

# MERCURY USE in BUTTON BATTERIES

## March 2005

### I. Introduction

This report has been prepared pursuant to the requirements of Resolves 2003, Chapter 125, a copy of which is attached as Appendix A. The resolve directs the Department of Environmental Protection (department) to review the use of mercury in button batteries, including:

- The amount of mercury in foreign-made batteries sold in the United States, including batteries sold with a consumer product;
- The availability of mercury-free batteries;
- Whether 38 MRSA § 2165 should be revised to further restrict the mercury content of batteries; and
- Whether mercury-added batteries that remain in commerce should be labeled and collected for recycling.

Manufacturers have long used mercury in batteries to prevent the buildup of hydrogen gas, which can cause the battery to bulge and leak. Battery production still accounts for about 1/3 of the global mercury demand based on data for the year 2000, and over 95% of this usage is attributed to battery makers outside the United States.<sup>1</sup>

In the U.S., the use of mercury in consumer batteries has declined sharply over the last two decades. In the early 1980s, battery manufacture constituted the largest domestic use of mercury (over 1,000 tons annually). By 1990, usage had dropped to 117 tons, still the third largest domestic use of mercury.<sup>2</sup> Shortly thereafter, usage by U.S. battery makers dropped to a few tons per year as several states, including Maine, became concerned about the hazard posed by disposal of mercury-added batteries and enacted legislation that greatly restricted the mercury content of batteries.<sup>3</sup>

By 1993, battery manufacturers had begun selling mercury-free alkaline batteries. This became the national standard in 1996 with passage of the federal Mercury-Containing Battery

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<sup>1</sup> Peter Maxson, *Mercury Flows in Europe and the World*, p. 41 (European Commission, 2004).

<sup>2</sup> Stephen Jasinski, S., *The Materials Flow of Mercury in the United States*, p. 17 (U.S. Bureau of Mines, 1994).

<sup>3</sup> See PL 1991, c. 808, § 2, enacting 38 MRSA §2165(6) to read:

- 6. Mercury content.** A person may not sell, distribute or offer for sale in this State the following batteries:
- A.** An alkaline manganese battery that contains more than .025% mercury except that any alkaline manganese battery resembling a button or coin in size and shape may contain no more than 25 milligrams of mercury;
  - B.** Effective January 1, 1993, a consumer mercuric oxide button cell;
  - C.** A zinc carbon battery manufactured on or after January 1, 1993 that contains any added mercury; or
  - D.** An alkaline manganese battery manufactured on or after January 1, 1996 that contains any added mercury except that any alkaline manganese battery resembling a button or coin in size and shape, may contain no more than 25 milligrams of mercury.

Management Act.<sup>4</sup> Today, most U.S. made batteries do not contain added mercury. The two exceptions are mercuric oxide batteries and button cell batteries, i.e., batteries that resemble a button or coin in size or shape.

In mercuric oxide batteries, mercury is used as an electrode rather than an additive to control gas buildup. The mercury accounts for up to 40% of the battery weight and cannot be reduced without reducing the energy output of the battery. Mercuric oxide button cells once were widely used in hearing aids but now are prohibited under both Maine and federal law. Larger mercuric oxide batteries still are produced for military and medical equipment where a stable current and long service life is essential. Both Maine and federal law allow these batteries to be sold, but only if the manufacturer has established a system to collect the waste batteries and ensure that the mercury is properly managed. Users are prohibited from disposing of spent mercuric oxide batteries except through the collection system established by the manufacturer.<sup>5</sup>

In button batteries, small amounts of mercury still are used to prevent the formation of gases. There are three separate button battery chemistries that typically contain added mercury. These include the zinc air batteries used mainly in hearing aids; silver oxide batteries, most of which are used in watches and cameras; and alkaline manganese batteries used in digital thermometers, calculators, toys and a myriad of other products requiring a compact power source.

Maine law and the federal Battery Management Act limit the mercury content of alkaline manganese button cells to no more than 25 milligrams (mgs), but the use and disposal of mercury-added button cells is otherwise unregulated. They do not have to be labeled; it is legal to dispose of them in the household trash; and they rarely are collected for recycling in most U.S. jurisdictions, including Maine. The remainder of this report explores whether mercury-added button cells should be targeted for additional regulatory action.

## **II. How much mercury are we talking about?**

Available data indicate that button batteries currently contribute from 3 to 5 tons of mercury to U.S. commerce each year. This includes sales of original equipment (e.g., toys, watches, calculators) with embedded button batteries and button batteries sold separately to replace batteries in original equipment.

U.S. made batteries account for about half of the U.S. consumption of mercury in button batteries. The National Electrical Manufacturers Association (NEMA) reports that U.S. manufacturers Duracell, Energizer, Kodak, Panasonic and Rayovac collectively used about 5,300 pounds of mercury in button cell batteries sold in the U.S in 2002.<sup>6</sup> Zinc air button cells for hearing aids accounted for over 4,500 pounds or 85% of this total. The mercury totals for silver oxide and alkaline manganese button cells sold that year were about 475 pounds and 270 pounds respectively.

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<sup>4</sup> 42 USC § 143301 *et seq.*

<sup>5</sup> See 38 MRSA §§ 2165(2) and (4).

<sup>6</sup> Richard Tozer, *Analysis of Battery Industry Sponsored Button Cell Collection Programs*, p. 10 (National Electrical Manufacturers Association, 2003). A copy of this report is attached in Appendix D.

Data on mercury use in imported batteries is limited. Only two foreign battery manufacturers—the Shanghai Biba Battery Company and Toshiba— have disclosed their mercury usage for U.S. sales. Based on information filed with the Interstate Mercury Education and Reduction Clearinghouse (IMERC)<sup>7</sup> by importers of products containing button cell batteries, at least 10 other foreign companies are known to make mercury-added batteries sold in the U.S. either individually or as a component in a larger product.

Table I below lists all known manufacturers of mercury-added button cell batteries sold in the U.S., and shows the total mercury for U.S. sales where known.

**Table I. Manufacturers of button batteries sold in the U.S.**

Manufacturer	Location	Battery Chemistry	Annual Hg - US sales
NEMA - Duracell, Energizer, Kodak, Rayovac, Panasonic	United States	alkaline manganese	270 lbs*
		silver oxide	474 lbs*
		zinc air	4540 lbs*
Shanghai BiBa Batteries Co.	Hong Kong	alkaline manganese	603 lbs**
		silver oxide	157 lbs**
Toshiba	Japan	zinc air	288 lbs**
Chener Battery Works	Hong Kong	alkaline manganese	?
Chung Pak (Evergreen)	Hong Kong	alkaline manganese	?
Gold Peak	Hong Kong	alkaline manganese	?
		silver oxide	?
Hitachi Maxell	Japan	alkaline manganese	?
		silver oxide	?
New Leader	China	alkaline manganese	?
		silver oxide	?
Renata	Switzerland	silver oxide	?
Schenzhen Konnoc (Konnoc)	China	alkaline manganese	?
Sony	Japan	silver oxide	?
Varta	Germany	silver oxide	?
Zhuhai Zhi Battery Co., Ltd	China	alkaline manganese	?

\* based on sales in 2002 as reported by NEMA

\*\*based on sales in 2001 as reported to IMERC

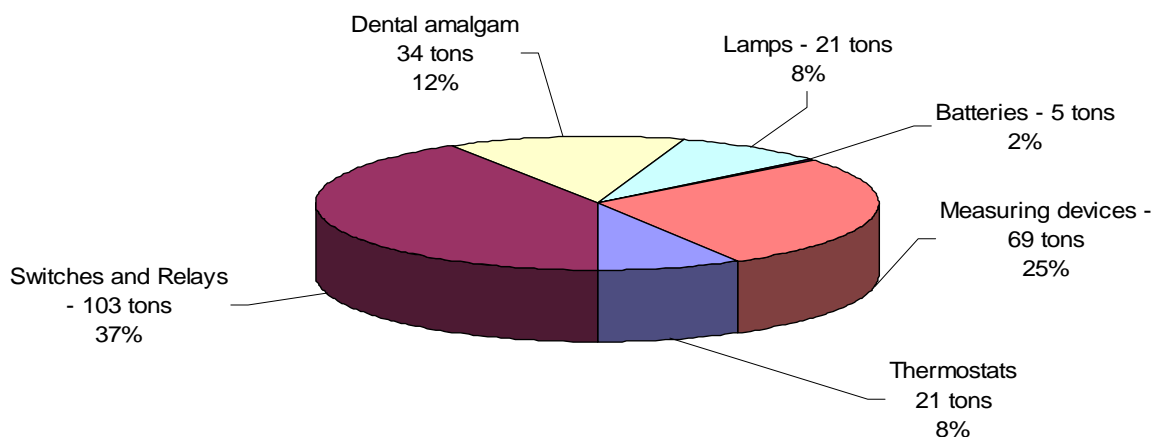
**TOTAL** > 6,347 lbs

<sup>7</sup> The Interstate Mercury Education and Reduction Clearinghouse or IMERC is operated by the Northeast Waste Management Officials Association. IMERC was formed in 2001 to coordinate the collection of data on mercury-added products under disclosure laws in Connecticut, Maine, Massachusetts, New Hampshire and Rhode Island. These states prohibit the sale of a mercury-added product unless the manufacturer has disclosed the amount and purpose of the mercury.

The degree to which Table 1 under-represents the total amount of mercury in all button batteries consumed annually in U.S. cannot be estimated with certainty. However, if each of the 10 manufacturers that have yet to disclose mercury totals contribute an average of 200 pounds of mercury annually to U.S. commerce, then the total annual U.S. consumption of mercury in button batteries exceeds 10,000 pounds or 5 tons. This in turn represents about 2% of the annual U.S. consumption of mercury in products as estimated by the U.S. Environmental Protection Agency and shown in Figure I.

**Figure 1. Estimated Annual U. S. Consumption of Mercury in Products**

Total annual consumption = 280 tons



Sources: Jasinski, S., *The Materials Flow of Mercury in the United States*, U.S. Bureau of Mines, 1994; US Geological Survey, *Minerals Yearbook: Mercury*, 1994-2002; Minnesota Pollution Control Agency, *Substance Flow Analysis of Mercury in Products*, 2001; Interstate Mercury Education and Reduction Clearinghouse, *Mercury in Products Database*, <http://www.newmoa.org>

Maine's share of the estimated annual U.S. consumption of mercury in button batteries is 45 pounds [10,000 lbs x .0045] based on 2000 census data.<sup>8</sup> Because button batteries currently are not widely targeted for recycling in Maine, almost all of this mercury presumably ends up in the municipal solid waste stream where it is either incinerated or landfilled.

<sup>8</sup> Maine's population as reported by the U.S. Census Bureau for 2000 is 1,274,923 or 0.45 percent of the U.S. population of 281,421,906. See <http://www.census.gov/population/www/cen2000/respop.html>

Mercury emissions from Maine's four waste-to-energy incinerators totaled 58 pounds in 2002; mercury emissions from landfills were estimated at 6 pounds that year. Together, these two sources accounted for about 11% of the estimated total amount of mercury emitted to the air from in-state sources in 2002.

Given that button batteries are only one of numerous mercury-added products that contribute to these emissions, the battery industry argues that mercury use in button batteries is insignificant and undeserving of regulatory attention.<sup>9</sup> The department disagrees. Here is why:

- Although button battery manufacture accounts for only about 2% of annual mercury consumption in the U.S., button batteries account for a higher percentage of the mercury in Maine's solid waste. This is because, of the mercury-added products shown in Figure 1, only batteries still can legally be placed in the trash in Maine. The other products either are targeted for recycling or elimination or, as in the case of dental amalgam, typically do not end up in the municipal waste stream.
- Sales of mercury-added button batteries appear to be increasing. NEMA members, for example, report using over 1000 pounds more mercury in 2002 than in 2000, presumably due an increase in the number of batteries sold. In Maine, button battery sales have grown from an estimated 450,000 units in 1990<sup>10</sup> to over 1.5 million in 2002.<sup>11</sup> And this estimate accounts only for Maine's share of button battery sales by NEMA members. Total button battery sales in Maine could be significantly higher due to the sale of toys, novelties and other products containing button batteries that enter the state from foreign sources.

NEMA's data on mercury usage, for example, suggest that its members sold about 11 million alkaline manganese button batteries in the U.S. in 2002. Yet the Kellogg Company, in a single nation-wide promotional campaign for its breakfast cereals, distributed 17 million Spider Man toys powered by a foreign-made alkaline manganese button battery. Further, China produced about 2.5 billion button cell batteries in 2003 and is expected to produce 5 billion in 2005. "It can be reasonably assumed that significant amounts of these batteries are included in original equipment manufactured in Asia and ultimately sold in the United States."<sup>12</sup>

- There is little scientific support for the proposition that it is "safe" to dispose of batteries or other mercury-added products in the trash. Mercury is a persistent neurotoxin that has bio-accumulated in the aquatic environment to the point where the state Bureau of Health now advises children and women of child bearing years to limit their consumption of fish from Maine waters. This pollution problem has evolved out of the cumulative impact of mercury releases from multiple sources. All releases of mercury, regardless of amount, are problematic because they contribute to the overall adverse health risk.

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<sup>9</sup> See Ric Erdheim of the National Electrical Manufacturers Association in correspondence to John James of the Department of Environmental Protection, December 17, 2004. A copy of the letter is included in Appendix C.

<sup>10</sup> Maine Waste Management Agency (MWMA), *Maine Used Dry Cell Battery Management Plan* (November, 1993), p. 10.

<sup>11</sup> Catherine Galligan and Greg Morose, *An Investigation of Alternatives to Miniature Batteries Containing Mercury*, p. 14 (Lowell Center for Sustainable Production, 2004). A copy of the LCSP report is included in Appendix B.

<sup>12</sup> *Id.* at 13.

- Maine remains committed to the goal of virtual elimination of anthropogenic uses and releases of mercury, as called for in the Mercury Action Plan adopted by the Conference of New England Governors and Eastern Canadian Premiers in June 1998. The continued disposal of mercury-added batteries in the trash is contrary to this goal.

The elimination of button cell batteries from Maine's waste stream will not solve the mercury pollution problem. Battery use in Maine, after all, consumes only about 45 pounds of mercury per year, compared with global consumption estimated at over 1000 tons in 2000.<sup>13</sup> Regional, national and global action ultimately is needed. Nevertheless, the actions of a single state, even one as small as Maine, can spur national and international action to eliminate unnecessary mercury uses and reduce the global demand for this poison. Prudence alone dictates that we shouldn't dump toxins like mercury in the trash when we have clear alternatives.

### **III. Can this mercury use be eliminated?**

#### *The purpose of mercury in batteries*

As previously mentioned, mercury has long been used in batteries to prevent the buildup of hydrogen gas that otherwise could cause the battery to bulge and leak. The formation of hydrogen gas is a phenomenon associated with batteries that have zinc anodes.<sup>14</sup> This includes alkaline manganese, silver oxide batteries, zinc air and zinc carbon batteries. The mercury coats the anode to prevent gas from forming.<sup>15</sup>

By the early 90s, the battery industry had found ways to eliminate the use of mercury to control gas formation in cylindrical and rectangular batteries. This was accomplished by reducing impurities that cause gassing, by using other techniques to suppress gas formation, and by redesigning the batteries to allow the gases to escape more readily. The relatively large size of cylindrical and rectangular batteries also "allows them to be packed less fully such that any buildup of gases will not lead to internal gas pressures that cause leaking or rupturing of the battery sealing systems."<sup>16</sup>

#### *Current limits on the mercury content of batteries*

In 1992, the Maine Legislature codified these mercury reduction gains when it enacted 38 MRSA §2166(6) prohibiting the sale of zinc carbon and alkaline manganese batteries containing added mercury. At that time, however, the industry had been unsuccessful in eliminating mercury from button cell batteries because their relatively small size leaves little room for internal gas buildup before the battery is adversely affected.<sup>17</sup>

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<sup>13</sup> Maxson *supra* n. 1 at 35.

<sup>14</sup> *Household Batteries and the Environment*, p. 15 (National Electrical Manufacturers Association, 2002).

<sup>15</sup> MWMA *supra* n. 10 at 16.

<sup>16</sup> NEMA *supra* n 14 at 16.

<sup>17</sup> *Id.*

In recognition of this unsolved technological challenge, the Legislature decided to exempt button cell batteries from the sales ban if they contain no more than 25 milligrams of mercury. Specifically, 38 MRSA §2165(6)(D) provides:

"A person may not sell...[a]n alkaline manganese battery manufactured on after January 1, 1996 that contains any added mercury except that any alkaline manganese battery resembling a button or coin is size and shape, may contain no more than 25 milligrams of mercury."

The 25-milligram mercury limit under Maine law applies only to alkaline manganese button cells; the law is silent on the mercury content of silver oxide and zinc air button cell batteries. However, Minnesota law<sup>18</sup> applies the same limit to all battery chemistries, and NEMA reports that U.S., Japanese and European manufacturers adhere to the 25 mg limit for all chemistries.<sup>19</sup>

The legal status of so-called stacked button cell batteries with respect to the 25 mg limit is open to question. Most button batteries are sold individually, but several manufacturers (including Duracell, Energizer, Kodak and Panasonic) combine stacks of silver oxide or alkaline manganese button cells to produce a cylindrical battery for uses that require a higher voltage, e.g., remotes for garage door openers and dog control collars. Stacks of zinc-air button cells also are combined to make a rectangular battery used in medical devices, but this usage is very limited.

When button cells are stacked, the voltage of the individual cells is additive and so is the mercury content. Most stacked cell batteries contain more than 25 mgs of mercury and many can exceed 50 mgs depending on the chemistry and number of individual cells. Whether the sale of these batteries violates Maine law depends on whether the 25 mg limit under section 2165 is applied to the battery or the individual cells that make up the battery.

Stacked cell batteries do not resemble "a button or coin is size and shape." Indeed, from the outside, it is difficult to distinguish stacked cell batteries from alkaline AAA and other cylindrical batteries that do not contain mercury. Nor are stacked cell batteries labeled to indicate they contain mercury. On the other hand, stacked cell batteries were available in 1992 when section 2165 was enacted,<sup>20</sup> and there is no clear indication in either the wording or history of the Maine law that would suggest the Legislature meant to prohibit their sale in Maine.

#### *The status of efforts to eliminate mercury from button batteries*

About a year after the 25-mg limit was enacted, the now defunct Maine Waste Management Agency issued a battery management plan that included the following statement:

"[Battery manufacturers] have indicated that the eventual elimination of mercury use in alkaline cell construction is technically feasible and have been working towards achieving this goal."<sup>21</sup>

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<sup>18</sup> Minnesota Statutes § 325E.125, subd. 2.

<sup>19</sup> Ric Erdheim to John James, personal communication, July 27, 2004.

<sup>20</sup> Ric Erdheim to John James, personal communication, December 9, 2004.

<sup>21</sup> MWMA *supra* n. 10 at 17.

The development of the zinc air technology in the early 90s allowed the industry to phase out the use of mercuric oxide button cells in hearing aids, thereby reducing mercury use in button batteries by over 90%.<sup>22</sup> However, although U.S. manufacturers continue to explore "no mercury" formulas,<sup>23</sup> they have not yet perfected the technology to eliminate mercury altogether as Table 2 below shows.

**Table 2. Mercury content of button batteries sold by U.S. manufacturers in 2002**

Battery technology	Average mercury content (mg)	Total amount of mercury (pounds)	Approximate sales quantity*
Zinc air	8.5	4,540.3	242 million
Silver oxide	2.5	473.6	86 million
Alkaline	10.8	269.6	11 million
Totals:		5,283.5	339 million

\* The approximate sales quantity was calculated based upon data from the columns: "Average Mercury Content" and "Total Amount of Mercury".

To independently explore whether further mercury reductions are possible, the department hired the Lowell Center for Sustainable Production (LCSP). LCSP's report—*An Investigation of Alternatives to Miniature Batteries Containing Mercury*—is attached as Appendix B. Among other things, LCSP found that manufacturers are beginning to market mercury-free versions of all three button battery types that currently contain mercury, although mercury-free zinc air batteries for use in hearing aids so far have been introduced only in Europe.

According to Energizer, the manufacturer of the zero-mercury zinc air battery, they are very challenging to produce and production capability is not yet robust enough to support introduction in the United States.<sup>24</sup> Energizer introduced this product in Europe because it presented a manageable volume.<sup>25</sup> The company currently offers mercury free zinc air batteries in four models, but has given no timeline as to when these batteries will be commercially available outside Europe.

At least two companies—Sony and New Leader—now offer mercury-free silver oxide button batteries for sale on the world market. Sony claims to be among the largest producers of silver oxide batteries in the world, with sales of over 400 million annually. The company produces over 40 models of silver oxide batteries in numerous sizes, consuming about 700 pounds of mercury per year in the process. It plans to introduce 10 models of mercury free batteries in 2005, and eventually plans to eliminate mercury from its entire product line. Sony silver oxide batteries are used use mainly in watches, digital fever thermometers and game products.<sup>26</sup>

New Leader, a battery manufacturer located in China, currently offers mercury-free silver oxide button batteries to original equipment manufacturers (OEMs) for use in their end products. New

<sup>22</sup> Tozer *supra* n. 6 at 9; see also "Energizer and the Environment", Energizer Holdings, Inc., <http://www.energizer.com/learning/environment.asp>.

<sup>23</sup> Erdheim *supra* n. 9.

<sup>24</sup> Ric Erdheim to John James, personal communication, October 13, 2004.

<sup>25</sup> *Id.*

<sup>26</sup> Sony Global press release, September 29, 2004, <http://www.sony.net/SonyInfo/News/Press/200409/04-051E/>

Leader also offers mercury-free alkaline manganese button batteries to OEMs, and claims Burger King, Macdonald's, Kellogg's, Hallmark Cards, Kmart and Wal-Mart as customers.<sup>27</sup>

Konnoc and Chung Pak, two other companies known to make button batteries sold in the U.S., also claim to make mercury-free models but LCSP was unable to obtain product specifications to confirm this. At least two companies—Sony and an unidentified company based in Hong Kong (Chung Pak?)—have applied for U.S. patents related to the development of mercury-free alkaline manganese button batteries.

LCSP notes that the performance characteristics of the mercury-free button batteries, as published by Energizer, Sony and New Leader, appear to be comparable to mercury-added batteries. These manufacturers must be satisfied that they have overcome the problem of controlling the formation of internal gases without the use of mercury; they presumably would be unlikely to market a product that could undermine their reputation for quality or expose them to product liability claims.<sup>28,29</sup> Nevertheless, the lack of independent testing data confirming that these mercury free batteries perform reliably in the field, especially as relates to the potential for buildup of internal gases, remains a concern for potential end users.

The American Watch Association (AWA) has expressed this concern, stating that it is unknown if the mercury free batteries will work over the long run to prevent the buildup of gases that could potentially damage a watch. Some AWA members plan to use the Sony mercury-free batteries as soon as they have proven track record of reliability but feel it is too soon to risk using them in their valuable watches.<sup>30</sup> According to the AWA, watchmakers need to conduct extensive testing demonstrating that the new batteries will function safely and properly before they are put into watches.<sup>31</sup> (See Appendix C for the comments of AWA Executive Director Emilio Collado.)

The reliability of mercury-free hearing aid batteries also is of concern. (See Appendix C for the comments of Gil Poliquin, a hearing aid dealer from Lewiston.) NEMA suggests, however, that quality and performance issues with the Energizer mercury-free zinc air batteries currently being sold in Europe are unlikely,<sup>32</sup> and no such issues have been brought to our attention. The main issue for the U.S. markets appears to be production capacity rather than reliability.

Limited pricing information suggests that mercury-free alkaline manganese and silver oxide button batteries cost about 30% more than mercury-added models. As the market expands, this initial price differential is expected to narrow due to increased competition and economies of scale from larger production runs.<sup>33</sup>

Cost may be a particular issue for hearing aid users, most of whom are elderly. Hearing aid batteries have a useful life of one to four weeks once they are placed in service, meaning users

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<sup>27</sup> LCSP *supra* n. 11 at 26.

<sup>28</sup> *Id.* at 24

<sup>29</sup> Erdheim *supra* n. 9.

<sup>30</sup> *Maine could ban mercury-containing watch batteries*, The National Jeweler, December 6, 2004

<sup>31</sup> Probir Mehta on behalf the AWA in personal communication to Terri Goldberg of IMERC, February 9, 2005.

<sup>32</sup> Erdheim *supra* n. 9.

<sup>33</sup> LCSP *supra* n. 11 at 24.

could go through 50 or more batteries per year depending on whether they wear one or two hearing aids. Hearing aid batteries currently can be purchased in the U.S. for less than \$1 dollar each, and it is not known if manufacturers ultimately will be able to offer mercury free hearing aid batteries at comparable prices. In Europe, however, Energizer did not increase prices when it launched its line of mercury-free zinc air batteries.

#### **IV. Is it feasible to recycle button cell batteries?**

NEMA is strongly opposed to any effort that would require manufacturers to share responsibility for the recycling of mercury-added button batteries. Its position is that collection of button cells for recycling is not cost-efficient, poses a fire safety hazard and will exacerbate the swallowing hazard associated with button batteries. A copy of the NEMA paper "Button Battery Collection: Why It Does not Make Sense" is attached in Appendix C.

##### *Battery ingestion*

NEMA points out that the use of button batteries carries a small risk of injury from accidental swallowing or insertion of the battery in the ear or nose. The battery industry responsibly has addressed this risk by funding medical assistance through the National Capital Poison Control Center, by providing the Center's phone number on battery packaging, and by labeling the packaging to warn users to "keep batteries away from children."

An official at Rayovac goes further, recommending against use of "button cells of any type in children's toys, especially ones that may be dissected or chewed..."<sup>34</sup> This official further observes that lithium button cells, which contain no mercury, are especially problematic because they have been shown to cause serious burns in the esophagus if swallowed. Lithium batteries, moreover, are larger in diameter than other button batteries, and presumably more likely to become lodged in the esophagus.

In 2003, U.S. poison control centers logged 2,395,582 human exposure cases.<sup>35</sup> In 2,568 of these cases, the exposure was to a "disc battery," a category that includes six different button battery chemistries including lithium, alkaline manganese, silver oxide and zinc air. Most of these incidents involved ingestion and, in most cases, the battery passed through the digestive system without causing harm. However, 135 of these cases resulted in minor injury; 32 caused moderate injury; and four led to major injury.<sup>36</sup> To the extent the battery type is known, lithium batteries are implicated most often in the cases resulting in injury.

Dr. Toby Litovitz, executive director of the National Capital Poison Center, has consistently opposed efforts to collect button batteries for recycling on the premise that recycling may increase the number of battery ingestions. Her most recent comments on this issue are included in Appendix C. In these comments, Dr. Litovitz points out that at least three children have died

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<sup>34</sup> Tim Anderson of Rayovac in personal communication to Ralph Erickson of the Madison, Wisconsin Metro Sewerage District, December 20, 2000.

<sup>35</sup> William Watson *et al.*, "2003 Annual Report of the American Association of Poison Control Centers," *Amer. Joun. Toxicol.* 22:335-404, p. 336 (September 2004).

<sup>36</sup> *Id.* at 377.

and hundreds of other severely injured from button battery ingestions since poison control centers began tracking data in 1983, and she is concerned that number of ingestions will rise if batteries are saved for recycling rather than thrown in the trash.

These concerns have been echoed by a least one Maine audiologist. Jean Toth, an audiologist who practices in Presque Isle, writes:

"I talk to every client about the dangers of swallowing a hearing aid battery, and safe handling of batteries. In the past twenty years, I have had one patient actually swallow a battery. That person was a ten year old child. If each person now collects the old batteries in a can or box at home, how many children will suffer the consequences of ingesting a battery? I can't help but think that the incidence of such occurrences will increase markedly." (See Appendix C for Ms. Toth email correspondence on this issue.)

Battery manufacturer Rayovac specifically recommends against recycling hearing aid batteries for this reason. On the Frequently Asked Questions page of its website, Rayovac writes:

"Zinc air batteries used in hearing aids cannot be easily recycled and are considered general household trash when they are drained. Please [throw] these out in the trash; saving them can present a choking hazard to children."<sup>37</sup>

The Energizer website, on the other hand, includes the following response to Frequently Asked Questions about hearing aid batteries:

**"Should I recycle the batteries?** If a local recycling center accepts batteries, definitely. While recycling is not required by law, Energizer encourages you to do it if you can. If you keep used batteries at home in anticipation of recycling them, remember to store them away from children and pets."<sup>38</sup>

### *Battery fires*

NEMA observes that any effort to collect mercury-added button batteries for recycling inevitably will capture lithium coin-shaped batteries. Lithium batteries do not contain mercury but may pose a fire risk according to NEMA. A NEMA consultant writes:

"Lithium electrolyte is flammable. These batteries also contain metallic lithium, highly reactive metal that, when exposed to water, liberates hydrogen, a very flammable gas. At a mercury recycling facility, batteries will be shredded or hammered. If the recycler shreds or hammers lithium batteries, they will ignite as they are opened. Ultimately, the lithium metal may ignite."<sup>39</sup>

According to the consultant, lithium coin cell batteries do not pose a fire hazard if disposed of individually as they are replaced, but pose a serious problem if they are placed in a combustible collection container with other lithium batteries or other types of button cell batteries. If lithium

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<sup>37</sup> [http://www.rayovac.com/about/environmental/e\\_faq2.shtml](http://www.rayovac.com/about/environmental/e_faq2.shtml)

<sup>38</sup> <http://www.energizer.com/products/ezchange/faq.aspx>

<sup>39</sup> Tozer *supra* n. 6 at 22.

coin cells are segregated in a separate container, their propensity to rapidly discharge increases the chances of heat generation; if they are mixed with other types of button cell batteries, those batteries can serve as bridge between the terminals of the lithium cell batteries and cause a heat-generating short-circuit.<sup>40</sup>

Short-circuiting can occur because many batteries are not fully discharged when disposed by consumers. Disposing of the batteries individually minimizes the risk of short-circuiting and fire. Alternately, the batteries can be protected from short-circuiting by taping the terminals or placing individual batteries in plastic bags, a time consuming process that NEMA points out adds to the cost of recycling.<sup>41</sup>

NEMA suggests that at least two buildings have caught fire as a result of efforts to recycle button batteries. In 2002, an 85-gallon drum of lithium batteries self-ignited at a hazardous waste facility in Clarence, New York, causing \$2 million in damage. And a RadioShack store in Pennsylvania burned to the ground due to a fire that allegedly started in a battery collection container.

NEMA also points out that U.S. Department of Transportation (DOT) recently issued a new regulation prohibiting the transport of lithium batteries aboard passenger aircraft.<sup>42</sup> The DOT acted in the wake of several fires involving shipments of pallets of lithium batteries by manufacturers and importers. In one incident at Los Angeles International Airport, two pallets stacked with 120,000 coin cell lithium batteries caught fire when they were damaged during unloading. At Indianapolis International Airport, a fire in a shipment of lithium batteries apparently started when the batteries short circuited inside their packaging. None of the incidents mentioned in the Federal Register notice of the new rule involved the shipment of button batteries for recycling.

In a phone interview with LCSP, a representative of a company that offers button battery collection services to municipalities and other generators says that the company has never had a fire in a community collection box or during transit of button batteries. LCSP further observes:

"[F]our elements are needed to initiate and sustain a fire: fuel, oxygen, heat and a chemical chain reaction. In general, there would be only a small amount of electrical energy left in spent miniature batteries (making the potential for heat generation minimal), the closed box will limit oxygen availability, and there would be little or no fuel to sustain a fire. Therefore it is unlikely that conditions supporting a fire would occur in a miniature battery collection box.

While there is always some risk of fire in most municipal waste recycling programs, we could not find evidence of any elevated risk associated with mercury-containing battery collection and recycling programs."<sup>43</sup>

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<sup>40</sup> *Id.*

<sup>41</sup> *Id.* at 24.

<sup>42</sup> Hazardous materials; prohibition on the transportation of primary lithium batteries and cells aboard passenger aircraft; final rule, 69 Fed. Reg. 75208-16 (December 15, 2004) (to be codified at 49 CFR Parts 171, 172, 173 and 175).

<sup>43</sup> LCSP *supra* n. 11 at 37-38.

*Button battery recycling in the U.S.*

In the U.S., no state currently bans the disposal of mercury-added button cell batteries and there are no state-sponsored programs to collect them. Some local jurisdictions in the U.S. include button cell batteries in programs targeting the collection of household hazardous waste (HHW). However, participation in these programs is voluntary and all reported a battery capture rate of less than 50%.

Hennepin County, Minnesota, and Chittenden County, Vermont, are two widely cited examples of local HHW collection programs that target button cell batteries. At our request, the LCSP examined these two programs and two others—a program run by a town in Massachusetts and program run by Wheelabrator Technologies, a company hired to operate three municipal solid waste incinerators serving 69 communities in the Northeast.

LCSP reports that, from the perspective of the program administrators, button battery recycling programs run smoothly and safely but there is an ongoing challenge to increase the recycling rate. In each of these programs, collection containers are distributed at multiple locations and the contents of the containers are periodically consolidated and shipped to a battery recycling facility. Among the locations chosen for collection containers are recycling centers, city halls, drug stores, health care facilities, hardware stores, libraries, photo stores, retail stores and senior citizen complexes.

Each of the program representatives interviewed by LCSP had heard of fire hazards associated with lithium batteries, but none have attempted to exclude lithium batteries at the button battery collection points and none have experienced a problem with heat or fire in the collection container. One of the counties, however, pays an intermediary to sort the batteries by type and tape the poles of the lithium batteries. No one was aware of a battery ingestion incident attributed to their recycling program.<sup>44</sup>

Although button batteries currently are not targeted for recycling in most U.S. jurisdictions, button battery collection and recycling services are well-established and readily available in this country. Several companies, including Battery Solutions, Toxco and Onyx Electronics Recycling, offer low cost battery collection containers that are easy to use. The containers are available in a number of sizes and the purchase price includes prepaid shipping labels that cover the cost of shipping, handling and recycling. If these containers are used, battery recycling generally can be expected to cost less than 1¢ per battery. Both Chittenden and Hennepin Counties report recycling costs of less than a penny per battery.<sup>45</sup> NEMA points out that the total costs of a button battery recycling program could be substantially higher depending on the resources and effort devoted to education and promotion.<sup>46</sup>

It also must be pointed out that many, if not most, silver oxide button cell batteries currently are recycled without government intervention. These batteries are collected by jewelers when they

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<sup>44</sup> *Id.* at 62.

<sup>45</sup> *Id.* at 35.

<sup>46</sup> Tozer *supra* n. 6 at 30.

replace watch batteries and are recycled to recover the silver. About 75% of the silver oxide button cells produced by U.S. battery manufacturers are used in watches (most of the rest are used in cameras). The American Watch Association estimates that 95% of jewelers replace watch batteries and it is thought that most consumers use the services of a jeweler to change watch batteries in order not to void the watch warranty. The AWA reports that large retail jewelers like Wal-Mart replace and recycle millions of silver oxide batteries every year.

#### *Button battery recycling in Europe*

In Europe, the recycling of mercury-added button batteries is mandated by directive of the Council of the European Union. Council Directive 91/157/EEC on batteries and accumulators containing certain dangerous substances, as amended by Commission Directive 98/101/EC, requires member states to, among other things:

- ◆ Mark batteries to indicate the heavy metal content and the requirement for separate collection and recycling;
- ◆ Establish programs designed to reduce the heavy metal content of batteries, promote the marketing of batteries containing smaller amounts of dangerous substances, and promote research into more benign batteries and better recycling methods; and
- ◆ Ensure efficient and separate collection systems for batteries.

The EU member states have taken divergent approaches to compliance with the directive. Twelve countries, for example, require retailers to take back batteries, including button cells, at the point of sale, with the collection costs funded by a fee on manufacturer battery sales. The European Commission reports, however, that the success of these efforts varies widely from country to country. Many mercury-added button batteries still are landfilled or incinerated in Europe, and the overall battery collection rate is thought to be low, only about 15% of estimated sales.<sup>47</sup>

One of the main reasons for the poor collection rate in Europe seems to be that consumers have considerable difficulty distinguishing between the batteries covered by the current directive (i.e., those containing mercury, cadmium and lead) and other batteries.<sup>48</sup> Fire safety and battery ingestion have not been identified as barriers to battery recycling in Europe.

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<sup>47</sup> LCSP *supra* n. 11 at 36.

<sup>48</sup> Commission of the European Communities, Proposal for a Directive of the European Parliament and of the Council on Batteries and Accumulators and Spent Batteries and Accumulators, p. 17 (November 21, 2003).

#### IV. Conclusions

- It is not safe to throw mercury-added button batteries in the trash and the Maine Legislature did not determine that it was safe to do so in 1992 when button batteries containing less than 25 milligrams of mercury were exempted from the limitations on mercury use in batteries. Button cell batteries were exempted because, at that time, the technology did not exist to control the formation of gas in batteries of that size without using mercury.
- Some battery manufacturers recently have found ways to make button cells without the use of mercury and have introduced mercury-free models to the marketplace. The long-term reliability of these new mercury-free batteries is unproven and production capacity is limited. Maine can hasten the deployment of mercury-free button battery technology by phasing out the exemption under 38 MRSA §2165(6) that currently allows button batteries containing less than 25 mgs of mercury to be sold in Maine. This exemption, if left in place, could become a disincentive to the use of mercury free batteries.
- Labeling of button battery packaging to identify those that contain added mercury will enable consumers to shop for mercury-free replacement batteries, and could hasten the deployment of mercury-free button battery technology.
- A rapid phase-out of the use of mercury in batteries will make it unnecessary to establish a statewide program to collect and recycle button batteries. This strategy is in keeping with Maine solid waste management hierarchy under which reduction of the toxicity of waste at the source is preferred over recycling.<sup>49</sup>
- If the Legislature decides to prohibit the disposal of button batteries (as proposed in legislation recently referred to the Committee on Natural Resources<sup>50</sup>), manufacturers should share responsibility for putting an effective battery collection and recycling program in place and the program should include a strong message aimed at making the public aware of the need to keep button batteries out of the reach of children. If manufacturers are made responsible for the costs of safely collecting and recycling spent mercury-added batteries, they will have a powerful economic incentive to redesign the product to eliminate the use of this toxic substance.

Since 1998, when Maine joined the other New England states and the premiers of Eastern Canada in pledging to virtually eliminate anthropogenic sources of mercury, this state has been a

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<sup>49</sup> 38 MRSA § 2101(1) reads:

**1. Priorities.** It is the policy of the State to plan for and implement an integrated approach to solid waste management, which shall be based on the following order of priority:

- A. Reduction of waste generated at the source, including both amount and toxicity of the waste;
- B. Reuse of waste;
- C. Recycling of waste;
- D. Composting of biodegradable waste;
- E. Waste processing which reduces the volume of waste needing land disposal, including incineration; and
- F. Land disposal of waste.

<sup>50</sup> *An Act to Regulate the Use of Batteries Containing Mercury*, LD 1058, 122<sup>nd</sup> Maine Legislature.

national leader in efforts to reduce the use of mercury in consumer products. In almost every case (the only exception being mercury manometers in dairy barn milking rooms), the targeted products account for a larger usage of mercury than button batteries.

Maine, for example, already has laws banning the sale of mercury thermostats (200 pounds of mercury per year), mercury fever thermometers (155 lbs/yr) and mercury switches in automobiles (55 lbs/yr). Maine also has banned the disposal of all mercury added lamps (125 lbs/yr) and assisted municipalities in building sheds to collect the lamps and keep them intact until they can be recycled. And two years ago, Maine passed a first-in-nation law that, effective July 1, 2006, will ban the sale all mercury switches, relays and measuring devices. If EPA's numbers in Figure 1 are correct, this law alone will reduce the amount mercury introduced into Maine commerce each year by about 1600 pounds.

The fundamental premise of each of these laws is that the use of mercury in product manufacturing should be eliminated wherever there are functional and affordable non-mercury alternatives. We now bring that same philosophy to the examination of button batteries. The initial focus on products that use larger amounts of mercury was appropriate, but should not be misinterpreted as implicitly condoning the disposal of other mercury-added products. Mercury is bio-accumulative and toxic; eliminating all unnecessary uses is a protective and prudent course of action.

## **V. Recommendations**

Based on forgoing findings and conclusions, the department recommends that the Maine Legislature:

1. Prohibit the sale of mercury-added button batteries in non-essential products such as toys and other novelties effective January 1, 2007;
2. Require battery makers to label the packaging of button cell replacement batteries sold after January 1, 2007 to identify those batteries that contain added mercury;
3. Prohibit the sale of all mercury-added button batteries effective January 1, 2010; and
4. Direct the Department of Environmental Protection, by February 1, 2008, to submit a report to the Legislature assessing: a) the reliability of mercury-free button batteries; and b) whether mercury-free button batteries are being produced in sufficient numbers to support the phase-out of all mercury-added button batteries by 2010.

Appendix E sets forth proposed legislation to implement these recommendations.

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# APPENDICES

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## **APPENDIX A**

*Resolve, Regarding the Sale of Batteries Containing Mercury, Resolves 2003, Chapter 125*

## **APPENDIX B**

Lowell Center for Sustainable Production, *An Investigation of Alternatives to Miniature Batteries Containing Mercury*

## **APPENDIX C**

Request for public comment

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Response to comment request

## **APPENDIX D**

National Electrical Manufacturers Association

- *Button Cell Battery Collection: Why It Does Not Make Sense*
- *Analysis of Battery Industry Sponsored Button Cell Collection Programs*

## **APPENDIX E**

Enacted legislation on button batteries in novelties

## **APPENDIX F**

Proposed Maine legislation to further regulate the use of mercury in batteries