. Department of Environmental Protection	617-292-5509
Wen, Chen	USEPA Headquarters	202-260-4109
Wingate, Fred	Wingate and Lathe, a heating oil company	207-622-7521
Whittier, Scott	Maine Dept. of Environmental Protection (MDEP)	207-287-2651

Appendix 3

List of Contributors

List of Contributors

This report was compiled for the Land and Water Resources Council by staff from the Department of Environmental Protection. Many people contributed to the preparation of the report, and to the on-going technical and policy discussions that shaped it. Thanks are due to all of the following individuals, with special appreciation to those who served on the ad hoc committee on mercury-added products.

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