WORKSHOP ON SOUND MANAGEMENT OF USED LEAD ACID BATTERIES

REPORT

26-27 November 2015, Osaka, Japan

Contents

Executive Summary

This is a report from a workshop on the environmentally sound management of used lead acid batteries (ULAB) held in Osaka, Japan on 26-27 November 2015. UNEP partners with governments and stakeholders to address the environmental and health risk pose by lead. Most of lead is used for batteries globally, and their unsound management and recycling are causing health and environmental damage in many places. This small workshop was aimed at initiating the analysis of the trade, recycling and health/environmental impact of ULAB, and elaborate on possible UNEP activities to address this issue, starting with some countries in Asia. Draft analysis was presented at the workshop, and the development of regional, subregional and national strategies was proposed. Further workshops will be convened in other regions towards the development of UNEP activities to assist governments and stakeholders in the sound management of ULAB.

Introduction

This report presents the outcome of the work undertaken in 2015 by UNEP in partnership with WHO, the Global Environment Centre Foundation and Basel Convention Regional Center for Central America and Mexico to address the environmental and health impact of the recycling of used lead acid batteries (ULABs). As a part of this project, a Workshop on Sound Management of Used Lead Acid Batteries was held in Osaka, Japan on 26-27 November 2015. Papers developed in preparation for and as a follow up on the workshop are included in this report as annexes. Further work, including further information collection and consultation on these papers, will be undertaken in 2016 with a view to developing a global strategy toward the sound management of ULABs.

Lead is a cumulative toxicant particularly hazardous to young children and pregnant women. Currently more than 80% of the global demand of lead is for batteries. Many reports exist which provide examples of health and environmental damages from inappropriate recycling of ULABs in developing countries. Therefore, international action is needed to achieve environmentally sound management of ULABs to reduce the risks of lead globally.

UNEP has been engaged in action to address the environmental and health risks posed by lead, focusing to date on the phasing out lead in fuels and paints. For example, UNEP, in cooperation with WHO, supports the Lead Paint Alliance, a global partnership aiming at phasing out the use of lead in paint by 2020. This workshop was organized for the initial discussion on the potential activities of UNEP to support international action to promote environmentally sound management of ULABs.

Goal and Objectives of the Workshop

The overall goal of the workshop was to advance international analysis, commitment and action to address the challenges associated with the management and recycling of ULAB.

Specific objectives of the workshop were the following:

- Review the current situation on the international movement, management and recycling of ULAB, and associated environmental and health risks.
- Exchange information on the government policies and stakeholder actions to address these risks.
- Identify potential future UNEP activities towards the environmentally sound management of ULAB.

- Finalize a draft report on proposed UNEP action to promote sound management of ULAB (this report).

Participants

The workshop brought together a small number of global experts, with a focus on participants from the Asia-Pacific region. Participants included experts on global trade and management of ULAB, an expert on health impact of lead, nominated by WHO, and government officials and policy experts from Cambodia, Indonesia and Japan. A list of participants is provided below.

- Mr. Chanthan Thol, Director, Department of Hazardous Substances Management, General Department of Environmental Protection, Ministry of Environment, Cambodia
- Ms. Qurie Purnamasari, Director for Hazardous Waste Contaminated Site and Emergency Response, Ministry of Environment and Forestry, Indonesia
- Ms. Yun Insiani, Director for Hazardous Substance Management, Ministry of Environment and Forestry, Indonesia
- Mr. Gagan Firmansyah, Head of Section, Hazardous waste for aero industry, Ministry of Environment and Forestry, Indonesia
- Mr. Arata Abe, Associate Professor, Faculty of Global and Science Studies, Yamaguchi University
- Mr. Miguel Eduardo Araujo Padilla, Director, Basel Convention Regional Center for Central America and Mexico
- Mr. Luis Guillermo Marroquin, Industrial Engineer Advisor, Basel Convention Regional Center for Central America and Mexico
- Mr. Brian Wilson, Program Manager, International Lead Association (ILA), Pure Earth (Blacksmith Institute) Technical Advisory Board
- Mr. Terrence Thompson, Managing director, Water and Environment International, Philippines (nominated by WHO)
- Mr. Tetsuya Kawata, Graduate School of Advanced Integrated Studies in Human Survivability, Kyoto University, Japan
- Mr. Perry Gottesfeld, Occupational Knowledge Network (participation by skype)
- Mr. Eisaku Toda, Senior Programme Officer, Chemicals and Waste Branch, UNEP
- Mr. Surendra Shrestha, Director, IETC, UNEP
- Mr. Mushtaq Memon, Programme Officer, IETC, UNEP
- Mr. Shunichi Honda, Programme Officer, IETC, UNEP

Partners

This workshop was organized through cooperation among the following partners:

- UNEP contributed through its Chemicals and Waste Branch (CWB) and the Economy and Trade Branch (ETB) and provided perspectives on the management of environmental and health risks of lead and the international trade of ULAB and their recycling respectively. CWB contributed through the Geneva-based Technology and Metal Partnership Team (overall coordination) and the International Environmental Technology Centre (IETC) based in Osaka.
- WHO nominated an expert to address the human health dimension and authored a part of the report (Annex 4).

- Basel Convention Regional Center for Central America and Mexico prepared the draft workshop document and developed a report on ULAB management with the help of the International Lead Management Centre and other experts.
- Global Environmental Centre Foundation compiled this report with input from these partners and experts, and made practical arrangements for the workshop.

Methods

The workshop was highly interactive in nature and was organized around a series of presentations experts had prepared in advance, followed by focused discussions convened by UNEP. Due to the small number of participants, the discussion was conducted in a plenary round-table format. The workshop was preceded by a preparatory meeting taking place on 26 November to discuss and further develop a workshop document which reviewed the international trade, management and recycling of ULAB and their environmental and health impact. The review also included skype conversation with experts and stakeholders who could not attend in person.

Programme

The workshop programme is shown below.

Thursday 26th November 2015: Preparatory Meeting	
10:00-11:00	Review of Trade Assessment
11:00-12:00	Review of ULAB management and recycling practice
12:00-13:00	Review of environmental and health impact
13:00-14:00	Lunch
14:00-15:00	Preliminary discussion on UNEP activities
16:00-17:00	Skype Conference with UNEP Economics and Trade Branch
17:00-18:00	Any other issues and conclusion.
Friday, 27th November 2015: Workshop	
Session 1: Opening and Introduction *Objective: Develop shared understanding of global challenges of ULAB management and recycling*	
09:00-09:30	**Introduction on the background and objectives** *Mr. Eisaku Toda*, Chemicals and Waste Branch, UNEP
09:30-10:00	**Trade of ULAB and environmental impact** *Mr. Brian Wilson*, International Lead Management Centre
10:00-10:15	**Health impact of ULAB recycling** *Mr. Terrence Thompson*, Water & Environment International
10:15-10:30	**Environmentally sound management and recycling of ULAB** *Mr. Brian Wilson*, International Lead Management Centre
10:30-11:00	**Discussion:** How can we manage and recycle ULAB in an environmentally sound manner
11:00-11:30	Coffee break
Session 2: Challenge in Asian Countries *Objective: Provide national perspectives and identify good practices for designing policy*	
11:30-13:00	**Presentations by participants on environmental and health risk of:** *Mr. Arata Abe*, Yamaguchi University, Japan *Mr. Chanthan Thol*, Ministry of Environment, Cambodia *Ms. Qurie Purnamasari*, Ministry of the Environment and Forestry, Indonesia **Discussion:** What are current situations and challenges on lead?
13:00-14:00	Lunch
Session 3: Future UNEP activities on lead batteries *Objective: Identify and design possible UNEP activities: what, who, where, when and how*	
14:00-15:30	**Proposals for a certification scheme for ULAB recycling** *Mr. Miguel Araujo*, Basel Regional Centre for Central America and Mexico **Case example and low-cost model for sound management of ULAB** *Mr. Luis Marroquin*, Basel Regional Centre for Central America and Mexico **Better Environmental Sustainability Targets (BEST) for Lead Battery Manufacturers** *Mr. Perry Gottesfeld*, Occupational Knowledge Network

	International Lead Management Centre Assessment scheme *Mr. Brian Wilson*, International Lead Management Centre **Discussion:** How can we design a pilot scheme for promoting environmentally sound management of ULAB?
15:30-16:00	Break
16:00-17:20	**Link with the e-waste projects supported by IETC:** *Mr. Mushtaq Memon and Mr. Shunichi Honda*, UNEP IETC **Discussion:** How can we implement sound management of ULAB as part of E-waste?
Session 4: Summary, conclusions and evaluation *Objective: Agree on course of action*	
17:20-17:30	*Mr. Eisaku Toda*, Chemicals and Waste Branch, UNEP

Proceedings

Mr. Eisaku Toda, UNEP, opened the workshop, and explained the background, goal, objectives and programme of the workshop. He explained UNEP's plan to submit a compilation of information on techniques for emissions abatement and on the possibility of replacing lead and cadmium with less hazardous substances or techniques to the 2nd United Nations Environment Assembly in May 2016, and stated that the outcome from this workshop will be an input to that document. He expressed UNEP's readiness to support international action toward sound management of ULABs.

Mr. Brian Wilson, International Lead Management Centre, presented data and information related to the trade and recycling of ULABs. He had reviewed the trade information available from national reporting on the Basel Convention, but due to the incomplete and inconsistent nature of many of the reports, it was difficult to conduct a meaningful analysis of the trade flow. He will proceed with the analysis of UN trade data, data from the International Lead and Zinc Study Group (ILZSG), Pure Earth's (Blacksmith Institute) "Hot Spot" dataset etc. The analysis of these data sets is attached as Annex 1 (trade analysis), and Annex 2 (analysis of ILZSG smelters and production data) and Annex 3 (analysis of hot spot data). He also presented his analysis of ULAB export, import and recycling in Asian Countries (see Annex 2). Participants were interested in this analysis, and agreed that such information should be further collected and refined.

Mr. Terrence Thompson, Water & Environment International, made a presentation on behalf of WHO on the health impact of ULAB recycling. He explained the sources, pathways and routes of exposure of lead. A draft WHO report describes how lead exposure can occur during the recycling of used lead acid batteries. It discusses the adverse health impacts resulting from exposure to lead and provides information on ways in which lead exposure can be assessed. Two case studies illustrate the impact that uncontrolled battery recycling can have on communities. The informal used lead acid battery (ULAB) sector, which is made up of small family businesses, is of particular concern to WHO as there are usually minimal environmental or occupational controls in such settings. These operations thus pose a higher risk of lead exposure during the various phases of the recycling process. Among the findings of the draft report, it is reported that lead exposure causes:

- 0.6% of global burden disease
- 143,000 deaths per year
- 8.977 million disability adjusted life years (DALYs)
- Approximately 600,000 new cases of children with intellectual disabilities per year

The draft WHO report explains the health effects of lead, vulnerability of young children and pregnant women, and economic and social impacts. A workshop document on health impact prepared by WHO is attached as Annex 4.

Mr. Brian Wilson made a presentation on the environmental and health risk of ULAB recycling, mitigation measures, and opportunities for sound management of ULABs. His presentation offered visual examples of environmentally sound management practice in ULAB collection, packaging, transport, draining and treatment of electrolyte, separation, smelting and slug treatment, including the aspect of industrial hygiene.

In the discussion in this introductory session, the Basel Convention Guideline was referred to as a standard reference document. Mr. Wilson and Mr. Miguel Araujo had already worked on proposing updates on the Guidance. The participants welcomed this work,, and agreed that this update should also address the aspect of cleaner production.

The second session on the situation in Asian countries started with a presentation by Mr. Arata Abe, Yamaguchi University, Japan. In the early 1990s, the pollution control cost was increased and the demand of lead was decreased. Therefore the price of waste batteries became negative and illegal dumping became a social problem. Battery manufacturers established a voluntary recycling scheme in 1994. However, this resulted in the loss of competitiveness of battery manufacturers. To address this problem, the lead Acid Battery Recycle Association started a new recycling system in 2014. Currently, this new system is facing a resource issue due to the relatively high lead price and increasing export of ULABs. The export of used batteries to Viet Nam or Hong Kong increased in 2004 to 2007. Recently the amount of waste batteries exported to the Republic of Korea has increased since 2005. The export price of waste batteries is higher than the domestic market price. ULABs are exported not as waste but as used products, so the Basel Convention does not apply.

Mr. Chanthan Thol, Ministry of Environment, Cambodia, presented the situation in his country. The demand for lead acid batteries in Cambodia is increasing with the progress of urbanization, not only for vehicles but also as domestic and other power sources. The import of lead acid batteries is also increasing from Viet Nam, Thailand, Japan, the Republic of Korea and Malaysia. However, there is no specific institution for ULABs and little formal information or data about proper procedures for the collection, transportation and recycling of ULABs. In addition, there are few hazardous landfill sites and not enough skilled people in ULAB management and recycling. To improve the situation, there is an urgent need to establish a national policy for ULAB management and recycling. The key first step is to recognize the correct information and data about the situation in Cambodia. The difficult point to motivate people is how to change the mind to take any action for solving the problem.

Ms. Qurie Purnamasari, Ministry of the Environment and Forestry, Indonesia, made a presentation on the situation in her country. According to some reports, there are several regions whose soils are polluted by the illegal smelters of lead and the levels of the lead in children’s blood are very high since they play on contaminated ground. The effects of lead on people are also reported as accumulation in the brain and decreasing IQ. In Indonesia, ULAB is regulated as hazardous waste and the import of ULAB is prohibited. She concluded that lead pollution is a threat to Indonesia’s future, and that awareness raising is of primary importance.

In session 3, presentations of existing initiatives were made to explore the future UNEP activities on lead batteries. Mr. Miguel Araujo, Basel Regional Centre for Central America and Mexico, presented the Green Lead initiative promoted in Central America. The initiative is based on the Basel

Convention Technical Guidelines, and also addresses occupational health and safety. It includes an internal self-assessment, external third party assessment (Green Lead Award) and external third party audit (Green Lead Certification). The protocols are publicly available and can be used in any other part of the world. Mr. Araujo highlighted that the Green Lead initiative had a positive impact in the implementation of the ULAB Strategy which was specially implemented in Costa Rica, Guatemala, the Dominican Republic and Colombia during 2002-2008, where the Green Lead Assessment was officially incorporated as part of this strategy, as he shared in a presentation in the preparatory meeting to this workshop. Moreover, the Green Lead Assessment was later used in Senegal.

Mr. Luis Marroquin, Basel Regional Centre for Central America and Mexico, presented a case example and low-cost model for sound management of ULABs. The Acumuladores Iberia, a Guatemala-based company, obtained the first Green Lead Award. The improvements include 70% increase in energy efficiency, 54% reduction in exhaust gas, 27% reduction solid waste generation, 98% reduction in the use of chemicals.

Mr. Perry Gottesfeld, Occupational Knowledge Network, presented the Better Environmental Sustainability Targets (BEST) for Lead Battery Manufacturers. He discussed a peer-reviewed publication demonstrating that average blood lead levels of people working in recycling plants in developing countries were 64 µg/dL and 47 µg/dl in lead battery manufacturing. (see: "Review: Lead Exposure in Battery Manufacturing and Recycling in Developing Countries and Among Children in Nearby Communities." Gottesfeld, P. and Pokhrel, A. Journal of Occupational and Environmental Hygiene, Volume 8, Issue 9, 520-532, 2011) He also discussed the situation in China where growing awareness of lead poisoning in communities surrounding lead battery recycling plants resulted in government action to close hundreds of plants in recent years. The contents of Better Environmental Sustainability Targets (BEST) Standard 1001 include air emission, water emission, occupational health and safety, other environmental impacts and ULAB take back schemes. The BEST Standard is an industry-specific certification standard for lead battery manufacturers that can be adopted and updated for use by lead recycling industries. Third party certification has a benefit for consumers and manufacturers and the environment. He concluded that certification can be an important tool to change industry behavior but regulation is also needed. Certification provides a low-cost mechanism to verify compliance with regulations, that certification can help increase exports/ trade, and that governments can encourage certification through mandates and preferred purchasing.

Mr. Brian Wilson presented a Benchmarking Assessment Tool. This tool is provided as questionnaire sheets covering the whole life cycle from ULAB collection, storage, packaging, transportation and recycling. By completing the assessment form it enables the user to identify key benchmarks, determine compliance, and prepare recommendations for improvement.

Mr. Mushtaq Memon and Mr. Shunichi Honda, UNEP IETC, presented the e-waste projects supported by IETC. IETC’s support included the development of training materials, workshops, awareness raising, data collection, policy recommendation, and project proposals based on public private partnerships. They recommended that pilot projects should include awareness raising, team building and training, baseline reports with gap analysis, target setting and identification of stakeholder concerns, development of ULABs management plan to fill the gaps, and capacity building for implementation of ULABs management plan.

Session 4 on summary, conclusions and evaluation was convened by Mr. Toda. These are presented in the following sections.

Conclusions and recommendations

It was agreed that the Basel Convention Technical Guidelines are a key document for the environmentally sound management of ULABs. There is a need for updating it, and work has already been undertaken. Indonesia agreed to consider leading the process through the Basel Convention process if needed. It was also agreed that the guidelines should also address cleaner production.

With regard to the analysis of ULAB trade and management, it was noted that Basel Convention national reports are difficult to analyse due to inconsistent and incomplete reporting from parties. It was agreed that further analysis should be done on ILZSG data on lead smelters and production, and UN Comtrade data. Also, an estimate of illegal/illicit flows will be done using Pure Earth (Blacksmith Institute) data on unsound management sites, commodity trade data (e.g. vehicles), etc. Price analysis should also be done in a follow-up activity.

UNEP will consider a targeted questionnaire to ASEAN countries on the import and export regulation of ULAB and other lead products, notifications and consents following Basel Convention, ULAB management practice, etc. UNEP should liaise with ASEAN Working Group on this. This survey could later be extended to other regions.

Different countries face different challenges. Japan faces resource management challenges where ULAB price and their increasing exports are making domestic recycling more difficult.

Cambodia has no ULAB recycling plants. Pilot projects should aim at developing a national strategy or policy on ULAB management and awareness raising, building on past projects. Documents should be translated into the Khmer language. Projects should involve from stakeholders such as the public sector, private sector and communities.

For Indonesia, pollution from ULAB is a threat to the future. The development of an inventory is needed. Enforcement of regulation is key. Awareness raising should be done using the BCRC-CAM package. Contaminated sites are also a major concern.

A pilot project should be considered in Indonesia to introduce a BCRCCAM package for the environmentally sound management of ULABs. The Basel Convention Regional Centre for Southeast Asia in Jakarta should be involved. A pilot project in Cambodia may include stakeholder participation, a ULAB management plan and Khmer version of documents. Health authorities should be engaged as stakeholders in country-level activities to play active roles in community education and awareness raising, evaluation of health impact, and advocacy for policy development.

Regional, subregional and national strategies for the sound management of ULAB should be developed. These strategies should include the following elements:

- Obtaining high level support
- Inventory with emphasis in the informal sector
- Public education/awareness
- Training of government officials and of managers engaged in any of the life cycle of ULAB, in coordination with national universities
- Policy and legal development
- Consolidation of small recyclers and integration of the informal sector to related but safe activities
- Collection and temporary storage

- Transport & shipping, supported by an electronic PIC procedure
- Recycling lead to be used for manufacturing other batteries and efficient use of by-products

A second workshop is proposed in Central America. Communication should be made with other Basel Convention Regional Centres and other institutions.

Evaluation

The participants felt that the goal and the objectives of the workshop were well met.

Follow up

Further work is needed for the analysis of trade and management of ULABs. The outcome from the analysis in Asia, attached as Annex 1, 2 and 3, will be further commented and refined. Another analysis in Latin America and the Caribbean will be done in preparation for another workshop in Central America. Analysis of Africa should also be done.

Annex 5 presents a draft strategy for environmentally sound management of ULABs in Asian countries. This was developed by the Basel Convention Regional Centre for Central America and Mexico, based on its experience in this subregion. Consultation with governments and stakeholders in the Asia and the Pacific Region is needed to develop UNEP activities to promote environmentally sound management of ULABs in this region.

UNEP will further conduct consultations with governments and stakeholders, organize follow-up regional and/or subregional workshops, and develop strategies for supporting international action to promote sound management of ULABs.

Annex 1: UN Comtrade Import/Export Data for SLI and other LAB between Asian Countries

Prepared by: Brian Wilson, International Lead Management Centre

OBJECTIVE

The purpose of compiling, collating and analysing the Comtrade data for the import and or export of Lead Acid Batteries (LAB) is to determine whether the trade in LAB between the Asian nations has any impact on the environmentally sound management of the Used Lead Acid Batteries, in either a nation state or the region in terms of the recycling capability or capacity.

The Comtrade data for LAB are divided into two distinct categories. The automotive LAB for Starting, Lighting and Ignition (SLI) are coded as HS 850710, and all other LAB for industrial, or other domestic uses, such as UPS, solar or invertor LAB are coded as HS 850720.

The trade in LAB between the Asian nations has to be taken into context when considering a national or regional strategy, because most Asian countries have their own LAB manufacturing plants with most of the domestic production going to the home market. In this respect, the most important data to collect and assimilate remains the number of LAB, of whatever battery type, is in use in a country or a region.

Nevertheless, analysis of the LAB trade data could identify nations that might have capacity problems with recycling the ULAB because of high LAB imports or sourcing issues if the country is a major exporter with limited domestically generated ULAB.

The outcomes of the Comtrade analysis will be included in any regional or national policy formulation for the Environmentally Sound Management (ESM) of ULAB and taken into consideration using the methodology set out in Section A of the "Training Manual for the preparation of national used lead acid batteries environmentally sound management plans in the context of the implementation of the Basel Convention".1

Data were also sourced on the ULAB trade between the Asian countries. The Comtrade code for Used Lead Acid Batteries (ULAB) is HS 854810 and for Lead Scrap (other than whole ULAB) is HS 780200. If these data can be analysed they will provide a very useful insight into the likely environment impacts when cross referenced with the ILZSG data on secondary (ULAB Recycling Plants) smelters.

The Analysis

The analysis of the Comtrade data sets for the import and export of LAB is focused on Asia and does not explore the impacts of global LAB imports and exports in the region. The logic behind limiting the scope of the LAB trade to only Asian countries is to test whether there are significant indicators of a strategic nature in the sample, and if so, then scale up to a global study. Nevertheless, the total Asian trade is compared to the world trade to test if there are any significant markers for adverse commercial, environmental or health issues.

[1] http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/tm-ulab/tm_ulab.pdf

Methodology

The Comtrade data for LAB is divided into two distinct categories. The automotive LAB for Starting, Lighting and Ignition (SLI) are coded as HS 850710, and all other LAB for Industrial, or other domestic uses, such as UPS, solar or Invertor LAB are coded as HS 850720. Data are available separately for LAB imports and exports for each country and spreadsheets were prepared and collated so that the data could be corroborated. Where the two data sets were about the same, the export data were given precedence, because the objective was to derive an overview, not to determine the precise number of LAB imported or exported. Where the data sets were at variance the import data were given precedence on the basis that as tax is levied on LAB imports, the data for imports are likely to be more accurate. This approach means that the tabulation is a mix of import and export data, but the overall picture has credibility in terms of the amount of LAB imports and exports, that is, large, very large or a low level of trade.

However, even when there is correlation between the data sets, consideration must be given when using the Comtrade data because it is not guaranteed to be completely accurate. For example, the data sets from the ILZSG list a ULAB recycling plant in Bangladesh and a LAB manufacturing plant that exports LAB to several countries including Nepal, but there are no data for any LAB exports from Bangladesh in the Comtrade data. As far as export and imports are concerned it has to be remembered that SLI LAB (Code HS 850710) are exported and imported in new and used vehicles without necessarily showing up in the Comtrade data sets.

Care has also to be taken when trying to derive any conclusions regarding adverse environmental or health impacts, because the data do not contain any information about the methodologies used in any of the Asian countries to recover and recycle ULAB, neither do the data (what there is of it) regarding the trade in ULAB include any information about the Basel Convention Prior Informed Consent (PIC) procedure for the ESM of ULAB.

The net weights in the Comtrade LAB data refer to the whole LAB including the electrolyte and case material. The weight of the lead content of LAB will vary slightly depending on whether the LAB is for automotive or standby use, but will be between 55 and 60% of the net weight of a LAB.

One major shortcoming of the Comtrade data is the inconsistency of trade information for the ULAB. The Comtrade code for Used Lead Acid Batteries is HS 854810 and for Lead Scrap (other than whole ULAB) is HS 780200. When formulating a policy or a strategy for the ESM of ULAB data on the import and export of ULAB and Lead Scrap would be extremely useful, but when trying to source this information there appears to be a dearth of information for some countries making any tabulation somewhat academic.

It should also be borne in mind that the Comtrade data for LAB only record the exports and imports and no account is taken of domestic production or consumption unless the gross export trade is linked to the ILZSG data sets for total lead output.

Data Sets

The data are presented in two tables.

Table 1. Shows the gross weight of LAB traded between the 17 countries listed on the top and left hand side of the table. The Comtrade data for LAB imports and exports are divided into two battery types, the SLI LAB, which is the automotive LAB and this is coded as HS 850710 and LAB used for any other purpose than SLI are coded as HS 850720. As these are two distinct battery types that require different strategies to recover the ULAB it is useful to distinguish the battery types in the table and so the weight of the SLI LAB – code HS 850710 is shown in the upper part of each cell and weight of the other LAB – code HS 850720 is shown in the lower part of each cell.

To interrogate the table, read horizontally to see the export trade. So for example, if China is selected on the left hand column and Cambodia on the top row, where the two intersect are the export weights for China to Cambodia, that is, 501 tons of SLI LAB and 547 tons of other LAB. Conversely the import data is obtained by reading the columns vertically. So for imports into Cambodia from China, select Cambodia on the top row and China on the left hand column; where they intersect displays the import data, that is, 501 tons of SLI LAB and 547 tons. Repeat for all other pairings.

The final vertical column shows the gross weight of exports from each country and the data in the final row show the gross imports for each country.

Table 2, follows exactly the same format, but the data displayed are for the number of units imported or exported.

Table 1. LAB Exports/Imports – 2014 – SLI (HS 850710 - Upper) and Other uses (HS 850720 - Lower) – Weight by Metric Tonnes

Country: To From	Bangladesh	Cambodia	China	India	Indonesia	Japan	Malaysia	Myanmar	Nepal	Pakistan	Philippines	Singapore	Rep. of Korea	Sri Lanka	Thailand	Viet Nam	Total Exports
Bangladesh		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cambodia	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
China	46 12,180	501 547		2,089 21,787	7,494 16,484	4,002 5,036	4,850 7,815	119 2,583	0 730	101 9,928	759 6,979	3,784 14,349	632 7,843	372 1,643	240 7,914	97 4,290	145,184
India	53 139	86.5 0	63 18		556 39	7.1 30	299 26	92 1,189	10,108 1,254	0	401 6	3,092 1,775	205 22	1,827 112	681 250	19 17	22,367
Indonesia	33 28	0	183 0	677 .03		195 0	8,510 120	375 11	0	0	3,033 19.7	1,737 12.4	2 0	346 0	201 0.9	74 17	15,575
Japan	2.5 7.6	40.3 3.2	571 1,763	134 1	0.4 431		777 316	36 6.2	0 2.4	0 6.6	1.9 59	252 389	40 2,510	208 0	156 141	21 96	7,972
Malaysia	0 0.9	0 1.5	0 0.4	465 2,577	262 51	3.5 0		72 10.4	0	0 18	65 12.5	1,250 84	0	0	1,052 802	41 23	6,791
Myanmar	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
Nepal	0	0	0	1.9 8.7	0	0	0	0		0	0	0	0	0	0	0	11
Pakistan	0	0	0	0	0	0	0	56 0	0		0	38 1.9	0	0	0	0	96
Philippines	0	0	0	0 39	493 0	0.009 331	9,985 0	334 0	0	0		881 0.003	0 0.6	0	34 0.5	327 0.04	12,425
Singapore	1.9 145	115 21	76 286	70 2,176	327 2,168	0 348	1,923 707	286 230	0.8 5.5	3 114	132 984		25 109	7.5 239	165 888	209 744	12,506
Republic of Korea	35 3.8	1,470 15.7	6,430 302	1,373 58	3,118 142	51,772 1,879	6,058 439	541 57	0	242 94	1,027 155	2,286 221		551 0	5,900 240	5,185 702	90,297
Sri Lanka	0 0.09	0	0	0 2,932	0	0	0	0	0	0 109	0	0	0		0	0	3,041
Thailand	0 11.7	5,133 59	406 0.1	909 0.4	2,215 704	1,028 636	11,561 1,259	18,931 713	44 0.7	422 2.5	2,909 0.2	2,947 795	0 193	1,398 0.2		2,426 123	54,827
Viet Nam	0 189	4,464 618	55 2,972	1,059 7,027	46 76	101 167	53 31	1,345 360	0	0 258	0 26,973	0 1,093	0 173	32 0	2 2,034		49,128
Total Imports	12,876	13,075	13,126	43,384	34,606	65,537	54,729	27,347	12,145	11,298	43,516	34,987	11,755	6,736	29,701	14,411	

Table 2. LAB Exports/Imports – 2014 – LAB (HS 850710 - Upper) & Other uses (HS 850720- Lower) – No. of items - Units in 000s

Country: To From	Bangladesh	Cambodia	China	India	Indonesia	Japan	Malaysia	Myanmar	Nepal	Pakistan	Philippines	Singapore	Rep. of Korea	Sri Lanka	Thailand	Viet Nam	Total Exports
Bangladesh		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Cambodia	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
China	19.5 6,940	38 31.5		819 40,081	1,785 5,206	733 1,249	717 2,245	8.9 634	0 100	7 2,931	213 1,922	295 3,437	152 2,736	143 584	59 1.992	9 818	
India	14.5 9	4.5 0	39 8		7 30	0.3 2	17 1.3	9.4 13	464 105	**0**	25 1.4	191 81	10 1.2	213 6.3	43 14	1 .7	
Indonesia	1.4 1.2	0	9 0	34 .008		14.5 0	520 1	23.5 0.4	0	0	210 0.7	105 0.08	0.2 0	24 0	10.3 0.05	4.7 14	
Japan	0.3 0.6	2.4 0.2	60 62	18 0.6	0.2 19		44 11	2.4 0.5	0 0.2	0 0.5	0.4 3.8	16 19	2 95	13 0	22.5 8.3	7 4	
Malaysia	0 0.001	0 0.002	0 0.006	43 213	21 10.6	0.2 0		5 1.2	0	0 1.8	3 0.7	49 8.7	0	0	67 512	3.7 15	
Myanmar	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	
Nepal	0	0	0	1.4 14.5	0	0	0	0		0	0	0	0	0	0	0	
Pakistan	0	0	0	0	0	0	0	4.8 0	0		0	1.5 0.002	0	0	0	0	
Philippines	0	0	0	0 1.5	30 0	0.004 27	733 0	19 0	0	0		53 0.001	0 0.021	0	1.8 0.3	18 0.001	
Singapore	0.004 16	5.3 0.5	6 24	1.5 75	51 498	0 216	642 623	15 6.4	0.03 0.1	0.04 3.8	1 19		0.4 2.6	0.3 6.9	1.2 563	7.7 179	
Republic of Korea	1.9 0.01	76 0.5	311 11	66 1.7	153 6	2,508 61	295 17.6	29 2	0	12.8 3	51 5.5	121 9.6		28.6 0	297 11	276 16.6	
Sri Lanka	0 0.002	0	0	0 1,966	0	0	0	0	0	0 43	0	0	0		0	0	
Thailand	0 0.4	400 52	27 0.002	97 0.003	208 35	197 24	1,118 65	943 169	2 0.4	19 0.002	321 0.06	130 49	0 11	170 0.01		166 7	
Viet Nam	0 8.6	233 28	3 135	55 319	2.4 3.5	5 7.5	2.7 1.3	70 16	0	0 12	0 1,224	0 50	0 49	1.7 0	0.1 92		
Total Imports																	

ANALYSIS OF THE DATA

In the final analysis there will be a commentary on the regional perception, but at this stage it is not complete

COUNTRY ANALYSIS

Interestingly in the case of China, where according to the ILZSG lead production data China produces about half of the global output of lead bullion only 8% of the LAB are exported and so the Comtrade data will not provide an insight into the state of the ESM of ULAB in China. On the other hand of course, it is important to ascertain where China is exporting LAB so that steps can be taken to find out if the Chinese exports are being recycled in an environmentally sound manner. In other words it is important to use the Comtrade data in the context of the overall picture.

The second point to note in the import/export LAB replacement market is the strength of the LAB destined for uses other than SLI LAB. SLI account for 53% of the trade at 222.57 MT and LAB destined for other uses account for 47% at 187,871 MT. Comtrade does not provide a breakdown of the "other uses" category, but this category usually comprises of industrial LAB, such as those used for motive power in fork-lift trucks, standby storage LAB as used by the telecommunications companies, inverter LAB for use during power outages and solar storage LAB for green energy systems in homes and commercial premises.

Within the Asian LAB Sector what came as a surprise in the data is the apparent size of the LAB manufacturing sectors in countries such as Singapore, Thailand and Viet Nam. In the case of Singapore it is unclear at this stage if the LAB exports are from domestic production or LAB in transshipment (re-export) from outside Asia.

In the case of Thailand the ILZSG data sets list seven government licensed ULAB recycling plants with a combined capacity of 114,000 MT of lead bullion production and mined lead bullion at about 12,000 MT. LAB exports to Asian countries exceed LAB imports by just over 25,000 MT (lead content) and as the laws of Thailand prohibit the import of ULAB, the question is where does the lead bullion come from to maintain the LAB output. Comtrade data for global LAB imports to Thailand do not correlate with the Asian export data at only 19,000 MT, leaving an annual lead bullion shortfall of 6,000 MT tons of lead bullion.

Viet Nam does not have any active lead mines and so it sole source of lead bullion to supply the LAB industry is from ULAB recycling. First point to note is that the Comtrade data for global ULAB imports into Viet Nam is zero.

The Comtrade ULAB import data are incorrect, in as much as the SBC study in Cambodia identified the ULAB cross border trade from Cambodia to Viet Nam and the Japanese presentation at the workshop also highlighted the export of ULAB from Japan to Viet Nam. This means that with LAB exports amounting to 49,128 MT in 2014 and imports of only 14,411 MT there is an unsustainable imbalance, unless ULAB are being imported without reference to the Basel Convention and by default, the Comtrade data sets.

Although domestic LAB manufacturing and consumption in Viet Nam is unknown, if Viet Nam is obtaining all the lead bullion required by the LAB manufacturing sector from domestic ULAB recycling, then there has to be concern about environmental contamination and population exposure, because of the conclusions about the state of the Vietnamese recycling plants highlighted in the FSC report and investigations by the Pure Earth (Blacksmith Institute). Indeed, the Australian consultants who conducted the survey for the FSC listed all the ULAB plants as informal, even though they are licensed by the Government, because the environmental performance of all the plants inspected in the study were perceived to be on a level only seen in backyard smelting.

In the case of Nepal, it has already been noted in the ILZSG Report that Nepal does not have a formal ULAB recycling plant and the Government does not comply with the requirements of the Basel Convention for the export of ULAB from Nepal to India because the enabling legislation has not been passed into law. However, the Comtrade data shows that just over 12,000 tons of LAB were imported into Nepal from countries in Asia in 2014, and that figure would be higher if the imports from Bangladesh were to be included. Attention should be given in any overarching strategy to accommodate countries with significant quantities of ULAB generated annually, but no domestic recycling facilities.

The situation in Indonesia was explained very well at the workshop in Osaka. Indonesia has its own domestic LAB industry and the country imports and exports LAB. Indeed, the country trades in the LAB with nearly every country in Asia. Any problems Indonesia has with the recycling of ULAB are not exacerbated by import of ULAB, because that trade is banned. Nevertheless, although the Comtrade data do not show it, LAB usage in Indonesia is scattered over many hundreds of islands and the challenge is, with sometimes poor transport links to recover the ULAB with sufficient margin to recycle them in a viable manner that is environmentally sound. (the trade flows for the ULAB are shown in the Workshop notes)

What the Comtrade data do show is that the Indonesian LAB sector is an important export industry with significant sales to Malaysia, Singapore and the Philippines.

As the only domestic supply of lead bullion is the Indonesian ULAB recycling sector it is therefore essential to have an environmentally sound domestic industry that is entirely sustainable not only financially, but free from any threat of closure due to poor environmental performance.

India has a huge domestic LAB manufacturing sector consuming approximately 477,000 MT of lead bullion annually. Nevertheless, India imported 43,000 MT of LAB in 2014 with 21,000 MT of non SLI LAB imported from China. Most of these imports are thought to be associated with the solar energy projects and the purchase of long life storage LAB. As for the domestic LAB sector, for reasons explained in the ILZSG report, between 40 and 60% of the lead supplied to the Indian LAB battery industry is sourced from the informal sector. As stated in the ILZSG report Indian legislation does not permit the import of ULAB, unless a special license is obtained and so the vast majority of the ULAB officially listed in the Comtrade data for India will be battery plates. Despite significant exports of LAB to Nepal, Singapore and Sri Lanka, only 2% of Indian domestic LAB production would appear to be exported.

The total exports of LAB from Japan to other countries in Asia would appear to be low at nearly 8,000 MT, but it has to be borne in mind that most of the LAB exported from Japan will be imported by countries outside the region. Despite the large automotive sector in Japan the ULAB recyclers are, by modern standards, small plants for an OECD member and that would explain why Japan had to import over 65,000 MT of LAB from Korea to meet domestic demand.

The ILZSG report outlined the LAB manufacturing and the ULAB recycling situation in the Phlippines and the LAB sector exports nearly 12,500 MT annually, but interestingly the Comtrade data shows that specialist non-SLI LAB are imported, in fact nearly 35,000 MT of these LABs were imported in 2014. As far as can be ascertained from the two ULAB recyclers the growth of the mobile phone industry and other telecommunications companies have been responsible for the imports.

The Comtrade data provide little or no information on LAB exports in Bangladesh, Cambodia, Myanmar, Nepal (although what is available for Nepal was useful) Pakistan and Taiwan.

The ILZSG information lists South Korea as the second largest producer of lead bullion in Asia at about 640,000 MT last year, but the export market to Asian Countries is only 90,000 MT of LAB with the bulk of exports to countries outside of Asia. The main driver for the LAB industry in South Korea is the automobile industry. One thing is clear, however, from the ILZSG data base is that South Korea has sufficient capacity to recycle ULAB and meet the demands of the LAB manufacturing sector.

Annex 2: The ILZSG Primary and Secondary Lead Smelters and Annual Production Data

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1. Introduction to the ILZSG

The International Lead Zinc Study Group (ILZSG) it was formed by the United Nations in 1959 to:

- ensure transparency in the markets for lead and zinc worldwide. This is achieved by producing a continuous flow of information to the market place on supply and demand developments in lead and zinc through the monthly publication of high quality statistics and in depth economic studies.
- provide opportunities for regular intergovernmental consultations on international trade in lead and zinc,
- provide continuous information on the supply and demand position of lead and zinc and its probable development and to make special studies of the world situation in lead and zinc,
- consider possible solutions to any problems or difficulties which are unlikely to be resolved in the ordinary development of world trade.

The Study Group is not an Industry Association and Industry representatives can only attend as invited guests and even then, are excluded from Government only sessions.

2. Global Production of Primary and Secondary Lead

Global Lead Production (Primary and Secondary) – 2010 to 2015

000 tonnes	2010	2011	2012	2013	2014	2015
Pb Production	9871	10634	10596	11107	10918	*11000*

Since 2011 when the global economy began to climb out of the recession, lead bullion and refined lead production has been fairly constant at about 11 MT per annum and the supply has for the most part been in harmony with demand.

The continued growth in vehicle ownership in Asia and the increasing interest in green energy solutions supported by Lead Acid Storage Batteries together with the development of Lead Acid Battery hybrid drive systems means that the Lead Acid Battery market will remain strong for the next five years at least. This in part because there is still no alternative battery chemistry with the necessary cranking power to start the traditional automobile. We even find that in lithium ion all-electric vehicles, they need a Lead Acid Battery to maintain certain 12 volt systems.

3. Used Lead Acid Batteries – Waste and a Commodity

ULAB are classified under the Basel Convention as a hazardous waste and should be recovered, stored, transported and recycled in accordance with the Convention and the Basel Convention Technical Guidelines for the Environmentally Sound Management (ESM) of ULAB.

As the lead production tonnages for primary and secondary lead for each of the Asian Countries are analysed, collated and tabulated, so is the extent of compliance with the Basel Convention, the national legislation for the import and export of ULAB, the presence or otherwise of ULAB recycling plants and their location and capacities.

Whilst ULAB are a Hazardous Waste, they are not treated in the same manner as Mercury based waste materials, because ULAB have an economic value ranging from US$ 5 to US$ 10 depending on the size of the battery and hence the weight of lead in the battery.

Indeed, ULAB are traded globally as a commodity with prices quoted as a percentage of the London Metal Exchange (LME) price. Analysing the secondary lead production data gives an insight into the formal ULAB recycling industries in the various countries in the region.

The fact that ULAB are traded as a commodity has a significant impact on the strategy necessary to ensure the ESM of ULAB.

For a start it is important to know precisely if and where there are environmentally sound and properly licensed ULAB recycling (secondary smelters) plants in a country and in a region.

The environmental control systems required to operate a modern ULAB recycling plant in a safe and hygienic manner are expensive, as much as 30% of the overheads, and so for small nations it is difficult to have a viable ULAB recycling plant and in these cases a regional solution is the only sustainable solution.

However, it has to be borne in mind that the data supplied by the ILZSG are official statistics supplied by the member governments and do not include any of the lead bullion produced or the ULAB plates traded between countries by the informal sector, because the informal sector operate without licenses and do not publish any production or import/export data in order to avoid paying taxes. The issues associated with the informal ULAB recycling sector will be explored in later discussion papers that include an analysis of Lead Acid Battery trade data and the Pure Earth's (Blacksmith Institute) "hot spots" data base for lead contaminated sites.

4. Regional Status Report

The following table is a summary of the analysis of the National lead production data supplied by the ILZSG together with information as to whether the countries in the Asian Region have:

- Ratified the Basel Convention
- Passed into law enabling legislation to enable the government to administer the Basel Convention and apply the rules of the Convention in the manner set out by the Parties and consistent with the Basel Technical Guidelines
- Systems or legislation in place for the ESM of ULAB
- ULAB Recycling Plants that are environmentally sound, or not as the case may be, including both formal and informal sectors
- Provisions for the legitimate export of ULAB under the Basel Convention, including the appropriate use of the Prior Informed Consent (PIC) procedure

- Legislation to either permit or prohibit the import of ULAB for recycling
- Licensed secondary lead plants and the lead production in 000s tons
- Licensed primary lead plants and the lead production in 000s tons
- The total official lead production for each country where applicable

The table should not be read in isolation, but reference should be made to the country reports for each nation that will follow on in the full report.

Data sets are only shown for those countries that are either members of the ILZSG or that have submitted data to the study group or through a third party.

Countries without any lead production data are likely to generate ULAB and so those countries omitted from the table will be included in the LAB trade data and "hot spot" analysis in further discussion papers.

It should be noted that total Chinese lead production is approximately half of the global production and about 80-86% of the production will be used in the manufacture of Lead Acid Batteries.

Country	BC - Ratified	Compliant	ULAB Plant	ESM - ULAB	ULAB Export	ULAB Import	Secondary Pb	Primary Pb	Total Pb MT
Bangladesh	1993	✓	✓	?	✗	✗	?	?	?
Cambodia	2001	✗	✗	N/A	✓	✗	0	0	0
China	1991	✓	✓	✓✗	✗	✗	1531	3173	4704
India	1992	✗	✓	✓✗	✗	✓	348	129	477
Indonesia	1993	✗	✓	✓✗	✗	?	46	0	46
Japan	1993	✓	✓	✓	✓	?	155	87	242
Malaysia	1993	✓	✓	✓	✗	✗	22	5	27
Myanmar	2015	?	✓	?	?	?	2	0	2
Nepal	1996	✗	✗	N/A	✓	✗	0	0	0
Pakistan	1994	?	?	?	?	?	9	0	9
Philippines	1989	✓	✓	✓✗	✗	✓	30	0	30
Singapore	1996	✓	✗	N/A	✓	✗	0	0	0
South Korea	1994	✓	✓	✓ & ?	✗	✓	340	299	639
Sri Lanka	1992	?	✓	?	✗	✗	2	0	2
Taiwan	?	?	✓	?	✗	✗	34	0	34
Thailand	1997	✓	✓	?	✗	✗	92	0	92
Viet Nam	1995	✗	✓	✗	✗	✓	5	0	5

5. Country Status Reports

5.1 Bangladesh

Bangladesh has one significant and registered manufacturer of Lead Acid Batteries (LAB) and that is the Rahimafrooz Banglasesh Ltd. with its LAB manufacturing base and small ULAB recycling plant located in Chittagong. The Company is certified for quality through ISO 9001 and for its environmental management systems through ISO 14001.

Bangladesh does not import ULAB through any mechanism that records the trans-boundary movement.

However, the lack of ULAB import records does not mean that there is no informal ULAB recycling of domestically generated ULAB.

5.2 Cambodia

Cambodia does not have an indigenous LAB manufacturing industry and all LAB, that is for automobiles, industrial and commercial use, are imported from various countries in the region, such as Viet Nam, Thailand, Japan, South Korea and Malaysia. A large percentage of the LAB solar storage batteries in the educational sector are supplied by Germany.

The Basel Secretariat secured funding for a ULAB recycling project in 2003 with the objective of ascertaining how the ULAB in Cambodia are collected and recycled. The project concluded that for the most part the ULAB generated in Cambodia are collected through a network of Vietnamese nationals living in Cambodia and transported through Cambodia and across the border into Viet Nam for recycling.

Although the Cambodian Environment Ministry administered the ULAB project in 2004, to date no Government Institution has been assigned outright responsibility for the ESM of ULAB or ensuring that ULAB exported to Viet Nam comply with the Basel Convention.

However, as part of the project in 2003 the Basel Technical Guidelines were translated into the Khmer Language. Nevertheless, without a National Strategy and the assignment of Ministerial responsibility for the ESM of ULAB nothing is likely to change. So Cambodia should be considering a National strategy that includes the following:

- The assignment of responsibility for the ESM of ULAB to a specific Ministry
- A sustainable and environmentally sound policy and process for the collection and recycling of ULAB generated in Cambodia.
- Adherence to the Basel Convention and the Basel Convention Technical Guidelines
- The introduction of licensing for the collection and recycling of ULAB

5.3 China

With an annual lead consumption of nearly half the global production, it is no surprise that China is the world’s largest manufacturer of LAB. China manufacturers LAB of every description and for all applications, that is, motive power, standby batteries, solar power systems and industrial batteries.

LAB production is to be found mainly in the east of the country with Zhejiang Province producing nearly 30% of domestic production.

Although the full trade data statistics are to be fully analysed, the initial indications are that China does not export LAB in huge quantities, because domestic consumption is so high, and not surprising with over 200 million electric bicycles powered by LAB on the road.

As far as the ULAB recycling industry in China is concerned the Government introduced into Law in 2012 environmental legislation called the "Access Conditions" or "Entry Requirements" that imposed tougher environmental regulations on plant emissions, discharges and working conditions. The new legislation was phased in over a three year period and also imposed proximity limits and capacity requirements on the lead smelter sector. That is, secondary lead smelters, primary or secondary, had to be at least 1 kilometre from population centres and have a minimum capacity of 50,000 tons of lead production per annum.

The new legislation led to the closure of many small operations and some large smelters that were "too close" to populations.

Nevertheless, what is really surprising is that the Zheijang Battery Manufacturers Association and the China Non-ferrous Metals Association (CNIA) estimate that only about 30-40% of the ULAB generated in China are actually recycled through formal licensed smelters.

However, if the locations of the licensed secondary lead smelters in China are plotted on the map, as shown below, it is clear that the majority of the secondary lead plants are located in the north east of the country.

China is a huge country and despite having good road and rail links between the major conurbations, the distances between most of the LAB users in China and the secondary lead smelters are long. So, the further away from the north east of China the ULAB are generated the more costly it is to transport them to the secondary smelters. Indeed, it is also likely that there is a distance where the cost of transport exceeds the margin to recycle the ULAB and make a profit on the sale of the secondary lead bullion. From a strategic point of view consideration should be given to an even distribution of ULAB recycling plants across the country.

Chinese Secondary Lead Plants in Operation

Company	**Location**	**Type**	**Smelter Capacity** (mt)
Anxin Chentai Non-ferrous Metals Smelting	Baoding, Hebei	Secondary	50000
Anyang Jinpeng Lead Industry Co Ltd	Anyang, Henan	Secondary	60000
Anyang Yubei Gold & Lead Co Ltd	Anyang, Henan	Secondary	250000
Baoding Gangan Nonferrous Metals Co	Baoding City, Hebei	Secondary	80000
Guangling Juyuan Silver Ltd	Yangzhou, Jiangsu	Secondary	60000
Hebei Anxin Huacheng Lead Co	Anxin, Hebei	Secondary	50000
Henan Asia Metal Recycling Co Ltd	Xinxiang, Henan	Secondary	86000
Hubei Chukai Metallurgy Co Ltd	Xiangyang, Hubei	Secondary	60000
Hunan Huaxin Nonferrous Metals Co Ltd	Chenzhou, Hunan	Secondary	330000

Jiangsu Chunxing Alloy Co Ltd	Rizhao City, Shandong	Secondary	200000
Jinyang Metallurgical Inc Co Ltd	Gucheng, Hubei	Secondary	150000
Jiyuan Jinli Lead Smelting Industry	Jiyuan City, Henan	Secondary	80000
New Chunxing Resource Recycling Group	Guangdong Province	Secondary	15000
New Chunxing Resource Recycling Group	Tianjin	Secondary	15000
New Chunxing Resource Recycling Group	Xiamen	Secondary	10000
New Chunxing Resource Recycling Group	Xuzhou, Jiangsu	Secondary	160000
Shandong Fangyuan Nonferrous Metals	Dongying, Shandong	Secondary	100000
Shanghai Jingao Chemical Industry	Shanghai	Secondary	12000
Shaoguan Zhongwei Non-ferrous Metal	Shaoguan, Guangdong	Secondary	50000
Shuikoushan Nonferrous Metals Group Co Ltd	Changning, Hunan	Secondary	25000
Taiding Non-ferros Metals Processing	Zhenjiang, Jiangsu	Secondary	50000
Taihe Changjiang Metal Materials	Taihe, Anhui	Secondary	100000
Taihe Dahua Metal Materials	Taihe, Anhui	Secondary	100000
Taihe Huanyu Chemical Co Ltd	Taihe, Anhui	Secondary	100000
Tianjin Toho Lead Recycling Co.	Tianjin	Secondary	
Tianneng Group	Changxing, Zhejiang	Secondary	100000
Tianneng Group	Changxing, Zhejiang	Secondary	60000
Yuguang Gold and Lead Group	Jiyuan, Henan	Secondary	110000
Yunnan Tin Company Group Ltd	Gejiu, Yunnan	Secondary	100000
Zhejiang Huitong Power Co Ltd	Zhejiang	Secondary	100000

Despite the difficulties associated with the percentage of ULAB recycled by the formal sector the fact that many of the smaller secondary lead plants have been closed, means that the government regulators have been able to increase their vigilance, monitoring and inspections of the remaining smelting operations. There is no doubt that China is making a determined effort to raise the environmental standards of its secondary lead sector.

Taiwan has a thriving LAB replacement market, particularly the motorcycle and scooter battery market and recycles all domestically generated ULAB at two licensed secondary lead plants, and they are; the 12,000 tons per annum ACME Metal Enterprise Plant in Taipei, and the 28,000 ton Thye Ming Industrial ULAB recycling plant in Kaochsiung.

5.4 India

The legislation that covers the recovery and recycling of Used Lead Acid Batteries (ULAB) in India comes under the jurisdiction of the Ministry of Environment and Forests and the Battery Management and Handling Rules as amended in 2010. The Battery Rules apply to all persons and businesses that manufacture, sell, buy or use Lead Acid Batteries (LAB) or exchange, collect or recycle ULAB, including those engaged in the auction of ULAB and the consumer that uses a LAB for whatever reason.

The aim of the Battery Rules, as stated by Ok International at the workshop, is to achieve a ULAB recycling rate of 90% against sales of new LAB through retailers.

Retailers of LAB must be registered with their respective State Pollution Control Boards and be authorised to sell LAB. Such retailers are required to submit records that show the number of LAB sold and the number of ULAB collected in exchange for a discount against the sale of a replacement LAB. The retailer’s target is 90% of sales to be recovered as ULAB and then, for the ULAB to be sent to an authorised or licensed lead smelter for recycling.

Responsibility for the implementation of the Battery Rules rests with the respective State Pollution Control Boards (SPCB) and their inspectors. Twice a year the State Pollution Control Boards will collect LAB sales and ULAB return data from the authorised ULAB collectors and once a year this data is collated, summarized and sent to the Central Pollution Control Board in New Delhi.

The State Pollution Control Boards are also responsible for issuing the authorisations (licenses) to retailers for LAB Sales and ULAB Collection and Recycling.

So LAB sales and ULAB recycling data is collated in every Indian State and submitted to the CPCB. In turn the CPCB prepare national statistics for ULAB recycling. For the most part, despite what the Industry say about the collection rates and the amount of scrap going to the informal sector or, as it is known in India, the unorganised sector, official statistics for ULAB recycling rates will be quite high and might even approach the 90% target in some States.

But the Unorganised Sector is still active and producing significant tonnages of lead bullion ever year. The India Lead Zinc Development Association estimates that the figure maybe even as high as 30% of total lead production in India. What is consistent through India is the fact that the best smelters cannot get sufficient supplies of ULAB to run at capacity. A shortage of ULAB supplies is an indicator of too many smelters, and it is most likely that they are the informal smelters.

Nevertheless, the key question here is, “Why are significant quantities of ULAB finding their way into the hands of the “unorganised” sector when seemingly the SPCB and the ULAB collectors are all doing their jobs correctly and statistics submitted to the Government point towards high recycling rates.

The first point to note is that the 90% recycling rate target is based on replacement Lead Acid Battery and retail sales only.

Lead Acid Batteries in new vehicles, that is, cars, trucks, buses and so on are not included in the initial sales statistics. This omission has a dramatic effect on the recycling rate calculations and this will be explained in the commentary below.

Another factor that has a major impact on the calculation of recycling rates is the life of the LAB. And it is actually unknown and varies by use, maintenance and location!! A Lead Acid Battery in India might have a life somewhere between 12 and 24 months, but it is an unknown factor.

Now, the fact is that ULAB are not distributed evenly over the country and so it is likely that in certain states the surplus of ULAB could be well above the 90% target and some below……… Vehicles move and with them LAB.

So, what happens to the surplus? Are they sold to the Formal and Authorised Sector? Are they sold to the Unorganised or Informal and unauthorised sector? The ILZDA’s members will state that the answer is to the “Unorganised Sector”.

The fact that the States and the Central Government can produce statistics that show that the current rules are returning 90% of ULAB to the formal sector means that at local and national level there is little official evidence to warrant any change in the way that ULAB are recovered and recycled in India.

The Battery Rules also make provision for the sale of a LAB to be discounted if a ULAB is offered in exchange, but the Rules do not specify the amount of the discount. Certain manufacturers, such as Exide, offer discounts of up to 1,000 INR (US$ 16), depending on the type of Lead Acid Battery purchased.

However, there are no data to determine how much the price of a new LAB should be discounted to ensure that ALL the ULAB are returned to the authorised retailers and smelters. What’s more, there does not appear to be any provision to ensure that discounts offered by retailers are only refunded on the number of ULAB sent to the licensed smelters.

There are 44 secondary lead smelters licensed to operate in India with widespread coverage of the country.

However, there is no location information for any of the informal operations.

Indian Secondary Lead Plants in Operation

Company	Location	Type	Smelter Capacity (mt)
A.I. Metals Pvt Ltd	Bhiwadi, Rajasthan	Secondary	17000
Aman Enterprises	Indore, Madhya Pradesh	Secondary	7000

Arya Alloys P Ltd	Bhiwadi, Rajasthan	Secondary	7000
Associated Pigments Ltd.	Panskura, West Bengal	Secondary	63000
Bhagwati Industries	Hissar, Haryana	Secondary	10000
Bindal Smelting Pvt Ltd	Noida, Uttar Pradesh	Secondary	15000
Deshmukh Lead Pvt Ltd	Thane, Maharashtra	Secondary	8000
Ganpati Metals	Indore, Madhya Pradesh	Secondary	5000
Gold Star Battery Ltd	Jamnagar, Gujarat	Secondary	6000
Gravita India Ltd	Jaipur, Rajasthan	Secondary	25000
Gupta Metal Works	Ghaziabed, Uttar Pradesh	Secondary	15000
Harsh Metal Industries	Nanpur, Madhya Pradesh	Secondary	6000
HBL Power Systems Ltd	Nandigama, Andhra Pradesh	Secondary	12000
HBL Power Systems Ltd	Vizayanagaram, Andhra Pradesh	Secondary	11000
Jarsons Metal	Thane, Maharashtra	Secondary	6000
Jayvel Enterprise	Kolar, Karnataka	Secondary	6000
Kavita Overseas Pvt Ltd	Ghaziabad, Uttar Pradesh	Secondary	14000
KMR Metal Mart	Coimbatore, Tamil Nadu	Secondary	7000
Kothari Metallurgical Exports Pvt. Ltd	Thane, Maharashtra	Secondary	7000
Lavanya Sponge Iron Pvt Ltd	Ghaziabad, Uttar Pradesh	Secondary	6000
Leadage Alloys India Ltd	Kolar, Karnataka	Secondary	24000
Lohia Metals Pvt Ltd	Kancheeipuram, Tamil Nadu	Secondary	10000
Met Trade India Ltd	Plant 1 - Kathua, Jammu	Secondary	45000
Met Trade India Ltd	Plant 2 - Dadri, Uttar Pradesh	Secondary	60000
Mittal Pigments Pvt Ltd	Rajasthan	Secondary	17500
National Steel and Agro Industries	Sejwaya, Madhya Pradesh	Secondary	11000

Ltd.			
Neha Industries	Indore, Madhya Pradesh	Secondary	6000
Nile Limited	Chittor, Rajasthan	Secondary	24000
Nile Limited	Nalgonda, Andhra Pradesh	Secondary	9000
Pondy Oxides & Chemicals Ltd	Kancheepuram, Tamil Nadu	Secondary	29000
Puransons Alloys Pvt Ltd	Bhiwadi, Rajasthan	Secondary	16000
Rahul Metal Industries	Alwar, Rajasthan	Secondary	6000
Raj Finoxides Pvt Ltd	Kharial, West Bengal	Secondary	8000
Rohini Metal Alloys	Kolhapur, Maharashtra	Secondary	6000
Sandeep Lead Alloys	Kolar, Karnataka	Secondary	18000
Shivalik Metalloys Pvt Ltd	Chopanki, Rajasthan	Secondary	10500
Shree Charbhuja Engineers Pvt Ltd	Sanwar, Rajasthan	Secondary	11000
Sterling Lead Pvt Ltd	Kolhapur, Maharashtra	Secondary	7000
Sumetco Alloys Pvt Ltd	Bhiwadi, Rajasthan	Secondary	7000
Tandon Metal Pvt. Ltd	Pune, Maharashtra	Secondary	24000
Trans Asia Metals	Bhiwadi, Rajasthan	Secondary	9000
Universal Lead Alloys	Vellore, Tamil Nadu	Secondary	7000
Varun Enterprises	Indore, Madhya Pradesh	Secondary	11000
Veera Narayana Metal Alloys	Ramanagara, Karnataka	Secondary	18000

It should also be noted that Indian legislation permits the import of ULAB plates, but prohibits the import of whole ULAB complete with electrolyte. This method of importing battery scrap does not conform to the practice outlined in the Basel Technical Guidelines and effectively means that there is a strong possibility that the battery electrolyte is drained into the environment when the ULAB is broken in the country of export. Currently India is importing ULAB plates from East and West Africa and the Middle East.

Until recently the State Licensing procedure for the formal authorisation for a secondary lead plant to recycle ULAB was an administrative task. Inspection of the ULAB recycling plant by the regulators was the exception and not the normal practice. However, the states of Tamil Nadu and Karnataka have recently trained their inspectors to carry out site assessments for the ESM of ULAB as part of the licensing process.

5.5 Indonesia

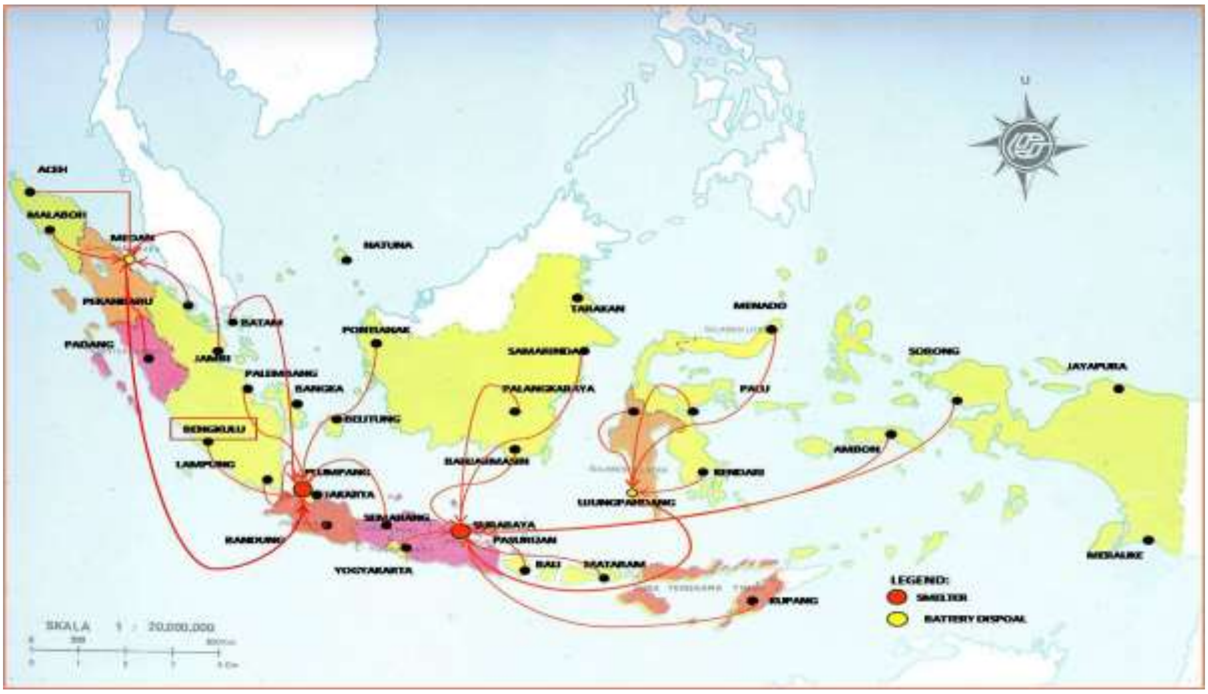
During the Osaka workshop Ms. Qurie Purnamasari, the Indonesian Government Director for Hazardous Waste Contaminated Sites and Emergency Responses stated that despite the phasing out of leaded gasoline in Indonesia in 2001 there were still sources of environmental lead contamination and population exposure, particularly from the "informal" ULAB recycling sector. The evidence for this source of lead contamination comes from the Toxic Sites Identification Program (TSIP) database that identified 70 lead pollution hotspots in and around the Jakarta municipality caused by the poor recovery and recycling practices of backyard recyclers of ULAB.

In view of the environmental and health threats posed by the illicit recovery and recycling practices of the "informal" sector, there is an urgent need to improve the environmental performance of ULAB recovery and recycling in Indonesia and reduce the risk of population exposure in vulnerable communities that are exposed to the "backyard" recycling of used lead acid batteries (ULAB).

However, in certain "hot spots" it was not possible to determine whether the source of the lead contamination was from a formal and licensed secondary lead plant or an "informal" operation, because in certain locations formal and licensed recycling plants were operating in close proximity to illicit and informal operations.

However, with the assistance of the Pure Earth (Blacksmith Institute) and a local NGO, the "***Komite Penghapusan Bensin Bertimbel" or KPBB (the Indonesian Lead Information Center) the Government now has a clear picture of the movement of ULAB and where the majority of the ULAB were being recycled.***

The import of ULAB into Indonesia was banned in 2002 and so the following chart of ULAB movements in Indonesia is simply the movement between the Islands and on the Islands.



Schematic showing the movement of ULAB from collection to recycling

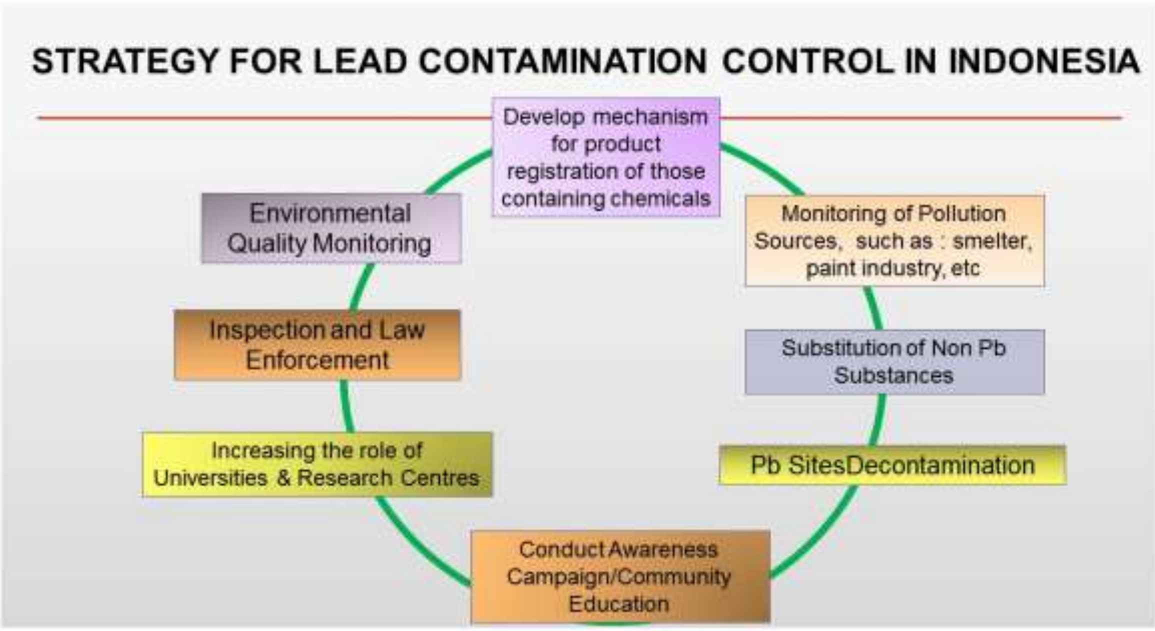
During the course of the investigation into the ESM of ULAB recycling in Indonesia the Environment Ministry had identified at least two smelting operations that were fully licensed and seemingly environmentally sound and located just outside of Jakarta, namely PT Muhtomas and PT. Non Rerindo Utama.

PT Muhtomas is a fully licensed secondary lead plant authorised by the Ministry of the Environment to recycle ULAB. The plant is a two furnace operation with a production capacity of 36,000 tons of lead per annum, but for the past three years has operated at about 50% of capacity due the difficulties in competing on price with the informal sector for ULAB. As far as the company is concerned any strategy for the ESM of ULAB that takes ULAB out of the informal sector, thereby increasing the availability of ULAB to the formal sector is most welcome.

PT. Non Rerindo Utama was founded in 1986 and is licensed by the Government of Indonesia as a secondary lead plant authorised by the Ministries of the Environment and Health to recycle ULAB. The PT Non Ferindo Utama plant has all the facilities and ancillary equipment to recycle about 50,000 tons of ULAB in a safe and environmentally sound manner annually.

Despite the request by these ULAB recyclers to reduce the participation of the informal recyclers, consideration should be made to how to integrate the informal sector into ULAB management activities in an environmentally sound manner (e.g. ESM collection).

In cooperation with the stakeholders, and that includes the local municipal authorities, the formal recycling sector and NGOs, the Government has put together a strategy for Lead Contamination Control in Indonesia, with a strong impact on ULAB management and recycling.



- The first requirement will be to develop a registration data base for products containing chemicals, and especially toxic substances, such as lead.
- Set up a monitoring regime to inspect potential sources of lead pollution
- To consider the use of non-lead based substitutes where possible.
- To initiate a program to decontaminate those sites contaminated with lead as a result of the improper recycling of ULAB.

- To build educational and technical capacity of government agencies and national stakeholders in the selected countries to take concrete action to minimize the adverse effects of lead on human health and the environment from lead in paint and unsafe ULAB recycling, including remediation. This would also require the publication of guidelines for the ESM of ULAB.
- To increase the role and participation of the universities, which may strengthen their participation in the delivery of the ESM for ULAB recycling
- To strengthen the regulatory agencies in terms the enforcement of ESM practices and standards.
- To provide a monitoring network to ensure environmental protection.

Of particular importance in local communities is the need to better understand the lead exposure pathways and the scope of contamination from lead due to lead in paint and the unsafe ULAB recycling practices by the informal recyclers, their impacts on human health, and feasible solutions to mitigate the exposure risks, especially the need to ensure that ULAB are not sold to any informal sector operators for recycling, unless there is a way to guarantee that they are properly trained for a proper collection and can provide assurances that the ULAB will be channelled to ESM ULAB recyclers.

The timing of the Osaka workshop was most convenient for the Indonesian delegation, because the Environment Ministries were currently in the process of preparing written Guidelines for the ESM of ULAB.

Unfortunately, although the Basel Technical Guidelines were adopted by the Indonesian Government in 2002, they were never translated into any of the Indonesian languages and so now, in 2015, the Government decided to prepare a set of Guidelines in at least one of the Indonesian Languages, albeit based on the Basel Technical Guidelines.

An intervention from the Director of the BCRC-CAM informed the Indonesian Delegation that the Basel Technical Guidelines for the ESM of ULAB had recently been informally revised and updated and the request to initiate the formal review process should have been presented to the COP earlier in the year, but regrettably the government which showed initial interest to lead the review process did not confirm its interest and the BCRC-CAM was now looking for a new sponsor.

The Director agreed to pass onto the Indonesian Delegation the final informal draft of the revised Guidelines to be considered as the basis for the governments initiative to prepare guidelines for Indonesia, in return for the delegates consideration of sponsoring the introduction of the revised guidelines to the next COP.

The Indonesian delegation welcomed the exchange of technical information and without making any commitments about the sponsorship of the revised guidelines, they assured the BCRC-CAM team that full consideration would be given to the request provided there was no cost to the promotion.

A full copy of the final draft of the informally revised Technical Guidelines has been sent to the Indonesian Delegation.

The Indonesian Delegation expressed special interest in the following content presented at the Osaka workshop:

i) the mitigation strategies and processes outlined by the ILA Delegate for minimising or eliminating the adverse environmental and health impacts caused by improper ULAB recovery and recycling and the cost effective processes for reducing fuel consumption during smelting and the virtual elimination of furnace residues.

ii) the 10 step model regional strategy developed and implemented in central America.

iii) the ESM and cleaner production framework applied in the Acumuladores Iberia Guatemalan ULAB recycling facility.

iv) the benchmark methodology to facilitate a quick assessment by government officials on ULAB recycling complying with ESM,

v) the Green Lead Award scheme as a tool to assess compliance with ESM in detail,

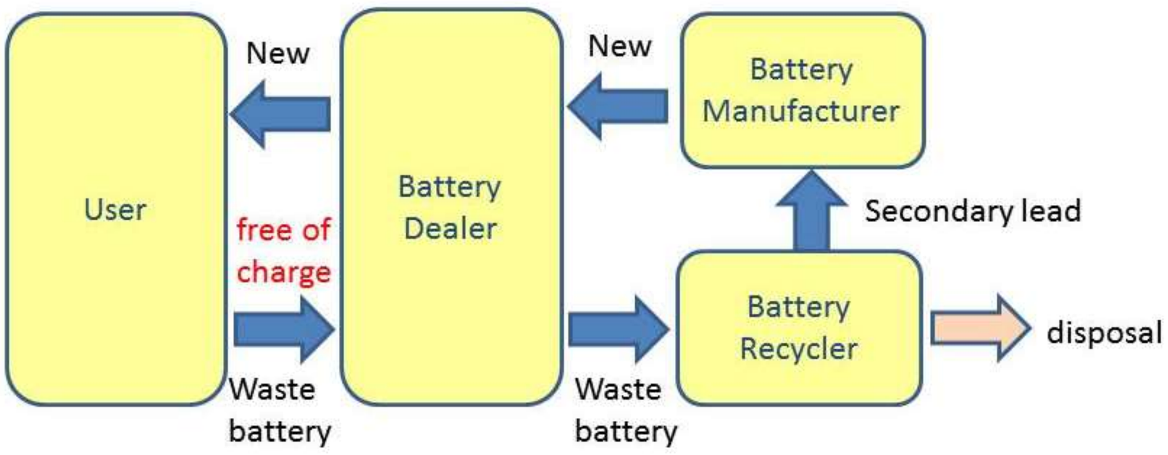
The Director of the BCRC-CAM agreed to follow on these topics with a view to developing a project to facilitate a technology transfer.

As a first step the Director of the BCRC-CAM agreed to contact the Head of the BCRC-SEA in Jakarta and set up an appropriate process towards developing a suitable project proposal to work with the Government of Indonesia to assist with the ESM of ULAB, based on a South-South Technical Cooperation Agreement which is in the process of being formalized between BCRC-CAM and BCRC-SEA.

5.6 Japan

Dr. Arata Abe from Yamaguchi University explained that in Japan the recovery and recycling of ULAB was environmentally sound, but the recycling sector was experiencing problems, although the issues were not related to environmental or health issues.

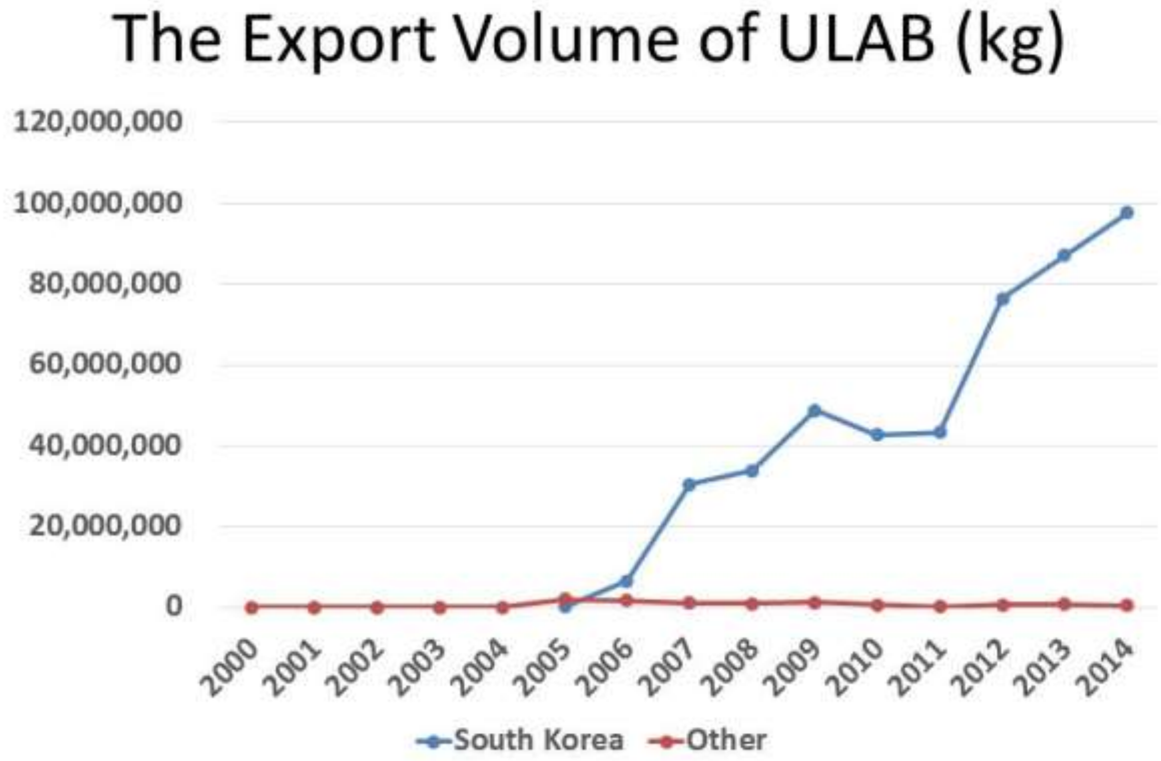
Beginning with the recovery of ULAB Japan has a recycling system in which the lead acid battery manufacturers are involved and support. The voluntary ULAB recovery system was established in 1994 and updated in 2014. Essentially, the recovery system is a type of "deposit refund" or "take back", and so for every replacement LAB sold, a retailer will collect the ULAB and send it to a licensed and environmentally sound recycler. The initial scheme also required LAB manufacturers to use a certain minimum percentage of secondary lead in new LAB.



However, whilst the ULAB recovery scheme did ensure that ULAB were collected and recycled, the scheme did not deliver the expected benefits to the Japanese LAB industry.

Japan does not prohibit the export of ULAB and in the period from about 2000 to 2005, more and more ULAB were exported to Viet Nam and Hong Kong for recycling leaving the Japanese recyclers short of feedstock and the LAB industry having to import refined lead to maintain production. In more recent years large quantities of ULAB are being exported for recycling in South Korea, much to the annoyance of the Japanese lead industry.

Now, whilst there is no suggestion that the ULAB exported to the Republic of Korea are not recycled in an environmentally sound manner, there has been increasing evidence from investigations undertaken by OK International and Pure Earth (the Blacksmith Institute) that ULAB recycling in Viet Nam is not environmentally sound and that populations and workers have been exposed to lead emissions from the smelters. Scrutiny into the environmentally sound management of ULAB in the Prior Informed Consent (PIC) procedure is a possible way to address the environmental and resource concerns.



Source: Ministry of Finance, Japan. Statistical Code: '854810000' (ULAB) [12]

As for the capacity of the Japanese secondary lead industry to recycle all the ULAB generated in Japan, there is no question that Japan has ample smelting capacity with 22 secondary lead plants. Furthermore, the smelters are distributed throughout the country, including the south where most of the ULAB exported to South Korea are generated.

By modern standards, the secondary lead plants in Japan are small, but that does not mean they are unprofitable, nevertheless the margins will be tighter.

Company	Location	Type	Smelter Capacity
Adachi Kinzoku Co.Ltd.	Yashio-shi, Saitama	Secondary	5000
Daiseki MCR Co.,Ltd	Utsunomiya-shi, Tochigi	Secondary	5000
Daishin Sangyo Co.Ltd.	Kita Kyushu-shi	Secondary	5000
Eiwa Kinzoku Co.Ltd.	Iwatsuki-shi, Saitama	Secondary	8000
Furuya Kinzoku Kogyosho Co. Ltd.	Hatogaya-shi, Saitama	Secondary	3000

Hayashi Metal Industries Co. Ltd.	Sakai-shi, Osaka	Secondary	4000
Honaga Kinzoku Seirensho Ltd.	Sashima-gun, Ibaragi	Secondary	2000
Hosokura Smelting Co. Ltd.	Hosokura, Miyagi	Secondary	29000
Ichikawa Refinery Corporation	Ichikawa-shi, Chiba	Secondary	20000
Kamioka Mining & Smelting Co. Ltd. (Mitsui)	Kamioka, Gifu	Secondary	32000
Kawasho Co. Ltd.	Asaka-shi, Saitama	Secondary	3000
Kosaka Smelting & Refining Co Ltd (Dowa)	Kosaka, Akita	Secondary	15000
Kyoto Refining Works Co. Ltd.	Kameoka-shi, Kyoto	Secondary	10000
Misaki Sangyo Co. Ltd.	Gotenba-shi, Shizuoka	Secondary	5000
Mitsui Mining & Smelting Co. Ltd.	Takehara, Hiroshima	Secondary	18000
Nichiden Kogyo Co. Ltd.	Tomakomai-shi, Hokkaido	Secondary	1000
Nihonkai Refining Co. Ltd.	Maizuru-shi, Kyoto	Secondary	14000
Osaka Namari-suzu Seirensho Co. Ltd	Amagasaki-shi, Hyogo	Secondary	20000
Tanada Shokai Co. Ltd.	Yashio-shi, Saitama	Secondary	3000
Tokai Press Co. Ltd.	Yatomi-machi, Aichi	Secondary	12000
Tokyo Namari Co. Ltd.	Sumida-ku, Tokyo	Secondary	1000
Tomatsu Metallurgical Corporation	Kariya-shi, Aichi	Secondary	20000

5.7 Malaysia

The Government of Malaysia does not permit the import of ULAB, despite the fact that Lead Concentrate can be imported for primary smelting in order to meet the domestic demand by its LAB manufacturing industry for lead bullion. Such national legislation takes precedence over the Basel Convention, but it is surprising that Lead Concentrate, with a lead content of over 60 % normally, and in bulk granular form, can be imported for smelting, but ULAB that are sealed in accordance with the Basel Convention Technical Guidelines cannot be imported for recycling.

There is only one formally licensed secondary lead smelter in Malaysia, that is, the 70,000 ton capacity Metal Reclamation (Industries) Sdn. Bhd. at Indah, close to the capital, Kuala Lumpur. The Metal Reclamation smelter can recycle all the ULAB that are generated in Malaysia and also has a smelting technology that can also process lead concentrate.

There is an effective recovery scheme for ULAB based on a take back scheme for LAB sales.

5.8 Myanmar

To date there is only one registered ULAB recycler in Myanmar, but it is likely that there is a thriving informal sector. The main problem is the dearth of information about ULAB recycling. Myanmar has been in relative isolation for so long that LAB and UAB statistics are not easy to find and it looks as if Myanmar is a country in need of a study into the use of LAB and the recycling of ULAB.

5.9 Nepal

Although Nepal is a Party to the Basel Convention, the national legislature has never introduced the enabling legislation for the official administration of the Convention. The Ministry of the Environment is nominally responsible for Basel Convention matters, but is not involved in the trans-boundary movement of any hazardous waste.

In 2011 the Government commissioned the Alternative Energy Promotion Centre (AEPC) to set up an expert mission to examine the state of the processing of ULAB. This study was promoted by two factors, firstly Nepal does not have any formal ULAB recycling plants and secondly AEPC had successfully installed just over 200,000 solar power systems in remote areas, with every one using a lead acid battery as the energy storage medium.

The study identified and comprehensive network of about 300 registered and licensed ULAB collectors and scrap dealers. All the ULAB collected in Nepal are exported to India for recycling. The Government are aware of the fact that the trade with India does not conform to the Basel Convention and have recently commissioned another study with the aim of assisting the Government to set up a ULAB recycling plant in Nepal.

In support of the drive to improve the environmentally sound recycling of ULAB the Government have also within the past year brought into law the Lead Acid Batteries Management Regulations, and these regulations set out the basic principles for the ESM of ULAB. The Regulations apply to every LAB manufacturer, recycler, importer, dealer, retailer, transporter, auctioneer of ULAB, and the users of LAB that are involved in the manufacture, processing, sale, distribution, purchasing and use of LAB.

The recent and ongoing border issues with India and the fuel embargo have exacerbated the situation because ULAB are no longer being traded and there are hundreds of tons of ULAB sitting in warehouses in Nepal waiting to be transported to India.

Three LAB manufacturers in Nepal have expressed an interest in setting up a recycling plant adjacent to their LAB manufacturing plant and are currently assessing the economics to ascertain the viability of such an investment based on the latest estimates of LAB consumption reaching 20,000 tons by 2020.

5.10 Pakistan

Very little is known about ULAB recycling in Pakistan and the existence of the 20,000 ton Atlas Metals recycling plant in Landhi, near Karachi, because the owner attends external conferences and keeps the ILZSG up to date with annual throughput.

5.11 The Republic of the Philippines

The Philippines has a number of large scale Japanese motor vehicle assembly plants on the main Island of Luzon. Essential to the presence of these plants is the requirement of the Japanese to use a percentage of locally produced components, one of which is the Lead Acid Battery (SLI – Starter, Lighting and Ignition), hence the reason for the large and thriving automotive battery manufacturing industry currently dominated by the RAMCAR Group and its subsidiary, the Motorlite Battery Company (previously known as Philippine Recyclers Inc. or PRI). Part of the same group of companies Evergreen Recyclers which is basically a secondary lead operation charged with the responsibility of maintaining a constant supply of refined lead to the battery manufacturing plant.

The Philippines does not have any lead bearing mines and many of the vehicles assembled in the Philippines are exported complete with an SLI LAB. As a result there is a chronic shortage of lead bullion, so acute that even if all the ULAB generated in the 7,000 islands of the Republic were collected and recycled, there would still be a shortfall of lead bullion according to Motorlite Batteries. For this reason as and when ULAB are purchased abroad the Government do permit the import subject to compliance with the Basel Convention.

Evergreen has a capacity of about 30,000 tons per annum is ISO 14001 certified for the Company's Environmental Management Systems and the operation is located close to the capital, Manila.

In 2015 a new company, EcoGlobal, with a capacity of about 15,000 tons of lead production per annum and also located close to Manila, started to recycle ULAB in an environmentally sound manner. EcoGlobal is fully licensed and a member of the International Lead Association.

Nevertheless, the presence of EcoGlobal and Evergreen has not eliminated the informal recyclers working in the backstreets of Manila, such as Tondo. In the absence of environmental controls these backyard operations can offer high prices for ULAB and outbid the two formal operations.

ULAB collection in an environmentally sound manner is also hampered by the current legislation that prevent the shipment from one island to another of ULAB filled with battery electrolyte, but provision for the safe disposal of the discarded electrolyte is not made.

As for the imported drained ULAB, provision can be made under the Basel Convention's Prior Informed Consent procedure to ensure that the ULAB are collected, packaged and transported in accordance with the BTG, but such a requirement would need an ESM Assessment prior to export and at present no such undertakings are made.

Scheduled to commence in 2016, the Philippine Government have secured funds from the Global Environment Fund (GEF) that will enable the Department for the Environment and Natural Resources (DENR) to embark on a project to raise the standards for the ESM of ULAB, including the introduction of polices to eliminate or formalise the illegal recycling of ULAB.

5.12 Singapore

Singapore collects all the ULAB generated in the republic on a take back scheme and exports the ULAB in accordance with the Basel Convention to a country, and not always the same country, that has environmentally sound recycling facilities for ULAB.

Whilst from a geographical perspective it would seem that the best option for Singapore would be to export the ULAB to Malaysia, Malaysia does not permit the import of ULAB and so, on occasions, Singapore will export its ULAB to countries as far away as Australia.

5.13 Republic of Korea

Republic of Korea (ROK) is the second largest producer of lead bullion in Asia with annual output of 640,000 tons. Among them, 300,000 tons is primary production from Korea Zinc Smelter at Onsan in

Kyoungnam Province and 340,000 tones is secondary production by seven ULAB recycling plants (From ILZSG group data, 2014. See 18 & 22 page).

The secondary lead production increase by three times from 2007 due to increase of demand in exporting automobile's battery, while the primary lead production is same during years. Percentages of the secondary lead production in ROK are larger than the primary production and most recycled lead comes from ULAB, with the remainder coming from lead scraps, cable sheathings and other wastes. Recycling of ULAB is essential element in sustainable development if it is conducted in environmentally sound manners.

Republic of Korea imports 372,114 tons of ULAB from various countries in 2014 (From Ministry of Environment of ROK, www.allbaro.or.kr). Import of ULAB is permitted only licensed collectors according to Prior Informed Consent (PIC) procedure by the Basel Convention and the national law, 'Waste Management Act'. All imported ULAB must be registered through allbaro system, the online waste management system by importers. Imports and exports of ULAB are also monitored and inspected using online UNI-PASS system by Korean Customers Service. ULABs are imported without any disassemble according to the Basel Technical Guidelines. Secondary lead refineries which receive the ULABs also must register detailed information on ULAB through the system within 2 days of receipt. On-site inspection of ULAB importers and recyclers are undertaken by Regional office of Ministry of Environment according to the 'Waste Management Act' annually.

All secondary lead refineries conduct drainage of sulfuric acid prior to battery breaking. Recovered sulfuric acid and plastics are sent to appropriate recyclers for sale. National Environmental Research Institute of ROK conducted mass balance studies of major emission facilities of Lead & Cadmium in 2012-2014. Four major secondary refineries, which produced 70% of secondary lead in ROK, were investigated in 2013 and lead concentrations of all inputs and outputs from the facilities were analyzed to calculate mass balances of lead. The results showed that lead emission to air from 4 refineries was only 14.2 kg/year and outflow to water stream was 21.0 kg/year, which implied that recycling of ULAB in ROK are managed environmental soundly.

Company	Location	Type	Smelter Capacity (mt)
Dansuk Industrial Co Ltd	Siheung city	Secondary	60000
Joong-il Metals Inc.	Ansan, Kyungki Prov.	Secondary	32000
Korea Zinc Co. Ltd	Onsan, Kyonugnam Prov.	Secondary	50000
Korea Zinc Co. Ltd	Onsan, Kyonugnam Prov.	Secondary	15000
Korea Zinc Co. Ltd	Onsan, Kyonugnam Prov.	Secondary	15000
Sangshin Metal Co Ltd	Ansan, Kyungki Prov.	Secondary	30000
Wha Chang Ltd	Haman-gun	Secondary	45000

5.14 Sri Lanka

As far as can be ascertained, the government of Sri Lanka does not permit the import of ULAB, but the government has licensed two companies, namely the 10,000 ton per annum Navam Lanka plant in Mirigama and the 2,000 ton per annum Associated Battery Manufacturers plant at Ratmalana.

The Associated Battery Manufacturers plant at Ratmalana is part of an integrated operation, because the company is also the biggest producer of LAB in Sri Lanka.

There is little information available on the state of environmental management of ether plant, but both smelting companies are part of larger multi-national Indian companies, that is Gravita and Exide respectively.

5.15 Thailand

The Government of Thailand does not permit the import of ULAB and domestically generated ULAB are recycled by seven secondary lead smelters strategically located around the country.

All the smelters are licensed by the government to recycle ULAB, but there is no information about their current level of performance, or the rate of ULAB recycling

Company	**Location**	**Type**	***Refinery Capacity-mt***
Bergsoe Metals Co Ltd	Saruburi	Secondary	50000
Kimlee Ltd. Partnership	Rayong	Secondary	1000
Liang Huat Ltd. Partnership	Samut Prakarn	Secondary	6000
Lou Thaicharoen	Ratchaburi	Secondary	1000
Thai Non-Ferrous Co	Chachengsao	Secondary	30000
Thai-China Non-Ferrous Metals	Hakhon Sawan	Secondary	20000
TK Metal Trading Ltd	Nakhonpathom	Secondary	6000

5.16 Viet Nam

In January 2009 the International Finance Corporation (IFC) engaged AWMC Pty Ltd to complete a study of ULAB recycling in Viet Nam and to assess, where possible the recycling practices with a view to determining whether they are environmentally sound.

Viet Nam is a planned economy and as such the government has designated certain villages or communes to recycle ULAB. Communes do not compete with each other and there are significant distances between communes that recycle ULAB. Neighbouring villages or communes might recycle aluminium or copper and so on.

The recycling plants in many instances are located in the backyards of homes, and look like informal operations, but they are not. All these ULAB recyclers are authorised to operate by the relevant local Government Environmental Agency.

Some of the smelting technologies employed are very old, some even dating back to 400 BC (YES 400 BC). Not surprisingly, the 2009 study recommended the introduction of a new generation of lead smelters to raise environmental performance.

As further confirmation of the detrimental effects of the use of crude and environmentally unsound recycling methods, Pure Earth (the Blacksmith Institute) has confirmed high levels of population exposures in those communes recycling ULAB.

Having noted the detrimental impacts of the currently state of ULAB recycling in Viet Nam, it is also important to understand the social reasons for these Craft Villages. One of the fundamental reasons the State Government set up the “Craft Village” communes was to make sure that there was meaningful employment opportunities for everyone in Viet Nam. So any plant upgrade needs to be in line with increased output so that employees are redeployed within the operation and not displaced. Without this social dimension any plans to improve the operations at the recycling plants will be rejected by the local commune, and the commune basically consists of the workers and their families and they are unlikely to vote themselves out of a job.

It is also true that because labour rates in Viet Nam are much lower than the rest of the world, manual battery breaking, the “dressing” of the furnace ceramics and the daily rebuilding of the furnaces are economic, but this will not always be the case.

ANNEX 3: Pure Earth's (the Blacksmith Institute) "Hot Spot" data analysis for lead contamination.

Prepared by: Brain Wilson, International Lead Management Centre

Pure Earth is an international non-profit organization dedicated to solving pollution problems in low and middle income countries, where human health is at risk. Since its inception in 1999, Pure Earth has completed more than 50 toxic clean-up projects in 21 countries.

The priority for the staff at Pure Earth is to focus their work in locations throughout the developing world where human health is most affected by pollution problems. Programs typically involve a multi-step process of:

- Identifying polluted places in the developing world:
- Assessing the health risks posed at those locations:
- Designing and implementing a remediation strategy tailored to the specifics of the site in question.

As part of the Pure Earth's global strategy for the elimination or remediation of all polluted places, a data base has been compiled for every continent that listed all the contaminated sites in every country with details of the type of toxin and the extent of the detrimental health effects wherever possible.

In the case of lead pollution Pure Earth has identified two main sources of contamination, namely artisanal gold mining and improper ULAB recycling.

As far as the improper recycling of ULAB is concerned, there are two categories. The first is the so called "legacy site", where licensed ULAB recycling has been in operation, but during a period when there was little or no legislation to control the levels of pollution and the site has since been abandoned, but left in such a contaminated state that local population are exposed to lead dusts.

The second category is where Pure Earth has found unacceptable levels of lead pollution caused by current and ongoing environmentally unfriendly ULAB recycling caused by informal and sometimes formal operations.

In the case of those contaminated sites where there is no record of any licensing, then it is not an unreasonable assumption to make that informal ULAB recycling has been in operation either at or very close to the contaminated area.

Since the sources of supplies of ULAB to the informal sector do not appear in any official government records, the fact that the likely sites of informal activity can be identified as a lead "Hot Spot" does provide a valuable insight into ULAB supply chains that would otherwise be hidden from the statistical analysis.

Furthermore, it is the informal and illicit ULAB recycling operations that are invariably the main causes of lead pollution and population exposure. Consequently, identifying informal ULAB recycling locations also identifies the sites that are in most need of attention for either remediation, medical assessments and intervention by the appropriate national or provisional government to change the mode of operation and formalise the recycling process to conform to internationally recognized standards of environmental control, occupational health and safety.

The chart below lists the places where informal ULAB recycling has been observed by Pure Earth staff and samples taken at the locations have shown high levels of lead contamination. The map plots the locations of the informal ULAB recycling sites across the Asian Region.

ULAB recycling plants that are registered with the national or municipal authorities are not listed in the chart or shown on the map. This does not mean that the licensed recycling plants are environmentally sound, but there is no data or evidence available to date to suggest otherwise.

It should also be noted that it is unlikely that the chart lists all the informal ULAB recyclers because by their nature, that is, they are illegal operations and consequently keep a low profile to avoid government inspectors and are therefore difficult to locate in many instances.

Nevertheless, what is clear is that there is a thriving informal sector operating in Indonesia and the Philippines.

Country	Location of hot spots
Bangladesh	Khulna; Tongi
Cambodia	Sihanouk Province
China	Meishan
India	Haryana; Morinda; Bhiwadi; Kolkata
Indonesia	Cinangka; Pasuruan; Jawa Barat; Tangerang; Dadap; Toyogiri; Kelapa Gading; Klapanunggal; Jababeka; Rawa Buaya
Japan	-
Malaysia	-
Myanmar	Pyay; Shwe Pyi
Nepal	-
Pakistan	Wakeel
Philippines	San Simon; Caloocan City; Labuin, Sta. Cruz, Laguna; Velasquez, Tondo, Manila; Davao City; San Simon, Pampanga; Bacolod City
Singapore	-
Rep. of Korea	-
Sri Lanka	-
Thailand	-
Viet Nam	Dong Mai; Chi Dao

Data used to compile the chart and the map of Lead "Hot Spots" was obtained through Pure Earth (the Blacksmith Institute) from the Global Alliance on Health and Pollution - Toxic Sites Identification Program – Identification Data Base.

ANNEX 4: Health impact of the recycling and disposal of used lead acid batteries

Prepared by:

Bernice Schaddelee-Scholten, Consultant

Joanna Tempowski, Scientist

World Health Organization

Introduction

The total global refined lead production and metal consumption amounted to about 7.1 million tonnes in 2004, of which roughly three quarters went into the production of lead-acid batteries (UNEP, 2010). These batteries are used in a variety of products including automobiles, solar panels and electric bikes. Recovery of lead from used lead acid batteries (ULAB) is an important source of the lead in current trade (UNEP, 2010).

Recycling and manufacturing lead acid batteries is practised worldwide in both formally and informally established facilities (UNEP, 2003). Lead recycling can pose a serious risk for the environment and for human health if the process is not carried out in an environmentally sound way (UNEP, 2004). The informal used lead acid battery (ULAB) sector, which is made up of small family businesses, is of particular concern as there are usually minimal environmental or occupational controls. These operations thus pose a higher risk of lead exposure during the various phases of the recycling process (UNEP, 2004).

This document describes how lead exposure can occur during the recycling of used lead acid batteries. It then discusses the adverse health impacts resulting from exposure to lead. Two case studies illustrate the impact that uncontrolled battery recycling can have on a community. Information is also provided on the ways by which lead exposure can be assessed.

How lead exposure occurs during recycling and disposal

Environmental contamination can occur when lead is broken up, ground, scraped or smelted. These processes can emit lead particles and fumes into the air, which are then deposited onto soil, water bodies and other surfaces, including in gardens and homes. Waste materials from lead processing can, if incorrectly disposed of, contaminate land and water bodies. Lead can enter the food chain through crops growing on contaminated land and from direct deposition of lead from the atmosphere, and through food animals that forage in contaminated areas and consume lead (UNEP, 2010; UNEP, 2003).

The following paragraphs outline the main steps in the recycling process and how environmental contamination and human exposure to lead compounds may occur.

Before reaching the recycling plant the batteries have to be collected, transported and stored. At this stage there may be a hazard from the sulphuric acid electrolyte if this is allowed to drain out or if it leaks

Once the lead acid batteries arrive in a recycling facility, the basic steps are as follows. First the sulphuric acid electrolyte is drained, then the batteries are broken and opened to separate the different components. The lead components are melted and refined to remove metals such as copper, arsenic and tin from the mixture. The purified lead is then cooled into blocks (UNEP, 2003).

In a well-run ULAB recycling plant much of this process is automated and enclosed, minimising human contact with lead and lead emissions into the atmosphere. The batteries are broken up in a crushing machine and the metallic components are channelled to a furnace for smelting and refining (UNEP, 2003). If these processes are not adequately controlled then lead exposure can result and examples are given below.

There are many recycling plants, both large and small, around the world where recycling processes are not adequately controlled, resulting in occupational lead exposure and significant environmental contamination. Examples are given below of the ways in which lead can be released when recycling processes are poorly controlled.

- In the battery breaking phase, the sulphuric acid electrolyte may spill out and may cause burns to the skin. The electrolyte contains dissolved lead and if it is poured onto the ground rather than being disposed of safely then the lead becomes incorporated into soil particles which subsequently become a source of lead dust. Manually breaking up the batteries releases lead dust and particles into the environment, which may settle in the surrounding soil (UNEP 2003).

- During the recycling process water may be used in automated systems for separating lead from other components. This water is heavily contaminated with lead compounds and if it leaks or is improperly disposed of it will cause environmental contamination. As the water evaporates it leaves a residue of fine lead dust (UNEP, 2003).

- In the final phase the lead from the reduction process is sometimes directly introduced into the refining kettle which can be up to 1,000 ºC. This practice creates large amounts of lead vapour which, if an open process is used, will contaminate the air in the surrounding environment and result in inhalation exposure to lead (UNEP, 2003).

- Waste from the recycling process will be contaminated with lead, therefore improper disposal is a further source of environmental contamination and human exposure (UNEP, 2003).

In a poorly run recycling facility there can be significant occupational exposure to lead. Were et al. (2012) investigated a lead acid battery recycling plant in Kenya and found elevated concentrations of lead in the air and elevated blood lead concentrations in workers. The study identified a number of weaknesses in work practices and control measures that resulted in excessive exposure to lead. Examples included inadequate engineering controls (including poor ventilation systems) and personal hygiene measures (including lack of respiratory protection and failure to use washing facilities).

A recent review of published literature on exposures from lead-acid battery manufacturing and recycling plants in developing countries found that seriously elevated blood lead concentrations were common (Gottesfeld & Pokhrel, 2011). In workers involved in battery recycling the mean blood lead concentration was 64 µg/dL, with a range of 37.7 to 112.5 µg/dL. This contrasted with data from developed countries where few workers have blood lead concentrations above 50 µg/dL. The review also found that high airborne lead concentrations were reported in recycling facilities, with a mean value of 367 µg/m^3. This is 7-fold higher than the permissible exposure limit as an 8 hour time weighted average (TWA) set by U.S. Occupational Safety and Health Administration of 50 µg/m^3. The same authors summarized 11 studies on lead exposure of children residing near lead battery manufacturing and recycling facilities and found an average blood lead concentration of 29 µg/dL, with values up to 71 µg/dL.

Family members or other co-habitants of workers in recycling facilities will be exposed to lead if the workers return home in lead-dust contaminated clothes and footwear. Lead poisoning in the spouses and children of lead workers, caused by transfer of lead from the workplace to home, has been documented (Baker et al., 1977; Chisolm, 1978).

Communities living near a recycling facility can be at risk of exposure to lead if environmental control measures at the facility are inadequate to prevent contamination of the surrounding area. Recently a large recycling plant in the USA was closed down after it failed to meet emission controls and waste management standards. This plant was found to have contaminated the surrounding area which lead to a distance of 1.7 Miles (California Environmental protection Agency, 2015). The case studies given below illustrate how the environmental contamination caused by ULAB can result in severe lead poisoning in a community, which may continue even after recycling operations have stopped.

The Basel Convention Secretariat has developed technical guidelines and a training manual that provide practical advice and guidance to national authorities for the environmentally sound management of ULABs (UNEP, 2003; UNEP, 2004).

Informal recycling

Informal ("backyard" or "cottage") recycling practices occur in many countries and have resulted in lead exposure and poisoning (Matte 1991; Haefliger et al 2009). This practice may take place in urban areas with high population densities. There are few (if any) pollution controls, and the work is usually carried out by small family groups, sometimes around the home. Because the recycling process is often done with little knowledge of the health impacts and conducted under poor conditions of safety, health and environmental controls , informal recycling is particularly likely to result in environmental contamination and human exposure to lead (UNEP, 2004).

Typical activities include pouring the electrolyte onto the ground or into a river or pond, breaking up the battery with an axe or hammer, then smelting the lead in an open container over a fire or a cookstove (UNEP, 2003). Open smelting can result in the inhalation of lead as operators usually have no respiratory protection beyond, perhaps, a wet towel to filter out lead fumes. The fumes will then settle as lead particles on surrounding surfaces and the soil. Waste, including pieces of broken batteries may be scattered on the ground and there is a potential risk of spreading lead oxide dust (UNEP, 2004).

Soil contaminated with lead compounds can turn to dust and spread throughout the community. If recycling activities are done around the home then lead-contaminated dust can enter the home and accumulate on the floor, on beds and other furniture (Haefliger et al., 2009). Settled dust can be resuspended in the air and inhaled when people walk through the dust or brush it up.

People involved in informal recycling as well as local residents have been poisoned with lead from emissions, dust and particulates, with young children being at particular risk (Matte et al 1991; Haefliger et al 2009).

While the focus of this document is on the release of lead from ULAB recycling, there are a number of other hazardous chemicals that may also be released when control measures are inadequate. These include other toxic metals such as arsenic and antimony, as well as gases such as dioxins and dibenzufurans from the open burning of plastic battery cases.

Health effects of lead exposure

The health impacts of lead exposure, including low-level exposure, have been extensively reviewed and are summarised here (ATSDR, 2007; JECFA, 2011; NTP, 2012). Young children and pregnant women and women of childbearing age are particularly vulnerable to the toxic effects of lead.

Routes of exposure to lead

The main routes of exposure and absorption of lead are inhalation, ingestion and to a much lesser extent dermal contact (ATSDR, 2007). Inhalation of fumes and dust is a major route of exposure for people working with lead. Young children are particularly likely to be exposed through contaminated soil and air-borne household dust because they spend a lot of time in one place, tend to play on the ground and have frequent hand to mouth activity. Children with pica, a compulsion to eat non-food substances, may persistently eat lead-contaminated soil (Mielke & Reagan, 1998).

The absorption of lead from the gastrointestinal tract is affected by dietary factors, age and nutritional status (JECFA, 2011). Infants and young children absorb proportionately more lead than adults, typically absorbing 41 – 53% of ingested lead compared to only 3-10% in adults. The absorption of lead is also greater in people with dietary deficiencies of iron or calcium, which may be common in economically deprived communities. Once absorbed into blood, lead is distributed to most organs of the body, including the central nervous system, liver and kidneys, but the largest proportion (up to 90% in adults) is stored in bone.

There is an equilibrium between the amount of lead in blood and in bone (Rabinowitz et al., 1991). Lead in bone does not cause toxic effects but it becomes a potential source of toxicity when metabolic changes cause its release back into blood. This can occur during pregnancy, lactation, the menopause and following bone fracture (Mushak, 1993). If the blood lead is reduced, e.g. following chelation therapy, some lead will be released back from bone.

Lead readily crosses the placenta so if a pregnant woman is exposed to lead the fetus will also be exposed. The lead concentrations in maternal and fetal blood are similar (Graziano,1999; WHO,1995).

Lead is present in breast milk from exogenous sources or through its remobilisation from skeletal stores. The concentration in breast milk is, however, low and there are no reported cases of lead poisoning resulting from exposure to lead in breast milk alone (Ettinger et al., 2004; Ettinger et al., 2014).

Toxic effects of lead

The toxic effects of lead are wide-ranging and affect almost all body systems. Acute lead poisoning from a single exposure is relatively rare and chronic poisoning is more common, however, the clinical features of poisoning are similar in both cases. The presenting signs and symptoms are very variable in both adults and children and may include gastrointestinal, haematological and neurological effects. Young children are particularly vulnerable to the neurological toxicity of lead. Lead also has toxic effects on the reproductive, immunological, endocrine and cardiovascular systems. Important toxic effects are summarised below by body system.

The duration of illness in lead poisoning may be long and periodic, requiring the monitoring of blood lead concentrations and repeated courses of antidotal therapy.

Gastrointestinal effects

Gastrointestinal effects are common in lead toxicity but are non-specific. These include anorexia with weight loss, constipation, abdominal pain or discomfort, nausea, vomiting and a metallic taste in the mouth. Diarrhoea occurs occasionally (Winship, 1989). Lead colic (intense, painful, intermittent abdominal cramps) is associated with severe constipation and vomiting, and can be mistaken for other conditions such as appendicitis, peptic ulcer, pancreatitis or intestinal obstruction (Janin et al., 1985). Gastrointestinal bleeding has been reported occasionally (McNutt et al., 2001; Frith et al., 2005).

Some individuals may show a 'lead line' (also known as a Burton or blue line) along the gums (ten Bruggenkate et al., 1975). This is a dark line composed of granules of lead sulphide precipitated by the action of hydrogen sulphide (from bacterial degradation of organic matter) on lead. It is usually only seen in individuals with poor oral hygiene (NAS, 1972). There may also be grey spots visible in the buccal mucosa and on the tongue (ten Bruggenkate et al., 1975).

Neurological effects

Lead exerts toxic effects in all parts of the nervous system. Lead poisoning can cause life-threatening encephalopathy (damage to the brain), particularly in young children. Encephalopathy is more rarely seen in adults (ATSDR, 2007). Initial signs include sporadic vomiting, loss of appetite, behavioural changes with aggression, irritability and agitation, headache, clumsiness and intermittent lethargy alternating with periods of lucidity. This may progress to persistent vomiting, ataxia, convulsions, severe cerebral oedema, raised intracranial pressure and coma. Death can occur within 48 hours of the first convulsions in patients who do not receive intensive supportive therapy (NAS, 1972).

In the days before there were treatments for lead poisoning the death rate in children from lead encephalopathy was 65% (Chisolm & Barltrop, 1979) and permanent brain damage was common (Perlstein & Attala, 1966). Children could be left with mental retardation, seizure disorders, blindness and hemiparesis (weakness of the entire left or right side of the body) (Perlstein & Attala, 1966; Chisolm & Barltrop, 1979; Al Khayat et al., 1997). Such severe impacts can still be seen in places where there is no access to treatment (Haefliger et al., 2009; Greig et al., 2014)

Chronic lead toxicity may also cause more subtle changes in neurological function in children and adults. Young children are especially vulnerable as the nervous system is still developing. There is a large literature on the neurotoxicity of lead in children (Lidsky & Schneider, 2003; Bellinger, 2004a; Koller et al., 2004; Needleman, 2004; NTP, 2012). Even low levels of exposure, with blood lead concentrations below 5µg/dL, can cause neurological damage in young children (NTP, 2012). The effects include reduced cognition and behaviour scores, changes in attention (including attention deficit hyperactivity disorder), visual-motor and reasoning skills, and impaired social behaviour and reading ability. Studies to date suggest that there may be no threshold blood lead concentration for neurotoxic effects in children (JECFA, 2011).

A pooled analysis by Lanphear et al (2005) found that an increase in blood lead concentration from 1 to 10 µg/dL was associated with a six point reduction in intelligence quotient (IQ). These neurological deficits have not been shown to be reversible and have been found to persist into later childhood and adulthood (Tong et al., 1996; Fergusson & Horwood, 1993; Fergusson et al., 1997; Tong, 1998; Tong et al., 1998; Needleman et al., 1990; White et al., 1993; Stokes et al., 1998). Delinquent behaviour has also been associated with lead exposure (Needleman et al., 1990; Needleman et al., 1996; Dietrich et al., 2001; Wright et al., 2008). Poor scores for social/emotional functioning have been reported in preschool children (Mendelsohn et al., 1998).

In adults, case reports and small studies describe a higher incidence of malaise, forgetfulness, headache, fatigue, lethargy, irritability, dizziness, weakness, impotence and decreased libido in occupationally exposed adults (ATSDR, 2007). Lead exposure may also be associated with a greater risk of neuropsychiatric and neurobehavioural problems (Valciukas et al., 1978; Williamson & Teo, 1986; Stollery et al., 1989; Stollery et al., 1991; Chia et al., 1997; Kumar et al., 2002; Bleecker et al., 2005a; Chen et al., 2005; Schwartz et al., 2005).

Lead can cause both motor and sensory neuropathy. In individuals with severe, chronic lead toxicity wrist drop and foot drop (inability to extend the wrist or foot) may be seen. These effects are more commonly observed in adults than children with lead toxicity (ATSDR, 2007). Sensory polyneuropathy has been demonstrated in lead-exposed workers (Seppäläinen et al., 1983; Kovala et al., 1997; Chuang et al., 2000; Rubens et al., 2001; Bleecker et al., 2005b; Wong et al., 1991). Motor weakness usually resolves once the individual is removed from exposure but this may not be the case with sensory neuropathies (Rubens et al., 2001).

Poor postural stability has been reported in children with mildly elevated blood lead concentrations (Bhattacharya et al., 1990) and in lead-exposed workers (Chia et al., 1994; Chia et al., 1996; Ratzon et al., 2000; Iwata et al., 2005).

Lead may also cause visual impairment and reduced hearing (Cavalleri et al., 1982; Rothenberg et al., 2002; Otto & Fox, 1993). Hearing impairment in children may occur even at low levels of exposure with blood lead concentrations below 10 µg/dL (NTP, 2012).

Cardiovascular

Lead exposure is associated with an increased risk of hypertension in adults and pregnant women, even at levels of exposure below 10 µg/dL (NTP, 2012). Significant, though modest, associations have been found between lead concentrations in blood and bone with blood pressure (Nawrot et al., 2002; ATSDR, 2007; Cheng 2001). The association is stronger with bone lead suggesting that the increase in blood pressure is related to the long-term effects of lead exposure earlier in life (Cheng 2001; Gerr 2002).

Lead exposure has also been associated with changes in cardiac conduction (Böckelmann et al., 2002; Cheng et al., 1998). A higher incidence of ischaemic electrocardiographic changes has been reported in lead-exposed workers (Kirkby & Gyntelberg, 1985). Ventricular arrhythmias can occur in severe lead poisoning (Restek-Samaržija et al., 1994).

Renal

Lead can cause damage to the renal tubules with impairment of renal function, however acute renal damage is usually reversible (Green et al., 1976; Wedeen, 1988; Loghman-Adham, 1997; Chisolm & Barltrop, 1979).

Chronic lead exposure may cause a progressive nephropathy (Loghman-Adham, 1997). The onset of lead-induced renal impairment is subtle and patients may remain asymptomatic until there is significant renal dysfunction (Loghman-Adham, 1997). Even low levels of exposure to lead can be associated with abnormalities in renal function (NTP, 2012).

Endocrine and reproductive systems

Environmental lead exposure has been associated with delays in sexual maturity in girls (Selevan et al., 2003; Wu et al., 2003). This may occur even with levels of lead exposure below 10 µg/dL (NTP, 2012). Lead exposure has also been associated with delays in growth and reduced growth (e.g. smaller stature, smaller head circumference) in children (NTP, 2012).

Impotence and decreased libido are reported occasionally in lead-poisoned patients (Cullen et al., 1983). Reduced fertility has been found in couples during periods when the blood lead concentration in the male is elevated above 25 µg/dL for several years or above 40 µg/dL more acutely (JECFA, 2011). This may in part be due to adverse effects on sperm or semen, such as reduced sperm motility, decreased sperm count and reduced semen volume (NTP, 2012).

Pregnancy

Lead has long been known to adversely affect reproductive outcomes in females and has been used as an abortifacient (Bastrup-Madsen, 1950). Maternal lead exposure, event at low levels, may be associated with reduced fetal growth, lower birth weight, preterm birth and spontaneous abortion (NTP, 2012). Lead exposure is a risk factor for hypertension in pregnancy (gestational hypertension) and high levels of exposure may be a risk factor for pre-eclampsia, which can be life-threatening for both the mother and baby (CDC 2010; Troesken, 2006).

Haematological

High levels of exposure to lead reduce the synthesis of haem, which is necessary for the production of red blood cells, resulting in anaemia (ATSDR 2007). Coarse basophilic stippling of red blood cells may be seen, though this is not found in all patients with lead poisoning. Interference with haem synthesis also has other negative impacts, for example haem is needed for the formation of cytochrome c, which is essential for cellular respiration, and this may contribute to the neurotoxicity of lead (ATSDR 2007).

Toxic effects in relation to blood lead concentrations

Exposure to lead is assessed by the measurement of lead in whole blood (see below). There is, however, considerable inter-individual variation in the blood lead concentration at which specific signs of poisoning manifest. Some individuals may be apparently clinically well at blood lead concentrations that are associated with encephalopathy in others (Bellinger, 2004a). This also applies to subclinical effects such as effects on IQ, meaning that children with the same blood lead concentration do not necessarily have the same risk of impaired neurodevelopment (Bellinger, 2004a). The table below presents information about health effects in adults and children associated with specific blood lead concentrations, based on reviews and large case series.

Table 1: Association of sub-clinical and clinical effects with blood lead concentrations

Blood lead concentration	Health effect		Reference
	Adults	Children	
< 5 µg/dL		Decreased IQ, cognitive performance & academic achievement	NTP, 2012
		increased incidence of problem behaviours,	NTP, 2012
		Increased diagnosis of attention deficit hyperactivity disorder	NTP, 2012

Blood lead concentration	Health effect		Reference
	Adults	Children	
	Impaired renal function	Impaired renal function in children <12 years (limited evidence for impact in children ≥ 12 years)	NTP, 2012
	Reduced synthesis of delta - aminolevulinic acid dehydratase (ALAD), contributing to anaemia	Reduced synthesis of ALAD	ATSDR, 2007
		Delayed puberty (limited evidence of effect)	NTP, 2012
	Reduced fetal growth (based on maternal blood lead concentration)		NTP, 2012
< 10 µg/dL	Hypertension		NTP, 2012
	Increased cardiovascular-related mortality, (limited evidence of effect)		NTP, 2012
		Delayed puberty	NTP, 2012
	Spontaneous abortion (based on maternal blood lead concentration - limited evidence of effect)		NTP, 2012
	Preterm birth (based on maternal blood lead concentration - limited evidence of effect)		NTP, 2012
> 20 µg/dL		Anaemia	Schwartz et al. 1990
> 30 µg/dL		Reduced nerve conduction velocity	ATSDR, 2007
> 40 µg/dL	Peripheral neuropathy	Decreased haemoglobin synthesis	ATSDR, 2007
	Neurobehavioural effects		ATSDR, 2007
	Colic		ATSDR, 2007
> 50 µg/dL	Decreased haemoglobin		ATSDR, 2007
> 50 µg/dL *(= lowest concentration in children with malaria)*		Severe neurological features	Greig et al. 2014
> 60 µg/dL		Colic	NAS, 1972 quoted in ATSDR 2007
> 60 µg/dL *(= lowest concentration; range 60-450, mean 178 µg/dL)*		Features of acute poisoning but no encephalopathy	NAS, 1972 quoted in ATSDR 2007
> 90 µg/dL *(= lowest concentration; range 90-800, mean 330 µg/dL)*		Encephalopathy	NAS, 1972 quoted in ATSDR 2007
> 105 µg/dL *(= lowest*		Severe neurological features	Greig et al.2014

Blood lead concentration	Health effect		Reference
	Adults	Children	
concentration in children without malaria)			
≥ 150 µg/dL		Death	NAS, 1972
≥ 170 µg/dL *(= geometric mean, range 51 - 460 µg/dL – including children with malaria)*		Severe neurological features	Greig et al.2014
>216 µg/dL *(= lowest concentration, range 216-460 µg/dL)*		Death	Thurtle et al 2014

The public health impact of lead exposure

At a population level the main impacts of lead exposure arise from its effects on neurocognitive development in children and on cardiovascular disease in adulthood.

In children the increased risk of reduced cognitive ability and IQ, poorer attention, visual-motor and reasoning skills, and impaired reading ability and social behaviour all contribute to an increased public health and economic burden. While the estimated IQ decrease in children from lead poisoning is small (6.9 points over the blood concentration range 2.4 to 30 µg/dL), the impact at the population level can be important (Lanphear, 2005; Bellinger 2004b). It is estimated that a mean IQ reduction of 3 points from 100 to 97 would increase the number of individuals with an IQ below 100 by 8% and there would be a 57% increase in individuals with an IQ below 70 (commonly considered the cut-off for identifying individuals with intellectual disability). There would also be a 40% reduction in potentially high-achieving individuals with an IQ score greater than 130 (JECFA, 2011; Bellinger, 2004b).

In the case of blood pressure, a review by Healey et al (2010) estimated that for the Canadian population a change in blood lead concentrations in adults from 1 µg/dL to 4 µg/dL would be associated with an estimated increase in mean systolic blood pressure of approximately 0.8 mmHg among Caucasian males and 1.4 mmHg in susceptible sub-populations. While the impact at the individual level is small, increases in blood pressure are associated with age-specific increased mortality rates for both ischaemic heart disease and stroke (Lewington et al., 2002; Fewtrell et al., 2003). At a population level, a decrease of 1 mmHg in mean systolic blood pressure reduces the prevalence of hypertension by 1% (Bellinger 2004b).

Lead exposure is estimated to account for 0.6% of the global burden of disease (WHO, 2009). It is estimated that the total burden of disease attributable to lead, in terms of mild mental retardation and cardiovascular disease, amounts to almost 9 million disability-adjusted life years (DALYs) (Prüss-Ustün et al., 2011). Of this 1,789,000 DALYs are due to lead-induced cardiovascular disease in adults and 7,189,000 DALYs are the result of mild mental retardation in children. Children carry 80% of the disease burden associated with lead (Prüss-Ustün et al., 2011).

Economic impact of lead exposure in countries

The economic impact of lead-exposure is made up of direct and indirect costs. Direct costs include those associated with screening and the medical care of acute and chronic lead poisoning. Indirect costs reflect the economic burden on society from a variety of factors including reduced intelligence and the consequent negative impact on economic productivity and tax revenue. Other costs include the provision of special education, and managing juvenile delinquency and other criminal behaviours.

Trasande and Liu (2011) estimated the total annual cost of lead poisoning in the USA due to lost economic productivity to be US$ 50.9 billion in 2008. The upper and lower bounds of these costs were US $44.8 billion and US$ 60.6 billion. There was an estimated US$ 5.9 million in medical care costs.

In France, Pichery et al (2011) estimated that lost lifetime earnings as a result of lead exposure in children amounted to € 53.9 billion (US$ 69.8 billion at 2008 values). The direct health care costs for children under 6 years old with blood lead concentrations of 15 to <24 µg/dL, 24 to <100 µg/dL and ≥ 100 µg/dL were estimated to be € 198 million, € 83 million and € 16 million (US$ 256 million, US$ 107 million and US$ 21 million at 2008 values), respectively (Pichery et al., 2011).

In Europe, Bartlett and Trasande (2014) estimated economic costs attributable to lead exposure to be around US$ 57 billion, with upper and lower bands of US$ 50.5 billion and US $67.9 billion. This was based on estimated IQ losses and impact on economic productivity.

The estimated economic costs in low- and middle-income countries are considerably higher than in high-income countries. The estimated economic losses in low- and middle-income countries attributable to the neurodevelopmental impacts of childhood lead exposure amount to (in international dollars) I$ 134.7 billion in Africa (4.03% of GDP), I$ 142.3 billion in Latin America and the Caribbean (2.04% of GDP), and I$ 699.9 billion in Asia (1.88% of GDP) (Attina and Trasande 2013). This equates to 1.2% of global gross domestic product (GDP) in 2011.

Two illustrative case studies

The following two cases illustrate how recycling batteries can result in severe lead exposure. The first case describes exposure to lead via reclamation of lead and lead salts from discarded batteries, and the health consequences. The second case shows that closing a battery recycling plant might not be a sufficient measure on its own to prevent human lead exposure.

Senegal

Between November 2007 and March 2008, 18 children died from an aggressive central nervous system disease of unexplained origin in a neighbourhood of Dakar in Senegal (Haefliger et al. 2009). One of the possibilities considered was lead intoxication as the mothers of some of the children were engaged in the recycling of ULAB. Informal lead recycling in the region had been taking place since 1995 and various lead compounds had accumulated in the sandy soil over time. Around October 2007, some local residents realised that the accumulated lead in the soil could be sieved and sold. They therefore started to collect lead-enriched soil in sacks, which they brought into the community, sometimes even inside their homes (Haefliger et al. 2009).

A WHO mission was sent to Senegal to work with the local health authorities in investigating this outbreak further. It was not possible to conduct autopsies and postmortem testing on the children who had died because of cultural prohibitions and therefore the researchers focused their examination on the siblings and mothers of the children. In addition another group of children and adults, who were living in the same community, but apparently unrelated to the deceased children, were investigated to evaluate the extent of lead intoxication in the area. In total 81 individuals were investigated and clinical investigations revealed that they were all poisoned, often severely, with lead. In the children blood lead concentrations ranging from 39.8 µg/dL to 613.9 µg/dL were found (levels above 45 µg/dL indicate serious poisoning) (Haefliger et al. 2009).

Environmental investigations in surrounding areas indicated that the homes and soil were heavily contaminated with lead. Lead concentrations in outdoor soil were up to 302,000 mg/kg and indoor concentrations were as high as 14,000 mg/kg. The exposure pathway was most likely via inhalation and/or ingestion of the contaminated soil and dust in suspension as young children were playing on contaminated ground. This indicated that other inhabitants of the affected area (about 940, of whom 460 were children under the age of 19) might also be poisoned with lead. While the causes of death of the 18 children could not be confirmed, circumstantial evidence, including heavy environmental contamination and the high blood lead concentrations in siblings suggest that most, if not all, of the children died because of encephalopathy as a result of severe lead poisoning (Haefliger et al. 2009).

Dominican Republic

A lead screening survey of 116 children was conducted in March 1997 in the coastal Caribbean community of Haina, Dominican Republic (Kaul et al. 1999a). The community was located near an active automobile battery recycling smelter. The results indicated elevated blood lead concentrations (mean value blood lead concentrations was 71 µg/dL) and soon after the initial report the government shut down the recycling plant.

In August 1997 a follow-up survey was conducted with 146 lead-poisoned children in the same community (Kaul et al. 1999b). This study found that mean blood lead concentrations were significantly lowered (the mean blood lead concentration in the follow-up study was 32 µg/dL), but were still too high. The frequency distribution indicated that only 9% of the children had blood lead concentrations below 10 µg/dL and 68% of the children were at the, then, medical intervention level with blood lead concentrations higher than 20 µg/dL. The blood lead concentrations found in the Haina community were significantly higher than the mean blood lead concentrations in a comparison group of 63 children in Barsequillo (mean blood lead concentrations was 14 µg/dL), 4 miles away (Kaul et al. 1999b).

An environmental assessment indicated that although the smelter had shut down, metallic scrap and mixed residual soil and solid materials were still scattered about. Some clean-up activities had begun during the time of visit, however an assortment of waste materials remained at the site and continued to be a hazard to the neighbourhood. The authors concluded that although closing the battery recycling facility significantly lowered blood lead concentrations of children, the children were still exposed to lead materials through their environment (Kaul et al. 1999b).

In 2008 and 2009 some remediation activities were carried out to remove contaminated soil and education workshops were given for local children to help minimize their exposure to lead dust and materials (Pure Earth (Blacksmith Institute), 2015).

How lead exposure can be assessed

Blood lead measurements

A range of human tissues and fluids - including hair, teeth, bone, blood and urine – are known to reflect lead exposure, however measuring the concentration of lead in whole blood is the most accepted tool for screening and diagnostic testing (WHO, 2011). A number of different analytical techniques are available to measure blood lead concentrations, from point-of-care devices to laboratory-based methods.

Point-of-care testing for lead involves the use of a portable analytical device that can be taken and used near the site of exposure or patient care. An example is the *LeadCare II* device, which uses anodic stripping voltammetry (ASV). This device has a limited analytical range (3.3 µg/dL – 65 μg/dL) and it is recommended that levels above 8 μg/dL should be confirmed by a laboratory method (WHO, 2011).

The advantages of a point-of-care device are that is does not require skilled laboratory personnel for its operation, it can be used at locations where transport of blood samples to an appropriate reference laboratory is difficult, and the result can be provided within a few minutes. The device can analyse blood from a capillary sample taken from a finger-prick, or a venous blood sample. It is extremely important to ensure no lead contamination. This means that the device should be used in a lead-free environment and that care should be taken to thoroughly cleanse the injection site prior to sampling. This is especially important for finger-prick samples as the fingers may be heavily exposed to lead (CDC, 2013).

Laboratory-based methods for measuring blood lead concentrations have a higher accuracy and can have a lower detection limit. Examples include atomic absorption spectrometric methods and inductively coupled plasma mass spectrometry (ICP-MS) (WHO, 2011). The more advanced laboratory-based methods, however, are more expensive and often require specific laboratory expertise.

The use of ICP-MS offers the opportunity for isotopic analysis. This is a specialised technique that can be used to help identify the source of lead exposure. Lead has four natural stable isotopes and the ratio of isotopes varies according to the source of the lead ore. This ratio remains constant when lead is extracted, processed or absorbed into blood. It is possible to map lead isotope ratios from different sources to obtain a “fingerprint” of lead from that source. This can be compared to the pattern in a blood lead sample, potentially identifying the source of exposure (Komárek et al 2008).

As with a point-of-care device, with laboratory-based methods it is essential to take care to prevent lead contamination of the blood sample at all stages from collection to analysis. This includes the use of certified lead-free blood sampling equipment.

Some of the factors that need to be taken into account when selecting an analytical method for determining blood lead concentrations are summarised below:

- Purpose of the measurement and circumstances of the investigation
    - limit of detection required;
    - accuracy and precision needed;
    - number of samples to be analysed;
    - need to perform analysis near the site of exposure; and
    - need to confirm the environmental source of exposure via isotopic analysis.

- Availability of operational equipment
    - local availability of suitable devices or the need to outsource analyses;
    - length of time and logistics required for the transportation of supporting supplies to and from the locations of equipment planned for use in the analytical work; and
    - availability of service support.

- Ease of use of the equipment and availability of skilled personnel
    - the degree of accuracy and precision required;
    - the condition of the instrumentation available; and
    - maintenance needs of the equipment.

- Analysis costs and availability of financial resources
    - installation, running and maintenance costs; and

- training and salary costs for laboratory personnel.

When choosing a laboratory, it is important to ensure that it has an adequate quality management system in place. Ideally the laboratory should be accredited by a recognised body for the analysis of blood lead concentrations.

More information and discussion about the different analytical methods available can be found in the *Brief guide to analytical methods for measuring lead in blood* (WHO, 2011). This guide also presents some typical scenarios in which blood lead measurements are required and how this might influence the choice of analytical methods. A suspected case of intoxication, for example, requires the rapid availability of test results whereas a low limit of detection is generally not required. However, for occupational health a method with a high level of accuracy is preferred to enable comparison of results with past and future measurements.

Environmental /occupational history

As part of an investigation into an individual's exposure to lead a thorough environmental or occupational history should be taken. This should include questions about the individual's work practices and those of co-habitants, hobbies that might involve lead exposure, use of traditional medicines, methods used for controlling dust in the home etc. (WHO, 2010).

Air measurements

Various stages in the recycling process can result in the release of lead fumes and particles in the air (see section *How lead exposure occurs during recycling and disposal*). Studies have shown that there can be high airborne lead exposure in lead acid battery recycling facilities (Gottesfeld & Pokhrel, 2011). Airborne lead concentrations are strongly correlated with blood lead concentrations in workers in lead battery factories (Were et al., 2012).

There are two ways of measuring airborne lead levels: personal and area air sampling. Area air sampling is a technique where a pump is placed somewhere in the work area being tested. The pump runs for a specific period of time at a certain flow rate. This method monitors general air concentrations near a worker to measure employee exposures. Air sampling can be carried out to get a general overview of the air quality and to determine whether further (personal) sampling is needed (EPA, 1993).

A personal air sampling pump is a small piece of equipment with an internal battery that can be used up to 8 hours without recharging. It is worn by the person whose exposure is being evaluated. It comprises a sampling pump with sample media which employees can wear, for example, hung from the belt with the tube attached to the pump head and the other end of the tube clipped at the collar area. With this technique it is possible to measure lead air concentrations close to a workers' breathing zone and thus reflect the concentration of a person's exposure to lead (EPA, 1993).

Conclusions

Recycling lead acid batteries is a common practice around the world, especially in low-income countries. Many recycling facilities do not operate to good environmental and occupational standards, with consequent impacts on the health of workers and the surrounding community. The informal recycling sector operates with minimal or nooccupational and environmental controls.

The only way to protect communities and workers is to ensure batteries are recycled in a properly run, environmentally sound facility. Methods for the environmentally sound recycling of ULAB are described in technical guidelines published by the Basel Convention Secretariat (UNEP 2003).

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Annex 5: Proposed Strategy for the Environmentally Sound Management (ESM) of Used Lead Acid Batteries (ULAB) in Asian Countries

Prepared by: Miguel Araujo, BCRC-CAM

I. Considerations for the Asian Strategy

Setting out a Draft Overarching Regional Strategy for the ESM of ULAB in Asia requires a number of considerations.

Firstly Asia is a huge and diverse region with a variety of geographical challenges and different national laws and regulations governing the import and export of ULAB.

Furthermore, there is a great variety in the levels of compliance to the Basel Convention and in particular the obligations under the PIC for the monitoring and control of transboundary movements of hazardous waste as well as to the objectives and principles of ESM as set out in the Basel Convention Technical Guidelines.

There are also wide variations in the environmental standards of the Secondary Lead Plants, with some having been identified as operating at the highest ESM standards and complying with the obligations of the Basel Convention while other operations such as those in Viet Nam and the informal sector would appear to pay less attention to the environment or the health and safety of workers.

Asia is the region of the world with the highest production of primary and secondary lead bullion. China is also the largest importer of lead concentrate and producer of primary and secondary lead bullion in the world.

The quantity of lead material being introduced in the production cycle in Asia has followed the steady increase in the production of vehicles in the region and in China, and the e-bikes growth that is now 200 million.

The region is also at the forefront of technology for the generation of renewable energy such as solar panels which rely on lead acid batteries for the storage of energy.

ULAB recycling in Asia employs a significant number of people, particularly in countries such as India and Indonesia working in the informal sector. Some of the operations taking place in the informal sector such as ULAB collection, breaking, transport, and lead recovery in an artisanal manner are potentially exposing the workers to lead and threatening the health of the people involved and those populations living close to such activities.

The dynamism of the ULAB collection, temporary storage, shipping, transportation and recycling derives from the fact that, contrary to many other hazardous wastes ULAB have an economic value as raw material for the production of lead ingots. When combined with the existence of appropriate technologies and production processes there is a real potential for creating a green economy. But is this viable or just a fantasy for many developing countries in Asia?.

Fortunately, there are all the necessary ESM of ULAB tools to raise the standards of ULAB management (collection, temporary storage, shipping and transportation, and recycling), including the applicable experience of the comprehensive ULAB strategy which was developed and implemented in Central America, the Caribbean, Mexico, Colombia and Venezuela during 2002-2008 by BCRC-CAM and BCRC-Caribbean, which continued to be partially implemented until today.

The first point of reference is the Basel Convention. All the Asian countries are Parties to the Convention and yet, for one reason or another so many countries either fail to follow the convention for the import and export of ULAB or fail to comply with the Basel Technical Guidelines for the ESM of ULAB.

The information compiled by both the International Lead & Zinc Study Group and Pure Earth (the Blacksmith Institute) compiled in this document help to draw a fairly good map of existing ULAB recycling capacities throughout the region, saving precious time for the other actions needed, like awareness raising and training.

65% of lead consumption comes from recycled material and lead is by far the most recycled commodity. Because so many of the Asian economies are in transition, they offer the greatest potential for market expansion, and therefore will require increased ULAB recovery and recycling. However, some developing countries in this region lack the internal infrastructure, technical experience and in some cases, the marketing expertise to encourage sustainable production and consumption of lead acid batteries.

Last but not least, there seems to be a deep lack of knowledge about the serious health and environmental impacts of unsound ULAB management by the informal sector.

For these reasons any overarching strategy for the ESM of ULAB in Asia must include:

- An important effort to raise awareness about the severe health and environmental impacts of unsound ULAB management.

- Suitable mechanisms for the transfer of green technology and best practices aimed at product improvement, vertical diversification and competitive advantage against inefficient informal operations

- Promotion of technologies and handling procedures that will improve environmental standards and occupational health

- Effective and efficient recycling of all the ULAB components to make best use of resources, materials and promote sustainable development.

- Improved regulatory monitoring and enforcement through better training of regulators and inspectors and tighter licensing procedures that include proscribed site inspections and assessments (using the Benchmarking Assessment Tool shared at the workshop).

- The introduction of certification schemes linked to the lead acid batteries manufacturing, the ESM of collection, storage, transportation, shipping and recycling including the PIC for ease of transboundary movement and ESM (Green Lead and BEST Standard, if appropriate).

- The capturing of existing synergies of related organizations operating in the region (e.g. UNEP regional office, UNEP-IETC, WHO, Basel Convention Regional Centres, subregional organisations, civil society organisations).

- The capturing of the opportunities of developing a vibrant green economy where small trained ULAB recyclers could set up a joint recycling facility and members of the informal sector can become formal efficient collectors of ULAB supplying efficiently to ESM recyclers.

II. Proposed Strategy for ESM of ULAB

It is proposed that this strategy is implemented in a dynamic manner, led by BCRC-SEA and BCRC-China, under the leadership of UNEP Chemicals and in coordination with the Secretariat of the Basel Convention, with strong participation by National Basel Convention Authorities, allowing for improvement of the analysis of the current recycling capabilities, degree of awareness, regulatory framework, efficiency of the system, etc.

1. Obtaining high level support
2. Inventory with emphasis in the informal sector
3. Public Education/Awareness
4. Training of government officials and of managers engaged in any of the life cycle of ULAB, in coordination with national universities
5. Policy and legal development
6. Consolidation of small recyclers and integration of informals to related but safe activities
7. Collection and temporary storage
8. Transport & Shipping, supported by an electronic PIC procedure
9. Recycling lead to be used for manufacturing other batteries and efficient use of by-products

Following, there is a brief explanation of each of these proposed nine steps:

1. Obtaining high level support

A Presidential, Cabinet or a Ministerial decision to support an ESM of ULAB National Action Plan is essential. This step requires preparing a special *executive information package for policy makers* which highlights the significant health and environmental savings which could be achieved when ESM of ULAB is implemented, as well how this could also spur a vibrant green economy sector.

Moreover this high level support could be strengthened when supported by regional integration schemes existing in Asia or South East Asia, like the new ASEAN Economic Community which brings together South East Asian Nations.

2. Inventory with emphasis in the informal sector

Because of the good existing information about formal recyclers within the ILZSG for most of the Asian countries, not a big effort is required here, but it is essential that this information is constantly updated.

Nonetheless, significant efforts are required to carry out an inventory of the informal sector and in understanding the economics of its operation.

It is proposed that step number 2 is used to generate a National Action Plan, where steps 3 to 9 are delineated in strong dialogue with several central government entities, decentralized government authorities, the private sector, the informal sector, Academia and NGOs.

3. Public Education/Awareness

This step is essential to obtain a paradigm shift in both government officials and operators of ULAB in their different life cycles. The severe environmental and health impacts of unsound management should be highlighted as well as its significant costs to government finances, quality of life and an attractive investment environment. Similarly, these efforts should highlight the opportunities to minimize the risks of ULAB management and to tap instead into the opportunities of creating a vibrant green economy when applying ESM.

This effort needs to be constant and should help to break sooner than later existing unsound practices in many countries like the improper draining of the untreated ULAB electrolyte, the reconditioning of ULAB or the trading of parts of a broken ULAB, all of which are against the sound practices included in the Basel Convention Technical Guidelines for ESM of ULAB.

4. Training of government officials and managers engaged in any of the life cycle of ULAB, in coordination with national universities

It is proposed that this training is organized with the following content:

i. The current Basel Convention Technical Guidelines on ESM of ULAB, its Manual and the new informally revised version of those technical guidelines, highlighting the responsibilities to minimize transboundary movements and to recycle as soon as possible from the source of origin, creating recycling capacity at the national or regional level (if economies of scale do not allow for an economically feasible ESM ULAB recycling operation nationally).

ii. The Benchmarking Assessment Tool for the Environmentally Sound Management of Used Lead Acid Battery Recycling (especially for government officials)**.**

iii. The advances on the ESM of ULAB and cleaner production applicable to developing countries (especially to managers of ULAB related companies).

iv. The economics of ULAB recycling to highlight the need for volume to tap into economies of scale and make ULAB recycling sustainable and the importance of effective monitoring and enforcement combined with facilitation of ULAB trade when it complies with ESM and Basel Convention PIC procedures (especially for government officials).

v. The Green Lead Protocols and the Green Lead Assessment Tool (especially for managers of companies with ULAB related activities).

5. Policy and legal development

It needs to start with the basic (e.g. clarifying the government office responsible for monitoring compliance) and include a clear system with integrated responsibilities by the Basel Convention

National Authority (e.g. Ministry of Environment or Ministry of Health) and auxiliary bodies like the Customs Office, the National Police, and the General Attorney´s Office, as well as a national legislation with internalizes the Basel Convention, and a set of mandatory standards which need to be complied with (which could be based on the elements identified in the Benchmark Assessment Tool for ESM of ULAB), combined with a requirement of compliance with Basel Technical Guidelines/Green Lead Protocols when authorizing exports or imports of ULAB through the Basel Convention PIC procedure.

A key recommended element in the policy/legal system is the incorporation of the extended producer responsibility of lead acid batteries, by setting a mandatory registry of ULAB manufacturers or distributors, which requires them to demonstrate that they have complied with growing targets of the batteries placed in the national market, being channelled to ESM recycling, supported by a take back program when consumers purchase a new lead acid battery. This key policy element will help to channel ULAB to ESM recyclers and help alleviate the recurrent problem of the scarcity of ULAB which these recyclers suffer. It is important that publicity of the market price is secured and that unfair competition from informal sector is reduced and public auctions of ULAB solely based on market prices are avoided.

6. Consolidation of small recyclers and integration of informals to related but safe activities

It is recommended that the consolidation of some small recyclers is promoted to help them achieve sufficient economies of scale, if and when they are committed to adopt ESM of ULAB.
In order to avoid unnecessary social costs, informals that after a training are committed to ESM should be given a chance to participate in some ULAB related activities that are low risk when managed properly (e.g. like testing of batteries to see is they can still be recharge, the collection of ULAB combined with the selling of a generic new lead acid battery, which could be part of a "social franchise") and providing them with financial support and training.

7. Collection and temporary storage

The collection and temporary storage of ULAB is very important, because when managed improperly it creates health and environmental problems which are difficult to fix afterwards (e.g. draining of the electrolyte, breaking of the batteries because they were not collected properly, occupational risks because of the lack of protective shoes). The Basel Technical Guidelines on ESM of ULAB with its companion Manual (and the new informal revision of the latter) provide a good guidance on ESM of ULAB during collection and temporary storage.

8. Transport & Shipping, supported by an electronic PIC procedure

This segment is especially important because if the ULAB are not packaged almost like new batteries they are likely to move and break during shipping with the risk of the electrolyte being spilled in the roads or in the oceans.

Here there is an interesting point which should be checked. Though the situation may be different in Asia, it has been reported in Central America and the Caribbean that some shipping companies by sea do not accept ULAB with their electrolyte, thus opening the possibility of the electrolyte being discharge prior to its shipping.

Again, the existing Basel Convention Technical Guidelines on ESM of ULAB, its corresponding Manual, and the informally revised version of these technical guidelines provide very useful guidance on how to minimize environmental and health risks in transport and shipping of ULAB. Furthermore, to reduce the risks of illegal transboundary movements of ULAB and to avoid inflicting undue economic costs to responsible ULAB operators, it is strongly recommended that as soon as possible, an electronic regional PIC system is developed and put into place.

It is very important to break up front the tabu that the Basel Convention is opposed to trade of hazardous wastes destined to proper recycling in a regional facility by facilitating the justified transboundary movements because there is no national capacity for ESM recycling of proper final disposal.

9. Recycling lead to be used for manufacturing other batteries and efficient use of by-products

This is a significant step which secures that the materials contained in ULAB will be properly separated and either converted into lead ingots which can be used as raw material for manufacturing new lead acid batteries or plastic which can be used to make new battery cases.

The transboundary movements of ULAB are regulated by the Basel convention and thus it is strongly recommended that a third party certification which supports the ULAB Basel ConventionTechnical Guidelines is required in order to obtain the license for operating a ULAB recycler. This will not eliminate the need for government supervision but it will increase the chances of ESM in ULAB recycling as Green Lead requires 100% compliance with the Basel Technical Guidelines for ESM of ULAB.

We should not forget that lead is a non-renewable element that can be recycled indefinitely and so, when considering the current challenge of global climate change, recycling ULAB requires up to 70 % less use of energy and its corresponding CO_2 emissions compared with the process of extracting lead from a mine.

As the case of Acumuladores Iberia in Guatemala demonstrates, ULAB recycling which is based on the powerful combination of ESM and Cleaner Production (CP) can be close to 100%, generating virtually zero waste, and reducing the use of chemicals, their corresponding occupational risks, while at the same time diminishing significantly the cost of recycling down to $200 per ton. Moreover, this combination of ESM and CP in ULAB recycling is an excellent way of implementing the Cartagena Declaration of the Basel Convention which calls for waste prevention and minimization. It is strongly recommended that in Asia, synergies are sought between National Cleaner Production Centres and BCRC-SEA and BCRC-China.

Suggested next steps for putting into action a regional strategy for Asia on ESM of ULAB

1) Organize national workshops starting with Indonesia to discuss the current management of ULAB in each country, its health and environmental impacts and to review and enhance the proposed national strategy. It is recommended that relevant stakeholders participate in these national workshops and that once the national strategy has been established, a 5 year action plan

is developed, taking into consideration national capacities for ESM recycling as well as the capacities in neighboring countries if there is no national capacities.

2) Organize discussions with ASEAN officials and with other relevant organizations of regional integration so that the establishment of a support and coordinating office for a ULAB regional strategy for Asia is considered, which could developed a regional strategy, facilitate exchanges of information on advances of the formulation and implementation of national strategies for ESM of ULAB as well as serve as a clearinghouse on information on ESM of ULAB, including licit and illicit trade of ULAB, health and environmental impacts of ULAB management, and advances in the development of ESM of ULAB. Basel Convention Regional Centres could play an important role in these efforts as well as the existing Asian network.