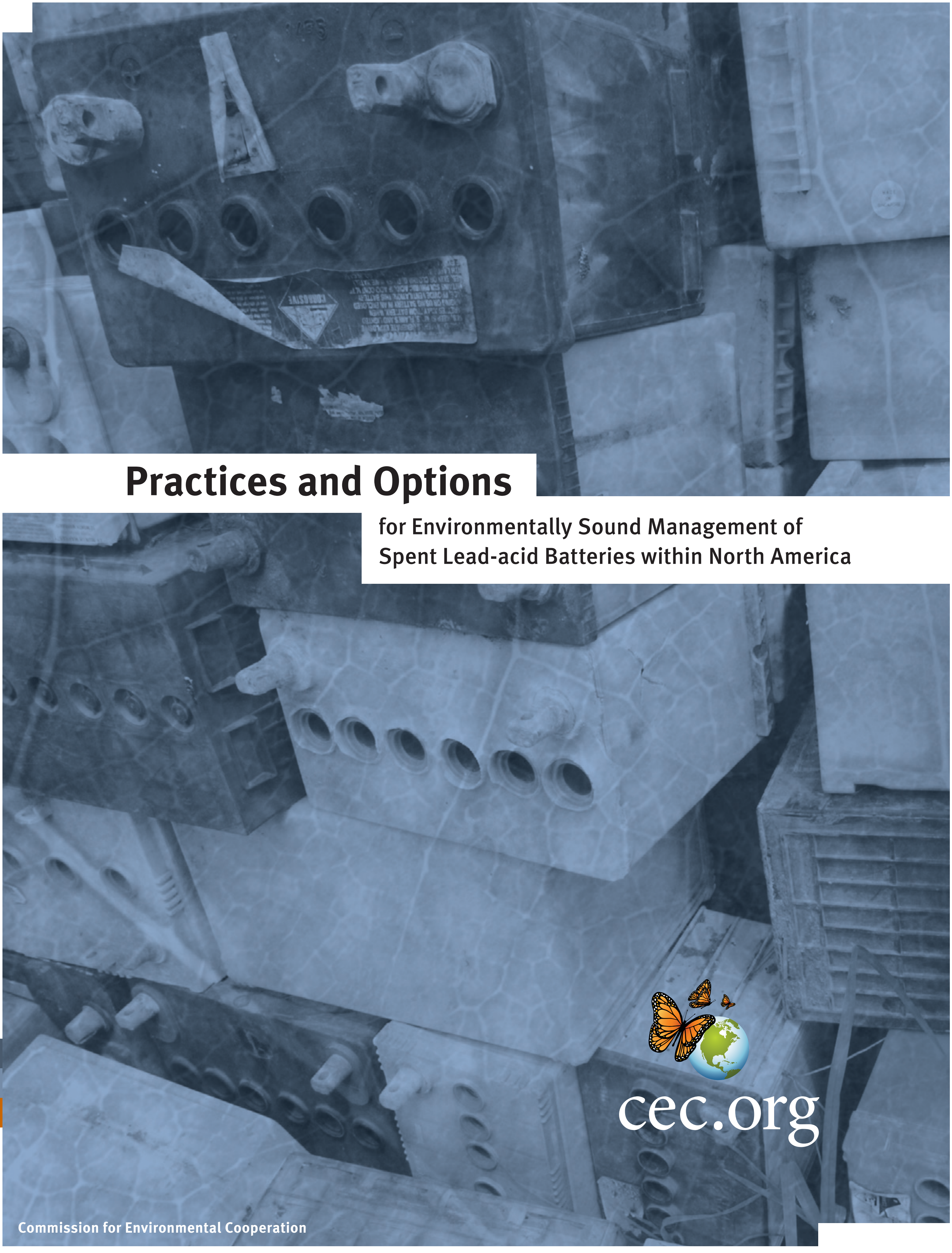

Practices and Options

for Environmentally Sound Management of Spent Lead-acid Batteries within North America

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Preface

Spent lead-acid batteries (SLABs) were chosen as the subject of study for this report because they are a priority substance of mutual concern in North America and the waste stream they create is a good candidate as a model for enhancing capacity building. Coordinated measures to improve documentation and strengthen environmentally sound management of the movement, recycling and disposal of SLABs could address current concerns, and the resulting framework could serve as a paradigm for the approach to other hazardous wastes and recyclables.

The guidelines in this publication are suggested as ways of complementing and expanding on those of the Basel Convention, and are not a substitute for regional, national or international laws or regulations. This CEC resource of environmentally sound management guidelines does not impose legally binding requirements, and the recommendations it puts forward may not be applicable to all particular situations or facility-specific circumstances. Furthermore, since some states or provinces have their own recycling standards, users of this text should understand applicable state and provincial requirements and guidance before implementing the guidelines herein.

Acknowledgments

This report has been assembled with the much-appreciated input of several experts from the three NAFTA countries. Among these, in particular, are:

Dr. Guillermo Roman, Alfonso Flores, Dr. Gerardo Alvarado and Dr. Cristina Cortinas, *Secretaría de Medio Ambiente y Recursos Naturales* (Semarnat);

Rick Picardi, Frank McAlister and Bob Heiss, United States Environmental Protection Agency (US EPA); and

Joe Wittwer, Nabila Elsaadi and Josée Lanctôt, Environment Canada.

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Executive Summary

Environmentally sound management (ESM) is one approach to ensuring that hazardous wastes and recyclables, including those moving across international borders, are being managed so that human health and the environment are protected.

The Hazardous Waste Task Force within the Commission for Environmental Cooperation (CEC) has selected spent lead-acid batteries (SLABs) as a priority hazardous waste/recyclable of common concern within North America. While all three NAFTA countries have policy and regulatory regimes in place to manage SLABs in an ESM manner, the US and Mexico could improve the availability of detailed information about the quantities of SLABs moving internationally for recycling and about the facilities to which the SLABs are exported**.**

This report provides background material on the environmentally sound management of SLABs, and possible options and criteria to ensure the ESM, including tracking and transportation, of spent lead-acid batteries in North America.

The report addresses ESM practices for SLABs from the time they become “used” or “spent,” through their collection, storage, transportation, and receipt and dismantling in a recycling facility, the recovery of lead in smelting/refining facilities, and the disposal of residues at the recycling facility. The ESM of the manufacture of new products that incorporate recovered components of SLABs, e.g., plastics, new batteries, etc., is not included in the scope of this project.

The components, uses, expected life of lead-acid batteries (LABs), and the steps involved in the recycling of SLABs are outlined. Recommended ESM elements and practices for hazardous recyclable management in general and SLABs in particular, for countries and organizations engaged in the management of SLABs, are summarized. Policy frameworks for collection systems to encourage safe recycling of SLABs are described.

Estimates, obtained from readily available material, are provided of the quantities of SLABs involved in the following actions: exports/imports to the three NAFTA countries, intra-country movements, and recycling and disposal. The ESM frameworks currently in place within government and industry in Canada, Mexico and the United States are summarized. Observations about the current ESM infrastructure and practices within North America and suggestions for possible next steps are offered.

The information in this report is based on the considerable work that has been undertaken internationally and within the three NAFTA countries on ESM and on documenting best practices for the management of SLABs. NAFTA can benefit from this work to explore a compatible approach to ESM within the three NAFTA countries to help ensure a safe and healthy environment while facilitating transborder movements for proper treatment, recycling and/or disposal based on capacity and proximity within the NAFTA family and outside North America.

The report corroborates that regulatory frameworks are in place for the ESM of SLABs in all three NAFTA countries. However, despite the abundant data available, information about the quantities of SLABs and the locations and facilities where they are being recycled and/or disposed of could still be improved. The report also cites concerns of some nongovernmental organizations about operations that may or may not be licensed in some jurisdictions, especially Asia (see **Section 6.6**).

The regulations and classifications for hazardous wastes/recyclables for SLABs differ in the three NAFTA countries. Regulations in all three countries require prior government notice and consent for any SLABs destined for disposal. In addition, Canada also requires prior notice and consent for any SLABs destined for recycling operations.

With the exception of SLABs exported to the United States from maquiladoras, Mexico has information on the quantities of SLABs exported and imported, but not whether they are exported for recycling or disposal. Mexico permits the import of SLABs only for recycling, not for disposal. In the United States and Mexico, data to provide the assurance that SLABs crossing international borders are being transported to and recycled in properly licensed facilities with up-to-date ESM systems are lacking. The revised regulations in Canada for the export and import of hazardous wastes and hazardous recyclable material should ensure that SLABs are not exported from Canada to non-ESM facilities. No movements of SLABs between Canada and Mexico have been reported.

In all three countries, the majority of SLABs is being recycled. Suspicions have been noted about a small quantity of SLABs being recycled in "backyard" operations that are not ESM, either in Mexico or in countries outside NAFTA, to which SLABs from the United States and Mexico may be being exported. Concerns have also been expressed by nongovernmental organizations (NGOs) about possible lead contamination around approved lead recycling facilities in the three NAFTA countries.

It would greatly facilitate the movement of SLABs and the availability of information among the three countries if a "crosswalk" between national export/import tracking systems, such as the CEC hazardous waste crosswalk project, were available, and these systems were integrated. One way of improving the information available on SLABs exported from the United States to countries other than Canada would be for exporters to report to the US authorities the country and facility to which the SLABs are exported.

Use of the ESM guidelines presented in this report by governments in permitting, licensing and auditing recycling operations and by operators can also help ensure that SLABs are being handled in an environmentally sound manner, and could form the basis for a compatible approach by the three NAFTA countries. In addition, minimum environmental performance standards applied to such facilities, coupled with the enforcement of permit conditions on these facilities, should further address the potential lead emissions issue.

While the regulatory frameworks are in place, it is possible that some companies, especially small and medium-size entreprises (SMEs), may not have appropriate environmental management systems (EMSs) in place and may not always operate in an ESM manner. Programs for training, education (capacity-building) and awareness of the hazards of SLAB recycling and how to deal with those hazards would assist in addressing this potential situation.

For the small number of SLABs that are not being recycled, it would appear that incentives for SLAB recycling would help. These could include: providing for a recycling framework that would make it easy for the individual to recycle, such as well-publicized, readily accessible depots for SLABs; a web site that would provide information about where to take SLABs for recycling; plus economic incentives such as a deposit/refund system for lead acid batteries (LABs) and/or a discount toward a new LAB when a SLAB is returned.

1.0 The Project

1.1 Purpose

The purpose of this project is to provide the Secretariat and the Parties of the CEC with a report which contains background material on the environmentally sound management (ESM) of spent lead-acid batteries (SLABs) and possible options/criteria to ensure ESM, including tracking and transportation, of spent lead-acid batteries in North America.

1.2 Scope

This report addresses ESM practices for SLABs from the time they become "used," through their collection, storage, transportation, receipt and dismantling in a recycling facility, the recovery of lead in smelting/refining facilities and the disposal of residues from the recycling facility. The report is intended to complement the Basel Convention *Technical Guidelines for the Environmentally Sound Management of Waste Lead Acid Batteries*.[1] The ESM of the manufacture of new products, such as plastics, new batteries, etc., has not been included and is addressed in other documents, such as the *Draft Technical Guidelines for the Identification and Environmentally Sound Management of Plastic Waste and for their Disposal*, prepared by the Technical Working Group of the Basel Convention[2].

1.3 How the Report Is Organized

This report presents the findings of the project and is organized as follows:

- The **Executive Summary** provides a short overview of the project purpose, scope, findings and observations.
- **Section 1** explains the purpose of the project, the organization of the report and the background and context of the project.
- **Section 2** describes the approach used in this project.
- **Section 3** outlines the components, uses and expected life of lead-acid batteries (LABs) and the steps involved in the recycling of SLABs.
- **Section 4** summarizes recommended ESM elements and practices for hazardous recyclable management in general and SLABs in particular, including ESM for countries and organizations engaged in the management of SLABs. Policy frameworks for collection systems to encourage safe recycling of SLABs are also described.
- **Section 5** presents estimates, obtained from readily available material, of quantities of SLABs exported and imported to the three NAFTA countries and of intra-country quantities, as well as estimates of the quantities recycled and disposed of.

[1] United Nations Environment Programme (UNEP). Basel Convention. *Technical guidelines for the environmentally sound management of waste lead-acid batteries*. Basel Convention series/SBC No. 2003/9. 2002.<http://www.basel.int/pub/techguid/tech-wasteacid.pdf>.

[2] Basel Convention, *Technical guidelines for the identification and environmentally sound management of plastic wastes and for their disposal*. UNEP/CHW.6/21. 23 August 2002. <http://www.basel.int/meetings/cop/cop6/cop6_21e.pdf>.

- **Section 6** outlines the ESM framework currently in place within government and industry in the three NAFTA countries.
- **Section 7** offers observations about the current ESM infrastructure and practices within North America and offers suggestions for possible next steps.
- **Appendices I to IV** provide: references, data tables, controls and regulations in the United States, a glossary of terms, and an outline of Basel ESM guidelines and Organization for Economic Co-operation and Development (OECD) ESM principles for recycling facilities.

1.4 Background

1.4.1 ESM

ESM (environmentally sound management) is one approach to ensuring that hazardous wastes (and recyclables), including those moving across international borders, are being managed so that human health and the environment are protected.

Considerable work has been undertaken internationally and within the three NAFTA countries on ESM and on documenting best practices for the management of SLABs. NAFTA can benefit from this work to explore a compatible North American approach to ESM to help ensure a safe and healthy environment while facilitating transborder movements for treatment, recycling and/or disposal based on capacity and proximity within the NAFTA community and outside North America.

The Hazardous Waste Task Force (HWTF) of the CEC has selected SLABs as a priority hazardous waste/recyclable of mutual concern within North America. While all three NAFTA countries have policy and regulatory regimes in place to deal with SLABs in an ESM manner, governments would benefit from detailed information about the quantities of SLABs moving internationally for recycling and the facilities to which the SLABs are exported**.** With the exception of SLABs exported to the United States from maquiladoras, Mexico has information on the quantities of SLABs exported and imported, but not whether they are exported for recycling or disposal. Mexico permits the import of SLABs only for recycling, not for disposal. In the United States and Mexico, there is a lack of assurance that SLABs crossing international borders are being transported and recycled in properly licensed facilities with up-to-date ESM systems. Regulations in all three countries require that prior notice and consent be provided by government for any SLABs destined for disposal. In addition, Canada also requires prior notice and consent for any SLABs destined for recycling operations. No movements of SLABs between Canada and Mexico have been reported.

The Parties can work both to improve already excellent recycling rates of SLABs (estimated to be from 80 to 97 percent) and to strengthen ESM practices regarding their transboundary movement, recovery and recycling. The work on SLABs can contribute to an understanding of the different approaches to ESM in Mexico, the United States and Canada, select from the best ESM practices worldwide and serve as a model for a coordinated, consistent or integrated approach to ESM for other hazardous wastes and recyclables that move between the three countries. Improving and coordinating ESM of SLABs can also address concerns expressed by the CEC and others about emissions of lead from smelters and recycling facilities and the decommissioning of lead recycling operations,[3,4,5,6] as well as concerns that some transboundary movements of SLABs may be occurring under variable standards in some jurisdictions. A common or integrated approach to the ESM of SLABs could facilitate shipments based on the proximity principle and ensure that all wastes are managed at facilities with appropriate technologies and environmental controls.[7]

1.4.2 Lead Production, Use and Recycling in North America

Over 5 million tonnes of lead metal are consumed annually in the Western World.[8] Some of its important uses include: provision of power and energy, shielding humans from radiation, and protecting power cables from harsh environments.

Battery manufacturing accounts for over 75 percent of all lead consumed.[9] During 1999, it was reported that there were over 100 million automotive batteries sold in the United States and Canada (an all-time record).[10] In the same year, over 1,000,000 tons (909,000 tonnes) of lead were consumed in North America for the use of batteries alone.[11]

According to a CEC task force report,[12] in Canada, lead-acid batteries and battery oxides accounted for the largest quantity of lead used in 1999—15,217 tonnes (16,741 tons) of primary lead and 18,202 tonnes (20,024 tons) of recycled lead. Mexico notes that SLABs are a major source of lead for product inputs.[13]

Much of the lead, particularly the lead in SLABs, is recovered and reused. According to the Battery Council International, during 1999 the lead-acid battery was the most recycled consumer product, with a recycling rate of over 94 percent.[14]

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[3] CEC, *Taking stock: A special report on toxic chemicals and children's health in North America*. Draft report to CEC Secretariat, 13 April 2005.
[4] CEC, Citizen submissions on enforcement matters: Metales y derivados. CEC Submission ID: SEM-98-007.
[5] Chris North, Council contends incinerator too much for polluted North. *New Brunswick Telegraph Journal*, 29 August 2003.
[6] Madeline Cobbing and Simon Divecha, *The myth of automobile battery recycling*. Greenpeace, <http://www/things.org/~jym/greenpeace/myth-of-battery-recycling.html>.
[7] CEC, Environmentally sound management of hazardous wastes and recyclables in North America. Draft report prepared for CEC, no date.
[8] Teck Cominco Products and Services, <http://products.teckcominco.com/Products/LeadApplications.html>.
[9] Nova Pb, Lead recycling, <http://novapb.com/lead_recycling.htm>.
[10] Ibid.
[11] Ibid.
[12] CEC, *Decision document on lead under the process for identifying candidate substances for regional action under the Sound Management of Chemicals initiative*. Public consultation draft, prepared by the Substance Selection Task Force for the North American Sound Management of Chemicals Working Group, of the Commission for Environmental Cooperation, June 2003.
[13] Semarnat-INE (Ministry of Environment and Natural Resources, National Institute of Ecology), Statement of concern on lead in Mexico, 22 November 2001.
[14] Battery Council International, <www.batterycouncil.org/recycling>. (Note: Web site has changed since 2004. In November 2005 it shows a 97% recovery rate; original reference to 1999 has been removed from web site.)

By the mid-1980s in the United States, about one million tonnes of lead (equivalent to 61 percent of US consumption) were recovered from SLABs alone.[15] Total use of secondary (recycled) lead amounted to 76 percent of the lead produced in 1999 in the United States.[16] The information in the CEC task force report shows that lead from SLABs represented about 90 percent of the lead recovered from scrap processed in the United States in the year 2000.[17] In 1999, lead recovery from SLABs in the United States amounted to 18 percent of world production.[18]

According to Environment Canada, six million SLABs were taken out of service every year in Canada up through 1995. This amounts to 100,000 tonnes of batteries, containing about 50,000 tonnes of lead. Environment Canada estimates that Canada's recycling rate for SLABs is about 90 percent (and in some years has exceeded 100 percent, as stockpiled batteries were recycled).[19] In a report prepared by Mexico for the Basel Convention Secretariat,[20] it was estimated that 80 percent of SLABs in Mexico are recycled, though this number has not been verified. There are some 255 companies managing lead in Mexico. The largest of these, Enertec, is thought to receive about 70 percent of the batteries collected and reports that it recycles 95 percent of what it receives.

While lead has many important uses, including in batteries, it can also cause serious health and environmental effects when improperly used and controlled. In North America, metallurgical hazardous waste management and solvent recovery (primarily from lead-acid batteries), electronic/electrical manufacturing, and chemical processes that release or utilize lead have consistently been the most significant sources of lead emissions since the phase-out of lead-additive gasoline formulations in road vehicles in the 1980s and 1990s.[21]

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[15] CEC, *Decision document on lead under the process for identifying candidate substances for regional action under the Sound Management of Chemicals initiative*. Public consultation draft, prepared by the Substance Selection Task Force for the North American Sound Management of Chemicals Working Group, of the Commission for Environmental Cooperation, June 2003.

[16] Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, *Draft technical guidelines on the environmentally sound recycling/reclamation of metals and metal compounds (R4)*. .UNEP/CHW.7/8/Add.3. 11 August 2004. <http://www.basel.int/meetings/cop/cop7/docs/08a3e.pdf>.

[17] CEC, *Decision document on lead under the process for identifying candidate substances for regional action under the Sound Management of Chemicals initiative*. Public consultation draft, prepared by the Substance Selection Task Force for the North American Sound Management of Chemicals Working Group, of the Commission for Environmental Cooperation, June 2003.

[18] Basel Convention, *Draft technical guidelines on the environmentally sound recycling/reclamation of metals and metal compounds (R4*). .UNEP/CHW.7/8/Add.3. 11 August 2004. <http://www.basel.int/meetings/cop/cop7/docs/08a3e.pdf>.

[19] Resilog Canada ISSN 0-255-5804, December 1995, <www.ec.gc.ca/tmb/resilog/eng/pdfs/v901e.pdf>.

[20] Basel Convention, *First meeting of the steering committee on the project Preparation of a regional strategy for the environmentally sound management of used lead-acid batteries in Central America, Colombia, Venezuela and the Caribbean island states*, December 2003.

[21] CEC, *Decision document on lead under the process for identifying candidate substances for regional action under the Sound Management of Chemicals initiative*. Public consultation draft, prepared by the Substance Selection Task Force for the North American Sound Management of Chemicals Working Group, of the Commission for Environmental Cooperation, June 2003.

Given that a battery has a reported limited life span of up to six years, it is important to be able to recycle the battery components for both economic reasons and environmental reasons, provided that the recycling is carried out in an environmentally sound manner.

1.4.3 Lead-acid Batteries—Uses and Recycling

There are two general types of lead-acid batteries: starting, lighting and ignition (SLI), and industrial. SLI batteries are sold as both original equipment and replacement batteries for use in the automotive market. Using lead in SLI batteries allows them to be fully recyclable.[22]

Industrial batteries can be either "motive," powering products like industrial trucks, forklifts, golf carts, and submarines, or "stationary," used for emergency lighting and power supply. Many institutions rely on un-interruptible power systems (UPSs) for emergency lighting and power. In remote areas unconnected to electrical power grids, batteries can provide electricity.[23]

Obtaining secondary lead from SLABs can be economically attractive, depending upon the market price of lead. Processing secondary lead takes about 25 percent less energy than mining primary lead. Batteries are a ubiquitous product with a predictable lifetime, and the large market for recycled lead creates economies of scale.[24] The lead-acid battery recycling sector has a well-established infrastructure in North America and internationally.

Recycling of lead-acid batteries, provided it is done in an environmentally sound manner, is important because it keeps the batteries out of the waste stream destined for final disposal. Lead from lead-acid batteries placed in unlined landfills can find its way to groundwater, if not properly complexed and fixed prior to landfilling.[25]

Many of the companies operating within the lead-acid battery recycling infrastructure are sophisticated, experienced organizations with rigorous health, safety and environmental management systems. However, there are concerns that in some instances, including in many developing countries, retired batteries are still dismantled manually (for instance, using an axe) and that recovery of lead is carried out using open burning. It has also been suggested that lead refining on a small scale may be going on in a non-ESM manner, such as by heating in a wok.

Management systems are continuously evolving as the understanding of the effects of unsafe practices evolves and as safe operating practices improve. It is important for countries to have an appropriate policy and executing regime in place that facilitates environmentally sound management practices and deters unsound practices. These regimes, while respecting regional needs, are best harmonized or integrated, to avoid

[22] Ibid.
[23] Ibid.
[24] Battery Council International, <www.batterycouncil.org>.
[25] CEC, *Decision document on lead under the process for identifying candidate substances for regional action under the Sound Management of Chemicals initiative*. Public consultation draft, prepared by the Substance Selection Task Force for the North American Sound Management of Chemicals Working Group, of the Commission for Environmental Cooperation, June 2003.

inadvertently creating incentives to send SLABs for recycling to locations where ESM requirements or practices may be less stringent.[26]

2.0 The Approach to This Project

Based on feedback from interviews with CEC and HWTF representatives (see **Acknowledgments**), the approach to this project included:

- development of the material in the report, using existing references, discussions with officials, and professional experience; and
- input from Dr. Cristina Cortinas[27] on the management of SLABs in Mexico.

Feedback from CEC and HWTF representatives indicated that the report should:

1. provide information about simple, practical ESM practices that rely on professional judgment as to good practices and that would improve the trading, transportation and management of SLABs in Canada, Mexico and the United States;
2. use a lifecycle approach to identify the steps that must be properly managed when recycling SLABs, from generation through transportation, dismantling, separation into different recyclable components, processing into new products, to the final disposal of residuals;
3. address incentives for recycling;
4. include information about regulatory, incentive and ESM practices in other jurisdictions, especially with regard to notice and consent requirements; and
5. provide information about movements and quantities of SLABs—across international as well as state/provincial borders.

[26] Ibid.
[27] Cristina Cortinas, personal communication with the author, May 2004.

3.0 Life Cycle of Lead-acid Batteries

3.1 Manufacture and Use of Lead-acid Batteries (LABs)

This section outlines: how lead-acid batteries (LABs) are manufactured, what materials are included, whether feed-stocks are primary or secondary, how SLABs are dismantled and where they are sent for further processing, recycling and final reassembly into LABs.

3.1.1 Lead-acid Battery Components and Manufacture

To understand the potential health and environmental issues that might arise from the handling of SLABs, it is helpful to review the materials and processes involved in lead-acid battery manufacture. A typical lead-acid battery is shown in **Appendix I** and includes the following materials:

- lead, metal and paste;
- plastic, e.g., polypropylene or co-polymer, polyvinyl chloride, polyethylene;
- sulfuric acid; and
- minor components such as antimony, arsenic, bismuth, cadmium, copper, calcium, silver, tin, barium sulfate, lampblack lignin, and lead-antimony alloy.

The battery plates consist of metallic lead structures covered by a lead dioxide paste, in the case of the negative plates, or by a porous metallic lead paste, in the case of the positive plates. The lead used in the plates may also contain several other chemical elements such as antimony, arsenic, bismuth, cadmium, copper, calcium, silver, tin and sometimes other elements. Expander materials, such as barium sulfate, lampblack and lignin, are also used in the manufacture of plates.

After being shaped, the battery plates are placed so that the negative and positive plates are alternated. Separators of polyethylene, polyvinyl chloride or fibrous paper are used between plates to avoid short circuits. There are 6 to 20 pairs of negative and positive plates aligned and electrically isolated. The plates of same polarity are then electrically connected and the plate sandwiches, referred to as battery elements, are inserted into battery compartments. A standard battery element has 13 to 15 plates. The elements are connected in series with a lead-antimony alloy connector in order to provide a higher voltage. The higher the voltage, the higher the number of elements connected: a standard automobile battery has six elements in series, producing 12 volts (2V x 6 elements). Finally, the battery is assembled and filled with electrolyte (sulfuric acid). The lid is then sealed and the product is examined for leaks, after which it will receive its first charge.

3.1.2 Lead-acid Battery Uses

Lead-acid batteries have many applications and these can require different voltages, sizes and weights, ranging from 2 kg, permanently sealed, to industrial batteries that may weigh 2,000 kg or more. Batteries may be classified as:[28]

[28] Basel Convention, *Technical guidelines for the environmentally sound management of waste lead-acid batteries*. Annex to United Nations Environment Programme document UNEP/CHW.6/22, 8 August 2002.

(a) **automobile**—those batteries used as the main energy source for starting, lighting and ignition (SLI batteries) in vehicles such as cars, trucks, tractors, motorcycles, boats, planes, etc.;
(b) **generic**—batteries used in portable tools and devices, domestic alarm systems, emergency lights, etc.;
(c) **industrial**—batteries for stationary applications such as telecommunications, electrical power stations, uninterrupted power supplies or no-breaks, load leveling, alarm and security systems, general industrial use, and starting of diesel motors;
(d) **motive**—batteries used to transport loads or people: fork lift trucks, golf carts, luggage transportation in airports, wheelchairs, electric cars, buses, etc.; or
(e) **special**—batteries used in specific scientific, medical or military applications, and those that are integrated in electric-electronic circuits.

3.1.3 Battery Life

Battery life is defined as the period of time over which a battery is capable of being recharged and retains the charge applied. Once the battery is no longer capable of being recharged or cannot retain its charge properly, its useful lifetime reaches its end and it becomes a "used, or spent, battery" no longer useful for the application for which it was designed.

The main cause of this "death" is the sulfation process. This begins when lead sulfate precipitates over the battery plates, coating them and preventing the reactions which produce the electric energy from taking place.

Under ideal conditions, an automobile battery can last up to six years, but several factors may decrease this optimal lifetime to anywhere from 6 to 48 months. The Basel Guidelines on ESM of SLABs notes a range of battery life in 1995 from 1.8 years in India to 5.0 years in Canada and 5.3 years in Western Europe.[29]

3.2 Recycling Infrastructure for Spent Lead-acid Batteries

Before reaching the recycling plant, SLABs must be disconnected, removed from their point of use, collected, transported and stored. A SLAB collection and recycling infrastructure involves several different sectors, including automobile service centers, waste transporters, scrap dealers, battery dealers, secondary lead processors and consumers. This infrastructure needs to be a well-organized network that provides a safe and continuous flow of leaded scrap materials to the recycling process.[30] A well-designed collection network makes it easy to recycle for all generators of used batteries, from the individual, through the small service station or retailer to the larger automobile dealers, automobile service centers and retailers, and/or from industry, including SMEs, through waste transporters and scrap dealers to recyclers.

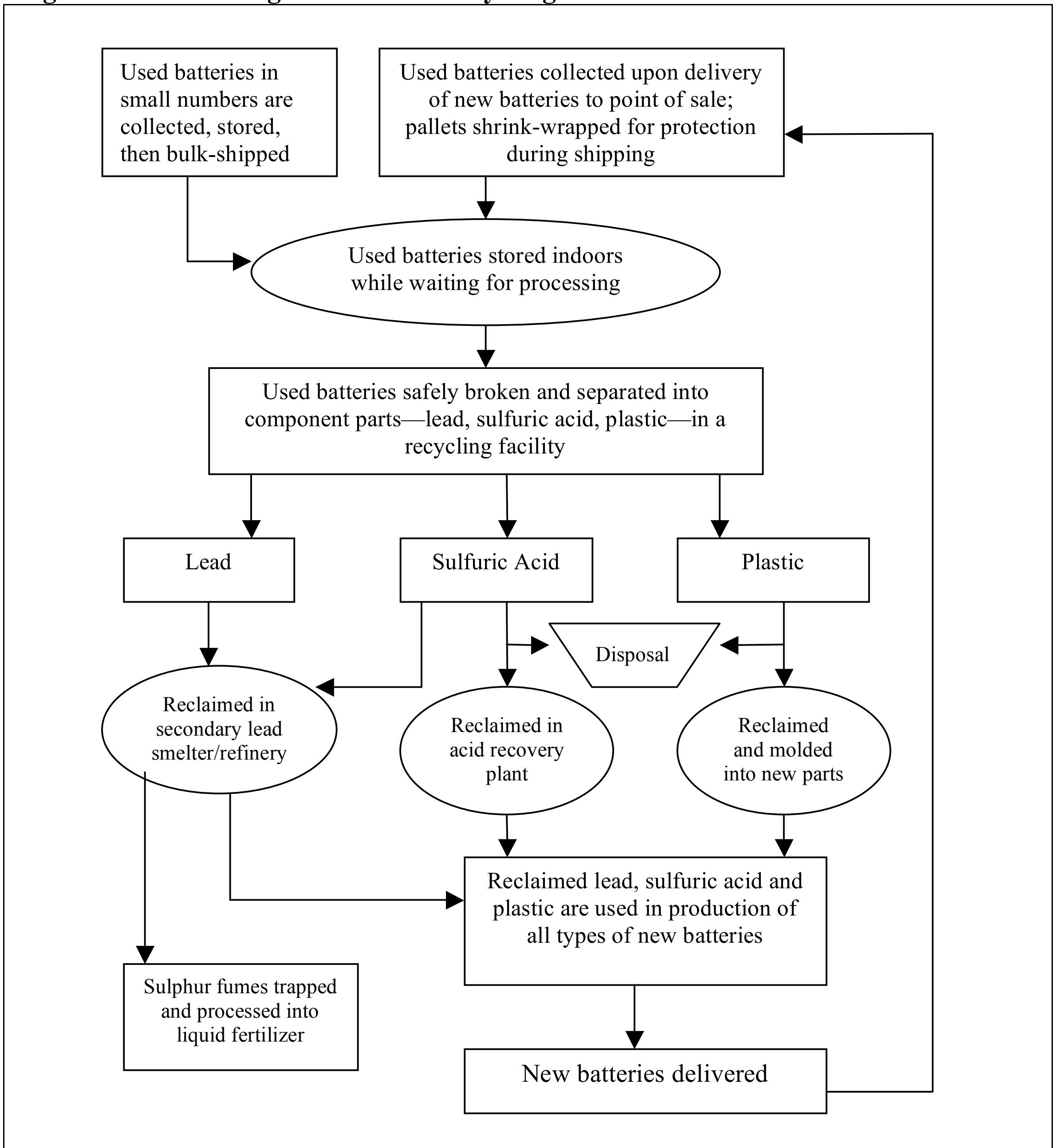
The recycling steps generally involved for the majority of SLABs that are recycled are shown in **Figure 3-1** and include the following:

[29] Ibid.
[30] Ibid.

- Collection of small numbers of SLABs
- Temporary storage of SLABs
- Transportation of collected SLABs to bulking facilities
- Temporary storage in bulking facilities
- Transportation of bulked quantities to recycling facility
- Dismantling and separation into recycling and disposal streams at the recycling facility
- Transportation to processing facilities for use as feedstocks in the manufacture of new products
- Production of lead in lead reduction and refining facilities
- Production of other products, e.g., plastics, etc.
- Transportation of residuals from recycling facilities to approved final disposal facilities

Many of the components recovered from SLABs are used in the manufacture of LABs; for example, the lead recovered is used in the lead component of new lead-acid batteries and the plastic recovered is used to make battery casings. Some plastic, which cannot be separated from lead components in SLABs, may be used for energy in lead reduction and refining facilities.

Figure 3-1 Flow Diagram of ESM Recycling of SLABs



Source: Adapted from Basel UNEP Guidelines.[31]

3.2.1 Collection, Storage and Transportation of SLABs

Collection of SLABs from individual users can take place at battery retailers, vehicle service centers, hazardous waste residential pickups or at designated locations on special hazardous waste collection days. SLABs are generally temporarily stored in these locations for transportation to bulking facilities (transfer stations), for bulking and eventual transportation to recycling facilities. Collection of non-vehicle SLABs from

[31] Basel Convention, *Technical guidelines for the environmentally sound management of waste lead-acid batteries*. Annex to United Nations Environment Programme document UNEP/CHW.6/22, 8 August 2002.

industrial facilities is usually carried out by licensed waste service companies, transporters or new battery suppliers.

3.3 Recycling Processes for SLABs

The recycling process for SLABs is considered to begin when the SLABS move from storage to the recycling plant and into processing. It can be divided into seven main steps:

- battery draining (**Section 3.3.1**),
- battery breaking or breakage (**Section 3.3.2**),
- separation into different components, largely plastics, acid, lead and other metals (**Section 3.3.3**),
- processing of acid and lead paste prior to lead reduction (**Section 3.3.4**),
- lead reduction (**Section 3.3.5**),
- lead refining (S**ection 3.3.6**), and
- processing of plastic for recycling or energy recovery (**Section 3.3.7**).

SLABs are drained, broken up and separated into different fractions. These steps can take place at a bulker or scrap dealer. More commonly today, they are carried out at the lead reduction facilities. Once broken into pieces, the different components are transported to the appropriate facilities for processing, recycling and/or disposal.

3.3.1 Battery Draining

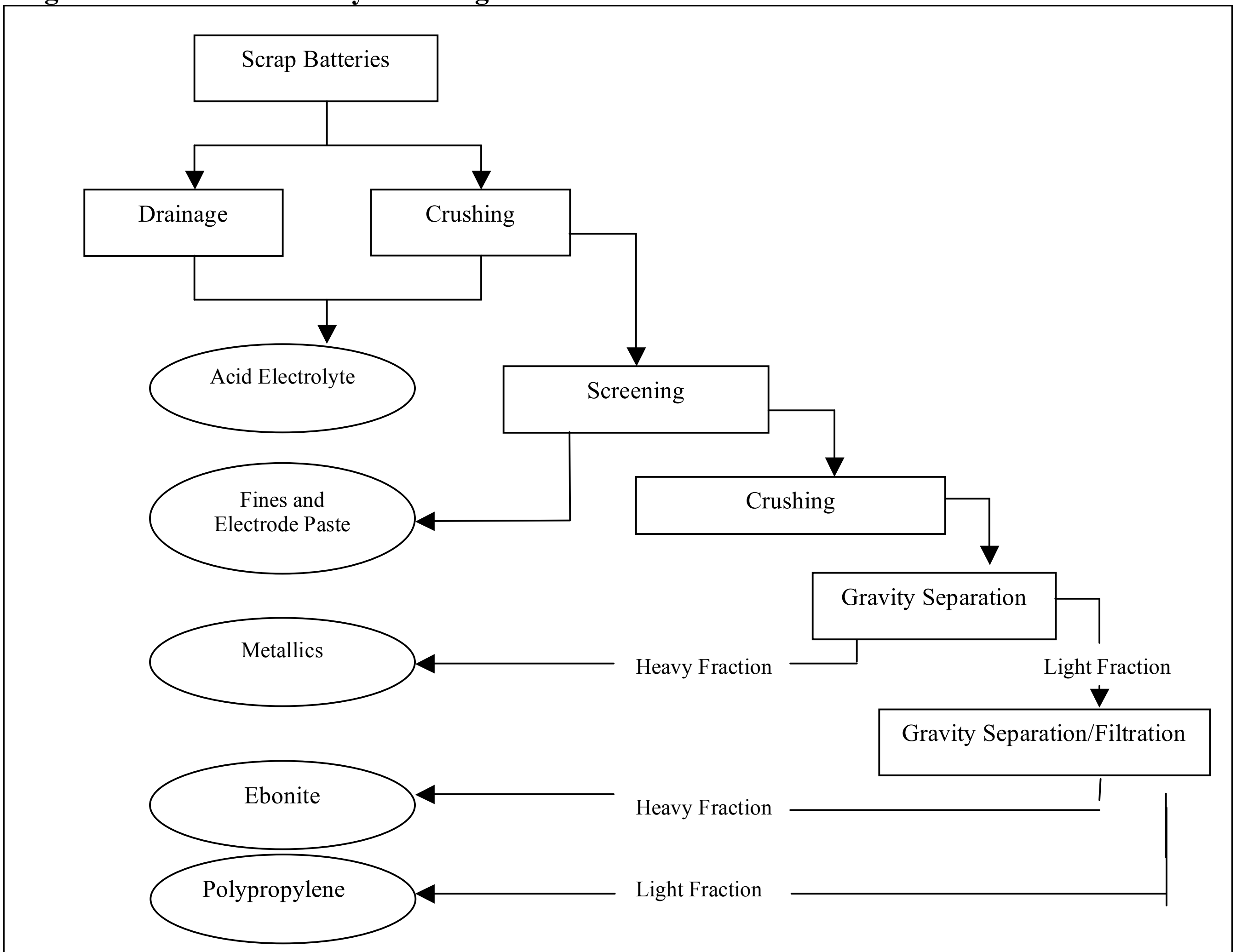
SLABs should always be drained before they enter the breaking process, since the acidic electrolyte produces several complications in the lead re-refining process. The acid may be neutralized to precipitate out lead in the form of lead hydroxide (see **Section 3.3.4**).

3.3.2 Battery Breaking

Once the SLABs are drained, they are delivered to the "breaking machine," where the dismantling process begins.[32] SLABs are broken into small pieces in hammer mills or other crushing mechanisms. This ensures that all components, such as lead plates, connectors, plastic boxes and acid electrolyte can be easily separated in the subsequent steps. **Figure 3-2** shows a generic battery-breaking process and identifies the various materials generated/recovered from the SLAB. Each of the components can be "recycled" to a greater or lesser degree. This process may take place at a separate facility from the lead recovery process in a smelter or refinery, or in a facility contiguous with a lead smelter (which has become the more usual case).

[32] Basel Convention, *Technical guidelines for the environmentally sound management of waste lead-acid batteries*. Annex to United Nations Environment Programme document UNEP/CHW.6/22, 8 August 2002.

Figure 3-2 Modern Battery-breaking Process



Source: Adapted from Basel UNEP Guidelines.[33]

3.3.3 Separation into Different Components

After breakage, the lead oxides and sulfates are separated from the other materials by gravity in water via a system of moving mesh conveyers.

After the first rough breakage, sometimes there are other crushing mechanisms that further decrease the size of the remaining materials. The metallic parts, including lead plates, grids, connectors and terminals, are then separated from the organic parts, which include cases, either polypropylene, ebonite or PVC, in the form of the plate separators, etc., by means of density difference in hydraulic separators which differ from process to process. The plastic materials are either shipped to plastic recyclers or used for energy recovery in the smelters (see **Section 3.3.7**).

Sometimes other processes, such as use of density differences and hydraulic mechanisms, are used to separate the broken battery pieces into three layers. The first layer consists of

[33] Ibid.

light fractions such as plastics, the second layer includes fine granular pieces of lead oxide and sulfates and the third heavy layer includes lead plates, connectors, etc. These methods lack a filtration step to remove lead compounds prior to plastic recovery. The complexity of these systems make them difficult to regulate and use.[34]

After the separation steps, the organic layer is further separated into polypropylene wastes (called light organics), and separators and ebonite (called heavy organics). The light organics are then washed to remove traces of lead oxides, and milled to small pieces, according to their future use, while the ebonite and separators are stored. Unless the breakage system is connected to the re-refining step in a continuous process, the lead compounds and metallic parts are stored until further processing.

3.3.4 Processing of Acid Electrolyte and Lead Paste

Prior to smelting, lead sulfate pastes may be de-sulfurized by combining them with a mixture of sodium carbonate and sodium hydroxide, converting the lead sulfate to lead oxide. An alternative de-sulfurizing agent is iron oxide and limestone. De-sulfurization reduces the amount of slag formation and also, depending on the smelting method, the amount of sulfur dioxide released into the air. Other methods bypass the de-sulfurizing step and add controlled amounts of lead sulfate as well as a de-sulfurizing agent directly into the smelting furnace.

If the lead content in the acid electrolyte is recovered in a smelting furnace, the acid is treated first by neutralization with sodium hydroxide. This precipitates the lead as lead hydroxide. The lead hydroxide is then removed by decantation or filtration and directed to the furnace. The neutralized acid, essentially sodium sulfate diluted in water, may be further treated to meet effluent discharge standards and discharged to the environment. Alternately, it can be further processed and converted to sodium sulfate for use in laundry detergent, glass and textile manufacturing. While is also possible to reclaim acid electrolyte for reuse in new lead acid batteries after topping up with concentrated acid, this is generally not economical.

3.3.5 Lead Reduction

The battery metal scrap obtained from the breaking process is a mixture of several substances: metallic lead, lead oxide, lead sulfate and other metals such as calcium, copper, antimony, arsenic, tin and sometimes silver. Either pyro- or hydrometallurgical processes can be used to isolate the metallic lead from this mixture. It is also possible to combine the two methods and use a hybrid process.

In pyrometallurgy, the metallic fraction and the lead compounds from the de-sulfurization and neutralization processes are added to a furnace and smelted with fluxing and reducing agents. The necessary heat is provided by several sources, depending on the specific method: oil, gas, coke, electricity, etc. There are several different vessels in which the smelting process may be carried out: rotary furnace, reverberatory furnace and blast or electric furnace, rotary kiln, etc.

[34] Ibid.

In hydrometallurgical processes, the lead compounds are electrically reduced to metallic lead. The electrolysis deposits lead as dendrites or sponge, which are subsequently shaken off and collected on a conveyor belt and pressed to form platelets of pure lead (99.99%), which can then be conveyed to a melting kettle for casting into ingots.

3.3.6 Lead Refining

If a smelting plant stops at the stage of reduction, it will produce a hard, or antimonial, lead. If the plant is meant to produce soft lead, the crude lead bullion must undergo a refining process. The objective of the refining process is to remove almost all copper, antimony, arsenic and tin, since the soft lead standard does not allow more than 10g per ton of these metals. As with lead reduction, lead can be refined pyrometallurgically or hydrometallurgically.

3.3.7 Plastic Recycling[35]

Washed and dried polypropylene pieces are sent to a plastic recycler, where the chips are melted and extruded to produce plastic pellets for use in the manufacture of battery cases. Polyethylene plate separators can be separated from the polypropylene stream and recycled, although in most secondary plants the current practice is to use this stream as a fuel supplement.

3.4 Environmental Controls for SLAB Management

The environmental controls for the main SLAB recycling facilities should at a minimum meet the requisite environmental regulations and guidelines in the jurisdiction in which they are located. The requirements may differ depending upon whether:

- the recycling facility has not yet been commissioned (a new facility);
- the recycling plant was constructed some time ago and needs technological improvements and monitoring guidance; or
- the recycling plant follows the best available technologies and only needs monitoring guidance.

The most effective pollution prevention method is to choose processes with lower energy usage and lower emissions. In addition, good housekeeping practices are key to minimizing losses and preventing fugitive emissions. More details on pollution prevention and control are provided in the referenced *Pollution Prevention and Abatement Handbook, Lead and Zinc Smelting* (World Bank Group), effective July 1998.

Key control features include the following:

Effluent treatment
Every lead recycling facility should have an effluent treatment system to contain, monitor and treat any water that leaves the recycling facility, including that coming from the electrolyte neutralization, rain water, spilled water from battery storage, etc. Any area that may be subject to leaks or spills, such as storage, breaking, processing areas, etc., should be covered with an impermeable surface, be contained, and be structured in a way

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[35] Basel Convention Technical Working Group, The environmentally sound management of used lead acid batteries in Central America and the Caribbean: What is a lead acid battery and why recycle used batteries. Workshop given by Brian Wilson, in Trinidad, May 2001.

that leaks or spills may be directed to areas where they can be properly contained and treated.

Air Emissions Control

All stages in battery recycling facilities can result in gaseous or particulate emissions, either as point sources from stacks, or as fugitive emissions. The fugitive emissions from smelting operations and traffic within and outside the plant are of particular concern. Fugitive emissions should either be prevented and/or captured by using dust suppression methods such as covering area sources and/or venting storage and processing areas through air pollution control equipment. The recovered emissions can either be reused in the facility or treated before being released to the environment and/or sent to final disposal.

Several potential sources of fugitive emissions have already been addressed in the sections on storage facilities, battery-breaking processes, lead refining, etc. Other sources include molten lead as it is drained from a smelting furnace. In the same context, fugitive emissions would be generated if lead furnace bullion is transferred in an open ladle and poured into a refining kettle, and if, later during processing, the dusty dross is skimmed manually without extraction or ventilation.

Pyrometallurgical processes are high-temperature, high–gas volume operations. Therefore, they require special attention to air emissions because they can generate relatively high quantities of particulates containing metals and sulfur compounds. Emissions should be routed through appropriate emission control devices, such as fabric filters, before being released. Hydrometallurgical processes, on the other hand, require special attention to effluent management because they use relatively large volumes of liquids for leaching and separating the desired metals.

Monitoring

Facilities should be routinely monitored. Monitoring provides a picture of the lead recycling plant’s environmental performance and indicates processing problems. It should be analyzed and reviewed at regular intervals to provide information for decisions needed to improve the process and reduce potential impacts on environmental and human health. The environmental monitoring provides the information needed for maintaining the environmental soundness of the recycling process.

4.0 ESM Practices for SLABs

This section addresses recommended ESM practices for regulatory agencies and for companies engaged in the recycling or disposal of SLABs, from the collection of SLABs through their recycling to the disposal of residues. Also outlined are collection system infrastructures and incentives that have been applied in different countries to encourage safe recycling of SLABs.

The terms "environmentally sound management" (ESM) and "environmental management system" (EMS) are frequently used in legislation and guidelines. Different stakeholders have different definitions in mind when they use these terms.[36] For the purposes of this project, environmentally sound management (ESM) is framed as a series of policies, procedures and approved practices. ESM encompasses not only the organizations engaged in the management of hazardous wastes and recyclables, it also incorporates a country's regulatory infrastructure and enforcement framework and capacity and addresses the capacity within a country to manage hazardous wastes and recyclables, that is, the availability of trained personnel and facilities to manage these substances. An environmental management system (EMS), on the other hand, is one (but not the only one) of the tools that can be used to achieve ESM. Many businesses and governments have developed sound environmental management systems, ranging in sophistication from a simple outline of procedures to third party–certified programs like ISO 14000.[37]

An environmental management system is a systematic approach used by an organization to identify measure and manage the effects of the organization's activities on the environment. An EMS is also used to set goals relating to a company's environmental performance and to achieve those goals. Ideally, company managers will use an EMS to set goals in areas such as compliance with environmental laws, minimization of potential risks to human health and the environment, use of natural resources, and prevention and reduction of pollution.

Empirical studies on the performance of EMSs have only recently begun to emerge. These studies provide a mixed message on the degree to which EMSs are leading to improved performance. However, several projects and numerous case studies tend to support the proposition that effectively designed EMSs can, under the right circumstances, provide significant support for improving performance. A key factor is the leadership of the top manager in pushing for continuous improvement.

An EMS by itself does not ensure ESM. A well-designed and implemented EMS can be a powerful tool for driving and monitoring the progress of facilities in achieving ESM.

[36] Basel Convention, *Technical guidelines for the environmentally sound management of waste lead-acid batteries*. Annex to United Nations Environment Programme document UNEP/CHW.6/22, 8 August 2002.
[37] <www.14000.org/>.

4.1 ESM at the Country Level

4.1.1 Regulatory and Enforcement Framework and Infrastructure

The following ESM elements are highly recommended for a country's regulatory infrastructure, enforcement framework, and capacity for hazardous recyclables:

- Appropriate legislation and regulations to protect worker and public health and the environment
- Appropriate resources, including trained inspectors, time and budget, to approve facilities, monitor and enforce compliance and to respond to legitimate public complaints
- Reasonable public access to government records on waste and recyclables treatment, storage and transport facilities and movements within and between countries
- Compatibility of legislation and regulations within country and with international environment and trade agreements
- Capability and will to be last resort protector of humans and the environment in the event of facility failure

4.1.2 Recycling Policy Framework and Infrastructure

This section outlines the policy framework and infrastructure that can improve the rate of SLAB recycling where necessary and that can help ensure that the recycling is occurring in an environmentally sound manner.

In addition to a regulatory and enforcement framework, countries should have in place a policy framework that facilitates the environmentally sound recycling of SLABs.

Specifically for SLABs, the participation of consumers is essential to the implementation of a SLAB recycling program. The following elements are needed for an effective lead collection and recycling program:

(a) Consumers need to understand that lead-acid batteries are recyclable, and be informed how to return SLABs to the retailer or depot. They should understand how SLABS are stored in an environmentally sound manner while waiting to be transported to a collection center, and where collection centers are located.

(b) Retailers or others who collect and temporarily store SLABs should be licensed to do so, provided in part that they have appropriate storage places that are ESM (see **Section 4.3**). A minimum set of relevant requirements or guidelines, particular to each country, should be defined through legislation, and further steps to encourage and enforce the implementation of environmental protection, such as periodic inspections of storage premises, should be undertaken. The licensing process can be used as a source of information to develop a map of the collection network.

(c) Lead smelters and refineries should be licensed and inspected. They should adopt the best available technologies if they are to be installed, or modify their processes and/or operating practices in order to achieve high standards of environmental protection.

(d) Resource sharing in partnership with industry or other organizations can be a solution to budget constraints. If pertinent, a set of guidelines to govern these partnerships should be implemented.

(e) SLABs should be prohibited from being sent to environmentally unsound destinations.

4.1.3 SLAB Collection Infrastructure Models

According to the Basel Convention's *Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries*,[38] several models for SLAB collection systems have been developed around the world in order to meet specific country needs. There seems to be a general trend to develop legislation based on the principle of extended producer responsibility. Some of these models are described below, in order of increasing complexity.

Simplified Reverse-distribution System
This is the simplest model possible under the scheme of the "reverse-distribution system" developed by some countries and is better suited to circumstances where the lead reduction facility is relatively close to the collection centers. The key feature of this system is that retailers are the collection centers for SLABs and, in the process of obtaining a LAB, the consumer leaves the SLAB at the retailer's, where it will be properly stored until it can be transported to the smelter. In this model, the lead reduction facility's role may be undertaken by the scrap exporter if the country chooses to export its used batteries instead of licensing a recycling facility. Since this system uses the premise that retailers are in direct contact with the smelter/exporter, the geographic area covered by this scenario should be small. This system is appropriate in locations where there is a lack of transport infrastructure, but would pose serious problems when the geographic area to be covered is quite large. Retailers of new batteries have been reluctant to support "take-back" programs in some jurisdictions; for example, in Canada, retailers and service centers have not been amenable to accepting used motor oil from do-it-yourselfers. In some jurisdictions, such as the province of Ontario, hazardous waste regulations are a barrier to collecting SLABs at retailers.

Some important regulatory considerations include the following:

(a) Transportation standards are needed in order to make the rather "informal" commercial transportation network environmentally sound.
(b) If there is no licensed lead smelter/refinery and the scrap exporter is the physical conduit for effective recycling, then the exporter should not only be licensed and operate with high standards of environmental protection in any storage facility (which could be quite a long time, depending on the battery demand), but also should exercise due diligence to ensure that the transportation and destination facilities for recycling are

[38] Basel Convention, *Technical guidelines for the environmentally sound management of waste lead-acid batteries*. Annex to United Nations Environment Programme document UNEP/CHW.6/22, 8 August 2002.

properly licensed and in compliance with regulatory requirements in the relevant country of operation.

Collectors' System
Based on the models implemented in England and Germany, this system relies on the premise that retailers, after the collection of SLABs, will use a specialized collectors' network that will deliver the SLABs to the recycling facilities. Different from the simplified reverse-distribution system, the role played by the collectors ensures that the transportation costs will not be absorbed completely by the retailers. Due to the increasing specialization of the activities, higher environmental standards may be achieved in the transport process. The main legislative step in this system is the control of the collection and transportation network and those players involved.

Due to the higher number of players in this system, its implementation allows for a wider geographic area to be served, suggesting that medium-size countries could benefit from it. This system could be also implemented in small countries without major changes to its structure.

Manufacturer-supported Returning System
Similar to the systems implemented in Japan and Brazil, this one foresees that the battery manufacturers will be indirectly responsible for the collection and transportation of SLABs.

This system differs from those described above in three ways:
(a) the manufacturers are responsible for planning and implementing the logistics of returning the SLABs so that they can be delivered to the secondary smelters;
(b) there are two different players for the collection and transportation of SLABs; and
(c) the collectors and those responsible for the transportation are linked to the manufacturers. Thus, despite the fact that the manufacturers are not directly involved with the collection and transportation of the SLABs, it remains their responsibility to provide the necessary means to accomplish these steps to a high environmental standard.

The manufacturer-supported returning system is ideally implemented in countries where a strong, but more informal and/or unregulated, collecting network is already present. Everyone benefits by formalizing a somewhat unorganized infrastructure by providing a legal framework for it so that it is possible to identify those involved and their responsibilities.

Reverse-distribution System
Based on the French and United States systems, this model is the complete reverse-distribution system, in which the manufacturers are directly linked with the collection and transportation steps. This system is voluntary in the United States. It is a collecting system that could provide precision about the quantities, origins and destinations of SLABs. A systematic legal framework could be considered in order to provide complete coverage of all steps in the recycling chain. An educational and environmental program is necessary for this approach to be effective.

4.2 ESM for Companies Managing Hazardous Recyclables

A metals recovery facility can provide better assurance that it will be operated in an environmentally sound manner by implementing an environmental management system. An EMS is a management tool that will provide a coherent set of organizational structures, responsibilities, practices, procedures, processes and resources to ensure a company achieves systematic implementation of its environmental policy. An EMS can apply to any type of organization or operation, and the principles are of general applicability.[39]

The key advantages of implementing an EMS are that it provides a disciplined approach to environmental management and ensures that issues that may have an impact on the environment are identified and addressed.

All companies engaged in any of the lifecycle steps of SLABs should have EMSs in place, whether or not they are certified by an outside body such as ISO 14000. Several sources of information have identified the appropriate EMS elements for a company engaged in the management of hazardous wastes/recyclables.

The key elements of an EMS for a recycling company include the following:[40]

- A permit/license to operate, from the relevant government authority.
- An environmental policy—a statement by the organization of its intentions and principles in relation to its overall performance which provides a framework for action and for the setting of the organization's environmental objectives and targets.
- A clear statement of environmental objectives and targets.[41]
- A procedure for identifying and addressing the significant environmental impacts arising from existing or planned activities.
- Programs which will enable the organization to achieve its objectives and targets. These will include defining the responsibilities of staff, and the means by which and timeframe in which they are to be carried out.
- Programs for ensuring that staff are trained and are aware of requirements.
- Procedures for operational control, internal and external communication, and document control.
- Procedures and financial resources for emergency preparedness and response.
- Procedures for monitoring performance and taking appropriate action if the performance does not comply with targets.
- An audit program to confirm that the system has been properly implemented and that plant operation complies with all applicable laws and regulations.
- Periodic management review and continuous improvement of the EMS.

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[39] CEC, *Decision document on lead under the process for identifying candidate substances for regional action under the Sound Management of Chemicals initiative*. Public consultation draft, prepared by the Substance Selection Task Force for the North American Sound Management of Chemicals Working Group, of the Commission for Environmental Cooperation, June 2003.

[40] Ibid.

[41] Basel Convention, *Draft technical guidelines on the environmentally sound recycling/reclamation of metals and metal compounds (R4)*. .UNEP/CHW.7/8/Add.3. 11 August 2004. <http://www.basel.int/meetings/cop/cop7/docs/08a3e.pdf>.

- A plan for shutdown or closure of the facility.
- A plan for remediation of buildings and soils and for financial assurance that a proper shutdown will happen.
- A procedure for public outreach and for notification of unusual occurrences (e.g., emergencies, spills, leaks that are released to the environment).

4.3 Guidelines for ESM for SLABS

The above guidelines should be used in all hazardous recyclable operations and it is recommended that they be in place for all SLAB operations. The guidelines in the following sections specifically address ESM practices for SLABs and are consistent with the Basel Guidelines.[42, 43] As a rule, SLABs and associated lead parts should be recycled with a metals or battery recycler rather than disposed of, provided that the recycling can be carried out in an environmentally sound manner.

4.3.1 ESM during Collection and Temporary Storage

The control measures that should be carried out at the collection points for SLABs in order to avoid accidents that may produce human and/or environmental damage include the following:[44, 45, 46]

- ***Batteries should NOT be drained at collection points.*** Batteries should be stored whole at collection points, rather than being drained of electrolyte.
- ***Batteries should be stored in proper places at collection points.*** The ideal place to store SLABs is inside an acid-resistant container (e.g., polypropylene pail or tub) that may also be sealed and used as the transport container. This minimizes the risk of accidental spillage. When SLABs are not stored inside an acid-resistant shipping container, the following measures for storing SLABs should be followed:
    - Leaking or cracked batteries, those spilling electrolyte, should be stored inside closed, water-tight, acid-resistant containers.
    - SLABs should be tested to determine usability or resale quality. If they are recharged for resale, the lead cathode ends should be removed from the batteries and stored in a covered container strong enough to hold the weight of the lead. If they are to be recycled, the lead cathode ends should be left attached.

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[42] United Nations Environment Programme (UNEP). Basel Convention. *Technical guidelines for the environmentally sound management of waste lead-acid batteries*. Basel Convention series/SBC No. 2003/9. 2002. <http://www.basel.int/pub/techguid/tech-wasteacid.pdf>.

[43] Basel Convention, *Draft technical guidelines on the environmentally sound recycling/reclamation of metals and metal compounds (R4)*. UNEP/CHW.7/8/Add.3. 11 August 2004. <http://www.basel.int/meetings/cop/cop7/docs/08a3e.pdf>.

[44] United Nations Environment Programme (UNEP). Basel Convention. *Technical guidelines for the environmentally sound management of waste lead-acid batteries*. Basel Convention series/SBC No. 2003/9. 2002. <http://www.basel.int/pub/techguid/tech-wasteacid.pdf>.

[45] Environmental Compliance for Automotive Recyclers (ECAR), ECAR fact sheet for Michigan batteries, <http://www.ecarcenter.org/mi/mi-batteries.htm>.

[46] Stanford Linear Accelerator Center (SLAC). Recycling lead-acid batteries. In *ES&H Waste Management Guidelines*, 18 May 2000, <http://www.slac.stanford.edu/esh/guidelines/leadacidweb.pdf>.

  - The storage place should be secure and covered, sheltered from rain and other water sources, be equipped with an effluent collection system, and be located away from heat sources.
  - The storage place should have a bermed, impermeable surface, such as acid-resistant concrete or any other acid-resistant material that will retain any leakage and direct it to a collection system from where it can be removed and treated prior to discharge.
  - The storage place should have an exhaust ventilation system, or a fast air recirculation system, in order to avoid hazardous gas accumulation.
  - The storage place should have restricted access and be identified as a hazardous material storing place.
  - Storage and handling areas should be paved to avoid soil contamination, and runoff from these areas should be contained and treated.
  - Any other lead-bearing materials which may be found, such as soils, glass, etc., should be packaged and stored according to their characteristics.
  - SLABs should not be piled higher than four batteries high.

- ***SLABs should be labeled.*** Each SLAB or container of SLABs should be labeled or marked as waste or spent battery/batteries.

- ***Collection points should not store large amounts of used batteries.*** Even after creating a protected storage place, a collection point should not store a large number of used batteries and should not be considered as a permanent storage place. The right storage amount depends on the through-put rate of the establishment and on local regulations. The storage place should be dimensioned to provide enough space for specific demands. Storing large amounts of used batteries or storing for a long time increases the risk of accidental spillage or leakage and should be avoided. Small collectors should be restricted to storage for a maximum period of 60 days. If collection points store batteries for a longer period, they should be licensed and regulated as waste storage facilities.

- ***Collectors should ensure that they sell their batteries to licensed lead recyclers.*** Smelters and refineries that are unknown to regulators and therefore are unlicensed can well be a main source of lead contamination, both human and environmental. Collectors should only sell or send their used batteries to establishments that follow high protection standards, that is, which demonstrate that they are properly licensed and in compliance with regulatory requirements and have EMSs, etc. This approach is an example of environmental supply chain management (ESCM).

4.3.2 ESM during Transportation

SLABs are dangerous goods and should be handled with appropriate care when being transported. The main risk associated with battery transport is the electrolyte, which may leak from used batteries, requiring control measures in order to minimize the risk of spillage and define the specific actions to be taken in event of an accident. The following procedures are suggested:

- ***SLABs should be transported inside containers.*** Regardless of the mode of transport, there is a risk of leakage, which may be high even if the batteries are appropriately transported in an upright position. Batteries may shift during transit, cases may break, leak, etc., thus making it necessary to provide a shock-resistant and acid-resistant, sealed container, such as a polypropylene pail or tub, as noted in **Section 4.3.1**.
- ***Containers should be well packed in the transport vehicle.*** Containers should be bound, shrink-wrapped or stacked properly so they do not shift while being transported.
- ***The transport vehicle should be identified with symbols.*** Following international conventions, the transport vehicle should be properly placarded with symbols and colors identifying the fact that corrosive and hazardous products/dangerous goods are being transported.
- ***Specific equipment.*** The transport vehicle should be outfitted with at least the minimum set of equipment necessary to neutralize any simple spillage or leakage problems, and the transport team trained on how to use it.
- ***Drivers and auxiliary transport personnel should be trained.*** People moving dangerous goods should always be trained in emergency procedures, including dealing with fire and spills, etc., and how to contact emergency response teams. They should also be aware of the specific kind of hazardous material being transported, how to handle it in a crisis situation and when to leave the situation alone and call emergency response teams for assistance.
- ***Personal protection equipment (PPE).*** PPE should be provided for the transport team, who should be trained in its emergency use.
- ***Transport schedule and map.*** If possible, hazardous waste transporters should choose routes that minimize the risk of accidents or other specific problems. A predefined route and schedule that takes such factors into account is preferable.
- ***All releases of battery waste residues should be immediately contained.*** Transporters should be trained to immediately contain any leakage or spillage in accordance with local, regional and federal requirements.
- ***Local authorities should immediately be notified of any releases of battery waste residues to the environment.*** Transporters should be trained to immediately notify local authorities of any leaks or spills.

The above transportation guidelines are not exhaustive. More specific training and instructions should be provided to SLAB transport teams, since the transport may involve, or pass through, heavily urbanized areas or other sensitive locations, such as water bodies, residential areas, hospitals, schools, etc., that could be greatly affected by the effects of spillage in the event of an accident.

4.3.3 ESM during Storage at the Recycling Facility

The protection measures for SLABs at the recycling plant are very similar to the storage requirements at the collection points. However, at the bulking or recycling facility, the amount of batteries stored can easily reach several thousands of tonnes. Therefore, the following additional measures should be adopted:

- ***Batteries should be drained and prepared for recycling.*** Better recycling rates and fewer environmental problems are created by recycling drained batteries. The electrolyte should be directed to an acid recovery process or to an effluent treatment plant and the batteries should be stored empty, ready to be recycled.
- ***Batteries should be identified and segregated.*** Different batteries may require different recycling approaches. Therefore, they should be correctly identified, labeled and stored in different places.
- ***Batteries should be stored in a proper building or covered place.*** Unless some specific circumstances require it, container storage is not practical at the recycling plant, since by this stage batteries should have been classified, identified and carefully segregated. A proper covered bay should be constructed to store them.

  The minimum criteria for battery storage at the recycling facility should include:
    - an impermeable and acid-resistant floor (e.g., epoxy-coated asphalt or concrete);
    - an efficient effluent collection system which directs spilled solutions toward the effluent or acid electrolyte treatment plant;
    - one entrance and one exit (restricted access), which should stay closed unless otherwise necessary, in order to avoid dust release;
    - a dedicated gas collection system, which filters the air to remove lead dusts and renews the air inside the building in order to avoid the concentration of toxic gases;
    - appropriate fire-fighting equipment—NOT WATER; although it is unlikely that the batteries on their own would be the start of a fire, they could be set afire by other means, due to their high content of carbon compounds such as found in the plastic cases; therefore, specialized fire-fighting equipment is necessary to prevent the production of toxic gases such as arsine and stibine; and
    - access restricted to authorized personnel.

The above are general guidelines that should be adapted to the specific requirements of each recycling plant. More rigorous approaches are encouraged. In particular, and wherever possible, the storage area should be a raised, acid-resistant area so that that any spilled acid can be contained. Such a contained storage area requires a spill collection system to collect and allow for the safe removal of excess liquids from the bay. Efficient ventilation is also a key element of such a design.

4.3.4 ESM during SLAB Recycling

The pre-recycling steps are considered complete when the batteries are received and properly stored at the storage place in the recycling plant. After this, the SLABs enter into the recycling process, which can be divided into three main steps:

(a) battery breaking or breakage;
(b) lead reduction; and
(c) lead refining.

The pre-recycling steps are largely limited to handling and mechanical operations, such as breaking, etc. Because the lead reduction and refining steps involve chemical processes and deal with large volumes of materials, often at high temperatures, the potential for environmental and/or health consequences are more significant than in the previous steps. Therefore, in addition to following the relevant ESM procedures outlined in **Sections 4.2** and **4.3.1** to **4.3.3** for collecting, storing and transporting SLABs, the environmental management systems during SLAB recycling should be more comprehensive, and environmental prevention and control systems, policies and procedures more rigorous, as appropriate for metallurgical facilities.

Table 4-1 provides an example of one regulatory jurisdiction's requirements for operation of a lead smelter.

Table 4-1 Examples of Pollution Control Objectives for a Lead Smelter

Pb Emission	Typical Pollution Control Objectives of Lead (Pb) and Devices (US EPA)
Discharges from stacks	License: <10 mg/m^3 Typically achieved: <1 mg/m^3 Device: cyclone followed by bag house
Ambient air	Policy objectives: <1.5μg/m^3, averaged over 90 days Devices used in factory to collect loose waste material and reduce fugitive emissions: vacuum cleaners, screens, filters, gas-cleaning apparatus
Workplace air	Standards: 150 μg/m^3 over an 8-hour period Personal protective equipment: protective respirators and appropriate clothing in areas where this standard is exceeded

Source: Adapted from Basel Convention, *Draft technical guidelines on the environmentally sound recycling/reclamation of metals and metal compounds (R4).* UNEP/CHW.7/8/Add.3. 11 August 2004. <http://www.basel.int/meetings/cop/cop7/docs/08a3e.pdf>.

4.3.5 ESM during SLAB or Residuals Disposal

When SLABs are sent directly for disposal, or residuals from SLAB dismantling are sent to disposal, they should be destroyed and/or contained in licensed hazardous waste destruction or disposal facilities appropriately designed and operated to handle such wastes and permitted by the relevant regulatory authorities.

The appropriate ESM elements described in **Sections 4.2** and **4.3** should also be applied for the final disposal or destruction step.

4.3.6 ESM for Emergency Response

- ***An action plan should be developed, and workers trained.*** To respond to emergencies or accidents, including proper use of personal protection equipment, an action plan is necessary. Emergencies may occur on-site at the facility or off-site during transportation. Consideration should be given to the past history of the operation and whether there have been accidents or uncontrolled releases of wastes to the environment. Part of the action plan should include guidance for the response to and remediation of a spill as well as addressing regulatory noncompliance.

- The plan should locate and provide emergency equipment at pre-designated spots in the plant. This equipment should include fire extinguishers and personal protection equipment (e.g., special clothing, face masks and respirators, spill absorbents, shovels) as required by the process and materials at the plant.
- The plan should ensure prompt reduction of any environmental impact of an accident if one should occur. Training exercises should be carried out to ensure readiness. Special handling requirements for the wastes on-site should be included.
- Insurance or other financial instruments may be needed to ensure availability of sufficient funds to finance a clean-up or to discharge liability in the event of an accident, either on-site or off-site.

4.3.7 ESM during Facility Decommissioning

- ***A site assessment should be undertaken.*** As part of the shutdown and decommissioning of SLAB recycling facilities, there should be a site assessment to identify any contamination of land and groundwater and any clean-up that is necessary to ensure that the land and groundwater are suitable for future use.
- ***Site should be cleaned up to remove any contamination.*** Any contamination of soils or groundwater that has occurred should be cleaned up to meet regulatory requirements. All waste material should be disposed of in approved facilities.

4.3.8 Incentives for ESM and for Recycling of SLABs

ESM Incentives

Incentives that are being used and could be used in jurisdictions with low return rates, to encourage or require ESM for SLAB recycling and disposal include the following:

- ESM guidelines—governments and/or industry associations prepare guidelines for ESM for SLABs.
- Streamlined approval and reporting processes for companies with appropriate EMSs in place and applied, which include use of ESM guidelines for SLABs, as exampled in the Ontario Ministry of Environment's Environmental Leaders Program.[47]
- Environmental supply chain management—companies/individuals/governments recycling or disposing of SLABs voluntarily offer SLABs only to operators that operate according to ESM.
- Education—preparation and delivery of materials that explain the hazards of non-ESM of SLABs. Preparation and delivery of programs that inform the public, SMEs, etc., about how to handle SLABs in an environmentally sound manner.
- Bounty/reward system in jurisdictions with low return rates, for turning in SLABs otherwise outside collection systems. (An unanticipated result, inherent in this approach, has been noticed in some regions, related to used oil: where a market with an already high recovery rate has seen a shift from re-refining to burning as a fuel—which is lower on the recovery hierarchy—since the introduction of a bounty.)

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[47] Ontario Ministry of the Environment, *A framework for Ontario's Environmental Leaders program.* Environmental Innovations Branch, Toronto, July 2004, <www.ene.gov.on.ca>.

- Training—development and delivery of training programs on ESM of SLABs.
- Community household hazardous waste collection days at a public location, to make it easy for individuals and others to deliver SLABs into the recovery system.
- Well-advertised days for door-to-door pickup of household hazardous waste, to make it easy for individuals to dispose of SLABs in accordance with ESM.
- Discussions on penalties for noncompliance with licensing conditions.
- Discussions on the development of potential regulations—such as requiring that all operators involved in management of SLABs have EMSs in place, and/or stipulating environmental performance requirements for facilities.

SLAB Recycling Incentives

Incentives specifically designed to encourage the recycling of SLABs over their destruction or disposal include the following:

- Deposit, surcharge on new LABs to fund return/collection of SLABs. (To be successful, funds collected would have to be dedicated to SLAB recycling.)
- Discount on new LABs when SLABs are returned to dealer.
- Education—industry, government or NGOs prepare and deliver materials that explain the merits of SLAB recycling over disposal.
- Reward for turning in found SLABs.
- Recycle fee—a fee collected on purchase of LABs to reimburse recyclers.
- Regulation/fines—regulations that require SLABs to be recycled and/or that streamline requirements for recycling as compared to disposal.
- Communication—establishment of a well-advertised web site that identifies where SLABs may be dropped off for recycling in each city or region.
- Product stewardship—battery manufacturers and/or retailers voluntarily operate SLAB take-back programs, possibly including a "deposit return fee."
- Sharing recycling incentive fees or tax breaks amongst the participants, generators, recyclers etc.
- Support for standards such as ISO 9000 and 14000, as well as eco-labeling.
- Social marketing to inform, engage and motivate consumers and industry.
- Support of initiatives such as training programs and regulatory language proposed by industry, for example, the Battery Council Draft Regulation.[48]

[48] Battery Council International, <www.batterycouncil.org>.

5.0 Estimated Quantities of SLABs

Readily available references were reviewed to estimate the quantities of SLABs being managed in international, trilateral, interstate, and interprovincial commerce.

5.1 Sources

SLABs are generated by consumers, industry, governments, institutions, automotive service centers and individuals. Battery trade associations and government departments of energy and environment report statistics on batteries, including SLABs.

5.2 Generated

The quantities of SLABs generated are based on new batteries sold coupled with returns when batteries are replaced. Some governments have passed laws and regulations to encourage or require SLABs be returned for recycle.

5.3 Collected and Transported

SLABs are stored and accumulated by auto service shops, industry, etc., for collection by specialized collectors who transport them to battery breaking facilities. Individuals can take their SLABs to household hazardous waste depots, where they exist, from which they are collected by authorized carriers and are also taken to battery-breaking facilities. The United States and Mexico do not require that SLABs be accompanied by a prescribed formal hazardous waste shipping document, or be "manifested." Canada does.

5.4 Recycled

SLABs have the best recycling rate of any consumer material. When compared to other recyclables, SLABs are reported at 97 percent (1,090,800 tonnes [1,200,000 tons]/ per year) in the US[49] and 94 percent (54,600 tonnes [61,152 tons]) in Canada.[50] The next closest rates are those of used crankcase oil, at 67 percent,[51] and aluminum cans, at 59 percent,[52] both in Canada.

5.5 Disposal

Some SLABs, or more often some of their constituents (acid, paste, plastic), may find their way to hazardous waste disposal if they are too contaminated or costly to be readily recycled. If not recycled, the acids and pastes would be treated (neutralized, etc.; see **Section 3.3.4**) and then the residue disposed of and the plastic sent to landfill.

5.6 Transboundary

Significant quantities of SLABs are transported across international boundaries for purposes of recycling. Some relatively small quantities of wastes (the acid residues, etc.) move across international borders for disposal.

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49 Battery Council, <www.batterycouncil.org>.
50 Mining Council of Canada, *2002 Annual Report*, <www.mining.ca>.
51 Cleghorn and Associates Limited, *Background study on the technical and socio-economic aspects related to the management of waste crankcase oil in Canada*, 19 July 2002.
52 Recycling Council of Ontario, <www.rco.on.ca>.

It is important to note that there are gaps in publicly available data and discrepancies in the three NAFTA countries about SLAB quantities being imported and exported. This suggests that the countries cannot ensure that SLABs are being handled in an ESM manner.

The quantities (where data are available) of "battery wastes" that moved between and outside the NAFTA countries in 2002 are difficult to compare and do not appear to include the same information/data. For example, a CEC ESM paper reports that, in 2002:

- the United States imported more than 1,078 tonnes (1,207 tons) from countries other than Canada and Mexico,
- the United States exported 104,000 tonnes (116,480 tons) to Mexico,
- Mexico reported receiving 51,813 tonnes (57,000 tons), and[53]
- Mexico reported exporting 20 tonnes (22.4 tons) to the United States for recycling.

Unfortunately there does not appear to be a way to match the data from various sources. General Canadian data for the transboundary movements of SLABs destined for recycling or disposal operations could be made available for the years 2005 or prior.

Data were not found on the quantities of SLABs that are imported into Mexico from countries other than the United States for recycling, for exports of SLABs from Mexico to countries other than the United States, for exports of SLABs from the United States into countries other than Mexico and Canada, and for imports of SLABs into the United States other than from Mexico and Canada. The facilities to which exports go outside North America are not known, nor, obviously, if they operate under ESM criteria. It is also not known what countries US and Mexican exports go to and if any facilities in the countries are ESM. Canada has not exported SLABs to or imported them from Mexico.

[53] Cristina Cortinas, personal communication with the author, May 2004.

6.0 Regulatory Frameworks

This section addresses the controls and regulations pertaining to the collection and management of SLABs by jurisdiction, in the North American context. It also briefly outlines the collection systems being used in the three countries.

6.1 Control Systems for Transboundary Movements within North America

NAFTA countries have their own respective definitions of hazardous wastes, notification forms and procedures for proposed exports or imports. This results in difficulties in comparing information, with respect to shipments between the United States and Mexico.

According to available data, SLABs move readily between the United States and Canada for both recycling and disposal. SLABS also move back and forth between the United States and Mexico for recycling. SLABS for disposal can move from Mexico to the United States. Mexico prohibits the import of SLABs for final disposal, but allows imports for treating, recycling or reuse by federally authorized facilities.[54]

Transboundary movements of SLABs between Mexico and the United States are governed by Mexican and US regulations as reflected in the La Paz agreement,[55] signed in 1983. Movements of SLABS between Canada and the United States are governed by a bilateral agreement implemented in 1986.[56] Movements of wastes from the NAFTA countries to other OECD countries for recycling are governed by Canadian and US regulations, as reflected in a 1992 OECD multi-lateral agreement (to which US, Mexico and Canada are parties) that was revised in 2001[57] to be more consistent with the Basel Convention.[58] Canada and Mexico are both parties to the Basel Convention. The United States has not ratified the Convention and cannot do so until the US Congress provides additional legislative authorities to implement it.

Both OECD and Basel explicitly require notice of intent and consent to export or import SLABs. Customs also has a role at border crossings, where it requires the appropriate customs import forms be filed as with any commodity, and in some cases copies of the Notices and Consent documents required by environmental regulatory agencies.

In accordance with Mexico's new General Law on Waste Prevention and Integral Management,[59] hazardous wastes generated by the maquiladora industry that can be

[54] Cristina Cortinas, personal communication with the author, May 2004.
[55] US EPA, *La Paz agreement overview*, <http://www.EPA.gov/usmexicoborder/progress/eng/05cper.pdf>.
[56] Environment Canada, Canada-USA Bilateral Agreement on Hazardous Wastes. <http://www.ec.gc.ca/tmb/eng/tmbcanusaag_e.html>.
[57] OECD Decision C(92)39/FINAL, 1992. Repealed by OECD Council Decision C(2001)107 on 14 June 2001. See: <www.oecd.org/document/52/0,2340,en_2649_34397_2674996_1_1_1_1,00.html>.
[58] Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. Adopted by the Conference of the Plenipotentiaries on 22 March 1989. Entered into force May 1992. <http://www.basel.int/>.
[59] Semarnat, Ley General para la Prevención y Gestión Integral de los Residuos. *Diario Oficial de la Federación*, 8 October 2004, Mexico.

recycled in Mexico are not required to be exported as in the past. If a company decides to recycle such wastes in Mexico, it will be required to pay the taxes for the importation of the materials that originated the wastes. As this import tax is much less than transportation costs, and recyclables are now allowed to stay and be recycled in Mexico, it makes economic sense to do so.

In the case of lead-acid batteries, a maquiladora that imports SLABs for recycling is obliged to export the recycled batteries as well as the hazardous wastes generated in the recycling process or, if it produces such batteries from imported materials (such as lead and sulfuric acid), it has to export the products as well as the related hazardous wastes. In either of these cases, it will export SLABs for recovery or final disposal in the United States.

Under Mexican law, waste movements from maquiladoras are considered "returns" rather than exports and so are not tracked as wastes. In the United States, under the Resource Conservation and Recovery Act (RCRA),[60] they are considered hazardous waste imports, but are not tracked at the national level if they are destined for recovery.

Under RCRA, a hazardous secondary material directly used as an effective substitute for a manufacturing material is not considered a waste provided it meets certain restrictions. As a means to promote recycling of SLABs, RCRA provides a specific regulatory exemption from the manifest and export requirements for those batteries destined for recovery. Therefore the exporters are exempt from notice and consent requirements and manifesting.

In 1995, the United States established a universal waste program[61] that addresses wastes that are generated by a wide variety of generators in many industries. Universal wastes include lead-acid batteries. The program was established to encourage proper collection, separation and handling of these wastes and, where possible, to encourage (but not require) recycling. Universal wastes are subject to export, notice and consent requirements but not hazardous waste manifest requirements. As a result, SLAB exporters may elect to follow the requirements of the Universal Waste Regulations, or alternatively, they may choose to follow the provisions of the SLABs exemption described above. Treatment standards for SLABs in the United States stipulate high-temperature metals recovery, effectively requiring that all lead-acid batteries must be recycled to recover lead.[62] The United States Environmental Protection Agency (US EPA) has published its intent to seek notice and consent requirements for export of SLABs.[63] Individual states also have requirements and incentives. See **Appendix III** for a summary of these requirements and incentives, by state.

[60] US EPA, Resource Conservation and Recovery Act (RCRA), 1976. See RCRA Online: <www.epa.gov./rcraonline/>.

[61] US EPA, Universal waste regulations, <http://www.epa.gov/epaoswer/hazwaste/id/univwast.htm>.

[62] Nova Pb, Lead recycling, <http://novapb.com/lead_recycling.htm>.

[63] Resource Conservation and Recovery Act, Proposed Rules, Sequence Number 3477, SAN No. 4778 Revisions of the Lead Acid Battery Export Notification and Consent Requirements, Federal Register/ Vol. 68, No. 245 / Monday, 22 December 2003 / Unified Agenda, p 73554. <http.www.epa.gov/fedrgstr/EPA-GENERAL/2003/December/Day-22/g28903.pdf>.

All reported Canadian movements of hazardous wastes and hazardous recyclables, including SLABs, have been tracked by Canada using the Export and Import of Hazardous Wastes Regulations (EIHWR)[64] and, as of 1 November 2005, the Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (EIHWHRMR).[65] Canada requires notification and prior informed consent before permitting the export, import or transit of SLABs, whether for recycling or disposal. Canada also requires the tracking of SLABs through the manifest or movement document, and confirmation of final recycling or disposal.

In Mexico, the quantities of SLABs imported and exported are known (other than for maquiladoras), but the breakdown between quantities exported for recycling and for disposal is not known.[66] No movements to countries that are not parties to the Basel Convention, other than to the United States, have been reported.

It was reported in *American Metal Market* that seven percent of the estimated 117,556 tonnes (129,325 tons) of batteries exported from the United States in 2000 went to countries other than Canada.[67] It is unclear to what countries other than Mexico they go and whether transportation and facilities to which they go are ESM. A Greenpeace report discussed in **Section 6.6** suggests batteries have been exported from the United States to Mexico, Brazil, South Korea, China and India.

6.2 Controls for Transportation of SLABs within North America

All three countries apply dangerous goods transportation rules to SLABs. Mexico includes its hazardous waste lists directly in the dangerous goods regulations.[68]

In Canada, transport of SLABs is controlled by the Transportation of Dangerous Goods (TDG) Regulations under the Transportation of Dangerous Goods Act, as well as by the Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (EIHWHRMR) and the Interprovincial Movement of Hazardous Waste Regulations under the Canadian Environmental Protection Act (CEPA 1999).[69]

In the United States, transport of SLABs is controlled by Department of Transport (DOT) Regulations.[70] The DOT requirements for labeling and containment apply to transportation; there is no requirement for notice, consent or the use of a manifest.

[64] Environment Canada, EIHWR. Online at <www.ec.gc.ca/tmb/eng/tmbregs_e.html#one>.
[65] Environment Canada, EIHWHRMR. Online at <www.ec.gc.ca/CEPARegistry/regulations/detailReg.cfm?intReg=84>.
[66] G. Roman, personal communication, 18 December 2003.
[67] Edward Worden, in *American Metal Market*, 2 August 2000. Online at <http://www.findarticles.com/cf_dls/m3MKT/148_108/64059126/print.jhtml>.
[68] Nova Pb, Lead recycling. <http://novapb.com/lead_recycling.htm>.
[69] Government of Canada, Canadian Environmental Protection Act, 1999. Online at <http://Laws.justice.gc.ca/en/C-15.31/28915.html>.
[70] US DOT, US DOT Regulations, Title 49 CFR Parts 100–185. Online at <http://hazmat.dot.gov/rules.htm>.

In Mexico, the transit of hazardous wastes through Mexico to other countries is restricted and requires government authorization. If hazardous materials or wastes have been prohibited by the country of origin, the permit for their transit is not approved. Such permits only can be obtained if there is a written consent from governments of importer countries. The transport of hazardous wastes is also regulated by the Regulation of Transport by Road of Hazardous Materials and Wastes, from the Secretariat of Communications and Transport,[71] and the installations that produce LABs or recycle SLABs are subject to a notification procedure established by the Ministry of Health under the General Health Law.[72]

6.3 Controls for Siting and Operation of SLAB Dismantling, Recycling Facilities in North America

All SLAB dismantling and recycling facilities in Canada, Mexico and the United States require operating permits or licenses and must go through formal approval processes.

In Canada, approvals for siting and operation are under the jurisdiction of the provinces or territories, other than for facilities located on federal lands. Under the authority of CEPA 1999, Environment Canada may refuse to issue a permit to import, export or transit hazardous waste or hazardous recyclable material if it will not be managed in a manner that will protect the environment and human health. Criteria for this determination are set out in the Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (EIHWHRMR), which are in force as of 1 November 2005.[73]

In the United States, approvals for siting and operation of SLAB dismantling and recycling facilities are provided by either federal or State agencies. Secondary lead smelters are subject to full hazardous waste permits and all hazardous waste handling requirements if they store batteries at the site of recovery prior to insertion of the batteries into the recycling process, effectively meaning that most secondary lead smelters are subject to stringent controls. Final permits also address clean-up of historical contamination at the site.

In Mexico, a new law has been passed[74] that requires "management plans" to be approved by states, based on a standard from the Mexican Secretary of Environment which will specify what is to be in the plan and what wastes are covered (SLABs are included). The General Law on Waste Prevention and Integral Management establishes the obligation of producers, importers, distributors and traders of products that become

[71] Mexico Secretariat of Communications and Transport, Reglamento del Transporte por Carretera de Materiales y Residuos Peligrosos.
[72] Mexico Ministry of Health, Ley General de Salud. Reglamento de Actividades, Establecimientos, Productos y Servicios. Acuerdo de trámites empresariales. *Diario Oficial de la Federación*, 14 September 1998.
[73] Environment Canada, Proposed export and import of hazardous wastes and hazardous recyclable materials regulation, under Division 8 of CEPA'99. In *Canada Gazette I*, 20 March 2004. <http://www.ec.gc.ca/CEPARegistry/regulations/detailReg.cfm?intReg=84>.
[74] Semarnat, Ley General para la Prevención y Gestión Integral de los Residuos. *Diario Oficial de la Federación*, 8 October 2004, Mexico.

hazardous wastes when they are eliminated to formulate and implement a "management plan," through which the consumers can return to them the used products listed in the same law (including SLABs) or that will be included on the lists of the standard (*Norma Oficial Mexicana*) that will be established for the purpose of identifying new products and wastes subject to a management plan. A transitory article of the law requires plans for the products covered to be formulated within no more than two years after the law's entry into force (passed in January 2004).

There are significant differences in regulatory requirements with respect to liability between Canada, the United States and Mexico. For example, the "Superfund Law," the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), in the United States has been identified by governments and generators as a factor in the decision of some US generators to export hazardous wastes to Canada for disposal.

6.4 Controls in Place by Industry for SLAB Management in North America

Many large organizations have voluntary EMSs in place. Some are ISO 14000–registered; these organizations are careful to operate within EMSs because of provisions of their strict operating permits or licenses, and potential for fines, etc., if found operating outside their permit conditions. Small and medium-size enterprises (SMEs) may be less likely to have an EMS in place because they have fewer resources. Dismantling facilities may have EMSs that are not as sophisticated as those found in lead smelters/refineries because the latter facilities are larger and more visible and have adopted voluntary EMS requirements as a condition of membership in their industry associations.

6.5 Collection Infrastructure Systems for SLABs in North America

This section addresses how SLAB collection and recycling generally operates in Canada, the United States and Mexico.

In the United States, many secondary lead smelters are owned by battery manufacturers, as, for example, Exide. They may also be owned by lead-mining companies. In Canada, lead smelters tend to be owned by large mining companies, such as Teck-Cominco, Tonolli and Noranda, the main exception being the smelting and recycling operations of Nova Pb. Capacity exceeds market in Canada, so Canada is a net importer of SLABs. Nova Pb and Noranda also recycle secondary lead from sources other than batteries, for instance dust and heavy metal sludges rich in lead, as well as glass and soils for lead silica. In Mexico, one major company, Enertec, a battery manufacturer, handles 70 percent of the batteries that are recycled.[75]

Recycling of SLABs is required by regulation in some provinces and states within Canada and the United States. In others, less rigorous "incentives" such as recycling fees at time of purchase are in place. In the United States, temporary storage for accumulation of hazardous wastes is limited to 90 days at the site of generation. Batteries (SLABs) that are classified as "universal wastes" can only be stored 10 days at a transfer facility by

[75] G. Roman, personal communication, 18 December 2003.

transporters and can be accumulated for only one year if the wastes are being stored for eventual proper recovery treatment or disposal.

In Canada and the United States, SLABs are generally collected from auto service facilities by specialized collection people. Except in the case of the individual who replaces his or her own, replacement of batteries usually occurs at a car dealership or service station, which accumulates them for pick up. Industrial generators of significant numbers of batteries have collection agents who collect from them directly.

A key issue for the do-it-yourselfer is whether or not SLABs can be returned to retail outlets or some other handy location such as a hazardous waste transfer station.

Generally, in Canada and the United States, SLABs are shipped on pallets, secured with shrink wrap, without draining of acid. This is the recommended method, because draining is better handled at dismantlers, who have proper procedures in place to collect and manage the acid.

In Mexico, consumers can return used batteries to some distributors, which offer them a discount on a new battery in exchange. In this case, the used batteries are then collected by the producers, which are authorized to recycle them. Nevertheless, a significant number of used batteries are not being collected and end up in refuse where scavengers or municipal services collect them and sell them to the producers or recyclers, or to intermediary small businesses.

6.6 Concerns of ENGOs about SLAB Recycling

Environmental nongovernmental organizations (ENGOs) have expressed concern about "disturbing" levels of lead, cadmium and arsenic in soils and vegetables from areas around smelters that have been operating for many years.[76]

Greenpeace investigated battery recycling in the mid-1990s. In a report entitled *The Myth of Automobile Battery Recycling*,[77] the authors state: "A global Greenpeace investigation of automobile lead-acid battery collection programs has revealed a massive flow of these extremely toxic wastes from heavily industrialized countries, particularly Australia, Japan, the UK and the US to many developing countries, particularly in Asia.

"The main factors causing the lead battery waste trade are typical to all waste trade schemes: in industrial countries, the environmental and occupational health regulatory cost of operating lead battery recycling facilities is ever-increasing, and the prices offered for secondary lead are low. It is not profitable to operate secondary lead smelters in many industrial countries. Battery brokers are finding more profitable markets in places where workers are paid little and environmental and workplace regulations are weak and/or un-enforced."

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[76] Chris North, *Council contends incinerator too much for polluted North*. In *New Brunswick Telegraph Journal*, 29 August 2003.

[77] Madeline Cobbing and Simon Divecha, *The Myth of Automobile Battery Recycling*. Greenpeace, <http://www.fish.com/~jym/greenpeace/myth-of-battery-recycling.html>.

The report goes on to discuss the “decline” of lead battery recycling in industrial countries, noting that “lead batteries and lead battery smelters have been transferring out of industrial countries in recent years as environmental regulations have tightened and domestic lead prices have dropped.” This may warrant some investigation into the situation. The UK could provide a good measure, given that the report suggests that most lead smelters there would be closed within four years from 2000. The “major” lead-waste exporting countries are identified as Australia, Japan, UK and the US. The US is reported as sending lead scrap to Brazil, South Korea, China and India in 1993. Mexico is reported to have received US lead scrap in the 1990s. The paper gives information on what the authors call “the third world reality of lead-acid battery recycling,” in which they describe non-ESM practices in Brazil, Indonesia, Mexico, the Philippines, Taiwan and Thailand. The Mexico section focuses on a specific facility, Alco Pacific, which apparently was closed in 1991, leaving a legacy of contamination to be cleaned up.

7.0 Conclusions and Recommendations

7.1 General Observations

Regulatory frameworks are in place to ensure ESM of SLABs in all three NAFTA countries. However, there remain some gaps in information on where SLABs are being recycled and/or disposed of, and some concerns about operations that may or may not be licensed in some jurisdictions. Guidelines should be used. Industries could be approached to find out what EMS they have, whether they are certified and/or part of voluntary industry stewardships systems such as Responsible Care®,[78] whether they have any voluntary guidelines in place, and whether they are willing to voluntarily practice environmental supply chain management (ESCM).

The majority of SLABs is being recycled in all three countries. In the case of the United States, the only known exports of SLABs are to Canada and Mexico. In the case of Mexico, the quantities of SLABs exported are known, but not whether those that are exported are recycled or destroyed.

In Canada, the Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (EIHWHRMR) set out criteria that provide Environment Canada with the ability to refuse to issue an export, import or transit permit for hazardous waste or hazardous recyclable material if it will not be managed in a manner that will protect the environment and human health.

While well-established, the lead recycling industry is changing. Free trade has led to industry consolidation. In the United States and Mexico, secondary lead exceeds primary lead production and, through vertical integration, smelters are owned by battery manufacturers that use the lead for the manufacture of new batteries. In Canada, lead smelters refine lead ore and recycle SLABs into lead metal, most of which is exported to the United States. In the literature, there was some indication that recyclers are moving from industrialized countries to developing nations. It would be useful to investigate this suggested "trend."

7.2 Information

There is an abundance of information on SLABs and guidance on their disposal to be found on web sites and in other references, some of it conflicting. Through the Basel Convention, OECD and World Customs Organization, there are easily identifiable, assigned international codes in place for SLABs. Therefore, the opportunity exists for the three countries to agree on the use of these existing international codes. A uniform requirement for standardized notices could also provide a common base for the collection of more accurate information.

In the case of SLABs exported from the United States to countries other than Canada, another way of improving available information would be to have exporters report to the US authorities the destination country and facility of shipments.

[78] Canadian Chemical Producers Association, Responsible Care® Program, <http://www.ccpa.ca/ResponsibleCare/>.

7.3 Regulatory Context

The regulations and classifications for hazardous wastes/recyclables for SLABs differ in the three NAFTA countries (see **Section 7.2**). Regulatory approaches proposed by industry should be given consideration.

The new hazardous waste legislation in Mexico should help, as it sets out an appropriate framework, but a lack of capacity to implement the waste management plans, etc., could be a problem.

In the United States, the EPA has proposed a regulatory amendment that will revise the requirements for exports destined for reclamation. The purpose of this regulation is to modify the spent lead-acid battery exemption to require appropriate notice and consent for those batteries intended for export.[79] Regulatory changes underway in the United States should result in a consistent notice and consent scheme in North America. Concerns also exist over the potential lead contamination on sites of approved lead recycling facilities in the three countries. Guidelines that recommend minimum environmental performance standards for such facilities, coupled with the enforcement of permit conditions for these facilities, as well as application of the ESM guidelines contained herein, should address such concerns.

While the regulatory framework may exist, there are also concerns that some companies, especially SMEs, may not have EMSs and may not always operate in an ESM manner. On some fronts there is a perceived inequity about facility performance requirements and questions as to whether standards are the same in the United States relative to Canada and/or Mexico. There is some question as to whether SLABs are being moved to jurisdictions where controls are less stringent or if movements are largely controlled by proximity to recycling or battery manufacturing facilities, given that SLABs are physically heavy and expensive to transport over long distances. Training, education (capacity-building) and awareness of the hazards of SLAB recycling and how to prevent them would assist in addressing this concern.

7.4 ESM Practices for SLABs

The following checklists in **Tables 7–1** and **7–2** set out the basic elements that comprise an environmentally sound management regime. Use of the ESM guidelines presented in **Section 4** of this report, as appropriate, by governments in permitting, licensing and auditing recycling operations and by operators could also help ensure that SLABs are being handled in an environmentally sound manner and could form the basis for a compatible approach by the three NAFTA countries.

Companies involved in any of the SLAB management steps should have the following framework in place to ensure ESM, and governments should apply this checklist as a guide when licensing or permitting recycling operations, as appropriate under domestic regulations.

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[79] See <http://yosemite.epa.gov/opei/Smallbus.nsf/b8c39d602103709985256d3b004de940/eafe7194aacbdc57852570970060c806!OpenDocument>.

Table 7–1 ESM Elements Specific to Regulatory Agencies Check List

Element	✓
Appropriate legislation and regulations to protect health and the environment, e.g.: • Minimum facility standards • Minimum transportation standards • Notice and consent	
Appropriate resources, including trained inspectors, time and budget, to approve facilities, monitor and enforce compliance, and respond to legitimate public complaints	
Reasonable public access to government records on waste and recyclables treatment, storage and transport facilities, and movements between countries	
Compatibility within country with international environment and trade agreements	
Capability and will to be last-resort protector of humans and the environment in the event of facility or transportation failure	
A policy framework that encourages recycling SLABs in an environmentally sound manner. • Incentives for recycling • Education programs	

Table 7–2 ESM Elements Specific to Facilities Check List

Element	✓
Voluntary collection systems, such as reverse-distribution	
Environmental supply chain management (ESCM)	
A permit/license to operate, from the relevant government authority	
An environmental policy—a statement by the organization of its intentions and principles in relation to its overall performance which provides a framework for action and for the setting of its environmental objectives and targets	
A clear statement of environmental objectives and targets	
A procedure for identifying the significant environmental impacts arising from existing or planned activities	
Environmental management systems (EMSs)	
Programs which will enable the organization to achieve its objectives and targets; these would include defining the responsibilities of staff, and the means and timeframe by which they are to be achieved	
Programs for ensuring that staff are trained and are aware of requirements	
Procedures for operational control, internal and external communication, and document control	
Procedures for emergency preparedness and response	
Procedures for monitoring performance, and taking appropriate action if the performance does not comply with targets	
An audit program to confirm that the system has been properly implemented and that plant operation complies with all applicable laws and regulations	
Periodic management review of the EMS	
A plan for remediation of buildings and soils and for financial assurance that a proper shutdown will happen	
Occupational health program	
Public outreach and notification procedure for unusual occurrences	
Insurance (self-insurance or other) to cover liabilities	

7.5 Recycling Infrastructure

This report has shown that SLABs are recycled to a great extent in the United States and Canada and the collection infrastructure is not in need of major change though the use of incentives and notices could be improved. Our research, enhanced by that of Cristina Cortinas,[80] suggests there is a need for collection infrastructure improvement and incentives in Mexico. The guidelines set out in **Section 4** for each of the SLAB recycling steps should be followed to ensure ESM.

7.6 Incentives

For the small number of SLABs that are not being recycled, it would appear that incentives for SLAB recycling would help, including: providing for a recycling framework that would make it easy for the individual to recycle, such as well-publicized depots for SLABs; a web site that would provide information about where to take SLABs for recycling; plus economic incentives such as a deposit/refund system for LABs and/or a discount for new LABs when a SLAB is returned. If the price of lead is high enough, few other incentives for recycling over disposal are needed; however, this is not currently the case and recent price fluctuation is not helpful.

The types of incentives that would encourage the recycling of SLABs over their destruction or disposal include:

- minimum EMS requirements for all facilities, including SMEs, involved in collection and recycling of SLABs set in regulation in all three countries;
- guidelines for ESM of SLABs subscribed to by all three jurisdictions, supported by training incentives;
- environmental supply chain management (ESCM) by major recyclers, as exampled by Ford, which requires ISO 14000 certification for all Tier 1 suppliers;
- policies that drive an increase in use of techniques such as life-cycle analysis, risk assessment, environmental auditing and EMSs;
- support for standards such as ISO 9000 and 14000, as well as eco-labeling;
- social marketing to inform, engage and motivate consumers and industry;
- support of initiatives such as training programs and regulatory language proposed by industry, for example, the Battery Council Draft Regulations;[81]
- deposit, surcharge, recycle fee on new LABs, to be used to support collection and recycling of SLABs;
- product stewardship programs that might include a reward for the return of "stray" batteries; and
- support for community household hazardous waste collection days.

[80] John Buccini and Cristina Cortinas, *Impact of chemicals pollution and use on health and the environment*, 2004.

[81] Battery Council International, <www.batterycouncil.org>.

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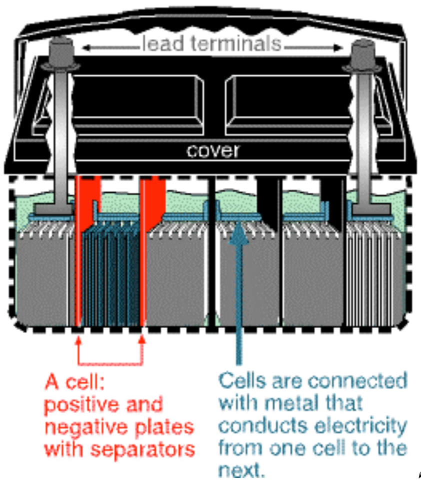
Appendices

Appendix I: Diagram of a Lead-acid Battery



Source: Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries, Annex to United Nations Environment Programme document, UNEP/CHW.6/22, 8 August 2002.

The materials are incorporated into the following constituents:[82]

(a) **positive and negative terminals:** posts, made of lead, where the external electricity consumer devices are connected
(b) **plugs:** entry points, one for each battery element, found on older batteries (new batteries are generally sealed), where distilled/de-ionized water can be replaced whenever needed and which provide an escape route for gases formed in the cells
(c) **connectors:** made of lead-antimony alloy; make electrical contact between plates of same polarity and also make electrical contact between separated elements
(d) **cap and box:** originally made of ebonite, but now more commonly made of either polypropylene or co-polymer
(e) **sulfuric acid solution:** the electrolyte of the battery
(f) **element separators:** usually a part of the box and made of the same material, provide chemical and electrical isolation between the electrical elements
(g) **plate separators:** dividers made of PVC or other porous materials which prevent physical contact between two contiguous plates while allowing free movement of ions in the electrolyte solution
(h) **negative plates:** a metallic lead grid covered by a lead dioxide (PbO_2) paste
(i) **positive plates:** metallic lead plates
(j) **battery element:** a series of negative and positive plates, placed consecutively and isolated from each other by plate separators

[82] *Technical guidelines for the environmentally sound management of waste lead-acid batteries*, Annex to United Nations Environment Programme Document, UNEP/CHW.6/22, 8 August 2002.

Appendix II: Glossary

- BCI—Battery Council International
- consent—formal acknowledgement and approval by regulatory agencies of proposed export/import in submitted notice (see “notice”)
- EMS—environmental management system; management system, such as ISO 14,000, for ensuring the environmentally sound operation of facilities, including transportation, storage, processing, etc.
- ESCM—environmental supply chain management; the application of supply-chain management techniques to the management of the environmental impacts of suppliers and products
- ESM—environmentally sound management; a framework of legislation, regulation, enforcement, policies, procedures and approved practices
- HHW—household hazardous waste
- HWTF—Hazardous Waste Task Force, Commission for Environmental Cooperation
- hydrometallurgy—recovery of metal through electrolytic conversion of aqueous salts in an aqueous environment
- LAB—lead-acid battery
- manifest—formal hazardous waste shipping documents prescribed by federal state and provincial agencies under laws such as RCRA, CEPA, etc.
- maquiladora—facility that imports raw materials for manufacturing or assembly processes within Mexico
- NAFTA—North American Free Trade Agreement
- notice—formal advisement to regulatory agencies of intent to export or import a hazardous waste or hazardous recyclable material
- pyrometallurgy—recovery of metal through thermal processes such as smelting
- SLAB—spent lead-acid battery; a used lead-acid battery that cannot be adequately recharged to fulfill a useful purpose (see “used battery”)
- SME—small or medium-size enterprise
- ton—2000 pounds (US)
- tonne—1000 kilograms, 2200 US pounds
- used battery—a battery that has been depleted of its capacity to hold an electrical charge or be recharged

Appendix III: Controls and Regulations, United States

Summary of US State Lead-acid Battery Laws[83]

State	Effective Date	BCI Model	Deposit[a] (refund-able)	Split of Deposit	Deposit Refund Period	Point of Sale Sign[b]	Fee (non-refundable)
Arizona[c]	09/27/90	Yes	$5	100% Retailer	30 days	Retailer	
Arkansas	07/01/92	Yes	$10	100% Retailer	30 days	State	
California	01/01/89	Yes				No	
Connecticut[d]	10/01/90	Yes	$5	100% Retailer	30 days	Retailer	
Florida	01/01/89	Yes				No	$1.50[o]
Georgia	01/01/91	Yes				Retailer	
Hawaii	01/01/90	Yes				State	
Idaho[l]	07/01/91	Yes	$5	100% Retailer	30 days	Retailer	
Illinois	09/01/90	Yes				Retailer	
Indiana	01/01/91	Yes				Retailer	
Iowa	07/01/90	Yes				Retailer	
Kansas City,[e] Missouri	03/14/90	Yes				Retailer	
Kentucky	07/13/90	Yes				Retailer	
Louisiana	09/01/89	Yes				Retailer	
Maine	10/30/89	Yes	$10	100% Retailer	7 days	State	$1.00[p]
Massachu-setts	12/31/90	No[g]				No	
Michigan	04/01/90	Yes				State	
Minnesota	10/04/89	Yes[f]	$5	100% Retailer		State	
Mississippi	07/01/91	Yes				State	
Missouri	01/01/91	Yes				State	
Nebraska	09/01/94	No[i]					
Nevada	01/01/92	No[g]				No	
New Hampshire	01/01/91	No[g]				No	
New Jersey	10/09/91	Yes				Retailer	
New Mexico	12/31/91	No[g]					
New York	01/01/91	Yes	$5	100% Retailer	30 Days	Retailer	
North Carolina	01/01/91	Yes				Retailer	
North Dakota	01/01/92	Yes				No	
Oklahoma	09/01/93	Yes[t]				Retailer	
Oregon[h]	01/01/90	Yes				Retailer	
Pennsylvania	07/26/89	Yes				State	

[83] Adapted from Battery Council International, <www.batterycouncil.org/states.html>.

Rhode Island	01/01/89	Yes	See note[u]			State	
South Carolina	05/27/91	Yes	$5	100% Retailer	30 days	State	$2[m]
South Dakota[r]	07/01/92	Yes				No	
Tennessee	07/01/90	Yes[q]				No	
Texas	09/01/91	Yes				State	$2/$3[n]
Utah[k]	01/01/92	Yes				Retailer/ Whole-saler	
Vermont	06/17/94	Yes				Retailer	
Virginia	07/01/90	Yes				State	
Washington	07/23/89	Yes	$5	100% Retailer	30 days	State	
West Virginia	04/6/94	Yes[s]				Retailer/ Whole-saler	
Wisconsin	01/01/91	Yes	See note[j]			State	See note[j]
Wyoming	06/08/89	Yes				State	

Notes:

a	This refers to a deposit in lieu of trade-in. The deposit is paid by any person who purchases a new battery without returning a used battery at the same time.
b	This refers to whose responsibility it is to make the educational signs, the state or the retailer. A "No" indicates that there is no sign requirement.
c	AZ requires all lead batteries sold to be labeled with a universally accepted recycling symbol. AZ also requires that State agencies and political subdivisions comply with the battery recycling law.
d	Retailers in CT must take back batteries one-for-one at the point of sale.
e	Kansas City's ordinance requires that retailers take back up to 3 batteries not at the point of sale, and it requires that junk batteries be stored in "an adequately ventilated enclosure in good repair that protects its contents from any precipitation, etc." Any spilled acid must be immediately collected and neutralized.
f	MN now requires that retailers take back up to 5 batteries not at the point of sale.
g	NH, NM, NV and MA placed a ban on the landfilling and incineration of lead batteries only. NV will allow lead battery disposal at state-"permitted" facilities, however.
h	OR requires that until 12/31/93 retailers must accept at least 1 battery from consumers, after which they must only accept batteries one-for-one at the point of sale.
i	NE placed a prohibition on only the landfilling of lead batteries.
j	WI law allows retailers to charge a $5 deposit in lieu of a trade-in, and to charge $3 for taking a battery.
k	UT requires retailers to take back a maximum of two used lead batteries from customers. In addition to the BCI model law, a 1998 regulation prohibits solid waste disposal of lead-acid batteries.
l	ID requires all lead batteries sold to be labeled with a universally accepted recycling symbol. In addition, batteries used in motorcycles, off-road recreation vehicles or lawn and garden equipment are exempt from the deposit in lieu of a trade-in requirement.
m	SC requires retailers to collect a $2.00 fee for lead batteries sold to the ultimate consumer. The retailer may retain three percent of the collected fees to cover administrative costs. Fees collected by the state treasurer are to be deposited into a Solid Waste Management Trust Fund. Small sealed lead-acid batteries are now exempt from the fee and BCI model provisions; however, a study on the recycling of these batteries is required. See SC Code Ann. x 44-96-40(23).

n	TX requires the collection of a $2.00 and $3.00 fee for batteries less than 12 volts, and, equal to or greater than 12 volts respectively. Exempted from the fee is any battery that is: 1) rated at less than 10 ampere hours; 2) sealed so that no access to the interior of the battery is possible without destroying the battery; and 3) with dimensions (sum of height, width and length) less than 15 inches. The fees are to be collected by any wholesaler or retailer who sells a battery not for resale. To cover administrative costs, the dealer may retain 2.5 cents per unit. All remaining money, less four percent to cover state administrative costs, goes to the state comptroller to be placed in a waste remediation fund.
o	FL requires the collection of a $1.50 fee per battery at the retail level.
p	ME requires the collection of a $1.00 fee per battery at the retail level.
q	TN prohibits landfills or incinerators in the state from accepting lead-acid batteries for incineration or disposal. Further, lead-acid battery retailers must accept used lead-acid batteries as trade-in batteries.
r	SD requires wholesalers and retailers to “accept, on a one for one exchange basis, used lead-acid batteries and ... ensure the proper handling and disposal of the batteries.” Further, after 1 July 1995, all lead-acid batteries shall be eliminated from landfilled wastes.
s	WV requires retailers and wholesalers to collect used lead-acid batteries from customers and post point-of-sale signs.
t	OK requires that retailers of lead-acid batteries post and maintain a sign at or near the point of display or sale to inform the public that lead-acid batteries are accepted for recycling.
u	RI law specifies that retailers may voluntarily add a core charge (amount unspecified) to the price of a new vehicle battery. The core charge must be refunded if a used battery is returned within 7 days of the date of purchase.

Final Note: Several states have adopted separate household or dry cell battery recycling laws that include provisions strictly applicable to small sealed lead-acid batteries. These states are California, Florida, Illinois, Iowa, Maine, Maryland, Minnesota, New Hampshire, New Jersey, New York, Oregon, and Vermont.

Summary (Total = 42 states and 1 city)**:**

- 37 states and 1 city with the BCI Model (with and without deposit)
- 7 states with a $5 deposit in lieu of trade-in requirement
- 2 states with a $10 deposit in lieu of trade-in requirement
- 5 states with a ban on municipal solid waste disposal (landfills and/or incinerators)

Lead-acid Battery Definitions, by State

State	Definition
Arizona	"[A] battery with a core of elemental lead and a capacity of six or more volts which is suitable for use in a vehicle or boat."
Arkansas	"[A] battery with a core of elemental lead and a capacity of six or more volts."
California	"[A]ny battery which is primarily composed of both lead and sulfuric acid, with a capacity of six volts or more, and which is used for any of the following purposes: 1) as a starting battery which is designed to deliver a high burst of energy necessary to crank an engine until it starts; 2) as a motive power battery which is designed to provide the sources of power for propulsion or operation; or 3) as a stationary standby battery which is designed to be used in systems where the battery acts as a source of emergency power, serving as a backup in case of failure or interruption in the flow of power from the primary source."
Connecticut	"[A] lead-acid battery or a motor vehicle battery."
Florida	Under the recycling provisions, the term lead-acid battery is undefined. Under the battery fee provisions, the term is defined as follows: "[T]hose lead-acid batteries designed for use in motor vehicles, vessels, and aircraft, and includes such batteries when sold as a component part of a motor vehicle, vessel, or aircraft, but not when sold to recycle components."
Georgia	The term lead-acid battery is undefined; however, the law applies only to "lead-acid vehicle batteries…"
Hawaii	The term lead-acid battery is undefined, however, the law appears to apply to "motor vehicle or other lead-acid batteries…"
Idaho	"[A] battery with a core of elemental lead and a capacity of six or more volts which is suitable for use in farm equipment, construction equipment, a motor vehicle or a boat. Batteries only suitable for motor cycles, off-road recreation vehicles or lawn and garden equipment are exempt from the fees in this chapter."
Illinois	"[A] battery containing lead and sulfuric acid that has a nominal voltage of at least six volts and is intended for use in motor vehicles."
Indiana	"[A] battery that: 1) contains lead and sulfuric acid; and 2) has a nominal voltage of at least six volts."
Iowa	The term lead-acid battery is undefined.
Kansas	"Any battery that consists of lead and sulfuric acid, is used as a power source, and has a capacity of six (6) volts or more."
Kentucky	The term lead-acid battery is undefined.
Louisiana	The term lead-acid battery is undefined; however, the law applies to "motor vehicle batteries or other lead-acid batteries…"
Maine	"[A] device designed and used to store electrical energy through chemical reactions involving lead and acid."
Massachusetts	The term lead battery is undefined and unqualified in the regulation.
Michigan	"[A] storage battery, that is used to start an internal combustion engine or as the principal electrical power source for a vehicle, in which the electrodes are grids of lead containing lead oxides that change in composition during charging and discharging, and the electrolyte is dilute sulfuric acid."
Minnesota	The term lead-acid battery is undefined and unqualified in the law.
Mississippi	The term lead-acid battery is undefined; however, the law applies to "motor vehicle batteries or other lead-acid batteries…"
Missouri	"[A] battery designed to contain lead and sulfuric acid with a nominal voltage of at least six volts and of the type intended for use in motor vehicles and watercraft."
Nebraska	The term lead-acid battery is undefined.

Nevada	The term lead-acid battery is undefined; however, the law applies to "motor vehicle batteries."
New Hampshire	The term lead-acid battery is undefined; however, the law applies to "motor vehicle or wet cell batteries."
New Jersey	"[A] lead-acid electric storage battery designed for use in motor vehicles, aviation equipment or marine vessels."
New Mexico	The term lead-acid battery is undefined and unqualified in the regulation.
New York	"[A]ny battery with a capacity of six or more volts which contains lead and sulfuric acid and which is used as a power source in a vehicle."
North Carolina	The term lead-acid battery is undefined; however, the law applies to "motor vehicle batteries or other lead-acid batteries…"
North Dakota	The term lead-acid battery is undefined.
Oklahoma	"[A] lead-acid electrical device used in boats, planes and motor vehicles."
Oregon	The term lead-acid battery is undefined.
Pennsylvania	The term lead-acid battery is undefined; however, the law applies to ""motor vehicle batteries or other lead-acid batteries…"
Rhode Island	"[B]atteries used in any vehicle, or of a capacity of six (6) volts or more, and of one hundred fifty (150) pounds or less in weight, and like batteries in stationary uses."
South Carolina	"[A]ny battery that consists of lead and sulfuric acid, is used as a power source, and has a capacity of six volts or more, except that this term shall not include a small sealed lead-acid battery. A small sealed lead-acid battery weighs twenty-five pounds or less, and is used in non-vehicular, non-SLI (starting lighting ignition) applications."
South Dakota	The term lead-acid battery is undefined.
Tennessee	The term lead-acid battery is undefined; however, the law applies to "automobile batteries."
Texas	Under the recycling provisions, the term lead-acid battery is undefined, however, the law applies to "motor vehicle batteries or other lead-acid batteries…" Under the battery fee provisions, the term is defined as follows: "any battery with a capacity of six or more volts which contains lead and sulfuric acid."
Utah	The term lead-acid battery is undefined; however, the law applies to any "motor vehicle battery or other lead-acid battery…"
Vermont	"Lead-acid battery means a battery that consists of lead and sulfuric acid and is used as a power source." The law exempts small, sealed lead-acid batteries weighing less than 25 pounds and not used as the principal power source for transportation, including automobiles, motorcycles and boats.
Virginia	The term lead-acid battery is defined as "any wet cell battery."
Washington	"[B]atteries capable for use in any vehicle, having a core consisting of elemental lead, and a capacity of six or more volts."
West Virginia	"Lead-acid battery means an encasement which contains or contained lead and sulfuric acid to produce an electrical charge."
Wisconsin	The term lead-acid battery is undefined; however, the law applies to any "motor vehicle battery or other lead-acid battery…"
Wyoming	The term lead-acid battery is undefined; however, the law applies to any "motor vehicle battery or other lead-acid battery..."

Appendix IV: Outlines of Basel and OECD ESM Guidelines

Basel ESM Guidelines [84]

The states are to undertake:

(a) Prevention, minimization, recycling, recovery and disposal of hazardous and other wastes subject to the Basel Convention, taking into account social, technological and economic concerns;

(b) Active promotion and use of cleaner technologies and production, with the aim of the prevention and minimization of hazardous and other wastes subject to the Basel Convention;

(c) Further reduction of transboundary movements of hazardous and other wastes subject to the Basel Convention, taking into account the need for efficient management, the principles of self-sufficiency and proximity and the priority requirement of recovery and recycling;

(d) Prevention and monitoring of illegal traffic;

(e) Improvement and promotion of institutional and technical capacity-building, as well as the development and transfer of environmentally sound technologies, especially for developing countries and countries with economies in transition;

(f) Further development of regional and subregional centers for training and technology transfer;

(g) Enhancement of information exchange, education and awareness-raising in all sectors of society;

(h) Cooperation and partnership at all levels between countries, public authorities, international organizations, the industry sector, nongovernmental organizations and academic institutions;

(i) Development of mechanisms for compliance with and for the monitoring and effective implementation of the Convention and its amendments.

OECD core performance elements for the environmentally sound management of waste[85]

The facility should have an applicable environmental management system (EMS) in place

The facility should take sufficient measures to safeguard occupational and environmental health and safety

The facility should have an adequate monitoring, recording and reporting programme

The facility shall have an appropriate and adequate training programme for the personnel

The facility should have an adequate emergency plan

The facility should have an adequate plan for closure and after-care

[84] Basel ESM Guidelines.

[85] OECD, *Final recommendation of the Council on the Environmentally Sound Management of Waste* (06-09-2004).

UNEP Basel Convention Battery Recycling Guidelines[86]

Setting Collection Systems: Policy Frameworks[87]

The technical aspects of the pre-recycling steps . . . comprising collection, transportation and storage, must all fall under a policy framework capable of identifying players, responsibilities and economic incentives in order to give them long-term viability. This policy framework is required to:

(a) reduce waste generation;

(b) provide means to:

(i) research the prolongation of battery lifetime;

(ii) research the use of alternative battery technologies;

(iii) the adoption of clean recycling technologies;

(c) maximize economic and environmentally friendly lead recovery by means of:

(i) making recycling operations environmentally sound, economically efficient and socially acceptable;

(ii) including short and medium term measures for improving the efficiency of small smelters;

(iii) gradual insertion of the informal sector into a national lead recycling strategy;

(iv) increasing collection volume and reducing its costs;

(v) enhancing the access to domestic lead sources;

(d) consider the strategy implementation as a consultative and multi-stakeholder process.

[86] *Technical guidelines for the environmentally sound management of waste lead-acid batteries*, Annex to United Nations Environment Programme document, UNEP/CHW.6/22, 8 August 2002.
[87] Ibid., p. 43.

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