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# BASEL CONVENTION
TRAINING MANUAL

## National Management Plans for Used Lead Acid Batteries

BASEL CONVENTION

# 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

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**The Secretariat of the Basel Convention is extremely grateful to the following experts for their valuable contributions to this manual:**

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# Foreword

The present manual is the product of experience gathered through the conduct of technical projects on the environmentally sound management of used lead acid batteries in countries which are Parties to the Basel Convention in Central and South America, the Caribbean and Asia in the last few years (2001-2004).

The Manual provides practical advice and guidance to national authorities for the development of a normative framework for the environmentally sound management of used lead acid batteries. A number of methodologies and field-tested tools are outlined to facilitate national diagnoses, the identification of the most appropriate policy strategies to enforce recycling policies, plans for public and targeted group education campaigns, the examination of occupational health and safety procedures as well as appropriate standards for the collection, packaging, transportation and recycling of used lead acid batteries. Practical local solutions for countries in transition are also described in order to meet the requirements for environmentally sound management as set out in the Basel Convention.

In this regard, the training manual is an operational tool to assist with the implementation of the Basel Convention Technical Guidelines for the Environment Sound Management of Used Lead Acid Batteries (2002). The Manual elaborates on the different scenarios for the environmentally sound management of used lead acid batteries at the national level discussed in the technical guidelines. In accordance with the objectives and principles of the Technical Guidelines, the Manual also provides elements for the preparation and the implementation of national plans for the environmentally sound management of used lead acid batteries.

The reader is invited to consult the UNEP-Environment and Industry Workbook for Trainers entitled ‘Environmental and Technological Issues related to Lead Acid Battery Recycling’ (96) as well as the UNEP-Environment and Industry Technical Report (14) entitled ‘Recycling of lead acid batteries and Environment’.

The manual is the result of a fruitful collaboration and sharing of expertise between stakeholders coming from a wide range of different backgrounds, including several national Governments, international specialized organizations, the academic sector and the lead industry.

# Contents

## Annexes

## A - Assessment of the management of ULAB at the national level

There are at least eight factors to take into account when determining the level of Environmentally Sound Management (ESM) of Used Lead Acid Batteries (ULAB). Assessing the eight factors below will facilitate an assessment of the current state of the management of ULAB and enable the right decisions to be made if it is necessary to improve procedures, amend legislation or provide incentives to achieve ESM for ULAB at National Level. In those instances where there might be a regional impact, regulators will also be able to determine the most appropriate options to initiate procedures consistent with ESM at a region level.

In order to make such assessments it is necessary to collect and collate data about the numbers and types of batteries in use, information about how the ULAB are collected stored, transported and recycled, what legislation exists to ensure the ESM of ULAB and how these laws are enforced. It is also necessary to determine how much the workers in the industry and local populations understand about the risks associated with ULAB.

The assimilation of the necessary data and information can be undertaken in a number of ways, but the most efficient and cost effective has proven to be a desk-top study run either consecutively or concurrently with a series of field trips. Both the desk-top study and the filed trips would work through a logical sequence of enquiries designed to either extract information and data or provide insights into how ULAB recovery is managed.

The desk-top study would focus on obtaining information and data on number of LAB and their uses, ULAB and their sources, legal responsibilities and try to track down the means of recovery for ULAB, that is the nature of the infrastructure. The information would be obtained by contacted a range of government agencies and following up the contact with a comprehensive questionnaire targeting the information required. The purpose of the field trips would be to visit a representative sample of households using LAB, retailers selling LAB, those people collecting ULAB, storing them, transporting them and recycling the ULAB to determine the level of ESM.

Once all the information has been collated, the assessment can take place (see in section 8).

Finally, a report for the preparation of a national plan for the environmentally sound management of used lead acid batteries can be prepared. The report would encompass the eight factors above mentioned, which are described in more details in the different sections of this manual. Guidelines for the preparation of the national report are proposed in Appendix 2.

### 1. Inventory

The first stage is to complete an inventory of the likely uses for LAB, domestically sourced and imported LAB and the sources of ULAB. It is particularly important to establish the quantities, collection mechanisms, collection rates and possible trends in LAB consumption and ULAB disposal for at least three to five years, depending on the quality of the records. The inventory should also include a list of licensed secondary lead

plants with a summary of smelting capacities, environmental control systems and occupational welfare provisions. Legitimate battery retailers and battery service centers should also be recorded together with summaries of their operations, noting in particular any environmental threats posed by inadequate storage of ULAB.
If possible, the location and the number of unlicensed battery reconditioners and illegal smelters or melters of ULAB should also be recorded. Obtaining information about illegal activities is sometimes very difficult due to the transient nature of the groups of people working in this sector. It is important therefore, to establish a rapport with the local populations in order to solicit information about any suspected local lead pollution incidents or health problems that might be associated with poorly controlled ULAB smelting furnaces or melting operations.

Obtaining all this information and data can be a costly and a time consuming exercise, particularly without any clues as to the likely sources of ULAB and potential pollution problems.

It is advisable therefore, to start with a desk-top survey to ascertain the number of LAB likely to be in use, how they are being used, where they are in use, where the LAB are being sourced domestically and how many are being imported.

It is very helpful to use standard questionnaires to obtain the information and data so that the results can be recorded on a PC database for cross-referencing and analysis.

Likely ULAB sources are:

- Automotive – domestic and imported
- Retailers, cars spares shops and repair shops
- Rural households – back-up power supply for TV and lighting
- IT systems – Uninterrupted Power Supply Systems (UPS)
- Burglar alarm system
- Telephone exchanges

As the majority of Lead Acid Batteries (LAB) are used in motor vehicles and trucks it is logical to obtain information from the Ministry of Transport on the number and different types of vehicle registrations, e.g. automobiles, motor cycles, trucks and so on. This information can then be used to categorize battery capacity by vehicle type.

Therefore, if a standard saloon or sedan has one LAB battery and this is categorized as one lead acid battery unit, then by comparison to the standard weights of the other main types of LAB, the different types of LAB can be expressed in terms of fractions of standard LAB units.

For example:

- An average car battery weighs - 17.7 kilograms (39 pounds)[i]
- An average truck battery weighs - 24.0 kilograms (53 pounds)[i]
- An average motorcycle battery weighs - 4.3 kilograms (9.5 pounds)[i]

A 6 volt LAB used for motor cycles would be a quarter of a standard battery unit and a truck or a bus with a large 12 volt battery would be one and a half standard units.

The design and layout of a typical questionnaire to be sent to the Ministry of Transport could look something like the table below. If possible, set up the information on the database with the formulae for the number of battery units embedded into the table. The summations can then be automatically programmed and the tabulations will look like this (See Appendix 3):

| Year | Type of Vehicle | No. of Vehicles a | Total No. of battery Units b |
|---|---|---|---|
| 2004 | Car | $a_1$ | $a_1$ x 1 |
| | Minibus | $a_2$ | $a_2$ x 1 |
| | Motorcycle | $a_3$ | $a_3$ x 0.25 |
| 1999 | Bus | $a_4$ | $a_4$ x 1.5 |
| | Truck | $a_5$ | $a_5$ x 1.5 |
| Total | Vehicles Licensed | a | b |

In this way, and based on the fact that the average battery unit contains about 9.7[1] kilos (21.4 pounds) of lead, the annual amount of leaded scrap material can be determined by examining the type of LAB, its use and life span by analysis of these variables[ii] and the appliance of the formulae outlined below in paragraph 2.2.

**1.1 Automotive Starter Lighting and Ignition (SLI) batteries for vehicles**

The Ministry of Transport will not be able to supply information about the life of a LAB. This information must be obtained through additional questionnaires sent to battery retailers, motorists and so on. Information about battery life can be obtained from battery manufacturers, but bear in mind that any such information will be treated as market sensitive and therefore might be based on laboratory tests and not "on the road". Examples of these additional questionnaires will be given later in this section.

a) The number and types of vehicles registered, e.g. cars, motorcycles etc.
b) The standard battery units per vehicle type, i.e. 1 unit for a car, $^1/_4$ unit for a motorcycle and $1^1/_2$ units for a truck battery
c) The average life-span of a standard battery (obtained from questionnaires);

Then using this information:
No. of standard battery vehicle units that become ULAB per annum is: $X_1 = {}^{b}/_{c}$

A set of sample of the basic questionnaires used in a number of ULAB projects to establish databases for LAB use and ULAB sources is available in the Appendices. See Appendix 3 for the data collection format for SLI batteries.

**1.2 IT and Security Batteries**

Obtaining information about the number of LAB in IT and Security Systems can be very difficult. It is advisable to contact the Department of Trade, Industry and Commerce to ascertain if they have any useful sales data. Major computer sales companies will be able to supply sales information about UPS systems and about the useful average life of the LAB in the UPS units. (See Appendix 4)

d) The number and types of IT and Security system batteries sold, e.g. UPS, back up security lighting and alarm system batteries.
e) The standard battery units per type, i.e. ¼ of a standard unit for battery IT and security batteries
f) The average life-span of IT and security batteries (obtained from questionnaires);

It should be borne in mind that whilst a UPS battery is only one quarter of the size of a car battery, the standard home PC UPS unit, providing 5 minutes of back up power to shut down, has at least 4 UPS batteries in series making the unit equivalent to 1 standard battery unit. Similarly, a network UPS Unit, providing 25 minutes of back up power to shut down, would be equivalent to 3 standard battery units.

Home security systems have single battery packs equivalent to ¼ of a standard battery. Industrial security systems tend to be equivalent to 1 standard battery unit.

Once again, the life of UPS systems has to be obtained from the questionnaires, but under most conditions, these sealed units will last 5 years.

A tabulation of UPS units would look like this:

| Year | UPS Units | No. of UPS Units | Total No. of battery Units |
|---|---|---|---|
| 2004 | Home PCs | $d_1$ | $d_1$ |
| | PC Networks | $d_2$ | $d_2$ x 3 |
| 1999 | Home Security Systems | $d_3$ | $d_3$ x 0.25 |
| | Industrial Security Alarms | $d_4$ | $d_4$ |
| Total | UPS Units | **d** | **e** |

Then using this information:
No. of standard battery IT/security units that become ULAB per annum $X_2 = {}^{e}/_{f}$

### 1.3 Deep Discharge Batteries (Boats, RAPS[iii], Telecommunications)

Visits to the major land-line and mobile (cell phone) companies will be very helpful in the compilation of data to determine the approximate number of LAB used in back-up systems for the telephone networks.

In most countries, boats have to be registered, particularly those anchored in the ocean, lakes, and commercial and recreational rivers, so contact with the appropriate government agency will yield information about the total number of boats registered and on average each boat has at least one Marine LAB. In the USA, the Department of Motor Vehicles is responsible for the registration of all motorboats. In the UK, the Environment

Ministry is the designated agency for boat registration. It is necessary therefore to establish which agency in each country holds the boat registration records.

g) The number and types of Deep Discharge batteries sold, e.g. Solar Power batteries, Telecommunications back up systems, Golf Cart, Fork truck, etc.

h) The standard battery units per type, that is, Golf Carts[2] are 8 units, Fork Trucks are 12 units. The solar power units vary from 4 units for a school system to hundreds for a RAPS to village.

i) The average lifespan of Deep Discharge batteries obtained from questionnaires and the manufacturers, but will be in the range of 5 to 15 years, depending on use and maintenance. (See Appendix 5)

Typically, a table of data obtained from a number of questionnaires would tabulate as follows:

| Year | Deep Discharge (DD) Batteries | No. of DD Batteries | Total No. of DD Batteries |
|---|---|---|---|
| 2004 | Boats | $g_1$ | $g_1$ |
| | Recreation – Golf Carts | $g_2$ | $g_2$ x 8 |
| 1999 | Industrial – Fork Trucks | $g_3$ | $g_3$ x 12 |
| | Telecommunications | $g_4$ | $g_4$ x N |
| | RAPS | $g_5$ | $g_4$ x N |
| Total | D D Batteries | g | h |

Then using this information:
No. of Deep discharge units that become ULAB per annum is: $X_3 = h / i$

## 1.4 Determination of Total Domestically Generated ULAB

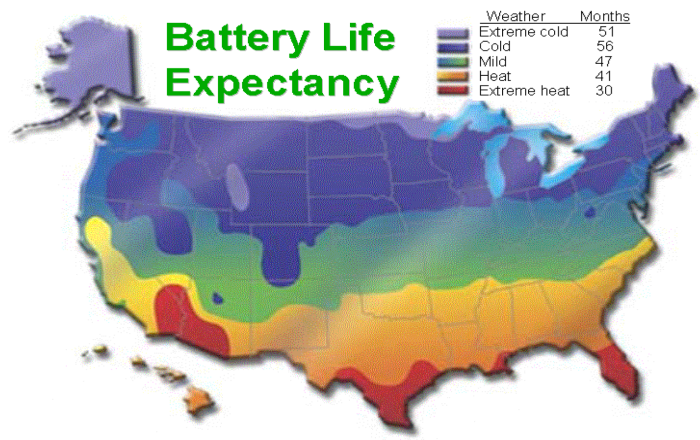
*1.4.1 Countries without Secondary Lead Smelting Capacity*

Whilst there may be many uses for lead acid batteries not included in the examples above, variations can be slotted into one of the three categories listed.

There is a huge variation in battery life. Automotive batteries tend to last between 18 months and 2 years in hot tropical countries and up to 5 years (sometimes more) in colder climates. In some instances, the short life of a battery in a hot tropical climate in a developing country is due to poor maintenance, but even with good care and maintenance, battery life is still very short compared to North American and European countries.
Deep discharge batteries used and maintained in the commercial and industrial sectors will have a useful life ranging from 5 to 15 years. Deep discharge batteries used for

[2] Golf Carts 6 volt battery packs vary in weight from 135 kilos (240 lb) to 293 kilos (520 lb) in weight.

domestic purposes and boating will not necessarily last as long as those in used in the industrial sectors, due to infrequent maintenance and improper charging regimes.




In many developing countries where mains electricity is not supplied through a national grid to every town or village, many homes, particularly in rural areas, rely on lead acid battery power for lighting and multimedia systems, such as the TV and radio. For example, in the case of Cambodia, a survey for the Government by the New Zealand based Meritec Group in August 2001[iv], concluded that in the rural areas "some 55% of households use car, truck or motorcycle lead acid batteries" for domestic purposes.

This is not surprising in a country where in the year 2001 nearly 90% of the country was not connected to the national electricity grid. Indeed, the World Bank concluded in 2000 that "poor households and communities are often dependent on diverse sources of energy for different needs", including lead acid batteries as well as kerosene, candles and wood.

Based on the data tabulations and calculations outlined above the total number of ULAB units in all three sectors would be:

Estimated No. of Domestically generated ULAB Units p.a. is: $X_1 + X_2 + X_3 = U_D$
Estimated Tons of ULAB generated domestically p.a. is: $U_D \; x \; (^{17.7}/_{1000}) = U_T$ tons
Estimated Tons of Scrap Pb generated domestically p.a. is: $U_D \; x \; (^{9.7}/_{1000}) = U_{Pb}$ tons

However impressive the calculations might be, determining the tons of ULAB generated each year tells you nothing about how the recovery process is managed. If ULAB are not collected and recycled in an environmentally sound manner, then the toxic nature of the battery components will have adverse impacts on the environment and potentially severe, maybe even fatal, impacts on the health of those working in the industry and populations living close to recovery operations. There are also legal considerations to take into account. For example, collecting ULAB safely in one country and then exporting them to another country to be recycled in a most environmentally unfriendly manner, is not only undesirable, it is illegal.

Additional questionnaires have to be designed therefore, to ascertain a whole range of information about the way ULAB are collected, stored, packaged and transported to a recycler. Furthermore, it will be necessary to include questions about compliance with national and international laws and conventions.

### *1.4.2 Countries with Secondary Lead Smelting Capacity*

The determination of the number of ULAB generated annually in a country with secondary lead capacity will initially follow the same steps as those outlined above in paragraph 2.4.1 on onwards shown above. However, there is also a need to add to the total of domestically generated ULAB the amount of ULAB imported for recycling to ascertain the total of amount of ULAB recycled.

ULAB are classified as a hazardous waste under the Basel Convention. Consequently, in case ULAB would be exported to or imported from a party to the Basel convention, the control regime of the Convention for the transboundary movement of hazardous waste would apply and such shipments should be documented.

Compliance with the Basel Convention for the import or export of ULAB means that there is an audit trail for the amount of ULAB transported form one country to another. Whilst the Government Agencies responsible for the administration of the transboundary movement of hazardous waste varies from one country to another, the annual records should be readily available for ULAB, although they might not be categorized by type, that is, automotive SLI, motor cycle, USP and so on.

In the case of any country with secondary lead smelters, it is necessary to check both import and export statistics for ULAB as many countries with domestic smelting capacity will still export ULAB for a number of reasons. The reasons for exporting ULAB from countries with secondary lead smelters include; inadequate smelting capacity; unplanned smelter maintenance; a country's geography makes it difficult and expensive to transport ULAB from every region to a domestic smelter and so on. The additional checks and information required for the assessment of ESM of ULAB for those countries with lead smelters can be ascertained using the questionnaire in Appendix 6.

It is likely that the transboundary movement records will show the tons of ULAB imported or exported. The amounts imported and exported will be as follows:

| | | |
|---|---|---|
| ULAB imported into a country as a BC transboundary movement is: | $U_I$ | tons |
| ULAB exported from a country as a BC transboundary movement is: | $U_E$ | tons |
| ULAB generated domestically: | $U_T$ | tons |
| Total annual tonnage of ULAB for recycling is: | $(U_I - U_E) + U_T$ | tons |
| Total annual tonnage of lead to be recycled is: | $\{(U_I - U_E) + U_T\} \times 0.55$[1] | tons |

In every country in the world, secondary lead smelters have to be licensed under one or more regulations. The regulations will vary, but essentially whatever the regulations are, the smelter management will be required to submit to the appropriate government agency details of annual tonnages for ULAB recycling. This information can be used to check for losses to landfill or the informal sector because if all the batteries in a country with smelting capacity are legitimately recycled then the sum of the ULAB available from domestic sources should be equal to the amount of ULAB recycled through one or more smelters, $U_R$.

The formula is:

$\{(U_I - U_E) + U_T\} - U_R = 0$ tons

Any serious discrepancies would indicate that there could be a number of issues to investigate.

If the tonnage is negative, there is an indication that more batteries are being recycled than imported and collected domestically. It is possible; there might be ULAB that are being imported without the correct notification and records outside of the terms of the Basel Convention. Check with Customs for transboundary movement documentation and likely illegal routes for ULAB imports.

If the tonnage is positive, then some of the imported or domestically generated ULAB might be finding its way into the informal sector for recycling or reconditioning.

Sample questionnaires relating to legal matters, both national and international can be found in Appendix 5.

*1.4.3 Domestic Use*

In many developing countries without direct electricity supplies, domestic lighting and electrical appliances are powered from 12 volt automotive batteries. It is essential, therefore, to find out the extent of such usage and how the batteries are used and discarded or recycled. Once again, personal interviews of a representative sample of the likely domestic users of LAB is essential to establish exactly what type of LAB is used in the home and how the ULAB are recovered.
A sample questionnaire is shown in Appendix 7.

## 2. Retailers – Sales and Collection mechanisms

It is necessary to survey a number of the major battery retailers to determine the numbers and types of batteries sold, SLI automotive, marine, UPS units and so on, and whether the retailers are collecting ULAB. If the retailers are collecting ULAB, then there is a need to assess how they are being stored and transported to the recycler, and whether the collection, storage and transport procedures are in compliance with the Basel Convention Technical Guidelines.

It is recommended that personal visits are made to battery retailers so that inspections determine whether the shop is engaged in ULAB reconditioning. The “tell tale” signs would be the presence of welding gas bottles, replacements battery grids and clear plastic bags of used battery grids. Reconditioned LAB may also be for sale in the shop. Such sales are not to be discouraged if the ULAB has merely been recharged. In fact, such practices should be congratulated and encouraged.

ULAB collection schemes are discussed in Sections C and D of the training manual and so the various mechanisms and incentive schemes will not be discussed here, but as collection is the first stage of the recovery process, it is a key component in the ESM of ULAB. Questions must be asked about the way that ULAB are collected and assessments of the rate of ULAB collection made. Obviously the closer to 100%, the better the recovery rate and in making assessments <u>any figure over 95% would be classified as close to ESM</u>.

The manner in which the ULAB are collected is required. In this regard, filed studies should examine any ULAB storage compound for cleanliness and the degree of conformity to the Basel Convention Technical Guidelines and the clear instructions made therein for storage of ULAB.

The Basel Convention Technical Guidelines also set out the provisions necessary for the legal and safe transport of ULAB. It is important to ascertain how the ULAB are to be moved to the recycler and whether the ULAB will be recovered domestically or exported. Irrespective of whether the ULAB are to be recycled domestically or exported, the provisions for accommodating leaking batteries, ensuring that the ULAB are not drained prior to transportation remain the same.

More detailed information on the standards required for sound storage and safe transport of ULAB can be found in section B. A sample questionnaire applicable to surveys of battery retailers, storage centers and transporters are shown in Appendix 8.

### 3. Recycling Processes

The components of ULAB are toxic, so it is essential that questionnaires are prepared to ascertain the extent of ULAB recycling, the processes involved and the environmental, safety and health precautions followed. Any degree of ULAB recovery operation will produce effluents, dust, discharges and residues and the questionnaires must be designed to establish what measures are taken to minimize any potential adverse environmental impacts and who is responsible for managing the processes and procedures. These questionnaires should be sent to ULAB recyclers, reconditioners and any company involved in ULAB recovery. Note that some companies will be reluctant to complete the survey, for fear of possible sanctions and in these cases, it will be necessary to visit the plant or shop and conduct a personal interview. Please review the Process and Environment Questionnaires in Appendices 9 and 10. The reader is invited to refer to the Basel Convention Technical Guidelines as regards the description of technologies, processes and practices considered to be environmentally sound.

### 4. Health and Safety

In addition to the information gathered about environmental management, it is also important to confirm the measures taken and the procedures in place to safeguard the health of those working in the industry and people living close to ULAB recovery operations. This questionnaire should include questions about the workforce, its age gender and length of service; process ventilation systems; personal safety equipment, that is, what is issued and what is used; washing and eating facilities and whether there is a medical surveillance program. Please see Appendix 11 to review the Occupational Health Questionnaire.

Whilst it is essential to survey the workers in the industry and people living close to recovery operations to determine the health impacts, it is also important to ascertain their knowledge, understanding and attitudes towards the risks involved and whether they know what precautions to take to minimize the risks of lead exposure. This questionnaire also provides an opportunity to ask about the life of LAB in service to the public. Please review the issues raised by the Awareness and Attitudes questionnaire in Appendix 12.

## 5. Public Education and Awareness

ULAB collection schemes will only be effective if the public is aware of them and the benefits of recycling together with an appreciation of the dangers of allowing ULAB to be dumped in the environment or recycled by unlicensed operators working in the informal sector. Public education and awareness can be raised in any number of different ways, but the key is to reach the target population groups; especially those likely to be at risk if the ESM of ULAB is not achieved, and that these groups understand the health and environmental threats.

Detailed information concerning the assessment of ULAB and level of information, consciousness of public safety and general awareness concerning ULAB amongst the most exposed populations can be obtained by developing focused local enquiries. The questionnaire shown in Appendix 12, "Awareness and Attitudes" can be used for such purpose.

## 6. Policy development - Regulations/instruments

All lead smelting operations must be licensed by the government in one way or another. This means that there will be regulations about the way the plant can operate and there will be government departments with responsibilities for monitoring the environmental, health and safety performance of the plant. In order to determine the effectiveness of the management of the ULAB it will be necessary to:

- Identify the appropriate national legislation and international conventions and rules covering ULAB;
- Identify the nationalt agencies responsible for enforcing the licensing, environmental, health and hazardous waste regulations;
- Find out the methods employed to control and monitor ULAB recovery performance;
- Examine the action taken in the event of non-compliance;
- Ascertain whether government policies are adequately tailored to promoting waste minimization initiatives and maximizing resource recovery;

The sample questionnaire shown in Appendix 6 is designed to provide an in-depth view of the legal and supervisory framework administered by the government and its agencies for the ESM of ULAB. Particular emphasis is put on the licensing of recycling facilities, the monitoring of environmental and health performance and the control of transboundary movements of ULAB. The questionnaire is comprehensive and weaknesses or gaps in any area of managerial control will quickly become apparent.

## 7. Consolidation of Informal activity

For those countries without ULAB smelting capacity, the ULAB collected should be exported for recycling to an appropriate smelter. It is very important to establish whether the ULAB from the informal sector are exported or recycled, because if they are not, it means that the ULAB might be dumped in landfill sites. Relying on the answers obtained from replies to questionnaire number 8 does not indicate whether all the ULAB have been exported legally.

The export of ULAB will be covered by the regulations for the transboundary movement of hazardous waste, and the required Prior Informed Consent (PIC) procedures used in the context of the Basel Convention.

Consequently, the appropriate government agencies; which could be the Customs and Excise Agency, or the Environment Ministry or the Department of Trade, Industry and Commerce in the exporting and importing countries; should have records of ULAB movements measured by the total weight of ULAB in tons. They should be able to provide information detailing the quantities of ULAB exported.

To check if there is any illegal smelting of ULAB in the informal sector or illegal dumping to landfill sites, a comparison between the tons of ULAB recorded as exports by the Customs and Excise[3] Agency, say $U_{CE}$, and the estimate for the total weight of the ULAB generated domestically per annum, say $U_T$, will provide the answer.

Any significant difference between the two figures will be indicative that large numbers of ULAB are not being exported for recycling and if the discrepancy cannot be accounted for by any administrative shortcomings, it will indicate that ULAB are being reconditioned or recovered by the "informal" sector. Ideally, the estimates for the tonnages of ULAB generated should equal the tonnages exported for recycling, or:

$$U_T - U_{CE} = 0$$

This mathematical model is a very good way of auditing the effectiveness of the administration of the regulations for the transboundary movement of hazardous waste under the Basel Convention.

However, the information will be meaningless unless the government agency responsible for controlling hazardous waste can be interviewed and the extent of their control of the transboundary movements documented using the questionnaire shown in Appendix 6.

[3] For the purpose of this manual, the agency responsible for the tansboundary movement of ULAB will be deemed the Customs and Excise Agency, but this will not necessarily be the case in every country.

## 8. Determining whether the National ULAB Recovery scheme is Environmentally Sound

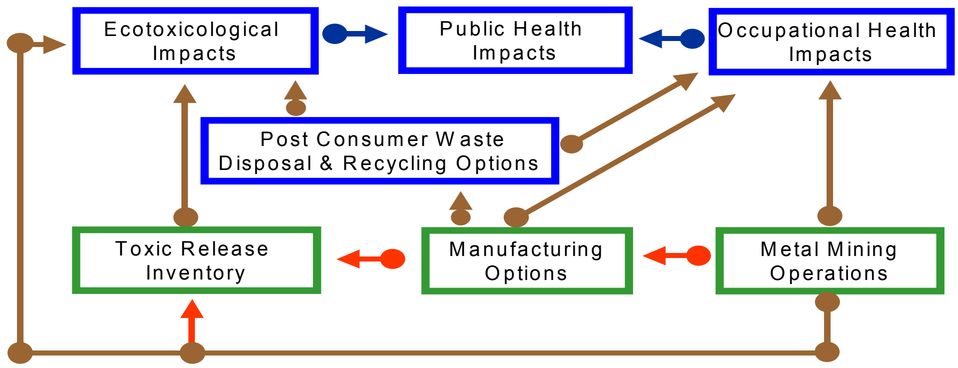
When analyzing the results of the desk-top study it is advisable to take a life cycle approach as a first step.Trace out the many varied paths that a LAB can follow from manufacture or entry into the country to recovery or disposal, including any intermediate steps such as reconditioning and servicing, where a ULAB might be returned for use. The completion of such a chart will show the routes that ULAB takes through the informal sector, but if compiled correctly will also show the preferred routes through the formal sector. Obviously, the preferred option would have all ULAB channeled through the formal sector for recycling to ensure environmentally sound recovery.

Accordingly, it is important to study each deviation that a ULAB makes from the preferred routes through the formal sector to a route that takes it through the informal sector. Establish the likely reasons why an informal route is taken. Is it for economic reasons? That is, has a person with a ULAB been offered a cash incentive to pass the ULAB to the informal sector? If so, what was the cash incentive? Was the ULAB collected by an informal trader because a retailer in the formal sector did not collect the ULAB? In which case, are changes in the collection infrastructure needed?

The same chart used to plot the life of a LAB can then be used to determine the environmental and occupational health risks associated with the various stages of its life. At each stage of the battery's life make a note on the chart of the environmental and occupational and population exposure threats.
A typical example of such a chart, albeit very simplified, is shown in the diagram below in.
This "Life Cycle Chart" was used by Researchers at the University of California, Irvine, in the preparation of a report examining various "Lead Replacement Policies and Practices" undertaken by governments. The chart was used as the basis for the determination of the outcomes of a number of lead based operations from mining through product manufacture and recovery.

Each operation or stage in the life cycle either, feeds to or from another in the life cycle, producing environmental and population impacts as can be seen by following the arrows. Whilst the diagram is qualitative and used to map the sequences, by breaking down each stage, taking appropriate samples, analyzing them and studying the results a "footprint" is quickly established.

Using the life cycle shown in Chart 1, and obtaining pollution and exposure data for each stage of the life cycle, the research team were able to estimate whether various lead substitutes had a greater or lesser impact on the environment and the population's exposure to toxic releases associated with the alternatives, than lead. It should be borne in mind that lead pollution and exposure levels are city, town or country specific.




Chart[4] 1 – Quantifying Uncertainty[v]

To supplement and complement environmental and population sampling for lead contamination and exposure, particularly when results are in need of interpretation, the questionnaires will enable a clear picture of the reasons for any lead exposures to be established. The questionnaires will also indicate where effluent discharges and population lead exposures arising from the informal activities are likely to occur. It is very difficult to undertake proper environmental and occupational sampling in the informal sector, so the questionnaires are a very useful source of information enabling many of the data gaps to be determined. Thought then has to be given to explain why the informal sector causes such environmental damage and decide how it could be curtailed and ultimately stopped.

Experience shows that sampling might not be difficult to arrange with the various populations, but difficulties may be to identify, in the absence of solid information about the recovery of ULAB, particularly in the rural areas, the right locations and target groups However, questionnaires adequately prepared for specific groups can help overcome the financial constraints associated with 'blanket' sampling of large populations and would help reveal the nature of ULAB recovery, the likely environmental and population exposure problems and trends in the changing use of lead acid batteries[5].

The purpose of this information gathering exercise will be to consolidate the life cycle chart showing LAB quantities, usage, environmental and health threats, ULAB sources and recovery routes. Also, gaps in the information and data will be more systematically

[4] Animated Powerpoint Slide Presentation - Use the right mouse button and click on the chart; from the menu select "Presentation Object" and click on "Show" from the menu. Press "ESC" when the animation has finished to return to the word document.

[5] Cambodian Ministry of the Environment; Department of Pollution Control, National Workshop Report on the Inventory Of Used Lead Acid Batteries In Cambodia, Phnom Penh, June 2004 – http://www.ilmc.org/Basel%20Project/Cambodia/Workshop/Report/PDF/Cambodia%20National%20ULAB%20Workshop%20Report.pdf

determined. Clearly, information gaps mean more foraging, but the second time around should provide a clear target for interview or sampling.

There is no "one size fits all" LCA and each country will have a slightly different chart with varying ULAB quantities, risks and threats. The levels of technology, the infrastructure, the recovery practices are also likely to vary and this should be reflected in the awareness and understanding that the population have for the effects of environmental contamination and lead exposure. It is recommended that LAB and ULAB use and recovery charts for each study are prepared so that an overview of the life cycle can be easily understood during any community briefing sessions and government training seminars.
Although the life cycle charts will vary, a typical chart will look something like that shown for a Manila bus battery in the Philippines and shown in Chart 2 below.

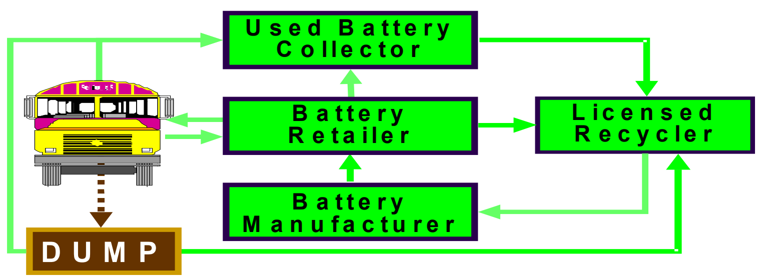



Chart2. Ideal life cycle for a Bus Battery in Manila.

## B - Set Up of an Environmentally Sound Collection, Storage, Transportation and Shipping Scheme (National Level)

Section 3.2 of the Basel Convention Technical Guidelines[vi] deals with collecting ULAB and advocates that a prerequisite to the implementation of a successful recycling program for lead acid batteries is to install an appropriate and efficient lead acid battery collection infrastructure.

Successful ULAB recycling programs rely on the fact that used lead acid batteries have an intrinsic economic value due to the high lead content of the battery. Recovery of the polypropylene battery case plastic material and converting the battery acid into a saleable product will add value, but these are not the only factors that influence the financial viability of recovery and recycling. It will depend on any one or all of these elements:

- The metal price of the recovered lead bullion. (LME)
- The availability of sufficient quantities of ULAB to maintain a viable operation.
- The cost of collecting the ULAB.
- The cost of transporting the batteries to a recycling plant.

In most instances the four elements are such that ULAB recovery is viable, except in remote locations where transport is not only uneconomic, but is not environmentally sound as the fuel used is maybe more harmful to the environment than failure to recovery the battery. However, for the most part, battery recovery from remote areas represents a tiny fraction of ULAB recovery and is dealt with later in this section of the manual.

### 1. Provisions for a Successful ULAB Recovery Infrastructure

To ascertain whether current legislation in any one country or region is adequate, there are several key factors that any laws designed to ensure ESM of ULAB recycling must encompass, including:

- The provision for a system of integrated pollution control (IPC) which addresses the generation, recovery and disposal of LAB by environmentally sound practices and procedures in compliance with international conventions and rules;

- The responsibilities for the environmentally sound recovery of ULAB are set out in a management hierarchy and the roles for government agencies and the private sector clearly defined, including the responsibilities of the battery retailers;

- A comprehensive list of standards for environmental discharges and emissions, and criteria for occupational health, covering all the stages in the collection, storage, transport and recovery of ULAB, including details of the sampling and testing procedures required;

- Progressive waste minimization is promoted and encouraged through mechanisms to extend LAB life and reuse;

- The necessary means to prohibit the indiscriminate dumping and uncontrolled disposal of ULAB to landfill or any other unlicensed waste disposal site;

- The provisions for the prosecution of those individuals and companies that fail to comply with relevant ULAB waste management legislation or undertake recycling operations without the requisite authorization. Such legislation should incorporate the presumption that any operation undertaken without license, and therefore without inspection, shall be deemed likely to cause environmental pollution and pose a risk to human health;

- Those involved in the sale of new LAB and the storage, transport and recycling of ULAB, together with any waste disposal operator handling furnace residues must be registered with the government environment bureau and submit their premises to regular inspections in order to obtain an operating license;

- The establishment and maintenance a national waste database for ULAB. This database must include details of the number of LAB sales, domestic LAB production, LAB imports, ULAB recycled domestically and ULAB exported for recycling under the Basel Convention's rules for the transboundary movement of hazardous waste. (The use of the ILZSG Statistics would also be useful);

- If domestic legislation fails to meet any one of these essential criteria, then amendments to existing legislation or even new laws should be considered as part of the strategy to establish a sound ULAB recovery infrastructure.

Many countries in the OECD include recovery targets in their waste management policies and this is certainly the case for ULAB. However, the need to meet targets for recycling is essentially a developed world criterion. Recycling is a way of life in the developing world and for many countries; the recovery of ULAB is close to 100%. The main problem for most of the developing countries is that the methods and procedures used to recover the lead and plastics from ULAB are environmentally unfriendly, and result in occupational and population exposure to lead dust and battery acid.

The "infrastructure" required and necessary to promote and ensure ULAB collection and recycling in an environmentally sound manner will invariably require some additional non-legislative elements to be put in place.

## 2. The Setting up of a legal framework – case studies

The first question is, "What is an efficient lead acid battery collection infrastructure?" It is not just legislation and the provision of enforcement of environmental laws. The vast majority of the Parties to the Basel Convention have all the legislation necessary to outlaw ULAB dumping and environmentally unsound recycling operations. Nevertheless, a comprehensive legislative framework is essential to facilitate and underpin the implementation of sustainable waste management practices. Where that framework is in need of improvement there are a number of countries that can provide examples of either model legislation or recovery procedures.

### 2.1 The European Union

Not every country has domestic secondary smelting capacity or an effective ULAB collection infrastructure; so different situations may require a slightly different framework. Surprisingly perhaps, the European Union has not been satisfied with the lead acid battery recycling rates in member countries for some time, even though rates are normally in excess of 90%. The main concern in the EU is that many member countries incinerate domestic waste and may inadvertently produce unwanted lead emissions to the atmosphere if ULAB are disposed of in the domestic waste stream.

The European Commission has, therefore adopted a Proposal for a new Battery Directive[vii], which will require the collection and recycling of all batteries placed on the EU market. The target for ULAB is set at 100%. As the target is set at absolute recovery of every ULAB, special measures will have to be introduced and the current framework for battery collection strengthened. The EU Commission imposes that the responsibility for ULAB recovery will rest with the battery manufacturers. Consequently, suppliers, agents, retailers and recyclers will need to determine what measures need to be taken to improve the present infrastructure to meet the new target. The most likely outcomes seems to be that there will be more ULAB collection points, additional take back and deposit/refund schemes and more retailers will be equipped and trained in the recovery of ULAB. EU Governments are also in the process of implementing legislation to prevent ULAB entering waste streams that go to either landfill or incineration.

### 2.2 Singapore

Singapore is a small country with a limited land mass and no facilities to recycle ULAB. Housing, industry, water catchments and recreation areas place great demands on the land available, so it is very important that hazardous wastes are safely managed to protect the population and conserve the environment.

The key elements in Singapore's framework to control ULAB and ensure their safe treatment and disposal are as follows. Firstly, the Government regulates, monitors and audits the collection and disposal of ULAB diligently and they have a strong emphasis on providing public educational and training programs about the management of ULAB.
The collection and safe disposal of ULAB are regulated under the Environmental Public Health Act (EPHA) and the Environmental Public Health (Toxic Industrial Wastes) Regulations (TIWR)[6]. However, the factor that makes the legislation in Singapore so different from that in the USA or the EU is that the TIW regulations define the functions and responsibilities of key persons involved in the handling of ULAB. These key people are the:

Generator of the ULAB, that is, the general public, for the most part. Anyone replacing a LAB must return the ULAB to the retailer.

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[6] The Management of Hazardous Wastes in Singapore - http://www.nea.gov.sg/cms/pcd/management_of_hw.pdf.

Collector of ULAB and that can be the retailer – It is necessary to obtain a licence from the Pollution Control Department (PCD) to collect and store ULAB in approved premises.
Carrier, that is, the person who arranges the transport of the ULAB. Written transport approval from PCD is also required for the transportation of ULAB. To prevent illegal dumping and disposal of toxic industrial wastes, the movement of wastes is tracked by means of the consignment note system.
Driver of the vehicle with the ULAB.

The Singapore government has invested in resources to explain and enforce these laws in order to prevent any dumping of ULAB or illicit recovery operations. Accordingly all ULAB are collected in Singapore and exported in compliance with the Basel Convention regulations for the transboundary movement of hazardous waste to an environmentally sound secondary lead plant. Monthly checks are conducted on the premises of ULAB collectors and the records are audited to ensure compliance with the requirements for collection, storage, transport and export of ULAB. (See appendix 13 for more detailes informations)

**2.3 Thailand**

In Thailand, responsibility for the sound management of ULAB is shared between three Government Ministries. Ministry of Natural Resources and the Environment's Department of Pollution Control is responsible for applying the appropriate legislation for the collection, storage and transport of ULAB to domestic recycling plants. Thailand does not permit either the import or export of ULAB. The Ministry of Industry is responsible for licensing the ULAB recycling plants and monitoring their compliance with environmental legislation.

The Ministry of Health is responsible for assessing the health impacts of the lead recycling plants on the workers and the general population, especially those living close to recovery operations. This Ministry has been given powers to shut down plants that fail to comply with the required health or emission standards and was responsible for closing the Klity Primary Lead Smelter in 2002. Thailand has a strong informal sector, but it is primarily engaged in collecting ULAB and selling them to the secondary lead plants. So much so, that the Government has not specifically legislated against the informal sector.

**2.4 The U.S.A**

An example of the model legal framework prepared by the Battery Council International and that has been adopted by many states in the U.S.A. can be viewed in Appendix 14.

**3. Establishing an Environmentally Sound ULAB Recovery Scheme**

The roles of those involved in the recovery of ULAB should be clearly defined in legislation (as outlined above), but participation in ULAB recovery requires interested parties to contribute their ideas and suggestions in the development and achievement of common goals and objectives.

Furthermore, it is very often the behavior of individuals and the decisions they make at local level about the fate of a ULAB that will determine whether the recovery route is environmentally sound or not. The better people are informed at local level, and the more opportunities there are for ULAB to be collected and placed in a formalized recovery program, the better the prospects for environmentally sound recovery of ULAB.

To undertake an effective and meaningful dialogue at the local level it will be necessary to conduct an audit to identify local and regional threats to the environment and population health. This is particularly important in the case of young children who are vulnerable to the long-term effects of lead exposure.

However, no dialogue can be effective if the population have little or no awareness of the environmental and health threats posed by the improper collection, storage, transport and recovery of ULAB. It is vital for them to understand the potential threats if improvements are to be made and such understanding must start with educating children at local schools and technical colleges.

### 3.1 Community Collection Schemes and activities

It is a characteristic of most developing countries that materials of any value, and especially ULAB, are recovered by "scavengers". There is little doubt that through their efforts used battery collection rates approach 100%. However, apart from some evidence of a change in practices in the Philippines, it is most unlikely that the ULAB collected by "scavengers" are recycled efficiently in the formal sector because studies in such places as Central America and Cambodia, suggest that they are invariably sold to the informal recyclers or battery reconditioners. The studies in Central America and Cambodia were undertaken by the Basel Convention Secretariat and the results and conclusions about the activities of the informal sector are likely to be typical of many developing countries.

Even with all these measures in place, it can be still be difficult to encourage people to change their actions, especially when links between actions and consequences are not apparent. This is certainly the case for most people who are usually some distance from ULAB recycling plants and will not see or be aware of the levels of lead exposure or acid contamination due to unsound recovery operations. However, a number of measures can be taken to bring home the message about ULAB recycling and ensure environmentally sound recovery of ULAB, and these are:

- New Lead Acid Batteries are labeled with information about the risks posed by lead and battery acid and instructions for the proper disposal of the battery when it is at the end of its useful life.
- Battery retailers must be required to take back ULAB as part of an environmentally sound collection scheme.

In countries where many ULAB are collected by scavengers, there is no doubt these two measures, especially the introduction of a "take-back" scheme at the point of sale, will be seen by the scavengers as a threat to their existence and income. To an extent, they are right, but scavengers are so good at collecting ULAB that it would be detrimental to ULAB recovery if they were excluded from collecting ULAB. The reason being, that a

LAB is heavy and for many people who use a LAB for domestic purposes, it is difficult for them to return a ULAB to the retailer for recycling. Consultation with LAB manufacturers, suppliers, retailers, scavengers and consumers is essential to explore the options and implement “best practice”. After all, there are still opportunities for scavengers to make a legitimate living and provide a vital service to the community by offering a “kerbside” collection service. For example, if the scavengers were to work with the local retailers by collecting domestically sourced ULAB, returning them to the shops and then taking out a new replacement LAB to the customer for a fee, then all parties would be satisfied.

In many OECD countries, particularly those in the EU, domestic waste is segregated and the Municipal Authorities collect the segregated waste via “kerbside” collection service, either weekly or twice a month. Most municipal authorities will also provide special collections for large items of waste, such as beds and cars, and special wastes such as automotive batteries and paint. However, despite the benefits of recycling more of societies disposables, “kerbside” waste collection schemes are expensive to set up and maintain. Waste collections have to be sorted, because the public is notorious for mixing waste materials, and then packaged for delivery to a suitable recycler. Scrap material prices are governed by a free market and there is no guarantee that the local authority will recover the cost of running the collection scheme.

Accordingly, ULAB collection schemes that are run safely by private enterprise and under the auspices of the local authority relieve the authority of any capital outlay of continuing financial risk. In the absence of “scavengers”, local authorities may have to make arrangements to initiate effective ULAB collection regimes, but where “scavengers” are available and willing to continue to collect UALB, the authorities should seriously consider working with them.

At local level with shop owners, consumers and scavengers, education, consultation persuasion, and engagement is preferable to policing and prosecution. When everyone can see and understand the benefits of environmentally sound recovery of ULAB, then the whole process becomes self-supporting and sustainable. Policing will be unnecessary because everyone understands their role and wants to fulfill it for the benefits of the community and the environment.

### 3.2 Multiple Recovery or Recycling options

The management of ULAB is not straightforward because a lead acid battery is not a single substance or compound, and ULAB can be found in a multitude of shapes and sizes. ULAB are a mix of lead, lead alloys, lead compounds, dilute sulfuric acid and this is sometimes in the form of a gel, polypropylene or PVC, and all these materials will be in differing proportions. Each material has the potential to impact differently on the environment and human health, depending on how the ULAB are recovered, and the impact will be influenced by the collection system used, the locations where the ULAB is generated and the resources available to managing the recovery. In a sustainable and integrated system of ULAB recovery, all these factors must be taken into account when making decisions on how best to manage ULAB.

The proximity principle suggests that ULAB should generally be recovered as near the place of origin as possible. This is in part to ensure that potential adverse environmental and health impacts are not exported to other regions or countries. It also involves recognition that the transportation of ULAB can have a significant environmental impact. A network of sound collection, storage and transport facilities would enable these adverse environmental impacts to be reduced.

Careful consideration has to be given to the application of the proximity principle when taking into account the collection of ULAB in remote areas where the LAB are used primarily for domestic purposes. The reason being that the environmental impact or cost of transport to a distant collection point and then a return to a reprocessing facility or market may outweigh the benefit of recovering the lead and plastic in the battery. Government Agencies and Planners should consider the mode of transport and not just the distances involved in the recovery process. That is local collection by bicycle and subsequent delivery to a central collection point, or a longer journey by river or rail may be environmentally preferable to a road journey by truck. However, the priority remains the collection of the ULAB.

In many cases ULAB may be exported for recycling and so it is imperative that waste planning authorities and businesses consider the need for a network of specialized collection and transport facilities for ULAB and collaborate accordingly with local communities, retailers, manufacturers and ULAB collectors.

Whilst there are preferred methods of collecting ULAB, it should be borne in mind that there is no “one size fits all” measure that will work every time and in every country. However, as long as the priority remains the collection of the ULAB and the focus is environmental protection, the various options applicable to each situation should become apparent. Moreover, it is very important to consider the options, because in many remote areas in developing countries, ULAB collection provides one of the few opportunities to earn a living. Deciding on the most appropriate options can be difficult so a guide has been prepared.

### *(a) Decision Making Process*

Identifying the most suitable mix of ULAB recovery options or prioritizing them, environmentally, economically and socially, can be a daunting task. However, the process can be simplified by breaking it down into smaller, more manageable tasks:

Step 1: Set the overall goals for making the ULAB recovery decision, subsidiary objectives and the criteria against which the performance of the different options will be measured, that is, social, economic, environmental, health and so on.

Step 2: Identify all the viable options.

Step 3: Assess the performance of these options against the criteria.

Step 4: Value or rate the possible outcomes for each of the viable options.

Step 5: Balance the different objectives or criteria against the outcomes for each option and measure the merits of each case.

Step 6: Evaluate and rank the different options and discuss them with the interested parties and local populations.

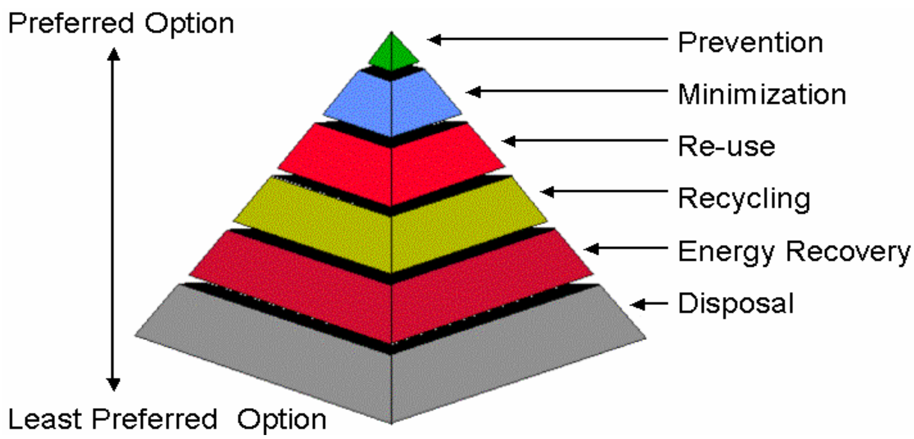
Step 7: Analyse how sensitive the results are to variations in the assumptions made or the data used.

Step 8: List that most appropriate options for each possible variation in circumstances and prepare contingencies.

## 3.3 Rationalization and Improvement of Existing ULAB Recovery Systems

Waste management strategies are traditionally based on a Waste Management Hierarchy of options with Prevention being the most desirable and Disposal the least desirable and the last resort. In the case of ULAB disposal to either landfill or incineration should not be an option in any strategic plan.

Energy recovery is sometimes considered by recyclers when recovered plastic case material is a copolymer mix, instead of a saleable load of polypropylene, which is of little or no value. The only useful way to dispose of such a mix and reclaim some benefit, is to incorporate the plastic chips with the furnace charge material and reclaim the material as a fuel and reducing agent. Nevertheless, this is the least desirable option and every effort is made by environmentalists to persuade battery manufacturers to use polypropylene for the case material so that it can be fully recovered and used to make new battery cases.




Pic. - Waste Management Hierarchy

### *3.4.1 Waste minimization – Reducing the Recycling Burden by Extending LAB Life*

Close to the other end of the scale is waste minimization and normally there is much work that can be done to reduce the frequency that lead acid batteries have to be replaced, and hence the rate of recycling. In many cases, motorists do not maintain or check their batteries regularly for optimum performance or realize when a battery needs servicing or external recharging.

All the major battery manufacturers publish service and maintenance manuals for the range of batteries produced, but a few simple steps taken will ensure that a lead acid battery operates to its full life expectancy. These simple steps can be explained to consumers and displayed in graphic format in battery retailers. Basically, the maintenance program is:

- Ensure that battery is clean and not covered in a layer of road dust and a mix of dust, grease and battery electrolyte. If necessary, clean the battery using a baking soda and water mix.
- Cable connections need to be clean and tightened. Ensure the metal exposed on the earth connection is clean and rust free as many battery problems are caused by dirty and loose connections.
- Check the fluid levels for each cell. If any cells need to be topped up use only mineral free water, distilled water is best, but de-ionized water will do. Don't overfill battery cells especially in warmer weather. The natural fluid expansion in hot weather will push excess electrolyte from the battery and corrode the battery fixing plate.
- To prevent corrosion of cables on battery posts or terminals, use a small bead of silicon sealer at the base of the post and place a felt battery washer over it. Coat the washer with high temperature grease or petroleum jelly (Vaseline). Then place cable on post and tighten, coat the exposed cable end with the grease. This will prevent the gases from the battery condensing on metal parts and causing corrosion.

Many motorists complain about the fact that despite the passage of time and improvements in vehicle technology, LAB performance has not improved.

The fact is, only 30% of batteries sold today reach the 48-month mark and 80% of all battery failures are related to sulfation of the battery grids. This sulfate build up occurs when the sulfur molecules in the electrolyte (battery acid) becomes so deeply discharged that they begin to coat the lead plates in the battery with a lead sulfate. Eventually, and sometimes not too long, the plates become so coated the battery effectively dies. The causes of sulfation are numerous and to an extent inevitable due to the chemistry of the lead acid battery, but understanding the reasons and causes of sulfation will help to determine strategies to minimize the rate of sulfate build up and extend battery life:

- If batteries sit for long periods between charges, say 24 hours in hot weather and several days in cooler weather, then there is a detectable sulfate build up.

- Long term battery storage without some type of energy input.

- Deep cycling an SLI battery designed for starting trucks and cars is undesirable, because the SLI battery is not designed to be completely discharged. In fact, the battery cannot cope with a complete discharge and sulfation will occur.

- Undercharging a battery to 90% of capacity means that 10% of the battery chemistry is not reactivated and 10% of the sulfate build up will remain on the metallic grids in the battery and the next time the battery is recharged some of the remaining 10% build up will not be removed.

- As temperatures rise to 32 degrees Celcius or $100^{o}$ + F and above so the internal discharge rate in the battery increases. A new fully charged battery left sitting 24 hours a day at 35 degrees Celcius or 110 degrees F for 30 days would most likely not start an engine. With the internal discharge comes sulfate build up.

- If electrolyte levels are low and the battery plates are exposed to air, they will sulfate immediately.

- If incorrect charging levels and settings are used to externally recharge a battery then it is possible to do more damage than good to the battery's condition. This is usually the case with cheap charging devices that do not have any instrumentation or settings and in many developing countries is the case with the recharging shops where 12 volt automotive, 6 volt motor cycle and heavy duty truck batteries are to be found under charge together on the same settings.
- Cold weather is hard on a lead acid battery and the chemistry is such that an SLI battery will not produce the same amount of energy as a battery, at say, room temperature. As a matter of interest a deeply discharged battery can

freeze solid in sub zero weather because virtually all the sulfate will be deposited on the battery grids leaving the battery filled with just water!

- Advances in vehicle technology have resulted in increased demands on the SLI battery making it even more important that the battery is always charged properly and remains charged at all times. Of course, this is very difficult to do when modern cars and trucks have electric clocks, security monitors and alarms running when the engine is switched off. Marine batteries will have to cope with automatic bilge pumps, radios, GPs and so on, all operating without the engine running at times. The drain on the battery by these electrical devices or a short in the electrical circuit is known as a parasitic load.

Constant demands on a battery will result in a repeated low or dead battery situations caused by excessive parasitic energy drain, the consequent sulfate build up and a dramatic reduction in battery life.

In the same way that vehicle technology has advanced, so has battery maintenance technology, and there are devices that will negate the effects of parasitic loads and prevent or dramatically reduce sulfation.
One of the easiest to use is the Pulse Width Modulated (PWM) solar charge controller-desulphator. This patented technology applies a high frequency pulsed circuit that continually recharges a battery while at the same time de-sulfating the storage plates, thereby allowing a battery to safely accept the highest rates of charge assuring maximum performance. The device is mounted on the dashboard and it normally plugs into a vehicle's cigar socket. It will keep a battery fully charged indefinitely (provided there is some sunlight) without ever overcharging and a battery condition indicator can be found on the control pad. There is also a version for marine batteries that is weather proof and available in solar powered and a receptacle AC/solar powered combination. A simplified version using Pulse Technology is also available for external charging from a mains supply in a garage.

Battery maintenance procedures and the correct use of charging devices should be made available to battery owners, retailers and service agents in the form of a simple leaflet.

Garages and battery service centers will use a range of electrical tests to determine a battery's state of charge and any service requirements. Again, the correct application of proper testing procedures and servicing will extend battery life. Battery manufacturers supply comprehensive service and maintenance manuals[7], and on request will usually be willing to assist with the training of technicians unfamiliar with lead acid battery servicing procedures.

[7] Bulldog Battery Company – Service Manual - http://www.bulldog-battery.com/PDF%20Files/SVC.PDF.

*3.4.2 Reuse and Recycling - Markets for the Battery lead, plastics and acid*

For those countries that export ULAB for recycling in another country, there is little prior consideration required about marketing of the recycled products. However, evidence from studies involving fishing communities in the Caribbean and Cambodia has revealed that fishermen will sometimes break open a ULAB, extract the metallic lead plates and melt them in an open fire to obtain the unrefined lead. This lead is then cast into fishing sinkers and they are either kept by the fishermen for their own use or sold to other fishermen. No regard is shown for personal protection or concern for the environmental damage caused by discarding the battery electrolyte or the illicit recovery of the lead bullion. These activities and many similar that produce such products as vehicle wheel weights and bullets for replica guns or historical societies are unsafe and most undesirable. It is very important for those involved in such illegal uses of recycled lead to be identified and made aware of the risks to themselves, others and the environment so that they might be persuaded to cease their recycling activities.

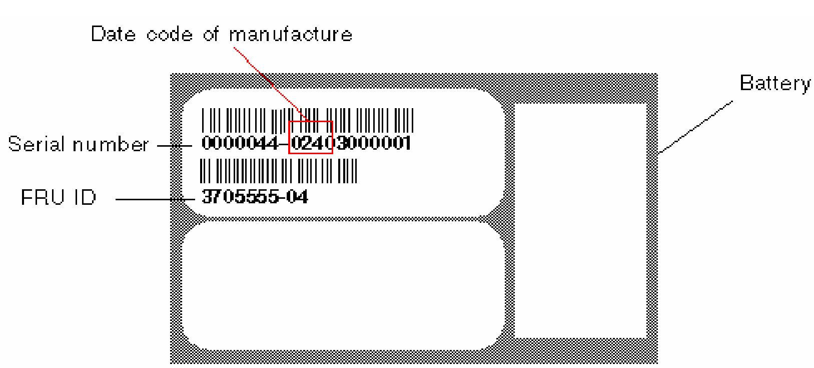
For those countries with licensed recyclers markets for the secondary lead, the plastic chips and acid by products recovered from ULAB are important and should feature in any strategy for the ESM of ULAB, but they will not be considered as part of this brief.

## 4. Labelling

The first point of contact with a battery is when it is either inspected or purchased and at that moment it is important that whoever is looking at the battery sees a label that clearly displays internationally recognized hazard warning symbols for lead and acid together with symbols for recommended personal safety equipment. The label should also have a graphic indicating that the LAB must NOT be dumped and another signifying that the LAB is a suitable item for recycling. Regardless of the country of sale, the label should also contain a local telephone help line or multilingual web site where safe disposal or collection information can be obtained.

<u>Several countries have laws or guidelines that impose or suggest minimum standards for LAB labels</u>. In the USA, many states will require battery manufacturers to comply with the guidelines set out by the American National Standards Institute (ANSI) Standard, under guideline ANSI C18. Under these guidelines all batteries must show:

- **Manufacturer** -- The name of the battery manufacturer.
- **ANSI Number** -- The ANSI/NEDA number of the battery.
- **Date** -- The month and year that the battery was manufactured or the month and year that the battery "expires" in a bar and numeric code.



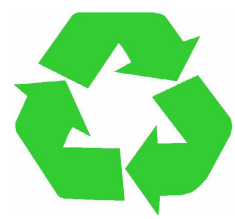

Diag.11 – Date of manufacture - Sun StorEdge 3310 SCSI Array Battery

In this example from a Sun StorEdge 3310 SCSI Array battery there is a seven-digit code below the top bar code that indicates the place of manufacture, followed by a dash (-), followed by a four-digit code that indicates the date of manufacture, followed by a six-digit supplier-assigned serial number. The date of battery manufacture is indicated by "0240," where "02" is the year of manufacture and "40" is the week of manufacture.

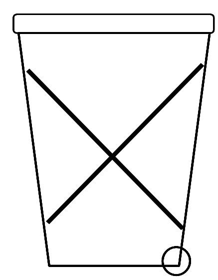
- **The nominal battery voltage.**
- **Polarity** -- The positive and negative terminals. The terminals must be clearly marked.
- **Warnings** -- Other warnings and cautions related to battery usage and disposal.

In the European Union lead acid battery labels must conform to EC Directives 157/91/EEC and 83/93/EEC for sealed Lead Acid Batteries and therefore must display the following symbols:

**a) Symbol 7 Recycling**



**b) Symbol 8 crossed out rubbish bin**



**c) Symbol 9 – The chemical symbol for lead - Pb**

The manufacturer/importer of a battery is responsible for ensuring that the label complies with the EC Directive. In addition, for the benefit of the customers and users of the battery, there has to be an explanation of the significance of the symbols, either on the label or attached to the battery.

Within the context of the quest for ESM for ULAB, ideally whatever the legislation or the American National Standards Institute requires of a battery label, each battery must comply with prevailing regulations and in addition clearly show:

- The international recycling symbol ISO 7000-1135, better known as the Moebius loop, with the words, Lead, return and recycle shown around the outside of the loop.

- Instructions for recycling the battery when it is at the end of its useful life, including the words “Contact your battery supplier”.

- A point of contact clearly displayed so that inquiries can be made if necessary. This can be phone, fax, web site or electronic address.

- The words “lead-acid battery”, "Pb" or the words "LEAD".
- The words “Protect the Environment – Recycle this Battery."

- A bar code with information about the battery’s place of manufacture, the date of production, the battery type and its components, including a list of the alloying elements.

- The bar code should also be designed for use by automatic battery breaker scanners designed to separate different battery types into segregated feed lines at the recyclers.

- The international warning hazard symbol or icon for acid.


- Instructions explaining what first aid to apply in the event of an acid burn or a splash to the face and eyes.

- A reminder to wash the hands after handling a LAB, and certainly before eating any food.

- A recommendation to wear the appropriate personal safety equipment and clothing, such as goggles and neoprene gloves, during battery maintenance or servicing.

- The words “Do not dispose of this battery in Household waste or at a Municipal Waste Dump”

Certain companies such as Panasonic have made considerable progress in designing a battery label that not only conforms to current legislation, but also takes on the responsibility for user safety and the promotion of recycling.

Pic: Panasonic LC-R127P UPS Lead Acid Battery

In the picture of the Panasonic LC-R127P UPS Lead Acid Battery the Mobius Loop and the words, lead, return and recycle are clearly visible as is the crossed out wheelie bin with the ISO lead symbol, Pb, visible under the bin. Not all the information recommended in this training manual is present, but the place of manufacture is shown as is the voltage, current and rating in ampere hours. There is a novel use of a contact telephone line, albeit only for US customers, and that is 1-800-SAV-LEAD and this phone number is just above the instruction to recycle the battery. Once seen and read, the phone number will be remembered.

The battery is a UPS unit designed for use in PC systems, so an Internet address for more information about safe disposal and recycling would be a welcome addition to the label. Moreover, URLs are understood by those with access to computers wherever they may be in the world and whatever language they might speak. Internet access provides a universal gateway to more information and companies can enhance the quality of the information and advice by offering their web pages in a range of languages or better still in the language of every country where their batteries are sold.

In the case of the Panasonic battery illustrated, an opportunity has been missed by not including an Internet link because the Panasonic web site has information about the SAV-LEAD program[viii] and the safe disposal and recycling of all their batteries[ix].

The Duncan Battery Group in Venezuela recently upgraded all their battery labels to provide more information to customers and promote recycling. Furthermore, the company has a safety label on the top of the battery as well as the sides so that the safety information is a visible reminder to the user, even when the battery is installed in its rack in a car.

Safety label

Pic – The new Duncan Battery Label Introduced in February 2004


The Duncan group is one of the few companies to state on the label that the battery is a lead acid battery. All the necessary safety graphics are displayed together with first aid instructions, hazard warning signs and recycling advice and symbols. There is a free phone contact number and the URL for the Company web site if more information is required. It does not conform to EU Standards because the crossed out wheelie bin is not on the label, but the Duncan Group do not sell their batteries on the European market.

In addition to labels on the batteries, retailers should display signs showing that the shop or garage is a collection center for ULAB.

## 5. Methods of Collecting ULAB

### 5.1 National collection schemes

The most environmentally friendly procedure for collecting ULAB is through the dual system of distribution and collection when manufacturers, retailers, wholesalers, service stations and other retailing outlets provide new batteries to consumers and retain the ULAB to be sent to collections centers or licensed recycling plants. Such a scheme is sustainable because it is based on the economic value of the lead content of the ULAB and can be run the industry without the financial support of the Government.

### *5.1.1 Deposit/ Refund schemes*

In many cases, Governments have initiated, in cooperation with the battery industry, collection schemes based on a financial incentive to return ULAB, such as a refundable levy on new batteries, which is repaid to the customer when the ULAB is returned to the retailer.
Countries have used these financial incentives in a number of ways:

USA - Several States require payment of a deposit of US$ 5 to US$ 10 on the purchase of all new lead acid automotive batteries. The deposit on the new batteries is refunded when a new battery is bought and the used one returned.

***(b) USA State Deposit Schemes for ULAB***

*Lead-acid batteries are subject to mandatory deposit systems in several states and voluntary deposit systems in most other areas. The lead in used batteries has positive economic value for battery makers. Deposit amounts are typically $5 to $10 per battery. Consumers can obtain refunds by returning a used battery and proof of the deposit to the same retailer, typically within 7 to 30 days after the purchase of a new battery.*

*Despite numerous voluntary ULAB collection schemes, 11 states require deposits.*

| *State* | *Deposit/Refund ($)* | *Unclaimed Refunds* | *Refund Period (days)* |
|---|---|---|---|
| *Arizona* | *5* | *Retailer* | *30* |
| *Arkansas* | *10* | *Retailer* | *30* |
| *Connecticut* | *5* | *Retailer* | *30* |
| *Idaho* | *5* | *Retailer* | *30* |
| *Maine* | *10* | *Retailer* | *30* |
| *Minnesota* | *5* | *Retailer* | *30* |
| *New York* | *5* | *Retailer* | *30* |
| *Rhode Island* | *5* | *State: 80%, Retailer: 20%* | *7* |
| *South Carolina* | *5* | *Retailer* | *30* |
| *Washington* | *Minimum of 5* | *Retailer* | *30* |

*Source: Weinberg, Bergeson & Neuman. 1996*

*As with beverage containers, deposit systems for lead-acid batteries appear likely to have a significant incentive effect because they offer motorists money in return for a used product. The percentage of battery lead that has been recycled nationwide has exceeded 90% since 1988.*

- Germany - there is a levy of 10 € on all LAB purchased without the return of a ULAB.
- Canada - Some retailers charge a $5 subsidy on the price of a new lead-acid battery if an old battery is not being returned.
- In British Columbia[x] there is also an incentive program to encourage consumers living in remote areas to return their used lead-acid batteries, with the subsidy paid varying with the distance traveled and the current price of lead.
- In Italy, consumers pay an additional charge of 10 € when buying a new lead-acid battery. This fee is refunded by the battery manufacturer to COBAT, an association which is responsible for collecting used lead-acid batteries and ensuring that battery, recycling is carried out according to strict environmental regulations (see below).

- In Sweden, battery producers and importers are charged an environmental levy of 40SEK per battery. This levy covers the cost of battery collection, transportation and recycling. Interestingly it also covers the cost of a public information and awareness.

An analysis of the costs and impacts of battery collection and recycling for all battery types, including automotive lead acid batteries has been produced by the Environmental Resources Management Group for the UK Department of Trade and Industry, entitled, an "Analysis of the Environmental Impact and Financial Costs of a Possible New European Directive on Batteries[xi]". This report provides and interesting perspective on the costs and benefits of good collection and recycling rates and is a useful model to justify start up funding for local, national or regional schemes.

### *5.1.2 Purchase Discount Schemes*

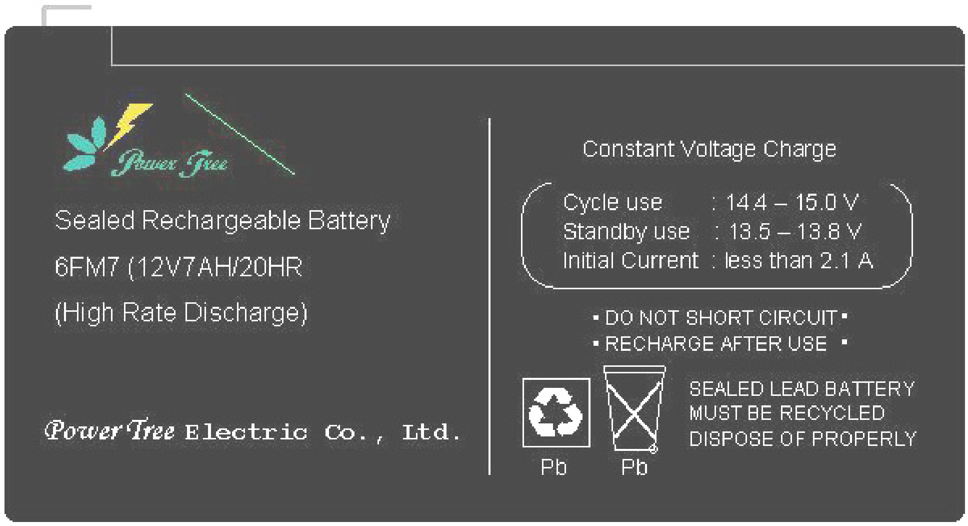
Purchase discount schemes operate in a similar way to the Deposit/Refund schemes, but instead of the consumer paying a deposit the first time a LAB is purchased, the consumer will only pay the retail price. However, when the battery is at the end of its useful life and is returned to the retailer, a discount will be given on the price of a new battery and the ULAB will be retained by the retailer and sent to a recycler.

These schemes are invariably run by the secondary lead recyclers and the battery manufacturers. The industry bears all the costs and sets up the necessary infrastructure to make the scheme work, but the costs are such that the schemes are really only viable in countries with domestic recyclers and battery manufacturers. In the Philippines, the battery manufacturer, Motorlite Inc., has teamed up with Philippine Recyclers Inc., the major licensed secondary lead plant to operate such a scheme throughout Motorlite's 300 retail outlets.
In some ways, schemes that are initiated and managed by the industry are similar to those being proposed in Europe under the "Extended Producer Responsibility" (EPR) principle. EPR is a philosophy where producers have responsibility for the environmental management of their products over the life cycle in order to obtain environmental benefits when it is being manufactured, during its useful life and at the end of its life.

The European Union has already legislated for automobiles through the "End-of-life Vehicles (ELV) Directive, for Waste Electrical & Electronic Equipment (WEEE) and the Restriction on Hazardous Substances (RoHS). Batteries are currently under discussion.

Purchase discount schemes are the standard for industrial batteries and that is why lead acid batteries used for motive power and lifting equipment throughout the world are all recovered.

More attention must be paid, however, to the collection of lead acid batteries used in Uninterrupted Power Supply (UPS) Units for large and small computer systems, in the business community and homes. All UPS units contain information about the lead content of the battery and the need to recycle the units at the end of their working life, but few schemes seem to exist to collect UPS batteries. Municipal authorities must involve the computer supply and retail industry in a ULAB management program for UPS batteries, and set up collection points in the IT shops. In developing countries, scavengers should also be made aware of the fact that UPS units contain ULAB so that they can add them to their collection list. A UPS unit is a good item for the scavengers to collect because the batteries are all sealed with a gel electrolyte that cannot be tipped into the nearest drain. Furthermore, householders will be pleased for the scavengers to take the UPS unit away because it is very heavy to lift as each unit contains a number of batteries connected in series.




Pic. - Power Tree Sealed and Rechargeable battery used in UPS units

## 5.2 Local Collection Schemes

### *5.2.1 Local Collection Schemes for Domestic LAB*

Whilst the most efficient method of collecting ULAB is through the battery retailers using deposit/discount or purchase discount schemes, some countries without a national electricity grid will find that the widespread use of LAB for domestic purposes, such as lighting and TV, does not lend itself to these types of collection schemes. Lead Acid Batteries are heavy and cannot be easily transferred to a retailer at the end of their useful life by the average consumer. Furthermore, in remote areas, the battery retailer may be some distance away, making the likelihood that the consumer will want to return the ULAB less than favorable. However, in the developing world, there are those in every city, town and local community that scavenge for discarded materials that can be reused or recycled. They will call at Garages and Repair Shops for used or reconditioned ULAB and Breaker's Yards so that they might remove the ULAB from the scrap vehicles. They will scour waste dumps, strip abandoned vehicles and wrecks and, most important of all, they will collect ULAB that have been used for standby power in domestic houses, and take them to a retailer or collection point. In many instances, the scavenger will pay the householder to take away the ULAB, because it has a resale scrap value. These scavengers are very efficient at finding and collecting ULAB. Moreover, they are popular in the rural areas because they will collect any ULAB from a person's home and pay them to take it away.

Their means of collection is usually with a wooden hand cart or a small trailer attached to a bicycle. Given the right safety precautions, such as wearing gloves to handle the ULAB there is nothing wrong with that. What is paramount in the design of a collection scheme is to understand the social as well as the economic positions in the target collection area and make sure that any new or modified scheme to collect ULAB does not reduce the collection rate. Every effort should be made to work with the communities involved and the scavengers, if they are present, to raise collection rates and above all ensure that the scavengers take the ULAB to licensed collection centers.

What is important, is that the battery caps are secure and that the scavengers do not pour the battery electrolyte into a stream, a ditch or the local sanitation system to lighten their load. Otherwise, the hand carts and the bicycle trailers are a good means of transporting small numbers of heavy ULAB to a central collection point.

Pic. – A scavenger in Phnom Penh with a hand Cart

"Kerbside" collection schemes can also work very well. Baterias de El Salvador has established an extensive local collection network for the recovery of ULAB from urban and remote rural areas through El Salvador, Costa Rica, Nicaragua and Guatemala. Whilst the collection scheme includes collecting used automotive batteries as well as domestic LAB, the basic principles are the same. Two specially designed trucks have a set weekly route with designated pick up times through the towns, villages and cities of El Salvador, Costa Rica, Nicaragua and Guatemala. Those individuals or scavengers wishing to have a ULAB collected will either, flag down the truck or leave the ULAB on the roadside for collection. Whatever method is used, the driver will respond by stopping the truck, collecting the ULAB and paying a small fee to the individual who owns the ULAB or the scavenger who has collected it. The ULAB are then transported safely to the company smelter in San Salvador for recycling in an environmentally sound manner.

The scheme initiated by Baterias de El Salvador is privately funded and relieves the local authorities in all four countries of any financial liability for the collection of ULAB.

However, because ULAB can leak electrolyte and damage vehicles that are not designed with acid resistant floors to transport ULAB, there are few large-scale "kerbside" or "roadside" collection schemes in operation. Even in Europe, most well managed domestic waste collection schemes will not collect ULAB left on the "kerbside" and insist that the owners take them to a specified hazardous waste collection center. One exception is the City London, where all waste is collected on the kerbside.

*5.2.2 Local Collection Schemes for Automotive LAB*

Pic. - The first ULAB Cage in Manila

However, for local collection from scrap yards, garages, retail outlets and so on, and especially where automotive ULAB are picked up by truck, a wire mesh cage provides a safe and convenient way of storing and handling the ULAB prior to collection.

It was evident from the UNCTAD study and the ILMC site visits in the Philippines, that local ULAB collection facilities were not necessarily easy to manage. ULAB were often stored on open ground at the rear or the side of a retail shop, or a garage or even a house. Occasionally ULAB were seen to be stored in the street outside a repair shop. Such storage practices are most unsatisfactory as acid can leak uncontrollably and children can "play" with the batteries.

Pic⌘. – The new design has wheels

Nevertheless, it is difficult to police or monitor such activities at a local level and so the solution adopted in the Philippines was the introduction of wire mesh cages. The cages are made of stainless or heavy gauge steel with a open mesh floor and the later models have wheels running on nylon bearings. The cages are chained to the outside of the shop (although the first cage in the picture was not chained at the time the photograph was taken) or garage and the ULAB are placed inside the cage, which now has a lockable lid to prevent anyone removing a ULAB. Use of a cage eliminates the risk of the build up of explosive gases and keeps the ULAB of the ground, enabling any spillage to be seen and the appropriate action to remove the contamination taken.

Closed containers must never be used to store more than one or two ULAB because of the risk of explosive gas build up in the container. The cages can also be used to send the ULAB to the local collection center, provided they are secured to the inside of the vehicle used for transport. Such use of the cages also minimizes the need to handle the ULAB, thereby reducing the risk of accidents and personal injury. In Manila these cages can be seen positioned adjacent to garages, repair shops and even in local communities. It is noticeable that in OECD and EU member countries, and in the developing world in countries such as Chile and Malaysia, there is an increasing demand on local municipal authorities to collect and recycle waste. Segregation of waste materials is the key to successful recycling and it can make the difference between a recycling program being self financing or profitable, and being a drain on public finances. Accordingly, collection bins for glass, paper, cans and plastics can be seen at many local supermarkets, community centers and retails parks. In many EU countries and the USA such collection bins can now be found in local housing estates. In some parts of London ULAB can be collected as part of the kerbside[xii] collection scheme. When local authorities are preparing their strategies for waste management it is essential that they incorporate facilities for ULAB and that they are separated from the other waste materials and placed in clearly marked bins or cages in compliance with local regulations for hazardous waste. As many municipal authorities in the EU incinerate their waste, it is important to minimize the risk of any unnecessary lead emissions by adopting procedures that eliminate ULAB from the incineration waste stream by proper collection and segregation.

## 6. Storage of Used Lead Acid Batteries

### 6.1 ULAB Reception and Control Measures

Section 3.2 of the Technical Guidelines advocates that "some control measures must be carried out at the collection points in order to minimize the risk of accidents that may cause personal injury or environmental contamination". This means that ULAB delivered to a shop, a garage, a service center, a collection center or a temporary storage depot, must be handled in a certain way and should undergo a series of checks to ensure that a used lead acid battery is safe to transport to a recycling plant.

Batteries should not be drained: The indiscriminate drainage of battery electrolyte poses threats to human health and the environment because:

- It contains high lead levels as dissolved ions and suspended particles.
- It is highly acidic and may cause burns to the skin if accidentally spilled.
- The high acidity of the battery electrolyte is detrimental to plant growth.

Every single ULAB should be inspected for:

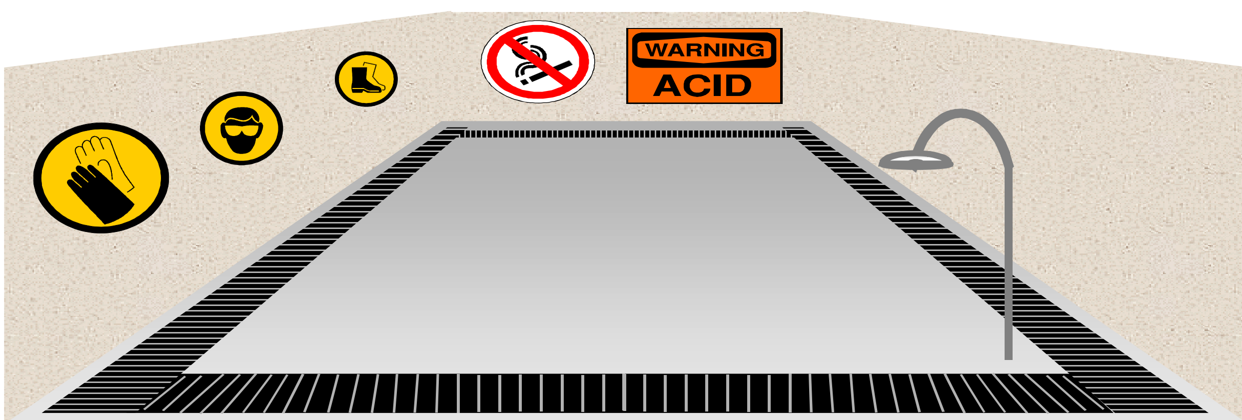
- Leaks
- Cracks in the battery casing
- Missing vent caps
- Leaking batteries, i.e. those spilling electrolyte, and these must be stored inside acid-resistant plastic containers.

Electronic testing is advised to determine whether the battery could be recharged and reused. This practice is a legitimate and worthwhile activity. Firstly, it ensures that any batteries still charged are identified and thereby reduces the risk of sparking during transit. Secondly, if a ULAB just needs to be recharged to restore it to full service, then a lead acid battery is returned to the market without the need for recycling, while at the same time, earning the ULAB collector additional income from the sale of a recharged battery. See Appendix 15 for battery testing methods.

**6.2 Storage Compound**

<u>ULAB should be stored in a secure compound</u>: to minimize the risk of accidental spillage, to allow any batteries found to be damaged or leaking to be contained and to provide a safe workplace.

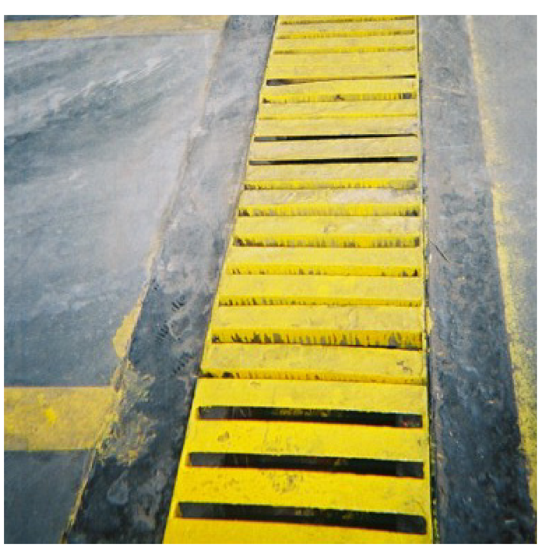
The base of the storage area must be acid resistant concrete or some other suitable impermeable surface to prevent the ingress of any sulfuric acid that might leak from a




ULAB or be spilled during handling. "Impermeable surface" means a surface or pavement constructed and maintained to a standard sufficient to prevent the transmission of liquids beyond the surface of the floor.

Pic. – A schematic of the inside of a model storage yard

If the store is under cover then an exhaust ventilation system must be installed, or simply a fast air renovation scheme, in order to avoid hazardous gas accumulation.



Pic. - Covered drainage channel at the Comercializadora de Baterias SA storage yard in the center of Mexico City.

The storage area must have a clean water supply to clean the floors and drainage channels that run into the sealed drainage system and collection sump. A sealed drainage system means a drainage system with impermeable components which does not leak and ensures no liquid will run off the floor area otherwise than through the drainage system and that any liquid run off is collected in a sealed sump.

In order to distinguish between a local or retail ULAB collection and a licensed collection site, it is suggested that no more than one ton of ULAB can be kept for more than 180 days at single location, or some form of similar restriction.

Safety procedures must be observed and employees should be wearing appropriate overalls, goggles, neoprene gloves, neoprene boots. Respirators should be available to wear if necessary. Normally respirators are not required to be worn when handling whole, un-drained ULAB, but in those cases where the ULAB is broken, there is the potential risk of lead oxide dust from the dry battery blowing into the face of the operator when handling the ULAB.

All ULAB should be handled and stored having regard for the potential fire-risk associated with them. The fire risks are associated with the possible build up of explosive gasses if the ULAB are stored in a confined unventilated container or room and the possibility that a battery might spark when short-circuited accidentally if it is not completely discharged. Fire extinguishers should be on hand in the event of fire and operators must be trained how to use them.

It is essential to install an emergency shower for use when acid is accidentally sprayed onto the skin or in the eyes and for after care First Aid kits should be available, complete with eye wash bottles and sterile solution.

A Materials Safety Data Sheet (MSDS) for LAB should be readily available for Supervisors and workers to seek additional information about potential hazards and the appropriate corrective action in the event of an accident. A typical and Generic MSDS is available in Appendix 16 and a specific MSDS for Valve Regulated Lead Acid Batteries prepared by the East Penn Company is available in Appendix 17.

ULAB must not be stored by stacking them one on top of another. The reason for this is because some makes of LAB were and are still manufactured to a design that leaves the posts or terminals and the cell

Pic. – A ULAB delivery to Funmetal SA in Venezuela showing protruding terminals and vent caps

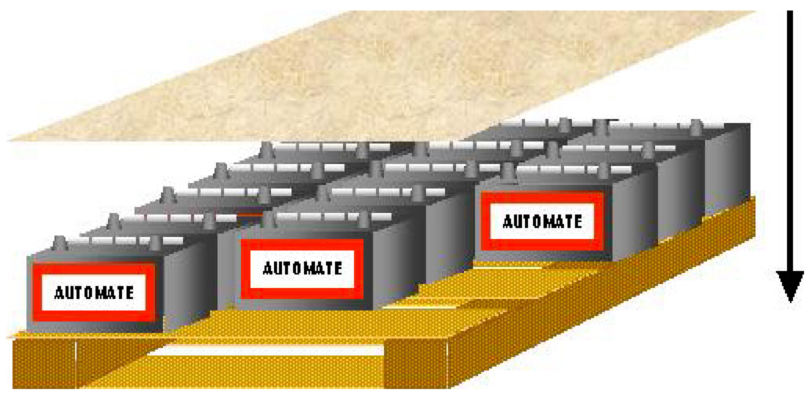

Pic. – A ULAB with the terminals and caps proud of the top of the battery (Red Circle). Fortunately, this ULAB was on the top of this pile in a London collection skip.

caps proud of the top of the battery, and there is a risk that the protruding terminal posts could puncture any battery case placed upon it. Such a puncture in the case will lead to acid leakage and risks to those handling the ULAB and the environment.
The safest way to store ULAB is on purpose built racking or to stack and pack them in readiness for transport. The package method is described in the next section.

Finally, ULAB must be stored in a secure compound with restricted access and away from children and animals.

## 7. Packaging of Used Lead Acid Batteries

Prior to packing, it is important to ensure that all the ULAB have the vent caps shut to avoid spillage during shipping. If possible, replace a missing vent cap or seal the inspection hole. Obtain a selection of caps from the nearest smelter or supplier and always have them readily available. From a practical point of view, damaged batteries can be transported with intact batteries if they are properly contained in sealed plastic containers or drums.




Pic[⌘]. – ULAB are placed on a wooden pallet and corrugated heavy duty cardboard is placed between each layer

ULAB should be stacked onto wooden pallets no more than four high to minimize the risk that the stack will become unstable. A sheet of corrugated heavy duty cardboard is placed between each layer of batteries to reduce movement, absorb any electrolyte that might spill and prevent the terminal posts from the batteries puncturing the plastic case of the battery stored above.

Pic. – The storage yard in Mexico City for Comercializadora de Baterias SA.

Pic. – The storage yard in Mexico City for Comercializadora de Baterias SA. A sheet of corrugated cardboard is placed on top of the final layer of ULAB.

ULAB stacked on a wooden pallet with three corrugated heavy duty cardboard sheets between each layer and shrink-A sheet of corrugated heavy duty cardboard is also placed on top of the final layer of ULAB so that the palletised ULAB can be stored on top of each other.

Finally, the whole stack is shrink wrapped in plastic as tight as possible to minimize any movement during transit. When storing palletised ULAB prior to transportation or shipment the layers of pallets should not be stacked more than two high.

Lead acid battery retailers participating in ULAB "take-back" or "deposit-refund" schemes should keep the pallets and corrugated cardboard that are used to wrap and protect new batteries when they are delivered from the manufacturers, to stack and pack the ULAB as they are returned. Then, when the pallet is full, that is four ULAB layers high with ULAB, collection by the local smelting company, the scrap dealer or the transport company can be arranged. This is the system used by Duncan Batteries of Venezuela in conjunction with their retailers and their secondary lead subsidiary, Fundicion del Centro.

Pic. – ULAB stacked & shrink-wrapped two high on pallets - Automotive Components Ltd.,Trinidad and Tobago.

ULAB collected in the metal cages will need to have corrugated cardboard placed between each layer of ULAB, but apart from that, the ULAB can be transported to the main collection center or smelter in the cages. The cage then needs to be returned to the drop off center or retailer for use again to collect more ULAB.

## 8. Transportation of ULAB

ULAB must be categorized as hazardous waste when making the necessary arrangements to transport them to a recycler. The main environmental and safety risk is associated with the battery electrolyte which may leak from the ULAB in transit.

Packaging the ULAB in a manner consistent with the Technical Guidelines renders them easy to move mechanically while reducing the risk of any movement during transit and thereby avoiding damaging the battery cases. As a further precaution, the guidelines recommend that the ULAB are transported in a sealed shock resistant container that will not leak any electrolyte in the event of unforeseen leakage.

The vehicle used to transport the ULAB, whether it is a ship a truck or a van, must be correctly identified, following international conventions and local legislation using the appropriate symbols and colors to identify the fact that corrosive and hazardous waste is being transported. In most countries, there are Department of Transport regulations for the transport of ULAB. It is essential that prior to the transport of any ULAB the necessary legal forms are located, completed and where required, are sent to the appropriate authorities prior to the movement of the ULAB. In some countries, the containers with the ULAB must be properly labeled, and the ULAB placed in the truck or boat in a manner that will minimize the risk to acid leakage. Failure to comply with any of the national laws and international conventions may result in civil or criminal penalties for the carrier and/or the person making the necessary arrangements to ship the ULAB.

The person designated to be responsible for the transport of the ULAB must ensure that the batteries are loaded and braced properly to prevent any damage, leakage of lead dust or battery fluid, or short circuits as the vehicle moves or a ship rolls. The pallets of ULAB or the cages must be secured to the inside of the truck using strapping attached to the battens inside the vehicle. Pallets or cages must be "snug" and any voids should be packed with wood or some other suitable material. Metal or wooden bracing should be used to block movement of the pallets at the end of the vehicle.

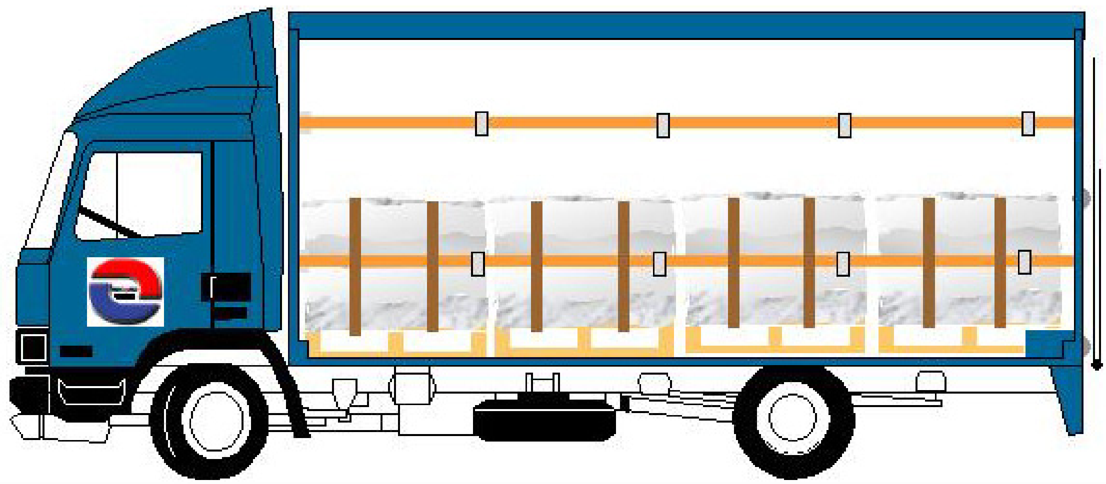
Pic. – ULAB shrink-wrapped, palletized and strapped inside the truck.

Pic. – Properly blocked back row to prevent movement of the palletized ULAB

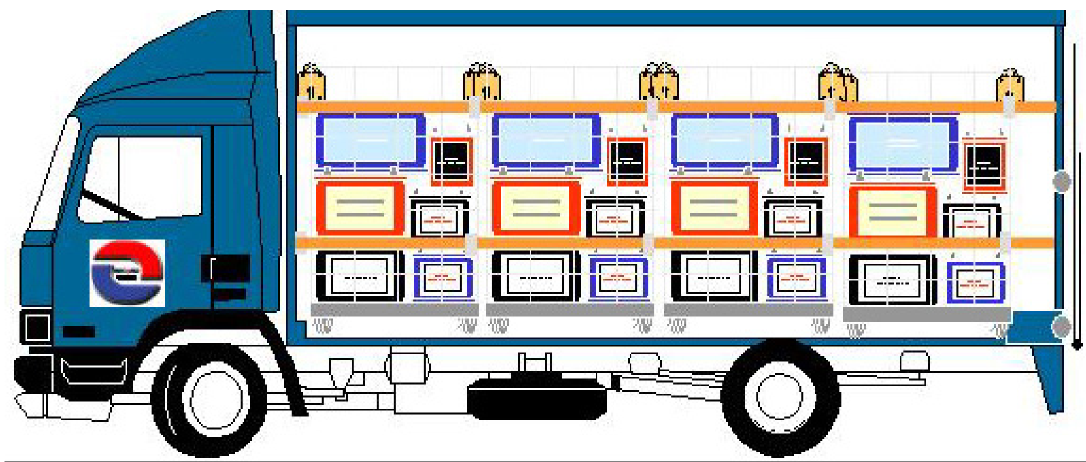
Similar procedures are recommended for packing shipping containers for the export of ULAB.

The safe collection and recovery of ULAB relies on the widespread use of wooden pallets, but it should be noted that the pallets used in the packing and transport of ULAB can be reused. Initially they should be reclaimed from the delivery of new lead acid batteries, but modern recycling plants that employ shredders can set the machines to separate and recovery the pallets. This is the case at the Fundicion del Centro secondary lead smelter and at the Enertec secondary lead plant in Mexico, they go one better and wash the pallets before returning them for reuse.

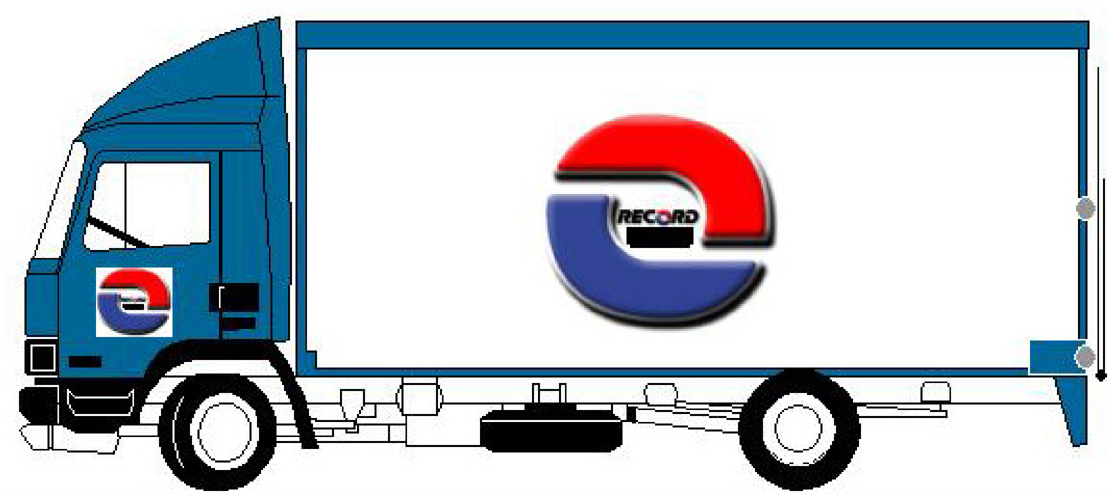
A bill of lading (see Appendix 18) or Hazardous Waste Manifest will almost certainly be required by the driver and that must match the consent documentation in the event of a transboundary movement. In many countries, hazardous waste documentation has to be kept for a number of years.



Pic. – Purpose designed ULAB pick up truck showing palletized and shrink wrapped ULAB secured by strapping to the inside battens ready for transit.



Pic. – Purpose designed ULAB pick up truck with tailgate lift and racks for the wire cages that are secured to the wooden battens inside the truck for transit.




Pic⌘. – Purpose designed ULAB pick up truck with the side down

## C - Control Strategies and Policies for the Recycling of Used Lead-acid Batteries in the Formal Sector

This part of the Training Manual will review the existing range of national profiles of ULAB collection and recycling in developing countries with a view to identifying the most suitable national policy framework. Key variables to be considered in this regard concern lead supply and lead demand in the country, imports and exports of LAB and lead scrap, the share of the formal versus informal sectors and the importance of collection and transportation costs. On this basis, this part will provide an overview of policy instruments that are best suited to the existing profiles of collection and recycling. This will include an extensive discussion of economic and other incentive measures that can be used to enhance collection and recycling of ULAB.

In addition, the following aspects of ULAB recycling policies will be assessed:

- dealing with the formal sector (normative versus a voluntary approach);
- development of a national normative framework and set up of an environmental performance monitoring and control system for the recycling industry;
- measures aimed at enhancing the role of the formal recycling sector.

### 1. The rational of material recovery and recycling

The fact that lead is so easy to melt and refine, that it has one dominant use (i.e. LAB) with a predictable life span, and that its environmental dangers are such that it precludes landfill disposal, makes the metal an ideal subject for recovery and recycling. In the last two to three decades, dissipative uses of lead, such as pigments, gasoline additives and ammunition have also significantly declined, making LAB increasingly important as major end use, which can be completely recycled. Moreover, unlike many other non-ferrous metals, lead scrap can be recycled and refined such that the recovered lead can match the quality of primary lead, that is, 9997, 99985 and even 9999[8]. In fact, the international lead market makes no distinction between lead of primary and secondary sources, because lead is sold by quality and not by origin, although the level of purity, as outlined above, has to be stated. Therefore in theory, lead can be infinitely recycled, rendering a LAB an outstanding candidate for a sustainable product. Lastly, the production of secondary lead is four times more energy efficient than primary lead production[xiii]; the "ecological rucksack" of primary lead, i.e. the amount of material used or moved in the production of one unit of primary lead, has been estimated as 1:19[xiv]. Altogether, this has led to a situation, in which (in recent years) the production of recovered lead accounts for over 60 per cent of total global lead supply, making primary lead with less than 40 per cent a supplementary source of supply[xv].

Although the factors above are compelling reasons for material recovery and recycling, by themselves they are not sufficient to make it a sustainable operation. Material recovery and recycling will only be practiced as long as the recovered material is lower or at most equal to the price of the primary material of the same quality.

For the case of ULAB, average recovery and recycling costs for pyro-metallurgical treatment vary at a range between US$ 450 and 550 per ton of lead content (taking

[8] 9997 Lead is 99.97% pure. 99985 is 99.985% pure lead and 9999 is 99.99% pure lead.

stringent environmental monitoring and pollution abatement costs into account). This price includes average transport costs of ULAB, but excludes the average profit of the recycler. If international lead prices are higher than US$ 550, lead recycling is profitable and sustainable. This has been the case in 2004, when average international lead prices have been between US$ 800 and 900 per ton. Conversely, for quite a number of years since the mid-1990s, international lead prices have ranged between US$ 400-500 per ton. There is therefore the need to keep recovery costs to a minimum, and recovery of all the recyclable components of a ULAB to a maximum, to assure the long-term sustainability of the operation. In years of exceptionally low international lead prices, governments might have to financially support ULAB recovery and recycling to preserve its environmentally sound operation.

Transport costs of ULAB can become a significant cost factor in countries with poor transport infra-structure, archipelagos or in the context of a sub-regional recycling scheme. For example, in the Philippines the transport costs for ULAB recovered in the archipelago of over 7,000 islands vary from, 5 to 16 % of the value of the shipment. Transport costs on the main island of Luzon to the main recycling plant are about 5 %; from the central islands about 13% and from the southern island of Mindanao about 16%. In this instance and similar cases, two options are available:

1) the transport network can be optimized, but cost reduction opportunities are constrained by the generally poor state of the transport system; and
2) ULAB can be pre-treated, i.e. removal and neutralization of the electrolyte and conversion of lead sulfate, lead oxide, and lead metallics in the ULAB into lead detritus (99.99% pure lead) or lead hydroxide, using hydrometallurgical recovery processes. They are lead fume free and either neutralize the battery electrolyte or convert it into saleable lead free gypsum. There are several different options available, two of which are the Placid and the Plint Processes. One process produces pure lead detritus and the other lead hydroxide. Both materials can be shipped as finished products and will not be subject to the hazardous waste regulations, thereby saving considerably on shipping costs. Once at a large pyro-metallurgical recycling plant, the lead detritus just needs to be heated and cast into ingots to produce a 99.99% pure lead and the hydroxide only needs to be heated in a low temperature furnace to decompose and produce 99.99% pure lead. In both instances no further refining is needed and the lead can be alloyed or sold as premium 99.99% lead (for more information in this regards, see Part D).

## 2. The importance of national collection and recycling profiles

Setting up effective collection systems and arranging for environmentally sound recycling of ULAB is desirable for all developing countries, but not economically feasible in every country. National approaches on control strategies and policies for the collection and recycling of ULAB in the formal sector depend on the volume of annually generated scrap batteries (i.e. the supply of lead scrap) and the "balance of power" between the formal and the informal sector. Collection of ULAB will always have to take place; their recycling in the generating country is however only justified if ULAB generation surpasses a critical mass of about 1,6 million pieces of scrap batteries per annum.[9] This volume of battery scrap generation would require a minimum vehicle population of about 3.2 million[10], which can only be found in countries with a large population or a relatively high per-capita income, such as many rapidly industrializing countries.[11]

In most of the other countries, ULAB should be collected in a sound way and then either safely shipped to sub-regional recycling hubs or exported to developed and developing countries with recycling facilities of proven ESM capacity. Such shipments would be undertaken on a regular basis among well-established partners, which reduces transaction costs, facilitates the creation of conditions for ESM and allows the concerned governmental authorities to regularly verify the ESM criteria. Transport costs for such shipments could be significantly reduced through the pre-treatment of ULAB, as outlined in the previous section.

Within these two principal approaches to ULAB collection and recycling, there is a variety of national profiles that determine the choice of control strategies. These national profiles fall into the following clusters:

a) Small country with no recycling capacity, but with a strong informal sector and relatively high collection rates of ULAB;
b) Small country that has no recycling capacity, a weak informal sector and a poor ULAB collection rate;
c) Very small country or island (with or without an informal sector) that needs to be part of a sub-regional recycling system or co-operative arrangements with neighboring countries;
d) Country with a formal recycling industry and a strong informal sector, showing high rates of ULAB collection;
e) Country with a formal recycling industry, but a weak informal sector;

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[9] As has been pointed out by several recent reviews on the technological requirements for enhancing environmental performance of pyro-metallurgical secondary lead smelters, a tonnage of around 15,000 tons of refined lead output per annum is widely regarded as the minimum scale for a conventional pyro-metallurgical secondary lead smelter in order to absorb increasing pollution control, prevention and abatement costs (see, for example, UNEP, Recycling of lead-acid batteries and the environment, Technical Report, No. 14 (1998), pp. 25 and 190). The minimum feedstock requirements for modern leaching technologies, such as the Placid and the Plint process, are not yet known. The lead content of scrap required for an annual lead production volume of 15 thousand tons is 15,500 tons, which on the basis of the lead content of a standard scrap battery translates into 1.632 million scrap batteries.

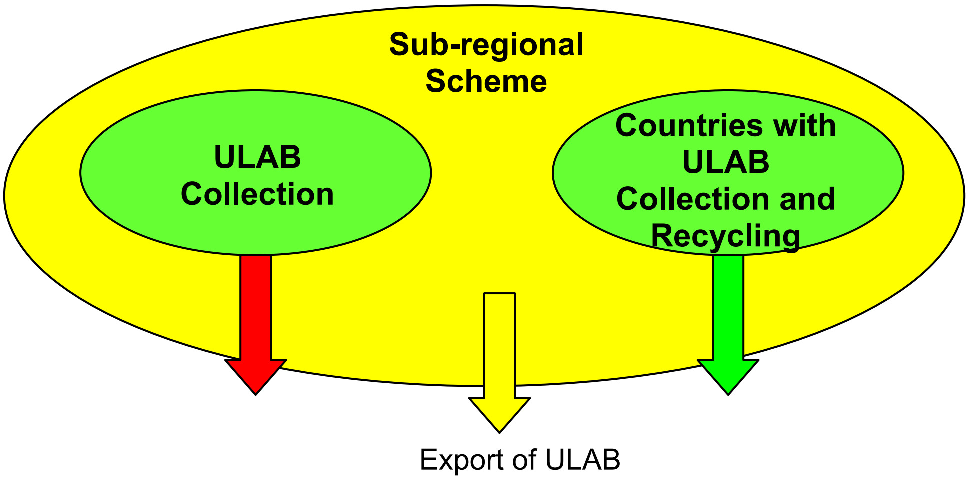
[10] The number of vehicles is estimated on the basis of an average battery life of about two years and an average vehicle structure. A shorter or longer average battery life or a different composition of the vehicle stock of a country (e.g. a higher share of trucks/buses or motorcycles/tricycles) might change this estimate.

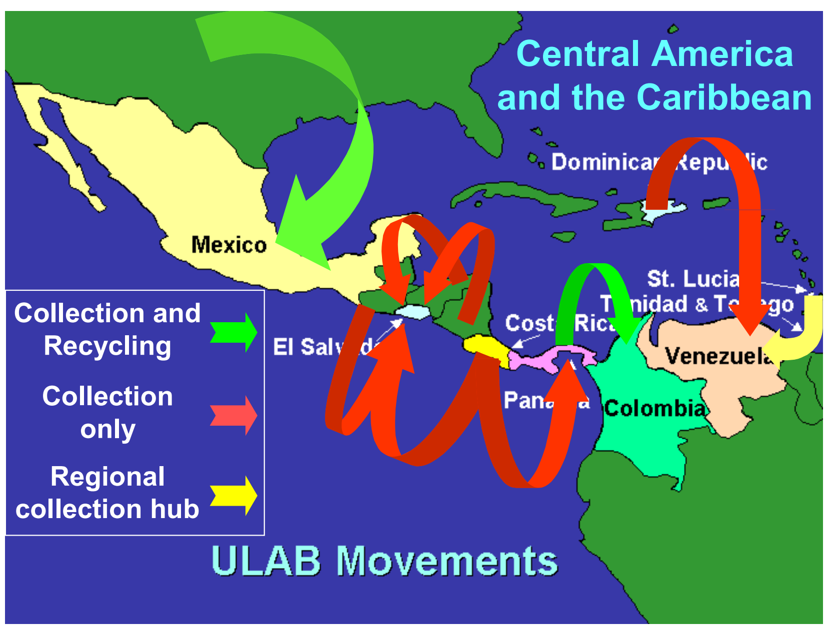
[11] Minimum scrap generation requirements are only based on vehicle batteries, the so-called starter, lightening and ignition or SLI batteries. Industrial batteries, which consist of motive and stationary power batteries (e.g. for foklifts, automatic guided vehicles, airline ground equipment or uninterruptible power supply systems or for storage of solar energy) have not been taken into account. They might generate up to one fifth of all lead scrap in ULAB, but their exact composition and importance for most developing countries is unknown. In a number of developing countries, SLI batteries are also often used for uninterruptible power supply systems. In one or the other country, this might become a significant share of all SLI batteries sold. They have also not been taken into account for the estimated vehicle population.

f) large country or archipelago with high transportation costs.

All these country profiles can be accommodated by the above-outlined two principal approaches to ULAB collection and recycling. However, the importance of the informal sector and of transport costs will bear on the specific package of policy instruments and economic incentives to be employed for each country.

Synopsis of Country Cases that Determine Control Strategies for ESM



## 3. Economics instruments and measures applicable to ESM of ULAB[12]

A ***strict licensing and control system*** for ULAB collectors and transport agents would be an effective tool to implement occupational safety and ESM requirements as set out in part B. There could be a central register of collectors and transport agents, which records their regular licensing and performance evaluation. Licensing and performance evaluation criteria, as outlined in part B, and procedures would have to be clearly defined.

***Mandatory take-back requirements or a one-for-one exchange system*** (i.e. selling a new LAB only if a ULAB is handed in) are one set of regulatory measures to increase ULAB collection. They are an alternative to a deposit-refund system, in particular in cases where a deposit might encourage informal sector activities. However, they also require that retailers and car repair shops need to follow specific instructions on proper storage of ULAB and do have appropriate storage facilities, as outlined in Part B.

A ***deposit-refund system*** aims at enhancing collection volume of ESM; it does not reduce collection costs. If combined with an information or awareness-raising campaign, it may significantly reduce the volume of uncollected jettisoned batteries. The amount of the deposit will have to be carefully set, because too high an amount might encourage battery theft or the use of reconditioned batteries provided by the informal sector (see part D).[13]

A ***recycling or transport tax*** might have to be considered in the light of the profitability of a recycling operation and the significance of the transport costs. The latter mainly depends on availability of established and well-functioning transport routes. Such a system was pioneered in Sweden, where a non-profit company (Returbatt AB) was set up to administer a collection and charging system and to publicise the desirability and advantages of recycling ULAB. If transport and recycling operations are properly managed, the need for a transport and/or recycling tax may only arise in periods of very low international lead prices, i.e. when the international lead price persistently drops well below US$ 500 per ton. Two practical safeguard approaches are possible to shield against such situation:

- Countries can impose a low, but permanent amount of a recycling/transport tax.
- The imposition of the recycling/transport tax is confined to periods of low international lead prices. While from an efficiency point of view, this is the preferable option, from a practical point of view the permanent levying of a low amount might be the easiest solution. Furthermore, such a levy during periods of low lead price should not unduly affect the price of the battery as it should cost less if the lead price is low.

[12] See also details in section B 4 of the Manual.

[13] By way of illustration, part B contains a table on the amount of the deposit/refund in several states of the United States. The amount there is as high as 10-20 percent of the price of a new LAB.

## 4. Control strategy for dealing with the informal sector

The informal sector, which consists of battery reconditioners and "backyard melters and smelters" often treats 15-30 percent or even more of nationally generated ULAB in the concerned developing countries. The major problem that arises from that situation is that the informal sector has a very low lead recovery rate of the available ULAB (at best about 40 percent for the melting operations and 90% for the smelters). In other words in the worse case scenario, 60 per cent of the recoverable lead from ULAB is not available for battery manufacturing, because it is released into the environment in highly problematic ways. Therefore, the more prominent the informal sector, the greater the environmental and health risks due to lead pollution, and the wider the domestic supply-demand gap.

In countries, where informal sector activities (i.e. battery reconditioning and "backyard melting") are significant, *additional measures to reduce partial lead recovery in the informal sector* need to be taken.[14] These additional measures are elaborated in Part D of the Manual, but should here at least be summarized for the sake of being consistent. They include short-term measures aimed at significantly reducing current levels of lead pollution caused by informal sector activities, and long-term measures that outphase undesirable activities in favour of desirable servicing and maintenance services that can be provided by the informal sector.

When dealing with issues of the informal sector it needs to be borne in mind that this sector exists because of social reasons and it meets the specific demand of cash-strapped, low-income consumers. Furthermore, the informal sector offers ample employment opportunities in low-skilled jobs using simple and inexpensive equipment.

The short-term measures to improve the occupational and environmental performance of partial lead recovery activities in the informal sector include:

- stopping the unauthorized disposal of battery electrolyte by introducing and enforcing legislative bans and providing 100 litre heavy-duty plastic drums for electrolyte storage;
- arrange for a regular pickup of these drums;
- educate and encourage owners to enforce and workers to follow simple safety instructions, such as wearing neoprene acid resistant gloves, a body apron, boots, goggles and facemasks. Owners also need to create hand and face washing facilities, introduce a regime of hand washing before eating or drinking and ban smoking at work (there are nuances in the requirements for reconditioning shops and "backyard" melting, which are elaborated on in Part D);
- legislate that formal recyclers are not allowed to buy parts of ULAB, such as defective cells. This will make broken ULAB worthless to battery reconditioners and significantly decrease the profitability of the operation. To a large extent this

[14] As mentioned in part D, the informal sector also provides a number of desirable activities that should be harnessed. This concerns the servicing of batteries, i.e. control of the charge level, recharging of the batteries and checking of the electrolyte, where applicable, repair and the collection of ULABs.

is already the case in Cambodia where ULAB reconditioning has been virtually abandoned by the informal sector because it is unprofitable.

The long-term measures to outphase undesirable reconditioning and "backyard" melting activities of the informal sector include:

- Battery manufacturers both in developed, but in particular in developing countries need to step up efforts to extend battery life (well beyond 2 years) under tropical or hot weather conditions, which exist in most developing countries.[15]
- Providing a special credit facility for low-income customers to acquire new, instead of reconditioned LAB. Such a facility would serve to overcome the cash-flow problems of many of these customers and thereby significantly reduce the market for reconditioned LAB.

It is advisable to implement a set of supportive and integrative measures aimed at turning the informal sector into a collection and servicing network. As far as services are concerned, this includes charge control, recharging and small repairs to defective batteries. The informal sector should also be adequately equipped to serve as collection and storage centers for ULAB. Moving into this direction will undoubtedly require some financial and technical support from the government. This support is however justified in the light of the social costs resulting from environmental and health damage that would arise from uncollected ULAB or significant lead contamination from battery reconditioning and "backyard" melting activities.

## 5. Control strategies for ESM in countries with no formal ULAB recycling industry

In accordance with the Basel Convention's proximity and self-management requirement for generated hazardous waste, interested countries may opt for a sub-regional management of ULAB, comprising a sufficiently calibrated recycling facility in one country (i.e. recycling hub) that processes ULAB in an ESM-compatible way for a sub-region or group of countries. This applies in particular to small islands, sparsely populated countries and all other areas with a vehicle population too small to support a viable ESM-compliant recycling industry.

Control strategies in these countries are confined to sound collection, storage and transport, as described in part B of the manual. A number of policy measures can be taken to enhance collection of ULAB. This can include:

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15 Although there has been little practical incentive for LAB manufactures in the past, there is increasing competition from LiMH battery manufacturers and so for the first time the companies with large investments in LAB manufacture really need to make a leap forward in longevity to maintain their cost advantage. This should not really be a major leap for them because the deep discharge batteries being installed in the solar installations in several developing countries have already chalked up lives in excess of 5 years. In Europe and the US these batteries last between 5 and 15 years. For more information, see: Brian Wilson, A review of the options for restructuring the secondary lead acid battery industry, in particular the smaller battery recyclers and secondary lead smelters and the informal sector, with a view to enhancing their environmental performance and improving health standards, paper prepared for UNCTAD, accessible at: www.unctad.org/trade_env/test1/publications/ battery2.pdf

- a strict licensing and control system for collectors and transport agents of ULAB;
- mandatory take-back requirements for retailers of LAB, including vehicle repair shops or a one-for-one exchange system;
- a deposit-refund system that encourages collection of all or almost all ULAB; and/or
- a recycling or transport tax;
- additional measures to reduce battery reconditioning and "backyard melting" in the informal sector;
- turning the informal sector into a collection and servicing network.

Attnetion should then be dedicated specifically to the situation arising from the activities in the informal sector. See in this regard section 4 above.

## 6. Control strategies for ESM of ULAB that are exported to the world market

Nationally generated ULAB may also be collected in a sound manner (as outlined in the previous section) and then exported to the world market, i.e. either purchased by importers in developed or developing countries. Such exports are only the second best option, because they are not always consistent with the self-sufficiency and proximity principle of hazardous waste management enshrined in the Basel Convention. In any case, if used, such exports need to meet the prior informed and consent procedure (PIC) in accordance with Article 6 of the Basel Convention.

## 7. Control strategies for ESM of ULAB in the context of a sub-regional co-operative approach

A co-operative, sub-regional approach that centres on a sufficiently large catchment area of ULAB linked to one or two sub-regional recycling hubs is a promising approach for ESM in conformity with the proximity and self-sufficiency principles of the Basel Convention. This strategy also has the potential to increase collection rates and secondary throughput thereby improving the viability of ULAB recovery operations. Such an approach is being implemented in Central America and parts of the Caribbean and based on environmentally sound recycling facilities in El Salvador and Venezuela (as illustrated in the graph above). Such an approach may also be well suited for the South Pacific Islands and various countries in Southern Africa bordering South Africa.

In those countries that only collect, temporarily store and safely ship or transport their ULAB to the sub-regional collection or recycling hub, control strategies are identical to those set out in section above. Control strategies in the host country of the sub-regional recycling hub, which imports ULAB from neighbouring countries, are similar to those outlined in the next section.

What complicates a co-operative, sub-regional approach is the fact that policy tools such as a transport and/or recycling tax need to be collectively managed. This starts with an effort to optimize transport routes and reduce transport costs, while meeting ESM standards as set out in section B. Only after such optimization is implemented, should discussions be held on the need to levy a transport tax. The same logic should apply to the collective consideration of a recycling tax. Such tax should only be considered by the member countries of the sub-regional recycling scheme, and only after the recycling hub enterprise has made every effort to optimize capacity utilization (including the correct calibration of the company size) and operating costs, while meeting ESM requirements. If transport and/or recycling taxes are levied, a decision among participating countries has to be taken on the modalities of the transfer of the levied resources to the recycling hub and the contracted transport companies.

## 8. Control strategies for ESM in the context of a national collection and recycling scheme

Developing countries with a sufficiently large stock of vehicles (as mentioned above, at least some 3.2 million vehicles, although this figure might vary as a function of vehicle composition and average battery life) and industrial batteries, including those used in UPS systems in the IT sector, should set up their own national collection and recycling schemes. For such countries it is also advisable to make recycling an integral part of manufacturing of new vehicle batteries, i.e. developing a high degree of self-sufficiency (or closed loop) in terms of ULAB management and supply of new lead-acid batteries.

Before turning to the control strategies for ESM of ULAB in this regard, it is necessary to highlight one critical problem that complicates the recycling of ULAB and manufacturing of new lead-acid batteries – a supply-demand gap of lead for battery manufacturing

### 8.1 The domestic supply-demand gap of lead for battery manufacturing

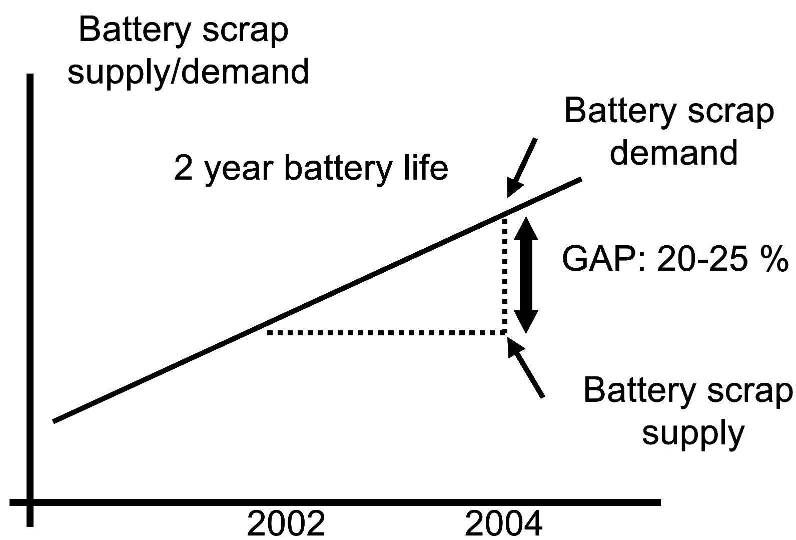
Several developing countries, such as the Philippines and El Salvador, have made quite remarkable headway in increasing the collection of domestically or regionally generated ULAB. Even so, most of these countries have realised that there persists a quite significant gap between domestic supply of lead scrap and the domestic demand for lead for new batteries. In the Philippines, for example, the domestic supply-demand gap was estimated to be in the order of about 40 percent in terms of total national lead demand in the 1990s[xvi]. This issue is important for calibrating the size of the recycling and battery manufacturing industry in the concerned developing countries. On the one hand, the size of the industry should be adequate to cope with future demand for new batteries. On the other hand, the recycling (and battery manufacturing) industry should not be too large as compared to the domestic lead scrap generation volume because otherwise significant imports of lead scrap, lead concentrate (i.e. primary lead) or lead bullion (finished lead) would be required as feedstock for new battery production.

There are three principal causes for the domestic supply-demand gap of lead: (i) the very high growth rates of vehicle populations in concerned developing countries; (ii) the significance of the informal sector in battery recycling; and (iii) the large number of ULAB that remain uncollected.

#### *8.1.1 The dynamics of vehicle population*

Vehicle population in many of the concerned developing countries grows at annual rates of 7-10 percent. This means that vehicle populations double in less than a decade. Although a certain share of these new vehicles is imported with new batteries on board, many of the concerned countries have a significant vehicle manufacturing capacity, which requires new batteries.

Even if all domestically generated ULAB were collected and made available to the recycling and battery manufacturing industry, there would still be a supply-demand gap because of the dynamics of vehicle population growth. The available battery scrap in any single year is a function of the battery consumption volume one average life-time ago for a standard battery, i.e. about 18 months to 2 years in most of the concerned developing countries. By way of illustration, the volume of domestically generated battery scrap in 2004 is determined by the battery consumption volume of 2002. In the light of the dynamics of vehicle population and the thus resulting demand growth, this factor alone creates an inherent domestic supply-demand gap of about 15-20 percent in volume terms.




Domestic supply-demand gap

This means that even if all annually generated ULAB were collected in a country, under conditions of high car population growth that fuels lead demand, there still is a supply-demand gap of 15-20 per cent that needs to be bridged by other sources of lead supply.

### *8.1.2 Uncollected ULAB*

Although the real figures of uncollected ULAB in developing countries are often overestimated because of the role that scavengers and other informal waste collectors play in recovery anything of any value whatsoever, estimates suggest that 5-10 percent of the domestically generated ULAB may remain uncollected. The share tends to be higher in periods of low international lead prices. This uncollected lead scrap volume is unavailable for recycling and battery manufacturing.

The size of the domestic lead supply-demand gap, the calibration and effective use of national recycling capacity are the key variables that need to be influenced by control strategies for ESM.
The control strategies for ESM therefore have a three-fold objective:

- to reduce collection and recycling costs in order to make recycling economically viable;
- to improve the environmental performance of ULAB recycling; and
- to keep the domestic supply-demand gap for lead as small as possible.

From the point of view of the Government, there are three possible policy approaches to meet these objectives:

- Allowing high capacity utilization at licensed smelters;
- Significant governmental intervention and financial support; and
- Combining both approaches.

**Possible Packages of Policy Approaches**

| **I** | **II** | **III** |
|---|---|---|
| **Allowing High Capacity Utilization at Licensed Smelters and Battery Manufacturers** | **Significant Government Intervention and Financial Support** | **Combination of Approaches I and II** |
| a) supplementary regulation prices and public financial support for collection | a) collection<br>b) R&D for prolonging battery life | a) if international lead temporarily fall much below US$ 500 per ton |
| b) private sector investment in new smelting technology and R&D for prolonging battery life<br>c) public support for improving sales conditions of new batteries | c) production of low-price battery line<br>d) facilitating use of environmentally sound technologies | b) if domestic and foreign demand for new batteries significantly shrink |

**8.2 Allowing high capacity utilization at licensed smelters and battery manufacturers**

This package of policy measures aims at allowing a high capacity utilization among licensed
secondary smelters and battery manufacturers so that generated profits can be reinvested into
- enhancing collection;
- R&D into prolonging battery life;
- process improvement for pollution abatement; and
- the use of new process technology.

Such reinvested private profit by licensed recyclers substitutes for public financial support under policy packages I and II. Profits tend to increase with capacity utilization because overheads, such as salaries and wages, maintenance costs, pollution control and abatement costs as well as depreciation remain unchanged, thus lowering production costs per unit of refined lead output.

The higher the capacity utilization and the international price of refined lead, the lower the need for public financial support. The government will however still have to provide some supplementary regulation and public financial support. The former concerns the imposition of the mandatory return of ULAB to licensed battery dealers and strict control of operating and scrap trading licenses. Whereas the latter implies;

1) support to battery reconditioners and "backyard" smelters for easing their gradual integration into the collection infra-structure of licensed smelters and the sales and service infrastructure of licensed battery manufacturers, and
2) creating a government-supported credit scheme, which offers very attractive sales conditions to cope with the cash flow problem of many customers in developing countries. The government may also consider the use of some economic instruments for enhancing collection of domestically generated scrap batteries, such as a well-calibrated deposit-refund scheme and the imposition of a battery tax, or alternatively surcharges on gasoline and car sales taxes.

Although this policy package will enlarge the collection volume of domestically generated battery scrap for licensed smelters, domestic lead supply mayl still fall short by, in many instances up to 20 per cent of the demand for SLI battery manufacturing. Therefore, to achieve a high capacity utilization among the principal recyclers and battery manufacturers, additional supplies of lead will most likely be required. Closing this supply and demand gap will require some import of refined (primary) lead, new batteries or imported battery scrap. Of the three options, undoubtedly the import of ULAB would normally be the preferred choice because it provides feedstock to the secondary smelters, thereby raises their throughput and helping them to remain viable while also securing employment for the workforce. From a business perspective, the import of ULAB provides industry with an opportunity to add significant value to the recycled materials. The government would also welcome the import of ULAB because the immediate adverse impact on the balance of payments for ULAB is far less than the impact for imported refined lead. In addition, in the case of regional collection and recycling the import of ULAB, essential for use in local industries, is permitted under the Basel Convention.

### 8.3 Significant governmental intervention and financial support

This policy package is based on the assumption that the domestic lead supply-demand gap for SLI battery manufacturing is significant and that imports of refined (primary) lead and new SLI batteries are preferred to bridge the supply-demand gap. The consequence for the secondary smelters in the formal sector are that they will continue to suffer from low capacity utilization and this will adversely affect profitability and may result in job losses in the recycling sector.

In order to enhance collection of domestically generated scrap batteries by licensed recyclers, the following regulatory measures should be taken:

- mandatory return of scrap vehicle batteries to licensed battery dealers;

- strict control of operating permits for recycling facilities;
- regular control of the environmental performance of recycling facilities; and
- national trade and auctioning of scrap batteries shall be limited to operators with a valid license.

In addition, the government might consider the introduction of a carefully calibrated deposit-refund scheme for enhancing collection volume and the imposition of a tax on new batteries, which can be used to offset collection costs of licensed recyclers. To be effectively levied, administered and used, the battery tax may require the forging of a consortium by the government or in a government-assisted way, rallying smelters, battery manufacturers, importers, and scrap traders. A battery tax may be replaced by direct public financial support fuelled by a surcharge on gasoline or car sales taxes.

To undermine demand for reconditioned batteries, the government will have to provide significant financial support to research and development into new batteries with an extended life under local (e.g. hot weather conditions). In this regard, there is room for regional co-operation, which may significantly reduce costs per collaborating country.
Besides financially supporting production of new batteries with a longer life, there will also have to be provisions for running a credit scheme, which offers very attractive sales conditions to cope with the cash flow problem of many customers in developing countries. There will also be the need to financially support the transformation of battery reconditioners and "backyard" (s) melters into collection and service points for licensed secondary lead smelters (for more detail, see part D).

As far as the facilitation of the restructuring of the licensed recycling sector is concerned, the geographical relocation of some small modern smelters will have to be financially eased. In the light of the low capacity utilization and therefore investment reluctance of the formal recycling sector, public financial support will also be required for more costly process improvements and the deployment of new process technology. In this regard, tax and duty free import of equipment might be one measure to be considered by governments.

The overall amount of public financial support inversely correlates with the level of international lead prices. This policy package is likely to be the most effective, but also the most inefficient, i.e. expensive.

### 8.4 Combination of government intervention and allowing high capacity utilization

This package of policy measures should be regarded as partial shield for assuring the continuity of efficient and environmentally sound battery recycling and manufacturing against the worst whims of international lead prices and economic recession.

To avoid any misunderstanding, the economic rational for recycling, i.e. being more cost-efficient than primary lead extraction, cannot be uncoupled from the medium-term trend of international lead prices. Therefore, the government can only provide some assistance so that the drive towards environmentally sound recycling and management of lead is not jeopardized by brief periods of very low international lead prices. However, the costs can be reduced by regional co-operation that provides a sufficient feedstock of ULAB for recycling and shares costs for R&D into modern recycling technology and the development of batteries with a longer life and better adapted to local conditions.

## D - Control strategies and policies for the recycling of used lead acid batteries in the informal sector, with a view to enhancing their environmental performance and improving health standards

### 1. Introduction

### 1.1 The Informal Sector

What is the "Informal" sector in the context of ULAB recovery? To answer this question there are a few concepts about ULAB recovery in the developing world that are important to note. Firstly, the concept of calculating percentage recovery rates for recyclable materials is a "First World" concept, and is necessary because so many valuable materials are discarded as "waste" and not recycled.

Such a calculation is not necessary in the majority of developing countries. Any material that is discarded as a waste and can be recycled will have a monetary value, albeit small in many cases. Nevertheless, recyclable materials whether discarded as waste or not, will be collected, sorted, graded and sent to a recycler to be either recovered, reused or converted into some other material or product.

However, this scenario is somewhat simplistic, because sourcing, collecting, sorting and grading scrap materials is very time consuming and most large scale commercial organizations, even those in the developing world, find such an operation, unprofitable. Consequently, such scrap collection and sorting is invariably undertaken by those people who are unable to gain employment in professional, vocational, retail or clerical positions. Very often, these scrap collectors are from the poorest people in the populations of the world. They will often be found working on the streets, in their homes or anywhere they find the scrap materials. Time is not a cost to them, time spent collecting and sorting scrap is a source of valuable income, no matter what the hourly rate might be or how little the return.

Countries have different names for those individuals who collect scrap, but the most common is "Scavenger" and so from this point onwards this will be the name they are assigned. In those developing countries with either indigenous lead smelters or easy access to a secondary lead plant in an adjacent country the scavengers are so efficient at collecting scrap, that recovery the rates would probably reach close to 100% for most consumables, and certainly for ULAB.

Whatever the contribution of the informal sector to the overall collection of ULAB, the ability of the "Informal" sector to collect recyclables is not matched by the quality of its recycling operations. In the case of ULAB, and depending on the smelting or recovery processes being used, between 10 and 60% of the lead content of battery scrap is lost to the environment when recycled by the "informal sector". In addition, in the vast majority of cases, little or no regard is given to environmental protection measures or occupational health.
In those countries where government permits are required to operate lead producing plants, none of the people in the "Informal" sector will have obtained a permit or license to work, or will have even applied for one.

Furthermore, the businesses, the owners and those employed will, most likely, not pay any taxes, because in many developing countries the whole operation will be illegal and existing only in the "black" economy. This means that a Government not only fails to collect income for the state, but the society will suffer from, and pay a price for the consequences of the illegal operation and the inevitable damage to the environment and the ensuing ill health of the workers and populations living close to the recovery operation.

Ideally, government policies towards the ULAB recycling industry should be formulated such that secondary lead plants operate only under strict licensing laws and the illegal and often clandestine activities of the informal sector are eliminated. Such policies, if applied successfully, raise the environmental performance of the recyclers and thereby considerably reducing environmental contamination, occupational and population lead exposure as well as increasing lead recovery.

**1.2 The Social Dimension**

It can be relatively easy after assimilating, collating and analyzing ULAB information to formulate and pursue policies and programs to improve environmental performance and reduce population exposure to pollutants such as lead and battery electrolyte. That is relatively easy compared to the understanding of determining the social impacts of any policies and program, particularly economic instruments. Indeed, so much so, that the social impacts of policy decisions can be overlooked and there is then a real risk that the standard of living for those directly affected could be adversely effected. Certainly, childhood, population and occupational lead exposure should be minimized and set at levels where personal health and well-being is not compromised. However, if policies designed to improve environmental performance and reduce population lead exposure significantly reduce the earnings potential of those engaged in ULAB recovery, there is a real risk that families' standards of living might fall drastically.

This section of the Manual will not include options and strategies that defer improvement projects and technologies designed to raise the standards of environmental performance. Nevertheless, it will emphasize how important it is to take into account the social needs, priorities and aspirations of those people working in the ULAB sector who are directly affected by any changes to Government policies, national legislation, new technologies and changes in trading patterns.

Unfortunately, assessment tools that take into account social needs, priorities and aspirations of those people affected by environmental policies that result in changes in technology or working practices have really been a subset of the "tried and tested" environmental impact assessment[xvii].

It is a sad fact that governments and development agencies have tended to focus on the predicted overall benefits on the "horizon" and look straight through any adverse social impacts that might impede change. In 1996 Dr. John Hay wrote in his submission to UNEP that, "Sometimes the environmental, cultural and human health and safety impacts of a proposed technology investment are overlooked by those advocating the use of a new or upgraded technology".

Indeed, many governments have used social impact assessments (SIA) to either determine strategies to offset any public unrest, remove the populations affected or calculate compensation[xviii]. To be effective SIA should predict and evaluate the social implications of an environmental project while it is still in the planning stage, and outcomes used to accentuate the positive opportunities as well as mitigate the adverse social consequences of a policy, a program, or an environmental project while it is still in the planning stage. Of course, this can only be achieved with informed consultation between government or local authority representatives, the developers and the local communities, together with other interested parties such as environmental NGOs and wildlife preservation groups.

UNEP has been in a unique position over the last 25 years to observe at first hand many of the advantages and limitations of traditional SIA and decided to design a tool for policy makers that addressed its main. This potentially useful tool, now know as, "Environmental Technology Assessment" or EnTA was developed over a number of years from 1993 onwards (See Appendix 19). The advantages of the EnTA process are threefold.

- Firstly, it forces planners to look at the overall project objective and in the event that a technology or process is preferred, as is usually the case, then EnTA requires that planners consider alternative or rival technologies and processes, and assess their impacts.
- Secondly, from the outset of the EnTA process community groups and NGOs must be involved in the assessment. This is so important because people's way of life, their culture, their community and their values vary and cannot always be predicted. There is no "one size fits all" when it comes to determining social impacts.
- Finally, and this it the real advantage the process, it ranks the various technology or procedural options for environmental, social and economic benefits, thereby simplifying the decision making process and at the same time making it more objective.

In 2003, there was a move to redefine SIA, and the International Association for Impact Assessment (IAIA) outlined the following principles as a basis for re-directing the use of SIA.

1) The goal of impact assessment is to bring about a more ecologically, socio-culturally and economically sustainable and equitable environment. Impact assessment, therefore, promotes community development and empowerment, builds capacity, and develops social capital (social networks and trust).
2) The focus of concern of SIA is a proactive stance to development and better development outcomes, not just the identification or amelioration of negative or unintended outcomes. Assisting communities and other stakeholders to identify development goals, and ensuring that positive outcomes are maximised, can be more important than minimizing harm from negative impacts.

3) The methodology of SIA can be applied to a wide range of planned interventions, and can be undertaken on behalf of a wide range of actors, and not just within a regulatory framework.
4) SIA contributes to the process of adaptive management of policies, programs, plans and projects, and therefore needs to inform the design and operation of the planned intervention.
5) SIA builds on local knowledge and utilizes participatory processes to analyze the concerns of interested and affected parties. It involves stakeholders in the assessment of social impacts, the analysis of alternatives, and monitoring of the planned intervention.
6) The good practice of SIA accepts that social, economic and biophysical impacts are inherently and inextricably interconnected.
7) Change in any of these domains will lead to changes in the other domains. SIA must, therefore develop an understanding of the impact pathways that are created when change in one domain triggers impacts across other domains, as well as the iterative or flow-on consequences within each domain. In other words, there must be consideration of the second and higher order impacts and of cumulative impacts.
8) In order for the discipline of SIA to learn and grow, there must be analysis of the impacts that occurred as a result of past activities.
9) SIA must be reflexive and evaluative of its theoretical bases and of its practice.
10) While SIA is typically applied to planned interventions, the techniques of SIA can also be used to consider the social impacts that derive from other types of events, such as disasters, demographic change and epidemics.

Significantly, the principles make it clear the need to not only involve stakeholders in the assessment process, but to take account and act on both positive and negative outcomes. However, although the principles recognize that the social, economic and biophysical impacts are inherently and inextricably interconnected, they fall short of finding a way to weight or rank outcomes to determine whether a change in policy, procedures or a technology based development merits pursuing.

## 2. Practices in the informal sector

It has been found in some instances that informal activities involve battery servicing and recharging. In these instances, failed batteries are returned for use after the electrolyte has been topped up with de-ionized water, or the battery simply recharged, or a combination of both.
However, in many cases ULAB are "reconditioned" by the informal sector. This means testing "spent" batteries delivered to their premise to ascertain whether the battery can be reused by just recharging the cells or whether one or more of the batteries cells requires replacing due the build up of sulfates on the surface of the active materials. If the battery merely requires recharging, it is quickly resold after a "boost" overnight charge and the electrolyte topped up with either distilled or de-ionized water.

Batteries with defective cells require more drastic action and cells that are inactive due to the build up of sulfates have to be treated, or removed and replaced. Where the build up of sulfates is not too thick, there are chemicals that certain reconditioners will add to the battery electrolyte to remove enough of the lead sulfate layer from the active surface on the battery plates to enable the battery to be recharged and put back into service. When chemicals are ineffective, reconditioners will usually break open the battery by cutting through the rubber or polypropylene weld at the top of the battery case and removing the top complete with the positive and negative terminal connections. Using simple measuring and observation techniques, the battery cell or cells that are "spent" are identified and replaced by cannibalizing another battery with some “good” cells. The internal cell connections within the battery are restored by welding the links between the cells. When a used battery is not available to be cannibalized the reconditioner will often purchase battery plates from a battery manufacturer. The positive plates are sometimes reused up to three times. The top of the battery that was removed to change the plates will then be replaced, glued to the base section and the battery recharged prior to resale. Electrolyte is replaced and topped up as required.

The expected battery life from these reconditioning methods will vary tremendously as some or all of the cells will fail shortly after resale. Experience has shown that some reconditioned batteries will fail after about three months, although many can last for five or six months, but useful life is very short compared to the expected two or more years life of a new battery, even in the hottest of climates.

Reconditioners rarely pay any attention to health, safety or the environment and those cells that are "spent" and batteries that are beyond "reconditioning" will be broken open and the acid “dumped” by washing down the street drain or allowed to percolate into the soil at the rear of their premises. The battery electrolyte is disposed of because it has no commercial value. The rubber or polypropylene cases are sold to a plastic recycling plant or directly to a battery manufacturer for reuse. The battery plates will be set aside, usually at the rear of the premises and allowed to dry. The dried plates will then be placed in large clear heavy duty plastic bags and usually sold by weight to a smaller secondary smelters or a backyard melting operation.

Most reconditioners will also sell new batteries and offer battery servicing to customers, so it is quite difficult sometimes to identify shops, garages and retailers that are engaged in environmentally unsound practices.

In countries with fishing industries, small cottage melters can be found. The reason is that there is a ready market for lead fishing weights that are easily cast from molten unrefined lead bullion. Typically, those involved in melting operations will work from the backyard of domestic premises or on a larger scale from abandoned industrial premises. None of these cottage businesses will be licensed lead recyclers and it is also probable that lead melting is not the only metal recovery activity. Very often lead melters' primary source of income will be derived from lead metal recovery from the collection of industrial and automotive battery scrap, because they can obtain a better price for the separated metallic lead content, when cast into fishing weights, than the whole scrap battery or the plates if sold separately.

Cottage melters break open the scrap batteries with an axe or a circular saw. The dilute sulfuric acid is disposed of by either tipping it into drains or rivers, or allowing it to percolate through the soil into the surrounding groundwater. The rubber and polypropylene cases are sold to plastic recyclers for eventual resale to the battery manufacturers. The lead battery plates, complete with the lead oxide and sulfate pastes still embedded in the battery plate grids are melted in large open kilns or cast iron "pots" of various sizes. The metallic lead grids melt easily and the metal is tapped from the kilns or pots and cast in moulds to produce unrefined lead ingots for remelting and casting into fishing weights. It is most unlikely that any backyard melter will have a furnace capable of recovering the lead from the paste. The most likely scenario is that once the metallic lead in the battery grids has melted and been cast into metallic ingots the melting pot or kettle will be emptied onto the ground ready for the next batch.

The waste paste tipped from the pot will be in the form of a heavy slag or residue with a lead content of over 90%. The most profitable method for disposal of this lead rich slag would be to sell it to a small or large smelter, but the most likely fate for this waste material is to be dumped either in the river, the rear of the melter's dwelling housing or some remote part of the countryside.

## 3. Gathering Information and Data

Gathering information and data about the activities of the informal sector is important and essential if the right decisions are to be made about exactly what measures will effectively improve environmental performance and reduce population exposure.

However, collecting such information is usually very difficult. The fact that the informal sector activities are usually illegal, if not the collection stage, then the final smelting and refining stages, means that as soon as questions are asked about a particular operation, then either the owner is hostile to those asking the questions or the operation closes and moves somewhere else. In these cases, the informal operation will become clandestine and often operate only at night to minimize the risk of detection.

Faced with these difficulties many legally based policies might fail to address the problems posed by the informal sector, unless there is a sufficiently large and well trained force of inspectors who can not only keep track of the illegal operations, but have the powers to arrest the owners and close down the smelters. Experience has shown that very few developing countries can find the funds to employ an adequate team of inspectors.
Accordingly, information about the extent of the informal sector's activities has to be determined by secondary means. That is, by obtaining as much relevant data about the activities of the licensed and formal sector, especially the battery retailer sales and returned ULAB. It is also very important to find out from government vehicle registration offices the number of automobiles, trucks, tractors, buses and motorbikes on the roads so that the numbers of batteries in use can be calculated. This information should also be cross referenced with vehicle, truck and motorbike import data from the Customs Office.

The battery retailers will be able to supply information about the average life of the various batteries sold and this figure will vary from country to country depending on the climate, the type of battery, use and care and quality.

Collating and analyzing all this data will provide useful information about annual battery consumption and the likely numbers of ULAB available for recycling each year. The numbers of batteries returned to the battery retailers in the formal sector and sent to licensed recyclers together with the numbers of domestically sourced ULAB any licensed recycler will, by difference, determine the extent of informal activities.

In those cases where informal activity levels are significant, it will be important to establish the nature of the activities and the markets for any lead products produced.

When inspecting premises suspected of engaging in battery reconditioning look out for discarded and empty battery cases, clear polythene bags of used battery plates, welding equipment, discolored or corroded concrete floors and plastic adhesive. Look at the hands of the operators because they are usually covered in light brown acid burns.

The clandestine activities of the ULAB melters are the most difficult to track down. Melters rarely use the same site twice; unless the operations are based at their homes, even then evidence of melting activities can be washed away in heavy rain. Even interviewing fisherman and asking them where they purchase fishing weights is not always helpful as many fishermen make their own weights by melting battery grids. Always look for empty battery cases and signs of scorching on the ground as evidence of ULAB melting operations.

Collecting data and information to determine the extent of informal activities and estimate their environmental impact is best undertaken on a formal basis using questionnaires that can be sent to the various government ministries and used as the basis for an interview when conducting site inspections.

## 4. Enquiries and Surveys

Designing questionnaires that will provide information useful in the formulation of policies and strategies to improve environmental performance and reduce population lead exposure is not just about listing data requirements. In order to formulate effective policies and implement strategies to deal with the activities of the informal sector a picture has to be built up of their ULAB sources, product markets, social behaviors and health so that policies provide incentive for change.
Furthermore, the questions should also provide a vehicle for effective communication during site visits, so that the questions engage the workers and owners of informal ULAB recovery operations in a dialogue with the interviewers. In this way, information can be exchanged and as data is collected, the people being interviewed can be given information about environmental and health risks and advice regarding simple ways and means to reduce those risks.

Questionnaires should be designed to cover these six areas where appropriate:

1) General Information – Name of the company or site, location, nature of the business, number of employees.
2) Process – Describes recycling and recovery processes for ULAB, including reconditioning and servicing.

3) Occupational and Environmental Exposures – Precautions taken, if any, to minimize lead emissions, reduce the risk of acid burns to the skin and eyes, and efforts to control discharges of battery electrolyte into the environment.

4) Retail and Collection – The numbers and types of batteries sold and the amount of ULAB collected. How the batteries are collected, stored and transported to a recycler. The types of lead acid batteries sold in developing countries are not in the same proportion as the percentages sold in developed countries. For example, virtually all computers in the developing world, even domestic PCs, are connected to a UPS unit because power supplies are often disrupted and suffer from peaks. This is not the case in any of the developed countries, where power supplies are stable and a simple surge protector will suffice to counter peaks.

5) Awareness and Attitudes – What knowledge and information owners and workers have about the potential occupational health risks if precautions to minimize lead exposure are not taken. What do those who work in the informal sector know about the environmental damage caused by the indiscriminate discharge of battery electrolyte into the environment?

6) Domestic Use – In many developing countries without direct electricity supplies, domestic lighting and electrical appliances are powered from 12 volt automotive batteries. It is essential, therefore, to find out the extent of such usage and how the batteries are used and discarded or recycled.

## 5. Analyzing the Results

When analyzing the results it is advisable to take a life cycle approach as a first step. Trace out the many varied paths that a LAB can follow from manufacture or entry into the country to recovery or disposal, including any intermediate steps such as reconditioning and servicing, where a ULAB might be returned for use.

The completion of such a chart will show the routes that ULAB take through the informal sector, but if compiled correctly will also show the preferred routes through the formal sector. Obviously, the preferred option would have all ULAB channeled through the formal sector for recycling to ensure environmentally sound recovery.

Accordingly, it is important to study each deviation that a ULAB makes from the preferred routes through the formal sector to a route that takes it through the informal sector. Establish the likely reasons why an informal route is taken. Is it for economic reasons? That is, has a person with a ULAB been offered a cash incentive to pass the ULAB to the informal sector? If so, what was the cash incentive? Was the ULAB collected by an informal trader because a retailer in the formal sector did not collect the ULAB? In which case, are changes in the collection infrastructure needed?

The same chart used to plot the life of a LAB can then be used to determine the environmental and occupational health risks associated with the various stages of its life. At each stage of the battery's life make a note on the chart of the environmental and occupational and population exposure threats. (See chart on section A, paragraph 8)

To supplement and complement environmental and population sampling for lead contamination and exposure, particularly when results are in need of interpretation, the questionnaires will enable a clear picture of the reasons for any lead exposures to be established. The questionnaires will also indicate where effluent discharges and population lead exposures arising from the informal activities are likely to occur. It is very difficult to undertake proper environmental and occupational sampling in the informal sector, so the questionnaires are a very useful source of information enabling many of the data gaps to be determined. Thought then has to be given to explain why the informal sector causes such environmental damage and decide how it could be curtailed and ultimately stopped.

## 6. Social Interactions

Whilst lead bullion tonnages produced by the informal sector can now be determined in some detail, in order to estimate the full economic impact of the informal sector there is a need to understand the social interactions between the informal and formal sectors and social reasons for the existence of the former. To an extent, this can be achieved by comparing the two sectors and their respective societal components.

In this respect, the formal sector is comprised of licensed battery recyclers and battery retailers that return ULAB to the regulated secondary smelters. These organizations are part of registered corporations paying tax and abiding by the prevailing legal requirements for ULAB trading and financial accounting.

In contrast, the informal sector comprises unregulated "backyard smelters" and ULAB reconditioners usually owned and managed by small family groups. Tax is not normally paid and prevailing environmental and employment laws are invariably ignored.
Those people working in the informal sector are almost invariably from the poorer sections of society, that is, not only are they poor financially, but with little or no formal academic education. Income derived from ULAB recovery might make the difference between destitution and a family's survival under the same roof and a meal day.

Social impacts are not the same across all sections of society and without a proper scientific analysis of the factors involved predicting social impacts is merely conjecture. What may be a perfectly valid policy decision for environmental reasons may result in undesirable social changes that are unwelcome in certain quarters, especially if the policies deprive people of vital sources of income and job opportunities. Understanding the social situations in any country or region is essential in determining environmental policies that will be supported by the local populations. Environmentally sound recovery of used batteries depends very much on the initial actions and decisions of local people, that is, whether to sell the ULAB to the informal sector for cash, or return the ULAB for recycling through the battery retailer and the formal infrastructure. Accordingly, if environmental policy decisions adversely affect populations, especially the poor, then even the best-intentioned policies can easily fail if they depend on public support to succeed.

### 6.1 Enquiring about social impacts

Social repercussions can be difficult to predict, but there are some basics principles that can provide a very useful guide to the likely social impacts. Firstly, it is important to collect as much relevant information as possible about the likely environmental impacts of various policy options. Then prepare a matrix as shown in Diagram 1, listing the series of policy options planned to improve environmental performance, column A, a column showing the environmental impact, B, together with the lists of the social groups or populations most likely to be affected by the policy changes, that is C to E.

| A - Policy Options | B Environment | C - Workers | D - Children | E - Population |
|---|---|---|---|---|
| Ban ULAB Reconditioning at Battery Retailers | | | | |
| Introduce LAB Deposit/ Refund Scheme | | | | |
| Set up ULAB Collection Centers | | | | |
| Improve Battery Service Centers | | | | |
| Educate Workers/Populations about Lead Risks | | | | |
| License Scheme for Lead Smelters | | | | |

Diagram 1 – Social Impact Assessment Matrix

Having established a possible Matrix the data and information has to be collected. Rule number 1 for data collection, particularly in the developing world, is that SIA must not be treated as a desk-top exercise. It is vital that interviews with those workers and populations likely to be affected by environmental policy changes are consulted and their views noted. The realities of life, particularly for those in poverty, and the social consequences of policy decisions are not obvious to those outside of such a social group, so their views are essential to any SIA. Consideration should be given to these factors when completing the SIA:

- Probability of positive and adverse impacts occurring
- Nature of the positive and adverse impacts, i.e. health, income, education
- Number of people or population groups will be affected
- Duration of impacts, both long-term and short-term
- Assessment of short and long term positive and negative impacts
- Value of any positive benefits and costs of adverse impacts
- Extent that any adverse impacts can be mitigated
- Relevance to present and future policy decisions
- Presence or absence of controversy over any issues
- Consequences of doing nothing and leaving the present situation unchanged

The purpose of this exercise is to consider whether the social consequences of environmental policy decisions are beneficial to those populations affected, and if so, to proceed with the implementation of the policy. However, the outcomes of the interviews with the various social groups do not always provide feedback in a form that makes decision making a straightforward matter. In these circumstances, it is necessary to look at the adverse impacts in the short and long term and decide if secondary factors mitigate the unwanted impacts. Secondly, consideration has to be given to any opportunities offered by the policy options. For example, would a ULAB collector who loses his income if all batteries have to be returned to the retailers, be able to generate sufficient income from battery servicing if he or she were trained in the necessary technical skills?

### 6.2 Analysing potential social impacts

If, for any reason, the SIA raises so many negative social impacts that a specific option cannot be justified despite the environmental benefits because the adverse social consequences are too severe to justify a policy change, then consideration should be given to examining possible modifications to policy options in order to avoid adverse social effects. For example, if the immediate introduction of performance standards for licensing lead smelters would lead to closure and job losses; then consider whether the new standards could be phased in over a period of months or years in accordance with an agreed timetable of plant and operational improvements. In this way, there is every prospect that jobs will be secured and the workers and local population will not only support the policy change but also welcome it.

Occasionally, there will be instances when alternative policy options or modifications to specific proposals still fail to mitigate adverse social impacts. In these cases, extreme measures have to be considered if the environmental issues are of overwhelming importance. If the SIA has been undertaken correctly, the costs of adverse social impacts should have been assessed and consideration will now have to be given to compensation, whether that is material, i.e. a housing move, or financial, i.e. a lump sum payment. It should be stressed at this stage how important it is for those involved in SIA to examine similar case histories to find out how other governments faired when implementing policy changes. The records show that history keeps repeating itself and it cannot be emphasized enough that compensating people for unwelcome environmental policy changes is the least socially acceptable approach to implementing change and causes the most discontent amongst local populations.

It should also be noted that the matrix in Diagram 1 is only an example and it may be necessary to add more columns depending on the number of different social groups identified in the field survey phase. It is always better to start by listing all the social groups, even if some are combined later, than miss out an important section of the population. Furthermore, it may be necessary to subdivide the columns where there are both positive and negative outcomes to record.

Where outcomes of environmental policy options are negative and positive it may be necessary to weight the outcomes in order to determine the most desirable options. Despite attempts by certain social experts to make SIA as objective as possible, weighting the possible social outcomes of a policy option is, and always will be, subjective. In which case, it is advisable to discuss the values to assign to each outcome with those population groups affected by the potential policy changes in order to try to achieve consensus on the weighting, and by doing so improve the prospects of adverse social effects being considered against any social or environmental benefits instead of being rejected outright[xix].

## 7. Environmental Impacts

In some instances the size of the informal sector maybe small by comparison to the formal sector, however, its relative importance would be country specific. Some countries will not have licensed lead recycling facilities and would be obligated to export ULAB to ensure the environmentally sound recovery of lead from ULAB. Others, in fact a minority, might possess established recycling industry with equally important ULAB recycling activities in the informal sector. The different national ULAB recycling industry 'profiles' will require specific policy packages with adequate balance of regulatory and voluntary or economic instruments (see also in section C).
Generally speaking, although ULAB recycling facilities in the developing world may necessitate technical and managerial improvements, <u>the pollution arising from the recycling or recovery of ULAB will be mainly caused by the poor and inadequate operating practices of the informal sector.</u>

Operating practices and working conditions in the informal sector will vary tremendously, but as a rule, expect to find that:

- There are little or no facilities for the neutralization and safe disposal of battery electrolyte. Hence, acidic effluent will percolate into the water table, rivers and sanitary system;
- Occupational hygiene is poor and few operators wear little more that a wet towel to protect themselves from the lead fumes and dust;
- There are few furnace exhaust control systems to prevent atmospheric pollution;
- Furnace residues have a high lead content, are leachable and are dumped indiscriminately either around the premises of the unlicensed smelter or are sent to landfill;
- Many of the informal operations are located close to shops and homes, in particular in large cities, increasing the risk of non-point population lead exposure.

Informal secondary lead smelters have been found supplying unrefined lead bullion to battery manufacturers and licensed recyclers in studies in the Philippines; so expect similar practices elsewhere[xx].

Indeed, prior to an UNCTAD and UNDP Project in the Philippines to introduce ESM of ULAB, the life cycle for LAB used in Buses or Jeepneys in Manila looked very different from the one shown in Chart 1. Chart 2 shows how the relationship between the formal and informal sectors in Manila prior to the year 2000.

The circumstances in India prior to the year 2001 were also very similar with the informal sector, or "unorganized" sector as it is known in India, recycling most of the domestically and imported sources of ULAB and then selling the lead bullion to the formal sector[xxi].

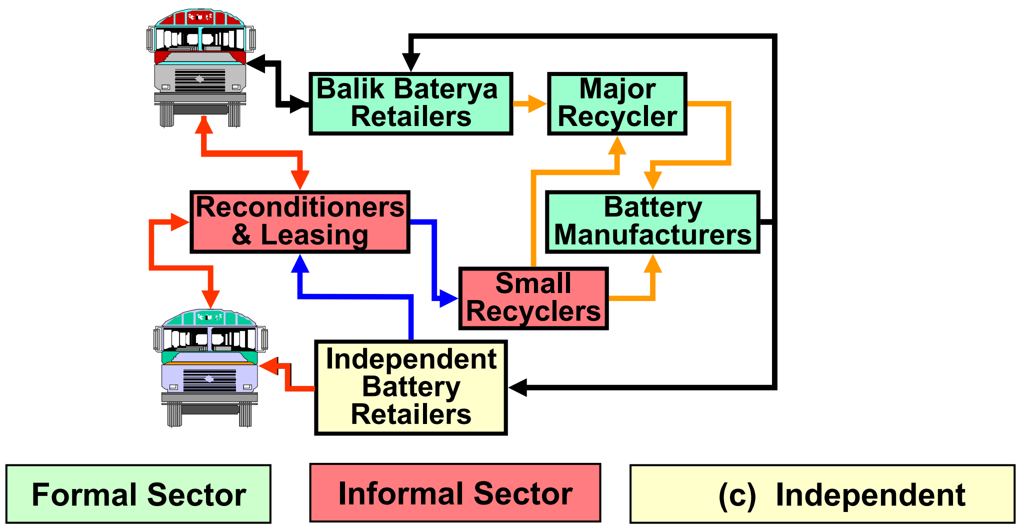



Chart 3. Typical Inter-relationship between the Formal and Informal Sectors

Despite the likelihood of a poor assessment of the informal sector's performance, expect to confirm that they also bring some benefits to the recovery processes. The informal sector may provide a valuable recharging service that extends battery life, as many of the battery reconditioning and collection shops associated with the informal sector also offere battery servicing, recharging and free checks to determine a battery's state of charge[xxii]. The Smaller Battery Recyclers collect batteries that are uneconomic for the major secondary smelters to recover and at least also prevent them from being dumped in landfill sites. These benefits may be small in the overall context of the extent of environmental contamination, but they should be noted on the LCA charts and taken into account when considering policy options.

## 8 Strategic Options

### 8.1 Following a legal approach

When considering what strategic options will facilitate an improvement in the environmental performance of the informal sector, it should be borne in mind that legislation is not the sole solution to problems identified in the LCA charts. Whilst there might not be specific legislation in place in some developing countries that set standards for lead exposure and leaded waste disposal, there is always legislation that can be found that the informal sector will fail to meet. Indeed, owners of informal operations are well aware that their activities are illegal, albeit they might not know exactly what laws they are breaking. If the owners were confident they were not in breach of national laws, then why are they so elusive and evasive?

Environmental legislation that sets out the rules for ULAB recovery, including emissions and discharge standards for recycling plants, is important to have in place because it legitimizes the work of the inspectors and monitoring technicians. Such legislation will provide inspectors with access to lead collection and storage facilities, recyclers and enable trucks carrying ULAB to secondary lead plants to be stopped and checked.

However, introducing and updating legislation that will adequately deal with the many environmental and health problems posed by the activities of the informal sector is not an easy task. Moreover, legislation covering the limits for environmental and population lead exposure are rarely seen as a priority. It is therefore advisable when preparing new legislation to consider "enabling" acts that refer to Codes of Practice or Standards prepared and updated by a small sub committee. Such legislation will then permit the implementation of the "rules" outlined in the Code of Practice. The enabling legislation can then be very short and take up the minimum of parliamentary time, while allowing the code to be comprehensive and updated without the need to go back to the legislators for permission to do so. A very good example of such a law is the UK's Control of Lead at Work Regulations (CLAW) (Appendix 33).

### 8.2 Other complementary options

Once the basis for a legislative approach has been agreed, the next and most important step is to determine what strategies will really change the way the informal sector work and behave when they are involved with the recovery of ULAB. Some of the answers will be found within the questionnaires. For example, it is likely that most of those employed in the informal sector have little idea of the risks they place themselves in when recycling ULAB, let alone the potential environmental damage. Simple educational programs explaining the environmental and health risks posed by poor ULAB handling and environmentally unsound practices will usually bring about positive changes to working practices and reduce the risk of personal injury and lead exposure.

However, an education program is not a long-term solution and it will not move the informal sector dramatically towards environmental compliance and membership of the formal sector. Such a transformation will require a complete overhaul of the way ULAB are recovered, a long-term strategy and perhaps a technology option that inhibits reconditioning. The valve regulated lead acid battery cannot be reconditioned, but it is relatively expensive compared to conventional low maintenance batteries and not always available as a viable alternative. The best option is to make sure that the financial incentive to return ULAB under a deposit/refund scheme to a retailer for recycling is greater than the risk of loosing the deposit by exchanging the ULAB for a reconditioned battery without recourse or warranty.

## 9. Long-Term Restructuring Options

Long term solutions to improve the environmental performance of the informal sector reducing the risk of occupational and population lead exposure and raising environmental performance usually fall into five distinct categories:

## 9.1 Reduce Lead Recovery in the Informal Sector

The first stage must be the introduction of a program that explains how to choose the right battery for the task envisaged and how to look after LAB so that battery life is extended and reliability improved. In many developing countries, (non-vehicle) domestic use of LAB can account for as much as 40% of automotive LAB sales, even though an automotive LAB is not designed to be used in the home and discharged to zero charge. Deep discharge batteries are ideal for domestic use and should last between 5 and 15 years, considerably more that the 2 years that an automotive battery normally lasts in domestic service. In addition, regular servicing of LAB increases battery life and these two measures will reduce the number of batteries in the recycle loop thereby reducing the greenhouse gas burden and at the same time rendering a reconditioned battery poor value for money.

## 9.2 Define a Role for the Small Recycler in the Informal Sector

One of the benefits of informal sector activities is that between them the scavengers and the small recyclers ensure a high percentage of ULAB are collected. The downside of this "benefit" is that the lead recovery rate is low and the environmental performance poor. A role needs to be found that builds on the fact that ULAB can be collected effectively by the informal sector.

Accordingly, improvements to the ULAB recovery infrastructure should be considered so that closer ties are forged between the licensed smelters and the informal sector in a way that encourages the scavengers to bring ULAB to the small recyclers for storage until they are transferred to the licensed smelter and environmentally sound recovery. In this way the small recyclers become the collection centers for ULAB.

Governments have a key role to play in this process to ensure that assistance is available to promote the strategies, and that may be in the form of new road building programs to improve access to remote areas, capacity building involving workshops for scavengers and LAB service technicians. Forging closer ties between the informal and formal sectors will improve environmental performance, but for a longer term solution, methods of collecting ULAB have to be revised to reduce the numbers of ULAB finding their way into the hands of the informal sector.

## 9.3 ULAB Collection Schemes

Hence, the Government should be formulating strategies that provide economic incentives for batteries to be recovered by the formal sector, even in remote areas. This will probably mean involving the battery manufacturers and either asking or instructing them to set up a deposit/refund scheme for the purchase of LAB, whereby a charge is made on the new battery and returned to the customer when the ULAB is returned to a shop that sells LAB for recycling.

Alternatively, if the incentives fail to provide sufficient impetus for customers to return their ULAB, then Governments may have to consider legislation similar to that adopted by the EU whereby the responsibility for collecting LAB at the end of their useful life lies with the manufacturer. These schemes are known as "Producer Take Back[xxiii]" and the responsibility is aimed at the manufacturer in an attempt to persuade the company to create products that are more durable, recyclable and less toxic and to develop a sales network that recovers the ULAB. If such a scheme is introduced, it should remove the financial burden of setting up such schemes from the government and local authorities[xxiv], although there will be a relatively small cost to monitor the scheme and to ensure that LAB sales, including those in new vehicles, match ULAB recovery. Collation and analysis of this data will have to take into account the gap between the sale of a new LAB and the return of the same battery some years later.


**X6402 Professional Battery Tester – US$ 100**

To date "Producer Take Back" programs for a variety of products have been adopted in over 28 countries across the world. In Europe, the European Directive on Waste from Electrical and Electronic Waste (WEEE), adopted in May 2001, requires manufacturers to ensure that 90% of large household appliances are recovered and recycled and for 70% of all other electrical and electronic products to be recovered and recycled. See Section C for more information about financial incentives that promote ULAB recovery.

**9.4 Funding Facilities for Formalizing the Informal**

Whilst it is relatively straightforward to list the changes in infrastructure, and the procedures for selling LAB and recovering ULAB in order to restrict the informal sector of access to ULAB, persuading those working in the informal sector to change their ways is often hindered by a lack of financial resources. Those working in the informal sector are, by their nature, not in the mainstream of business life. Few have bank accounts, pay taxes or have access to a credit line.

This means that despite any agreement with them to change their ways and stop environmentally unfriendly activities, such as battery reconditioning, and instead, set up a battery service center, they may not be able to invest in testing equipment or proper training. Without the funds to invest in a new venture, battery reconditioning and any other undesirable practices will continue as a matter of survival. It is very important therefore, that any policy initiatives instigating new working methods include sufficient funds to invest in new equipment and training courses to explain how to use the equipment correctly and how to adopt new working methods. Fortunately, battery testing and charging equipment is not expensive by comparison to the continued environmental damage caused by lead and acid contamination from illicit ULAB recovery operations and poor handling procedures.

Professional battery chargers range from about US$ 100 to 700, depending on the level of complexity of the charger. The more sophisticated the charger the more options available to optimize the charging sequence. The more expensive chargers will have different charging regimes for 6 and 12 volt batteries from 7ah to 180ah, low maintenance lead acid batteries, no maintenance lead calcium batteries and valve regulated deep discharge gelled electrolyte batteries. When the battery is fully charged, the unit automatically switches to a maintenance charge regime that will not overcharge the battery, thereby extending the battery's life. If the battery is faulty, the charger will display a warning signal and under these circumstances will have a built in protection against polarity inversion and short circuits.


**Century Welders 2/15 Amp Battery Charger – US$ 100**

Whilst it is relatively easy to provide small sums of money to purchase battery testing and charging equipment within environmental projects to assist those reconditioning ULAB in the informal sector in order to convert their operations to environmentally sound LAB service centers, the financial obstacles preventing the transformation of informal smelting operations to environmentally friendly recyclers can be huge. For those informal smelters that upgrade operations to meet strict environmental standards for plant emissions and discharges, and can source their feedstock requirements entirely from domestic sources, working capital requirements could be kept to about three to four weeks of running debt.

## E - Communication and Information

### 1. Strategies for the Preparation and Dissemination of ULAB Educational Materials

### 1.1 Strategic Communication Objectives

Used lead acid batteries (ULAB) pose potential environmental and public health threats, if not managed in accordance with environmentally sound procedures.

Prevention of population lead poisoning and contamination of eco systems from ULAB and other sources of lead is a public health concern of many governments of Parties to the Basel Convention. The cost of preventing lead –poisoning, especially amongst children, and contamination of the environment is always preferable to dealing with high levels of population or occupational lead exposure and the remediation of lead-contaminated sites.

However, the avoidance of lead exposure in humans and environmental contamination caused by improper handling of ULAB, requires the education of those involved in the lead acid battery (LAB) industry, those that use lead acid batteries, in particular workers in the informal sector and populations most at risk. These include battery retailers, ULAB collectors, transporters and recyclers, their families and neighbors, as well as members of the public who retain and handle ULAB, or dispose of them in environmentally unsound ways. In many cases, people who sell and use lead acid batteries, and those who recover ULAB, lack the basic knowledge of the risks to human health and environment posed by lead and the acidic electrolyte from ULAB, or the means for the proper disposal of ULAB. Their education is therefore essential for the safe handling and sound recycling of ULAB.

The development of appropriate strategies for education of the general public and specific populations should aim at maximizing the recovery of ULAB, while simultaneously minimizing the risks to human and environmental health.

Emphasis should also be placed on the benefits of environmentally sound ULAB recycling as a valuable source of jobs and therefore a national resource.

Systems for the effective return of ULAB, together with the a financial reward for returned ULAB, such as a deposit refund scheme should be in place, to coincide with the start of an educational campaign. This is usually well handled by the private sector, which understands the needs and demands of consumers who may wish to return their ULAB to designated retailers drop-off or re-collection points, but also needs the active support of the national government and local authorities.

Similarly, the hazards posed by improperly handled ULAB should be highlighted.

These may include:

- The ease and permanence of contamination of environments by lead and associated heavy metals in battery alloys and the sulfuric acid from broken or leaking batteries
- The difficulty of subsequent remediation of the contaminants from polluted environments
- The contamination of crops and water supplies by lead and the possibility of affecting public health
- The toxic effects of lead and other heavy metals found in ULAB, such as Arsenic and Cadmium and on humans, pets and livestock, describing symptoms and health effects (short and long-term)
- Graphic examples of consequences of lead contamination and lead poisoning, to reinforce the written material
- Examples of the detrimental effects of battery electrolyte on the environment

**1.2 Preparation and Dissemination of Educational Materials**

The following organizations should be included in the development of strategies to recycle ULAB and to protect human health and prevent environmental contamination. Collaboration among these organizations is essential in ensuring that the levels at which the educational campaign is directed are appropriate and accurate and thus likely to achieve the objectives of the educational campaign:

- Public health authorities (Inspectorate and Health Education)
- Environmental authorities and organizations (Regulatory and NGO)
- Educational authorities and institutions (Schools and Universities)
- Battery manufacturers, ULAB exporters, importers and recyclers (Collection of ULAB from members of the public and battery recyclers)

Discussions among the various stakeholders at this level in any country should be directed at the following:

*1.2.1 Each factor may be expanded as follows:*

Identification of those involved in the LAB industry likely to cause population exposure and environmental contamination through the improper handling of ULAB

- Battery retailers
- ULAB collectors and carriers
- Companies or families involved in battery servicing, repairs, recycling and reconditioning

*1.2.2 Identifications of populations at greatest risk from ULAB:*

- Battery collectors and transporters
- Persons involved in battery repair, recharging and recycling
- Persons living on or adjacent to ULAB lead-contaminated sites
- Members of the public who retain or dispose of ULAB and their residues in an environmentally unsound manner

*1.2.3 The human and economic effects of lead pollution and poisoning:*

- Chronic and acute effects of lead poisoning, especially in young children
- Economic losses incurred by individuals or families in event of lead poisoning, involving medical testing, medical treatment and associated costs
- Costs associated with environmental contamination by ULAB, including:
    - Devaluation and loss of use of land for recreation, housing, agriculture or industrial activity
    - Contamination of water resources, livestock and crops
    - Cost of remediation of lead-contaminated lands and waterways

*1.2.4 The economic feasibility and logistics of battery recycling programs:*

- Existing systems of ULAB collection, storage, transport and recycling:
- Incentives for collection and recycling (fiscal, technical, trade facilitation)
- Legislation affecting ULAB recycling (Restriction of ULAB imports/exports, except by organizations with capability and capacity to meet health and environmental standards)
- Actions required to encourage environmentally sound methods of recycling, and to improve collection efficiencies of ULAB

*1.2.5 Estimation and identification of resources required to undertake effective educational campaigns for maximizing ULAB recycling and simultaneously preventing lead pollution and poisoning*:

- Identify groups towards which educational campaigns are targeted
- Decide on most effective means of preparing and disseminating educational materials
- Obtain estimates of cost of developing, editing/re-editing and distribution of educational material
- Identify possible funding agencies to support educational campaign
- Prepare proposals to funding agencies

**1.3 Effective strategies to prevent lead poisoning and environmental contamination**

**1. Summary of the stages through which the objectives of preventing population lead exposure and environmental contamination**

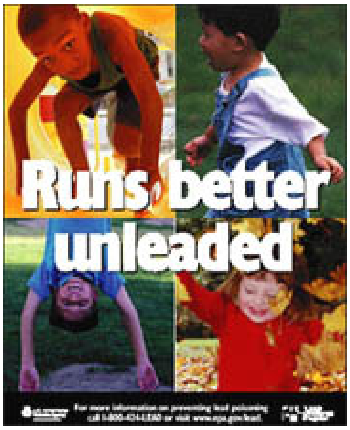
- Identification of persons and populations at greatest risk of lead-poisoning from ULAB, through Public Health, Environmental and Educational Authorities; Battery Manufacturers and Importers; NGOs
- Determine educational levels of persons who will benefit from information on prevention of lead pollution and poisoning
- Decide on most effective levels and means of distribution of educational material, through consultation with all stakeholders
- Use most cost-effective means of reaching target populations (interactive web-sites; posters for schools and Health Centers; pamphlets for battery repair and recycling communities)
- Collaborate with stakeholders to source funding, prepare and distribute educational materials, to ensure ready acceptability by all sectors
- Obtain required level of funding from governments, funding agencies and /or private corporations, to sustain educational campaign for at least 5 years (preferably 10 years)
- Prepare educational material in appropriate form; distribute and assess impact; revise as necessary to improve effectiveness; distribute and continue assessment
- Prepare information material, such as battery labels, battery servicing and recharging instructions in appropriate forms; distribute and assess impact; revise as necessary to improve effectiveness;
- Advise manufacturers, distribute to dealers and continue assessment

## 2. Communications Tools

Several means of dissemination of such information may be used, namely:

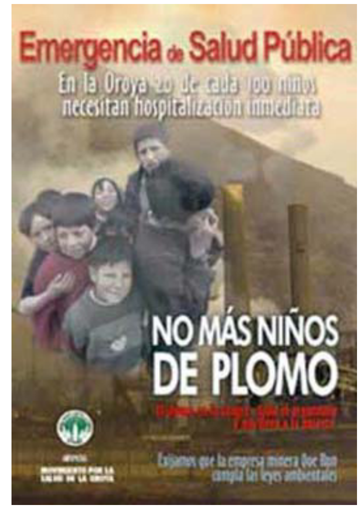
### 2.1 Written Information

*2.1.1 Posters*, especially those explaining the consequences of failing to recover ULAB in an environmentally sound manner and a list of the steps to be taken to return a ULAB to a licensed collector for sound recycling, can be very effective. They are best place in battery retailers, service centers, children's nurseries and schools.



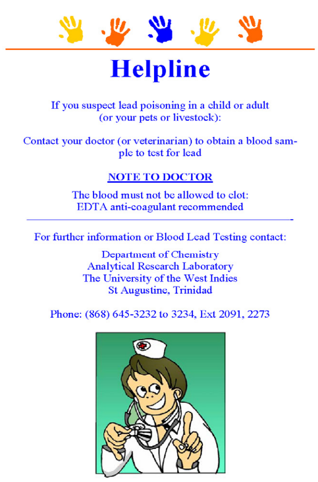

*Poster from the U.S. Environmental Protection Agency's campaign*

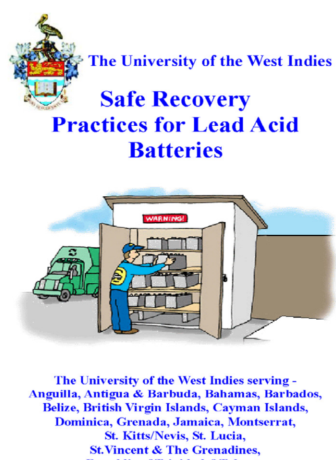

*U.S. National Library of Medicine – Visual Culture and Public Health Posters*




*Giddings-Lovejoy Network, La Oroya Peru, "Public Health Emergency: No more children of lead."*

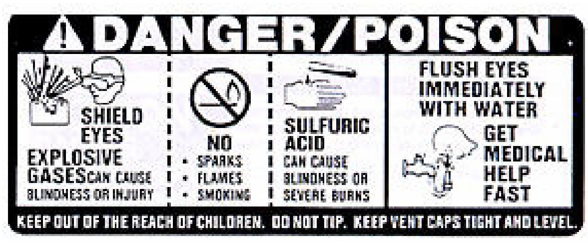
*2.1.2Pamphlets*, especially those targeted at mothers and young children are effective in reminding populations about handling ULAB and the risks posed by failing to avoid exposures. See below an example of a pamphlet designed for use in Trinidad in the Caribbean (see also in Appendix 20).

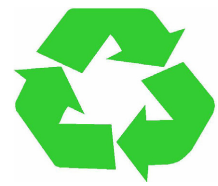



*2.1.3 Information sheets* outlining details of the ULAB recovery program should be prepared and sent out to the appropriate interested parties. Each sheet should target one sector in the chain of the recovery process and explain what that sector needs to do to be in business and what it needs to do to stay in business. Health, safety and the environment should be the main focus for these briefing sheets.

*2.1.4 Eco Labels*. It is important that whoever is looking at the battery sees a label that clearly displays internationally recognized hazard warning symbols for lead and acid together with symbols for recommended personal safety equipment. The label should also have a graphic indicating that the LAB must not be dumped and another signifying that the LAB is a suitable item for recycling. Regardless of the country of sale, the label should also contain a local telephone help line or multilingual web site where safe disposal or collection information can be obtained (see also in section B of the manual).



*2.1.5 Instructions for battery retailers, service and collection centers*

Battery manufacturers issue instructions to their dealer networks and battery retailers to promote and encourage recycling. See the poster in Appendix 21 issued by Exide Technologies[16] to advertise battery recycling.


Instructions should be clearly displayed at the premises of the retailer and in such a position that they can be easily seen by the general public.

Other posters include a Chart produced by the Battery Council International, outlining the recycling process and available to retailers throughout the USA, Canada and Mexico. (Appendix 22)

Finally, the whole program with all the relevant laws, domestic and international, the correct procedures for collecting, storing and transporting ULAB should be available in one Operating Manual that should be available to all major players in the ULAB recovery industry.

[16] Exide Technologies – "Our Commitment to the Environment Battery Recycling and the Environment" - http://exideworld.com/recycling.html

## 2.2 Oral presentations in schools and health centers

Shouting "wolf" too often leads to complacency, so taking an opportunity to get the message to populations at special events means that the message will have impact because it may only be heard or seen once or twice a year.

Apart from the fact that it is important to emphasis the need to return ULAB to the retailer for recycling, special events such as World Environment Day or World Health Day will enable more information to the made available to local populations and community groups. Do not fall into the trap of scaring people, lead is toxic, but it is very rare indeed that anyone dies of lead poisoning. Instead, remind people of the potential risks to the environment and humans and how easy it is for them to avoid those risks by returning the ULAB for recycling.

Have pamphlets prepared for the different community groups, such as then one shown in Appendix 20, which is designed for mothers and young children. However, so that people understand the potential risks it may be necessary to have some charts prepared outlining the health hazards and so on. An example is shown in Appendix 23.

## 2.3 Television, documentaries, public discussions, interviews

Competition for news coverage is always oversubscribed. At times it seems as though every major organization, all the politicians and every known sportsperson is trying to find their way onto the evening's TV news, the breakfast radio programs and the morning's newspapers.
An examination of the statistics quickly shows why this is. Market research tells us that 80% of the public nominated the TV as their source of news and information.

Furthermore, and this point is particularly applicable to the Lead Industry, a good picture or story will wipe out a good few horror stories. Having made that point understand the sort of stories that journalists tend to report:

1) We name the guilty
2) We reveal the startling facts
3) The powerless will fight
4) Underdogs win
5) Shock statement
6) Incredible facts
7) Cuddly pets

Most companies and community groups will struggle to identify with the "scoops" the journalists are looking for, and with such pressure from other competing headline "grabbers" here are a few tips that will help to move stories to the towards the top of the pile:

- Prepare a good media release of no more than one page with a good headline followed by the text that explains the "who, what, when, where and why" in this order:

- A headline that gets to the "meat" of the story.
- A paragraph that summarizes the story.
- Quotes from a senior person in the company or community.
- The Facts.
- The Benefits.
- The Future.

- Keep the message simple and relevant to the target audience and ensure that the story means something to them.
- Don't be too technical; if the news-team do not understand the story, they will NOT use it.
- Paragraph the text so that it can be edited for a 120 word or 60 second TV or radio news item.
- Choose a designated pastel color for your news stationary and use it every time, so that the journalists get to recognize when your briefing notes arrive.
- Always provide at least two contact names and four 24 hour contact numbers so that the editor can speak to someone if there is a follow-up.
- After you've sent the media release, make follow-up calls to make sure it reaches the journalist you have selected to receive the article.

**Ten Golden Rules for TV and Radio**

2. **Keep it short.**
3. **Think pictures and headlines.**
4. **Be positive.**
5. **Set an agenda and stick to it.**
6. **Avoid jargon and technical terms.**
7. **Rehearse any interview.**
8. **Never speak of the record.**
9. **Never apportion blame on TV or radio.**
10. **Always look at the interviewer.**
11. **Always thank the interviewer.**

If there is an opportunity for a TV interview, prepare your lines, just like an actor. Do this by anticipating the questions and at the same time use the reply as an opening to get your message across.

Whilst every opportunity should be taken to accept Television interviews and participate in TV documentaries that promote recycling, waiting for a reporter to offer such an opportunity will require a huge amount of patience. It is recommended, therefore, that at the first opportunity a visit to the local TV station should be arranged with a view to meeting the local reporters and anyone connected with environmental matters so that they become aware of who you are, what your represent and what might be newsworthy. However, most importantly ascertain what is newsworthy to the TV station and ask exactly what needs to be done to generate an event that will attract their interest.

A case study in the Philippines

One company that has done this very successfully is Philippine Recyclers Inc. (PRI) in Manila. ABS-CBN is the premier broadcast network in the Philippines. ABS-CBN was the first commercial television station in 1953, the first to broadcast color television in 1967, and the first with satellite transmissions in 1969. Today, ABS-CBN programs are still the top ten-rating shows.

In respect of and in response to the loyalty shown to the station by its audience ABS-CBN Broadcasting Corporation made a corporate commitment in 1989 to the public by establishing the "not for profit" ABS-CBN Foundation Inc. (AFI). Initially, the AFI produced television programs for charitable and educational purposes. Its chief concerns then were to generate welfare funds by broadcasting the situations of those in dire need of assistance and ensuring the proper allocation of resources and help.

Not content with being a mere broker of resources, AFI later restructured itself to accommodate a more developmental approach to affect strategic sectors of society. This all-around approach has become a model for its mission to provide a better quality of life for every Filipino. All developmental programs for the grassroots now cover a wide range of issues with a focus on issues that do or will affect children, now or in the future:

- Care for victims of child abuse or disasters
- Child care
- Educational multimedia programs
- Small business financing
- Community based environmental initiatives

With this impressive track record in mind PRI approached ABS-CBN and asked if their Foundation, AFI, would consider the Company as a partner in one way or another in the promotion of environmental protection (a ULAB recycling scheme).

PRI were not turned away, and AFI suggested that if PRI could donate half of the profits derived from the ULAB collections promoted by ABS-CBN to the Foundation's Childcare health program, then a partnership would be forthcoming.

PRI welcomed the opportunity to raise the company profile and fund medical services to the community. In support of this initiative, AFI launched "*Bantay Baterya*", that is Filipino for, the collection of used automotive batteries.

PRI's own collection scheme, Balik Baterya, for ULAB operates through the company's Motorlite Battery distribution and sales network throughout the Philippines and at the time of the launch of *Bantay Baterya,* was responsible for collecting about 60% of the used car batteries in the Republic or 120,000 per month. Nevertheless, a considerable number of ULAB were not being collected and as such, might well have pose a threat to the environment or the popuation.

Accordingly, AFI prepared a series of community based educational programs and publicity campaigns to draw attention to the potential health and safety risks associated with uncollected ULAB. With the communication resources of the ABS-CBN Broadcasting Corporation and the support of well-known TV personalities such as Karla Andaya and Lia Andanar, the scheme had a national time slot for the launch on the TV station.

**60 TONS OF BATTERIES FOR BANTAY BATERYA PROJECT**

*Used vehicle batteries, if left alone, may spill toxic materials like lead compounds and sulfuric acid. These materials pose health hazards to people and plants as these could render soil infertile or could poison water in reservoirs.*

*A solution, however, has been found in recycling. Towards this end, Procter and Gamble recently donated 60 tons of dead forklift batteries to Bantay Kalikasan's Bantay Baterya Project. The donation marks the beginning of an agreement where P&G will donate its ULAB to Bantay Kalikasan. P&G will also encourage its employees to donate their ULAB for recycling. Bantay Kalikasan will set up battery cages for its battery drop off stations at P&G*

AFI Program Director Marlo Mendoza set a collection target of 40,000 ULAB to be collected each month and the money raised through the scheme has provided additional financial support for the AFI's childhood and environmental initiatives.

Pic. – Top left, AFI Program Director Marlo Mendoza, PRI Director, Irving Guerreo; Front left, PRI CEO, Jacob Tagorda and media star, Lia Andanar

The main lesson from the PRI experience is to develop a media plan and take it to the media for exposure and advice. (See also appendix 24)

**2.4 Internet, web-sites (informative and interactive), specially for local ULAB collection centers**

Most leading Cities and Municipal Authorities have taken full advantage of the communication opportunities offered by the Internet and posted by-laws applicable to ULAB recovery and details of local collection centers and "kerb-side" collection schemes on their web sites for public consumption.

**Bantay Kalikasan**

Bantay Kalikasan is the environmental arm of the ABS-CBN Foundation, a media-based project supported by a multi-sectoral network of government agencies, private organizations, and non-government organizations.

It envisions a responsibly protected and preserved Philippine environment where future generations of Filipinos can lead a better quality of life.

Bantay Kalikasan was launched as a response to the worsening state of the Philippine environment: air pollution particularly in Metro Manila, destruction of the marine ecosystem, denudation of the uplands, poisoning and silting of major freshwater ecosystem, and the pervasive garbage problem in urban centers.

It is important to bear in mind that it does not matter how much advice and information is available on a web site, it is impossible to anticipate every inquiry and every question. So rule number one, always provide contact information so that anyone who cannot find the information they are looking for on the web site is able to either send an e-mail with the details of the inquiry, call by telephone or send a fax. Secondly, whilst it is so important to provide a means for personal inquiries, the number of personal inquiries can be minimized if there are hyperlinks from the web to other sources of information, such as International Conventions, Scientific Data and so on.

When designing a web site that has content useful to countries in the developing world, bear in mind that Internet speeds can be, and are very often, as slow as 7 and 22 kb/s. Low Internet connection speeds means that access will be subject to timeouts and graphics will not load. So always, have a plain opening page, similar to the search engine Google, and offer a choice of graphics or text. In this way, those wishing to access the site with slow Internet speeds will not be excluded.

On the subject of graphics, far too many websites use clever techniques that just frustrate those accessing the site for information and data. No marks will be awarded if surfers have to wait while the site loads a "*Flash or Javascript*" moving graphic. Follow the KISS code; "Keep It Simple, Silly!"

To provide easy access to data and information and get your message across follow this guide to website design:

1) Decide who is the target audience and collate all the advice, information and data that the target groups are likely to want.
2) Set out easy to read and intuitive categories for the website content.
3) Set up a file page system so that the minimum number of pages has to be traversed to reach the required data – "Three clicks or Less!".
4) Include a site and web search engine.
5) Limit the content and length of each web page so that it loads quickly.
6) Design a template for clarity and ease of use.
7) Use plain black text and a white background.
8) Provide a contact window for e-mail and telephone inquiries.
9) Update and check to website regularly.
10) Never forget the focus and purpose of the website.

These days, be aware of the needs of those with disabilities and health problems. Eight percent of the world population is colorblind, so always choose color safe options (See Safe Web Colors for color-deficient vision[xxv]). Provide a large Font size choice for those in developing countries with poor eyesight and no reading glasses.

Another consideration is to make the website easier for dyslexic surfers. Like many other visually limited users, many dyslexics use computer speech output technology to read the pages to them. Ensuring that your page is speech reader-friendly is essential. Make sure that all of your important information is contained within text and not in graphics, as speech readers can't read or interpret graphic imagery. Dyslexic users without a text reader, will have to try to read your page on their own and they will not cope with the navigational scheme if it is complicated. Flashing graphics, distracting animations, wildly varying font styles, and textured or patterned backgrounds will make it very difficult for them to use the website. Small icons that aid in navigation are useful, as long as each icon has a text alternative and/or an ALT tag. Whenever possible, keep paragraphs short and focused and as mentioned above, limit the amount of text on each page. Finally, if possible do not specify a particular font as most dyslexic readers prefer a particular font and stick to it, so allow their browser setting to overide the default webpage font. For more information and to view a very well designed website visit the dyslexia society[xxvi] Internet site.

An example of an Interactive web site designed for children by the US EPA[xxvii]. Double click anywhere in the City below to view the waste management program. See the full version and explanation in [Appendix 25](#).


A final note is a reminder that the Internet knows no borders and a passport is not required to traverse the globe, but there are many different languages in the world so always have a window linked to a free translation site for the web page, such as the Google Language tools[17] page.

## 2.5 Training

Just having laws, procedures and adopting international protocols is meaningless unless all those involved in the ESM recovery of ULAB understand what needs to be achieved, why there is a need to adopt and follow certain procedures, exactly what those procedures are and what their role in the recovery process is, then nothing will be achieved. There are many ways to communicate effectively and the communication of any new legislation, practices, licensing and permits will have to be discussed and explained in a number of different ways depending on the target group.

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[17] http://www.google.com/language_tools?hl=en

The basic steps in the implementation of a strategy to raise understanding and participation through capacity building and training activities such as seminars, workshops and on-site training would be combined with Specific Group Projects:

1) Government Personnel, such as those involved in licensing, ULAB storage site inspections, environmental monitoring of effluent discharges and atmospheric dusts, customs regulations for transboundary movements and community relations.

2) Medical practitioners and nurses, especially those involved in the care of young children and occupational health. The content of this program will include the health effects of lead exposure to young children and workers, ways to avoid or minimize lead exposure and the clinical options available to reduce lead intoxication.

3) ULAB collectors, including battery manufacturers, retailers, wholesalers and representatives of those scavenging for ULAB. The content of these programs will be focused on safe methods of collecting, storing and transporting ULAB to a recycling plant. Practical information will be given on the design of storage facilities and methods of packaging broken or damaged batteries.

4) People involved in the transport of ULAB, whether for domestic recovery or export for recycling. The content will include an explanation of any new measures to license truck owners and companies involved in the transport of ULAB. There will also be a focus on the safe methods for transporting ULAB, especially packaging. Drivers will also be given instructions to cope with electrolyte leakage or spillages.

5) Service engineers and those who recharge domestic LAB. Support for this initiative will have to come from the private sector and Governments are advised, at an early stage in the program, to solicit the support of those battery manufactures with significant domestic sales to provide the expertise for this training package. Training will be given in the correct procedures to use to test LAB, service and recharge them. This is very important for those who recharge LAB used for domestic power, because surveys in Cambodia and the Philippines suggest that the charging methods used, actually shortens the life of many of the batteries.

**2.6 Educational Programs for schools and community groups**

Multi-level educational programs should be developed for all sectors of the population, to ensure that the issues are readily understood and easily assimilated by those most in need of them. Parents and young children should be specially targeted, since they are focal points for dissemination of educational materials and children are the most vulnerable to lead exposure.

Provided the Education Ministry agrees, information packs for teachers in Primary and Secondary Education should be prepared and made available to schools in the form of a class project for the environmentally sound management of ULAB[xxviii].

*A typical project might be:*

- Identify the use of LAB in the community – at:
  - ➢ Home
  - ➢ Workplace
  - ➢ School

- Identify the various types of LAB in use in the community, e.g. LSI automotive 12 and 6 volt, UPS for computers, SLA's for fire and burglar alarms, emergency lighting, Deep Discharge batteries for solar power storage systems

- Determine the amount of LAB used in any 2 year period in your school, your neighborhood, your local garage, the fire station and so on.

- List the methods of disposal for ULAB, including dumping, returning them to retailers, selling them to scavengers and exchanging them for a new battery.

- List and explain the risks involved for the community if ULAB are not disposed of in an environmentally friendly way.

- Determine the most desirable methods of recovery for ULAB in your community.

- Design a Poster to promote battery recycling in the local community. See the Case study in Appendix 26 and view the results of a poster competition held by the Pennsylvania Department of Education.

An Example from a School Logo Competition


Designed to encourage motorists to take ULAB to local collection points.

People's Daily **Monday, April 23, 2001, updated at 07:50 Life Section**

**Young Chinese Actively Engaged in Environmental Protection**

A waste batteries recycling project in Beijing's high schools and primary schools has ended with a remarkable result: 3 million waste batteries have been collected in the past 15 months.

"Those kids showed great enthusiasm for this project," said Jia Feng, an official with the State Environmental Protection Administration (SEPA) that sponsored the project. Jia added that the waste batteries they collected weighed 55 tons, about 40 percent of the total gleaned in the city.

Environmental protection and pollution control in the urban area are the issues of top concern for Chinese aged between 16-25, according to a latest nationwide survey done by the Urban Survey Organization of the National Bureau of Statistics (NBS).

The survey revealed that 5.4 percent of the young people chose environmental protection as their top concern among 12 other issues such as income and housing. Another 7.3 percent said that pollution control in the urban area is their top concern, the rate being much higher than their parents'. This can be attributed to the better education about environmental protection than any time in the past, said Jia. Environmental knowledge has become part of the curricula in primary and middle schools.

"I also regarded the waste batteries recycling project as a course to develop children's consciousness of environmental protection," said Zheng Daling, a Beijing primary school teacher.

Another primary school teacher Wang Weidong said that the kids not only took an active part in this project but also got their parents involved, and even their neighbors and colleagues of their parents. The project proved that environmental protection education on children will also have positive effect on grown-ups, which is expected to help raise social consciousness on this issue, said Jia.

The SEPA has promoted a number of projects for education recently, including a poster designing contest, a non-profit advertisement design contest and a ten-episode TV program.

This form of communication can be very revealing, as students will undoubtedly find LAB in the science laboratories, the computer room and the backup electrical supply up for the telephone systems. It is important that educational campaigns be reviewed regularly for their effectiveness through feed-back systems, by encouraging comments and recommendations to designated telephone numbers, e-mail addresses etc, provided with the educational materials.

The educational material should be revised as required, to meet the needs of the user and thus achieve the objectives of the campaign. Similarly, it is necessary that any educational campaign be continued for a sufficiently long time (at least 5 years), to allow recycling practices of ULAB to become good habits, particularly among young children. This can ensure the continuity of sound environmental practices through successive generations of young adults, who are the normal driving forces of any campaign.

For those countries with significant domestic LAB use, it is very important for Government officials to visit local communities and discuss with the residents the need to preserve the environment and recover ULAB in an environmentally sound manner.

However, if you find yourself in the position of a government minister or spokesperson, "Never go to these meetings unprepared!" Bear in mind that the only reason that LAB are used for domestic purposes is because the Government has not provided mains power. Be prepared to talk on matters other than ULAB and anticipate what you will be asked by the local community groups.

When these sessions go well, then support for the ESM of ULAB will be forthcoming.

When it comes to communicating with local people about issues that impact on them without their knowledge, there is no real substitute for a personal visit. Obviously, one government official cannot visit every village, but through the capacity building seminars it should be possible to train every local environmental officer in the mechanics of the ULAB recovery program, so that in then course of say 12 months, they will visit every village in their sector and hold discussion sessions with all the interested groups.

Briefing sessions should be held for battery rechargers, scavengers, scrap yard owners, garage owners and local battery retailers in those villages where they operate. Private sector participation may be advantageous here as technical issues about controlling pollution may be an important feature of these sessions.

## F - Strategies for Remediation of Lead Contaminated Soils

### 1. Introduction

On those occasions when informal smelting sites and reconditioning shops are closed by the Regulators and the smelting residues or discarded battery plates present a potential risk to the environment and populations if they are not managed in a responsible manner.

A Modern Environmental Management System (EMS) provides a framework for the control of leaded wastes and residues and minimizes the risk of environmental pollution and population exposure. Unfortunately, in the informal sector, no such provisions exist and if a disused site is left to the elements, the leaded wastes are likely to leach into the environment and contaminate the surrounding area with lead bearing dust and acidic residues.

Such situations represent a potential environmental liability and a financial burden to the local authorities, the state and the local community, because in the absence of legitimate owner, the government is likely to have to bear the cost of rendering these sites environmentally benign.

In these situations, resources must be used effectively and any remediation plan should provide a framework to identify, evaluate, and remediate used reconditioning sites and informal sector lead smelters in order to mitigate the effects of past practices.

### 2. Core Principles of Lead Contaminated Site Remediation

- Remediation plans need to be designed in accordance with local population exposures and specific site contamination.
- It is essential that local populations, especially young children, living close to lead smelters undergo a medical assessment to determine their lead in blood levels.
- Remediation options should provide for the use of locally sourced materials wherever possible, especially bio-waste and indigenous plants.
- Treatment remedies should be sensitive to local conditions, that is, whether the area is primarily rural, agricultural, industrial or urban.
- Only proven technologies and methodologies should be considered.
- Cost minimization is always a prime consideration and every opportunity should be made to use long-term low maintenance solutions.
- Where there are local populations living close to a contaminated site every effort should be made to consult and involve them in the preparation of the plan and its implementation.

### 3. Core Elements of Possible National Strategies for Development of Action Plans on Lead Contaminated Soils

The remediation of a lead contaminated site is carried out in several successive stages, some of which may occur simultaneously and require careful coordination. This is necessary to ensure that prompt and effective actions are taken to minimize further human suffering and environmental contamination.

These are as follows:

- Reporting and identification of site suspected to be lead or battery acid contaminated
- Investigation of suspect site to verify and assess the extent of lead/acid contamination and potential health risks to inhabitants, neighbors and/or the surrounding environments
- Recommendations for actions on contaminated site
- Identification of resources required for site remediation and provision of funding at earliest opportunity
- Legal and public health involvement in assigning responsibility for site remediation and cost –recovery
- Communication with those likely to be affected by the contaminated site and the consequences to them of NOT remediating the site. It is vital to gain the understanding, approval and support of local residents to prevent panic amongst the population, or anger and opposition to the remediation.
- Remediation of the site, using cost-effective and least environmentally damaging technologies
- Environmental monitoring of the site and clinical examination of residents before, during and after site remediation

***Details of each stage are detailed as follows:***

### 3.1 Reporting and identification of site suspected to be lead/acid contaminated:

- Reporting systems should be available for use by any member of the general public, to alert authorities to sites suspected to be lead-contaminated
- Reporting system can be operated within a network of public health, environmental and academic institutions, to ensure prompt action on reports
- Telephone and fax numbers, e-mail addresses etc. should be provided in telephone directories, pamphlets, posters, or via public health centers

### 3.2 Investigation of suspect site to verify and assess extent of lead contamination and health risk to inhabitants, neighbors and the surrounding environments:

Once a report is received and directed to authorities responsible for investigating a site suspected to be lead/acid contaminated:

- Initial site visit undertaken, to view and undertake preliminary investigations, to verify whether site is contaminated by lead or battery acid
- If lead or acid contamination is verified, follow-up visits are made to:
  - ➢ Obtain an accurate assessment of the concentrations of lead or acid in the contaminated materials and soils and the volume of soils requiring remediation
  - ➢ Carry out blood lead analyses of site residents, especially children under 12 years old, to determine whether there is a need for medical treatment and/or relocation from the contaminated site

### 3.3 Recommendations for remedial actions on contaminated site:

Based on the findings of the investigating team, recommendations for site remediation are made, with respect to:

- Immediate removal of children diagnosed with lead poisoning to uncontaminated environments
- Cost-effective solutions for site remediation, using available materials and technologies available
- Removal, transport, treatment and disposal of lead/acid contaminated soils
- Consultation with site residents on their relocation, prior to remediation of contaminated areas of site
- Monitoring of blood lead levels of residents and workers involved in site remediation before, during and after site remediation, to protect health of all persons exposed to lead-contaminated soils
- Environmental monitoring required before and after site remediation, to ensure safety of site workers and residents

### 3.4 Identification of resources required for site remediation and provision of funding at earliest opportunity:

Resources required for site remediation include the following:

- Earth-moving equipment and personnel for possible removal and transportation of lead/acid contaminated soils to treatment plant or hazardous waste disposal site
- Location of suitable hazardous waste disposal site for receipt, treatment and disposal of lead/acid contaminated soils
- Uncontaminated/treated soils, to replace contaminated soils removed from site
- Safety and monitoring equipment and services for blood lead and environmental testing of personnel and soils before, during and after site remediation
- Relocation of residents before and after site remediation
- Provision of social, legal and health services for residents of lead/acid contaminated site

### 3.5 Legal and public health involvement in assigning responsibility for site remediation and cost recovery:

To carry out remediation of lead/acid contaminated sites in the shortest time possible it may be necessary to involve public health, environmental and legal authorities in the following actions:

- Examination of legal framework governing responsibility and liability for site assessment and remediation costs
- Assignment of roles and responsibilities for assessment, remediation, health and environmental monitoring respectively, of lead/acid contaminated sites
- Recovery of costs associated with site monitoring and remediation, from persons and/or companies responsible for site contamination

### 3.6 Communication with those likely to be affected by the contaminated site and the consequences to them of NOT remediating the site.

It is vital to gain the understanding, approval and support of local residents to prevent.

- Residents are fully consulted and made aware of the reasons for their relocation and/or remediation of the contaminated site and of the adverse health threats posed to them and their families, if the site is not remediated or they are not moved from the area close to the site.
- Every effort is made to gain the confidence of the local residents and the surrounding community and their full agreement to the remediation proposals.

### 3.7 Remediation of the site, using cost-effective technologies:

Once decisions are made on site remediation, all necessary actions are taken to ensure that:

- Where necessary, residents are relocated (temporarily or permanently) to uncontaminated environments, with assurances of re-housing before or after site remediation
- Remediation is carried out efficiently, following recommended procedures and taking appropriate safety precautions and monitoring actions, to protect health of site workers
- Removal and transportation of lead/acid contaminated soils to designated treatment facility or hazardous waste disposal site, with monitoring to endure completeness of removal of lead-contaminated soils
- Replacement of contaminated soils by uncontaminated or treated and tested soils, to ensure the safety of returning residents to remediated site
- Residents are relocated to remediated site, with assurances of safety on return and a program to monitor their health over an appropriate period of time.

### 3.8 Environmental monitoring of site and clinical examination of residents before, during and after site remediation

Protection of health of site residents should be done by:

- Continued blood lead monitoring and medical treatment of any lead-poisoned residents, especially of young children, to complete therapeutic regimes initiated after initial verification of any lead poisoning
- Follow up environmental monitoring of remediated site, to ensure the safety of returning residents, as well as neighbors who may have been previously affected by lead or acid contaminated soils and during removal of contaminated materials
- Follow up testing of ground water and fresh water, if previously contaminated by either, lead dust, lead smelting residues or battery acid, to ensure effectiveness of site remediation.

See Appendix 27 for the Case Study: The experience in Trinidad and Tobago in investigation and remediation of lead-polluted sites.

## 4. Strategies

Unlike organic compounds that can be transformed, heavy metals, such as lead, can only be covered, buried, removed and recycled, moved to a safer location, or transformed into a less toxic or inert form. One of the most common remedies used worldwide for lead contaminated soils, for example, has been to mix the soils with chemical binders such as Portland cement and to transfer the contaminated waste to a secure landfill site. However, landfill strategies are becoming increasingly unacceptable solutions and an expensive option where it is permitted.

The chemical form of lead contamination in soils and waste residues is an important consideration in determining the appropriate strategy. Some industrial lead compounds are toxic, whereas certain naturally occurring forms have a lower toxicity because many natural mineral forms of lead have a low bioavailability. This low bioavailability means that the naturally occurring forms of lead can pass through the human digestion system virtually unabsorbed.

It follows therefore that if toxic lead compounds can be converted to naturally occurring forms then a contaminated site could be rendered safe, even for human habitation and possible agriculture, although crop selection will be limited to those plants with low lead uptake.

Soil and residue characterization will be a key element in determining the appropriate remediation strategy. It must take into account the mineral form, particle size, toxicity and encapsulation of the lead contaminant, because these features will have a direct impact on solubility and bioavailability. As these characteristics are site specific, it is very important to prepare remediation strategies and models on real field sampling, monitoring and accumulated exposure data. There are four main remediation strategies to consider and selection should be based on the most appropriate or a combination of two or more of the four:

1) Removal and replacement of contaminated soils by either:
    - Removal and treatment to decontaminate the soils to safe lead levels and then return the treated soils to the original site
    - Removal of contaminated soil and replacement with uncontaminated soil.
2) Treatments involving the transformation of contaminants.
    - Thermal, biological, and chemical treatment methods that can be applied on or offsite.
3) Immobilization of contaminants
    - Including capping of landfill residues, chemical[xxix] and "*in-situ*" stabilization[xxx], solidification, and containment technologies.
4) Extraction, separation and recovery of contaminants
    - Including soil treatment by, soil washing[xxxi], thermal extraction[xxxii], and phytoremediation[xxxiii] extraction using "*in-situ*" phytoextraction using specially selected plants to "pull" the lead out of the soil. Where appropriate ground water treatment using gravimetric separation, ion exchange, and bio-chemical or phytoremediation[xxxiv] extraction.

Anticipate that a single technology or methodology might not adequately remediate an entire site and be prepared to consider several different treatment technologies that can be integrated to reduce if not eliminate the risk of lead exposure from all the sources of contamination.

## 5. Work Plan

During the initial remediation planning stages the abandoned lead mine site and/or lead smelter must be visited and inspected to ensure that any remediation plan addresses the potential lead exposure problems and issues associated with any population exposure or environmental contamination. A logical work plan should:

- Characterize the contaminated site and the surrounding area.
- Establish the environmental impact and the likely extent of any population exposure.
- Identify the most appropriate remediation technique(s) to be employed.
- Determine logistical problems associated with remote locations, arid conditions and equipment needs.
- Sequence the remediation work
- Suggest the agenda for a suitable communication workshop to acquaint those involved in the process and the local community with the appropriate remediation techniques and methodologies.

## 6. Maintenance and Aftercare

To ensure that a site remediation process continues to provide a safe environment it is important that any remediation plan considers maintenance and aftercare issues. For example, if any one or combination of the strategies outlined in section 10.3 above is appropriate, it will provide a safe, but sterile environment that is liable to erosion by wind and rain. In order to compliment soil abatement strategies for lead contaminated sites and inhibit erosion by the elements, <u>the plan must incorporate a number of agronomic options to encourage plant growth in treated areas to keep soil in place.</u>

Agronomic options to consolidate the top-soil and improve soil fertility should consider the use of domestically available and digested bio-solids[xxxv], as well as several other options that might be considered to cap certain areas where an agronomic option is inappropriate. See in particular information related to the use of biosolids for reclamation/remediation.

In most cases specific plants will have to be selected to sequester pollutants in their roots and inhibit any subsequent migration or leaching of stabilized lead compounds in the treated soil or capped residue dumps. Plants that sequester pollutants can be harvested and treated as pollutants, but in the long-term such plants will decontaminate the soil. (Gardening on Contaminated Soils)[xxxvi].

## 7. Regulatory Issues

In order to ensure compliance with the appropriate national, federal, municipal and local regulations for the remediation of lead contaminated sites and lead smelters the plan must include a section detailing the requirements of the various legal instruments applicable to the site. This section must also include the monitoring and testing regime necessary to ensure that the remediation plan will compliant with the appropriate regulations.

## 8. Publication and Distribution

It is recommended that once the Plans for the Remediation of contaminated sites and informal lead smelters have been prepared, they should be made available for distribution to the Offices of the National and local Government Regulators, any interested Academic Institutions and the local community representatives for their consideration.

Initial publication of the remediation plan should be treated as a period of consultation and feedback. Any comments, concerns or suggested improvements should be considered carefully and where appropriate the plan amended accordingly.

## 9. Links or Contacts for Information on Successful Remediation Projects

- Coeur d'Alene Basin, including mine site reclamation[xxxvii].
- The Doe Run Company - calcareous lead/zinc mine tailings[xxxviii].

## G - Occupational health and safety procedures

### 1. Personal Safety for Collecting, Storing and Transporting ULAB

### 1.1 Potential Adverse Health Effects of LAB materials

Lead acid batteries contain components and chemicals that are toxic and can damage the environment and cause harm to people. The two main substances of concern are:

- Lead

Acute health effects: Lead dust or fumes can irritate eyes on contact. Inhalation of lead dust can irritate nose and throat. Exposure can cause poor appetite, weight loss, upset stomach, nausea, and muscle cramps.

Chronic health effects: May cause kidney and brain damage and damage to blood cells causing anemia. Probable teratogen that can damage a developing fetus. May decrease fertility in males and females. Repeated exposure causes tiredness, trouble sleeping, stomach problems, constipation, headaches, and moodiness; higher levels may cause trouble concentrating and remembering things, and aching and weakness in arms and legs. Exposure increases the risk of high blood pressure. Accumulates in the body with repeated exposure.

- Sulfuric Acid

Acute health effects: Extremely corrosive; can severely irritate and burn skin and eyes. Inhalation can irritate lungs, causing coughing and/or shortness of breath; higher-level exposures can cause a build-up of fluid in the lungs.

Chronic health effects: Limited evidence that sulfuric acid causes lung cancer in refinery workers. Repeated exposure can cause bronchitis, with cough, phlegm, and shortness of breath; may cause emphysema; can cause chronic runny nose, tearing of the eyes, nosebleeds, and stomach upset.

### 2. Occupational Surveillance

### 2.1 Lead exposure in the workplace

Monitoring of lead-in-blood levels is critical to ensure workers' health. Although many regulatory agencies require monitoring of, and apply limits to, lead levels in air it is the level of lead in the employee's blood that is the determinant of whether or not risk of adverse health effects exists. The sampling of blood, preferably by venipuncture, and analysis for lead concentration is the most commonly accepted index of exposure in the occupational setting. In the occupational setting, exposure via air and ingestion constitute the primary routes of exposure. Dermal absorption of inorganic lead through unbroken skin is considered to be minimal and does not represent a risk to the workers.

The relationship between air lead and blood lead has been the subject of much study. In general, the blood lead/air lead relationship is curvilinear in nature. This means that the impact of a given lead in air level upon blood lead will vary as a function of intensity of exposure. In general, a given unit of lead-in-air will produce a greater increase of blood lead in an individual with a low blood lead level as opposed to one with a high blood lead level. Thus, estimates of the relationship between air lead and blood lead suggest that there is an increase between 0.02 and 0.08 $\mu g.dL^{-1}$ (micro grams per deciliter) of lead-in-blood for each $\mu g.m^{-3}$ (cubic meter) of lead-in-air depending on a persons' lead in blood level.

The air lead/blood lead relationship in the occupational setting will also vary as a function of the particle size distribution and chemical speciation of the lead contained within occupational aerosols. The uptake of inhaled lead varies as a function of the area of the respiratory tract in which it deposits. Deposition patterns within the lung, in turn, will vary as a function of particle size. Very fine particulate matter (less than approximately 5 microns in diameter) will deposit in the deep lung. Material that deposits in this section of the lung is taken up into the body with very high efficiency. Particulate matter that deposits in the upper airways or in the nose and throat exhibits much different behavior. Head and throat deposition is followed very rapidly by swallowing and transport of material to the gastrointestinal tract. Upper airway deposition is followed by mucociliary clearance that similarly transports deposited particles into the gastrointestinal tract. The uptake efficiency of lead from the gastrointestinal tract is much lower than uptake from the lung and is typically on the order of 5 -10% of the amount ingested. Furthermore, whereas uptake from the deep lung is very high and independent of chemical speciation of the aerosol, the uptake of material from the gastrointestinal tract will vary as a function of chemical speciation. In general, soluble forms of lead (e.g. the sulfate) will be taken up with higher efficiency than insoluble forms (e.g. lead metal).

The lead-containing aerosols in many work environments are quite coarse with approximately 90% of the particles having a diameter equal to or larger than 10 microns. Upper airway deposition, followed by clearance to the gastrointestinal tract, thus is to be expected in many work environments. However, the particle size characteristics of any aerosol will potentially have extreme variability, and will vary in a site-specific fashion as a function of both process-specific and general work environment conditions.
This variability imparts yet further uncertainty into the anticipated impact that a given amount of lead-in-air will have upon increased blood lead levels in workers. The nature and extent of engineering controls employed at a facility will also impact upon the particle size characteristics of workplace air. Effective engineering controls will dramatically lower the total amount of lead-in-air; but tend to have highest capture efficiency for larger particle sizes. Engineering controls can therefore, potentially yield workplace aerosols with very fine particle sizes capable of deep lung penetration and deposition. This means that direct proportionality cannot be inferred between reductions in air lead that result from engineering controls with decreased exposure risk. A tenfold reduction of lead-in-air will not yield a tenfold reduction of lead exposure risk if the lead removed from occupational air is predominantly large particulate matter taken up into the body with low efficiency leaving behind fine particulate matter taken up with high efficiency. In the extreme, a very fine particulate aerosol will increase blood lead levels approximately 2 $\mu g.dL^{-1}$ for every $\mu g.m^{-3}$ of lead-in-air.

The actual level of exposure experienced in the occupational setting will also vary as a function of industrial hygiene practices. Ingestion of lead via frequent hand to mouth activity and inadequate industrial hygiene, smoking, or eating in the workplace can all produce significant increases in blood lead. Thus, proper control of lead exposure in the workplace requires that not only are adequate safeguards maintained to limit inhalation exposure, but that industrial hygiene programs are also in place to limit exposure through ingestion.

**2.2 Lead- in- blood monitoring programms**

The precise guidelines to be followed for the monitoring of lead-in-blood will vary as a function of regional regulatory requirements. In any workplace, it is important to establish a starting point for the exposure of new employees. Accordingly, an exposure baseline should be obtained before any worker commences activity in the workplace involving potential contact with lead or any of its compounds. Workers should then be tested at regular intervals, with the frequency of testing increasing as a function of exposure intensity. Thus, a worker may be tested every month upon first exposure to lead and/or if blood lead levels are in excess of a value such as 20 or 25 $\mu g.dL^{-1}$. Some employers will also increase the frequency of monitoring for a given employee if there has been an increase of blood lead of 10 $\mu g.dL^{-1}$ between tests. Should lead-in-blood levels remain low, typically below 25 $\mu g.dL^{-1}$, the frequency of testing will often be decreased.

All biological monitoring results should be shared with employees together with a full explanation of the significance of a particular level of lead-in-blood and the meaning of any changes in lead-in-blood levels. Sharing the results of blood tests with employees and discussing trends and variations in levels is a very important part of a lead risk reduction strategy. This is especially true for adverse trends and only by discussing a person's work schedules and tasks, and then checking these activities with any personal background lead-in-air monitoring and the levels of respiratory protection or the ventilation afforded to the employee, can conclusions be drawn and recommendations for reducing exposure be agreed and implemented.

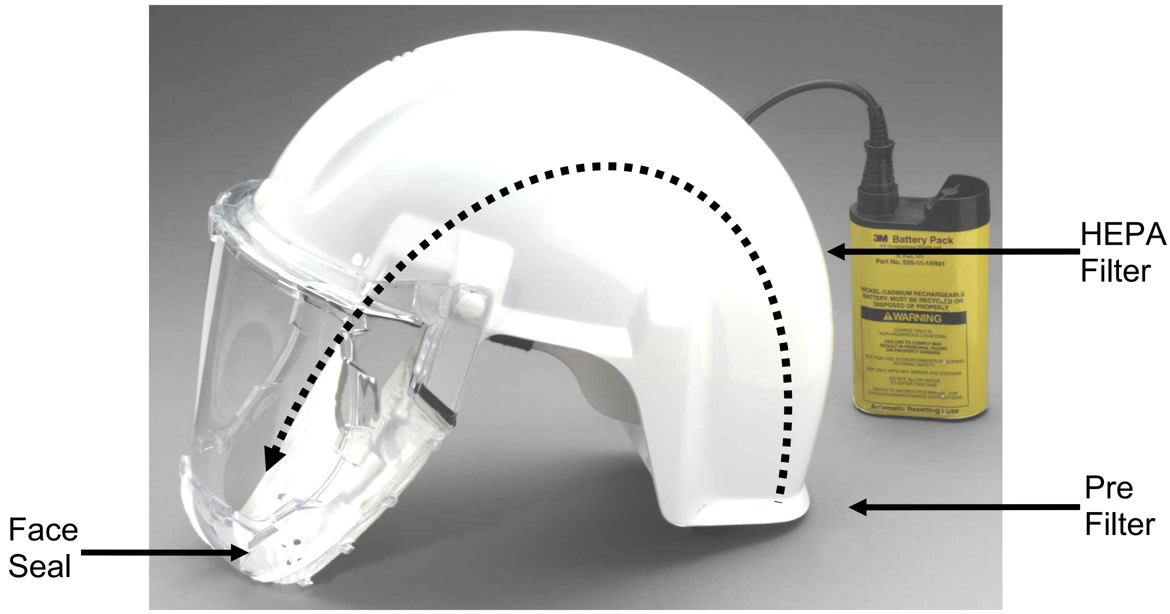
This counseling aspect of the risk management process is being increasingly recognized by the lead industry as an essential component of a medical surveillance program. Moreover, in 2003 the U.S. Department of Labor's Occupational Safety & Health Administration (OSHA) introduced an "e-tool"[xxxix] for secondary producers that describes ways to reduce lead exposure to employees in lead smelter plants. This internet-based resource specifically targets the following operations:

- Raw materials processing,
- Smelting,
- Refining,
- Casting,
- Environmental controls
- Maintenance

There are helpful diagrams with potential exposure sources highlighted and suggestions for either reducing the levels of lead exposure through an engineering solution or a change in working practice. Employers should also review test results for all workers by job, department, section, process and shift in order to help identify jobs or work areas where there is a pattern of problems associated with elevated lead exposure occurring.

### 2.3 Respiratory Protection

Whilst every effort should be made to minimize the risk of lead emissions during the recycling process, it is prudent to ensure that operating personnel are suitably equipped with the appropriate respirators in the event of fugitive emissions or ventilation system failure.




Pic. A 3M HEPA Airstream helmet

Those personnel working in the hot metal areas should wear an airstream type of helmet because it also provides a full face mask to protect against metal and slag splashes. Airstream type helmets have a battery-powered motor and fan located in the helmet shell that draws contaminated air through a pre filter at the base of the helmet. Air from the fan then passes through a high efficiency particulate air (HEPA) filter and over the user's head. The filtered air is directed down over the user's forehead and provides a pleasant cooling airflow over the entire facial area. The air is expelled at the bottom and periphery of the disposable face seal.

For those operators working in the battery breaking or desulfurization processes the standard HEPA filter will not afford protection against the chemical mists that can be given off during operations. In these cases, and others where a specific toxic gas threatens the well-being of those working, the most efficient method of ensuring safe working is to use a battery-powered motorized filter pack, such as the 3M Breathe Easy with interchangeable filters.


Pic. The 3M BreatheEasy

The BreatheEasy Turbo motor blower unit draws ambient air through a filter/cartridge/canister and supplies filtered air through the breathing tube to the headpiece. The turbo unit can be paired with a number of conventional masks and airstream helmets designed to fit the breathing tube to form a complete filtration system. The fan-assisted flow of cool filtered air makes breathing easier, eliminating the fatigue caused by the effort of inhaling through filters during many hours of work.

Maintenance and engineering work inside baghouses and filtration systems requires specialized equipment and airline breathing apparatus supplied with filtered air from an external or self-contained supply, such as a gas bottle. Facemasks and personal filter systems are not designed to cope with the extreme exposure likely when inspecting or maintaining filtration equipment. It is very important to choose a mask with an external supply nozzle and its own filter so that when the external supply is disconnected the wearer will be able to breathe filtered air. Such respirators are designed to be worn in an air or water shower and any operator working in extreme conditions must continue to wear the face mask until all contaminated clothing has been removed, placed in a suitable bag, and he or she has washed off any dust in the shower. Only then should the mask be removed and then the operator should wash again. The mask must be placed in a suitable bag to be decontaminated.


Pic. 3M airline supplied breathing apparatus

For those personnel working in "low risk" areas, the use of a paper "comfort mask" should be strongly discouraged. These masks do not provide a good seal around the mouth and nose and do not conform to the standards required for protection from lead-in-air. As a minimum standard, only those "paper" masks specifically designed for particulates and welding (with neoprene face seals and adjustable nose clips) should be used.


Pic. 3M-8511 N95 particulate respirator

In addition to a neoprene face seal, such respirators feature an exhaust valve to keep the inside of the respirator as dry as possible.

## 2.4 Employee's Amenities

In addition to the supply of personal protective equipment and the maintenance of plant hygiene control systems, it is essential to ensure that:

- Cleaning regimes are in place in all the operating areas
- Employees are provided with clean working clothes every day
- There is a clean area to drink and eat meals
- Hot showers are available so that employees can wash at the end of the working day and whenever they are contaminated with lead dust during the course of their work.

The design of a changing room in a secondary lead-plant or battery manufacturing facility, together with washing facilities and eating areas is critical to maintaining good practices and personal hygiene. The design should follow these principles:

- Location

The changing room should be located on the perimeter of the secondary lead-plant so that access to the "leaded" area is only possible through a lead-free area. All amenities for employees working in the leaded areas should be located in the same building as the changing rooms. Workers will thus be in close proximity to work clothing, safety equipment, washing facilities and the canteen or eating area.

- Segregation

The clean and plant changing rooms should be segregated, with access from the clean side to the plant side through a corridor that passes the plant clothing and safety store. Works personnel should leave all their own clothes, including underwear, in their designated clean lockers. The lockers should have coded locks so that there is no need to take keys onto the plant. There should be access to a bathroom and toilet from the clean changing room.

Access to the plant from the clean locker room should be via a corridor with a one-way restaurant door so that once an employee passes through it he or she cannot go back into the clean area without passing through the washroom. The corridor should take the works personnel past the clothing store where they can collect clean overalls and/or any necessary safety equipment. As personnel enter the corridor, they should place simple disposable or washable sandals or socks on their feet for hygiene purposes. These socks or sandals are discarded at the end of the shift or placed in the wash-bin. When works personnel have changed into their works clothing and are wearing the appropriate safety equipment, they should leave the changing room by the only exit to the plant.

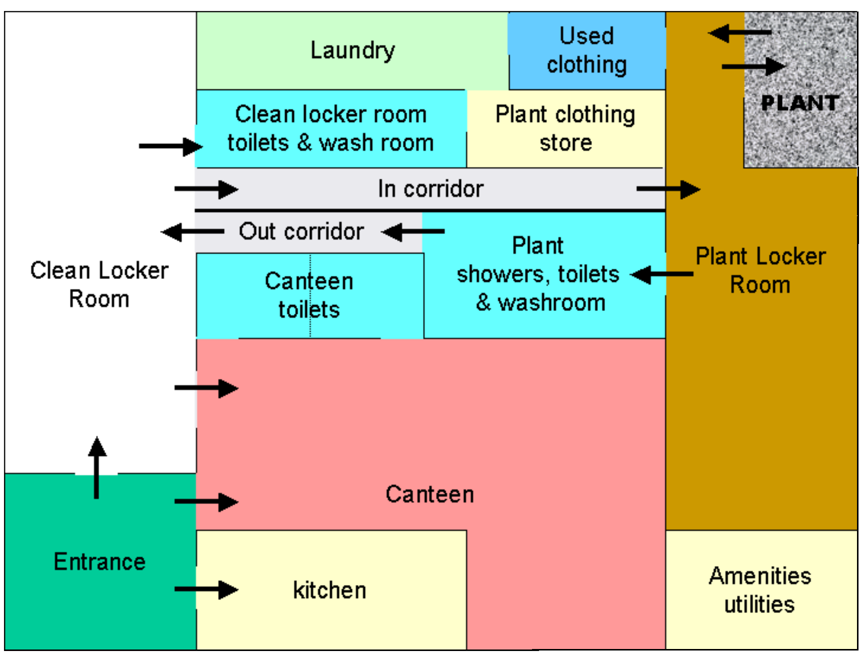
- Containment

At the end of the shift, or when it is time for a meal break, plant personnel should enter the only entrance to the plant locker room. Outside the entrance, there should be ample boot cleaners. These can be electric powered vacuum brush cleaners, although upturned wet brushes in standing water will suffice. After cleaning their boots employees should enter the lobby area of the plant locker room and remove their boots. Then all contaminated works clothing should be removed and placed in the "used clothing bin" located in the lobby of the changing room. This should be a sealed bin with an envelope slot facing the entrance to the plant so that contaminated clothing can be pushed into the bin without creating any lead-laden dust.

The "used clothing bin" can have more than one slot if segregation of the various items of clothing is required. Furthermore, water-soluble bags can be used to line the bins so that full bags can be placed straight into the washing machines, thereby avoiding exposure risks to the amenity and laundry attendants. The contents of the bag need never be handled. The bag dissolves totally into a bio-degradable solution in hot water over 60°C.

Works personnel should proceed to the shower and washroom area through another one-way door, so that they cannot return to the plant room from the shower area. Ideally, the design should be such that operators must pass through automatic showers. Thus, all workers have to shower as they leave the plant. Toilets, soap dispensers and clean towels, should be available in the shower room.

"Clean" plant personnel can then exit the washroom and return to the clean changing room through another one-way door. Personnel can change back into their clean clothes and either leave the plant at the end of their shift or go to the canteen.




Dia. Typical design for a lead plant change room and canteen

The amenity plant layout shown minimizes the risk of lead exposure. However, there are a number of additional points to bear in mind:

- The whole washroom, canteen and changing facility should be air-conditioned. The air pressure in the plant locker room should be less than that outside so that lead dust does not enter the clean areas.

- As plant personnel should not carry money into work areas, clean drinking water must be freely available in the plant.
- Safety equipment must be returned to the safety store at the end of each shift for cleaning.
- Smoking should be banned. If not, plant personnel will undermine the segregation strategy if they are allowed to take cigarettes onto the plant and then return to the clean areas with them. Hand to mouth contact during smoking will also increase lead ingestion.
- Access to and from the canteen and laundry must be carefully planned in order to maintain the highest level of segregation.
- Similar facilities should be built side-by-side for men and women if both sexes work on the plant.

**2.5 Health and Safety Precautions in the smelting industry**

Accordingly, due regard must be given to the safety of those involved in collecting, storing and transporting the ULAB and anyone else who may have to assist in the event of an accident. Each truck carrying ULAB should have equipment necessary to combat any simple spillage or leakage problems and there should be personal protective equipment available to wear, such as goggles, gloves and neoprene boots.

The appropriate authorities and emergency services should be notified of the transport route for truck loads of ULAB from collection centers and wherever possible a route should be chosen that minimizes the risk of possible accidents and avoids populated areas.

It must not be forgotten that it is important to train personnel that have to transport hazardous wastes in emergency procedures, including fire, spillage and skin burns. It is also essential they know how to contact local and national emergency response teams.

The driver of a truck containing ULAB must have a label on the truck and inside the cab displaying an emergency telephone number to call in the event of an emergency.

**The Ten Golden Rules to minimize lead exposure and hand to mouth contact**

1. Remove rings, chains, and other metallic items before handling ULAB; then only handle ULAB with acid resistant rubber or neoprene gloves and have dust masks or respirators available to wear if necessary.
2. Operators must only wear work clothes in the workplace.
3. Shower and wash after a days work or whenever contamination risks have been high.
4. Change into clean work-wear every day or shift.
5. Avoid procedures that generate high levels of lead exposure.
6. Segregate ULAB working areas and the non-leaded offices and eating areas.
7. Keep eating and drinking areas clean and lead free.
8. Wash hands and face prior to eating at work.
9. Keep homes clean and lead free; do not take work-wear home.
10. Keep sparks and flames away from ULAB and do not smoke in a ULAB collection, storage or delivery center.

If the ULAB are being transported out of the country then it will be necessary to comply with the Convention's regulations for the transboundary movement of hazardous waste.

## 3. Process and emissions

### 3.1 Engineering centrals

Occupational exposure to lead and other toxic substances can be problematic at multiple stages of the recycling process. Although much attention has been paid to exposure reduction via ventilation controls or personal protective equipment, basic process design is also important. Process modifications may be feasible to eliminate or reduce the generation of emissions. For example:

- Blend dusty materials in enclosed facilities using water as needed to reduce dust levels.
- Lower pot temperatures to decrease the rate of dross formation and the surface generation of dust.
- Furnace metal can either be tapped into moulds/pots under a ventilated shroud or directly into a bath of covered and ventilated molten lead between 310 and 350 °C to minimize fugitive emissions.
- Plant layout can also be modified to minimize movement and reduce the amount of materials handled.

Exposure can be reduced if machines are used to perform high exposure tasks permitting employees to be removed from the area. This is especially useful during the furnace tapping phase when close proximity to slag and melt taps will result in high personal exposure. Many companies have automated the tapping operation so that it is remotely controlled from an air-conditioned environment.

Efforts should be made to enclose any emission source to the greatest extent feasible. A description of methods and devices to capture and contain furnace gases, lead fumes and dross dusts is given in appendix 28 (Process Emission Controls).

### 3.2 Housekeeping measures

A number of other housekeeping measures can be effective, including:

- Where engineering controls are provided to minimize or contain lead emissions, inspections and maintenance regimes must be established at service intervals that are recommended by the manufacturer or comply with statutory regulations. An up-to-date record of all inspections and engineering maintenance work must be kept.

- Efforts should be made to wash down areas with water and keep areas damp, especially the working surfaces. Operator training, prudent work practices and good housekeeping are key elements in minimizing lead exposure when operating mobile equipment.

- Local exhaust ventilation, and clean air stations with positive filtered air, can be provided so that employees can retreat to the clean air station when they are not needed in the process areas.

- Respiratory protection is important and should be available to any employee. Such equipment can be of the mask type or the filtered air hood. If sulfur is present, carbon filter combinations should be made available.

- Belt wipes should be added to all tail pulley systems. Conveyors should be subject to regular cleaning, and skirting should be placed at the head of any belt drive system. This is especially important on battery breaking equipment because engineers will be working on the equipment when it is dry. It is also important to make efforts to contain dust-emitting process in one enclosed building and to separate one operation from another so that there is no cross-contamination in the event of fugitive emissions.

Pic. Cyclones in series at the Baterias de El Salvador plant in San Salvador

### 3.3 Emission Testing and Analysis

The effectiveness of control measures should be assessed using all of the following methodologies:

- Static atmospheric monitoring
- Personal lead-in-air monitoring (in the breathing zone of the employee)
- Biological monitoring of employees in lead-risk jobs.

When persons are liable to receive significant exposure to lead in workplace air, the employer must ensure that the concentration of lead-in-air is measured in accordance with a suitable national, regional or international procedure. Emission testing and analysis can take a number of forms, but it is generally important to test for particulates, sulfur dioxide and visible emissions.

Air samples of the workplace should be taken using calibrated sampling pumps with cassettes containing either mixed cellulose ester (MCE) or polyvinyl chloride (PVC) filters. There may be a number of country-specific statutory sampling requirements.

Nonetheless, the following guide will provide an overview to the effectiveness of control measures:

| Type of Sampler | | Characteristic and Purpose |
|---|---|---|
| Static perimeter samplers | - | Located on the boundary limits of the operations. |
| Personal monitoring | - | The sampler is located on the employee and the test proceeds as he or she undertakes his or her duties. This test measures the level of occupational exposure at the place of work. |
| Static process samplers | - | Are located close to those operations most likely to produce lead fume or dusts. Typically used to monitor efficacy of emission controls. |
| Static urban/rural samplers | - | Located outside the plant and close to places that may be of concern to the public. Typical locations would be a farm, local housing estates, hospital, school or nursery. |

Secondary operations may also be required to test for hydrocarbons and dioxins in the furnace off-gasses. The engineering maintenance department should pay particular attention to any baghouse leaks using opacity tests or baghouse leak detectors. In-line organic or sulfur dioxide testing equipment is available, but will not function consistently unless installed downstream of the baghouse or dust collection control equipment. After any new installation or modification to the lead process, it is recommended that a determination of lead-in-air values be made as soon as possible and that the sampling cover the lead exposure of a representative number of employees who are likely to be those most exposed to airborne leaded dust.

While it is essential to comply with national emission limits for any lead industry, it is also important to set internal company standards and these should cover three sources:

- Process emissions.
- Fugitive sources of emissions.
- Fugitive dust sources.

Before any monitoring takes place a clear strategy should be agreed with all concerned so that everyone understands that it is in the interests of employees and the local community that all workers cooperate with the program. Those implementing the strategy should be aware of all the lead processes at the workplace including:

- Equipment used for transporting and processing lead-containing materials;
- The composition of lead-containing materials;
- Process details, e.g. smelting regimes, temperatures and cycle times;
- The range of operational tasks in the process and maintenance areas.

Sufficient samples, whether from static or personal sources, should be taken during routine monitoring to identify any major changes in exposure levels. Any abnormal results, whether low or high, should be carefully investigated by trained personnel in order to establish the reasons for the abnormality. If the results are higher than expected, it is important to ensure that the employees concerned are adequately protected until any further controls needed are introduced.

Group sampling and observation is the most efficient and effective monitoring method because comparisons can be made between employees, and rogue results are easily identified and eliminated. However, when such procedures are carried out, it is important that results are carefully analyzed to make certain that they are valid for all the individuals who make up the group.

The statutory requirements of many national standards for occupational health monitoring require results to be reported as a time-weighted average, normally based on an 8 hour working day. As personal sampling rarely lasts more than four hours it is important to take into account the full range of operations carried out, particularly those at the beginning or end of the work period where there might be significant lead exposure. Any monitoring strategy should therefore require monitoring times to vary through the shift so that, over the course of a year, workers in all the various stages of the recycling process are sampled.

Fugitive emissions and fugitive dusts can be measured with a personal monitor or high volume filter testing equipment when studying internal emission sources. However, working methods and personal practices are the most important factors that affect occupational lead exposure and all personnel involved in lead operations must be adequately trained in lead abatement strategies and informed of the results of observations and monitoring, whether a cause for concern or not.

## H- Transboundary movements of used lead acid batteries

### 1. Classification of ULAB under the Basel Convention

ULAB exhibits the following hazardous characteristics listed in Annex III to the Basel Convention:

- H8 Corrosives: Substances or wastes which, by chemical reaction, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport; they may also cause other hazards.
- H11 Toxic (Delayed or chronic): Substances or wastes which, if they are inhaled or ingested or if they penetrate the skin, may involve delayed or chronic effects, including carcinogenicity[18].

ULAB subject to transboundary movements are classified under the following categories in annex I and Annex VIII of the Basel Convention.

1) Y31 waste, that is, waste having as a constituent lead or lead compounds. The sulphuric acid that can be drained should be classified under the Y34 category: acidic solutions or acid in solid form. ULAB can also be classified as a Y31 and Y34 if the acid was not drained;

2) Annex VIII -category A1160 waste: waste lead acid batteries, whole or crushed

### 2. Classification of ULAB under the World Custom Organization (WCO)

Under the WCO Harmonized System (HS) of tariff nomenclature[xl], used lead acid batteries are classified in 8548.10 code: " spent primary cells, spent primary batteries and spent electric accumulators", those which are neither usable as such because of breakage, cutting up, wear or other reasons, nor capable of being recharged (Note7 to Chapter 85).

Some countries have added more digits to the code of the Harmonised system. Therefore, for each country the exporter has to check the exact code.

### 3. Control system under the Basel Convention for ULAB

The control system of the Basel Convention needs to be followed in cases of the transboundary movement of ULAB. The detailed procedure for each agent involved is described in detail in the Instruction Manual (Basel Convention Series/SBC No.98/003).

Before proceeding to the transboundary movement, the exporter is held liable for the waste and for initiating the procedure. The exporter will be held liable until the disposer signs the movement document and certifies the acceptance of the waste. Prior to the movement, the exporter will make sure that:

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[18] The lead compounds used in the manufacture of LAB are not carcinogenic, but may induce other delayed or chronic medical conditions.

- The states of import and export are both part of the Basel Convention or signatories of a bilateral agreement according to Article 11 of the Basel Convention, and the export/import of ULAB is not prohibited through international law or the national law of the States of import, transit, or export;

- The State of export does have the technical capacity and the necessary facilities, capacity or suitable disposal sites in order to dispose of the waste in question in an environmentally sound and efficient manner;

- The waste is required as a raw material for recycling or recovery industries in the State of import;

- The facilities of the licensed disposer are in accordance with the national legislation of the State of import and the management of the ULAB will be environmentally sound;

A contract needs to be signed between the exporter and the disposer in the state of import. In the contract, several elements must be specified; the contract period, the dates of arrival and of treatment or disposal, the quantities of ULAB, the packaging to be used, delineate liability, insurance and the financial arrangements that have been arranged previously. A more detailed description of the type of contract will be found in the Appendix 6 of the Instruction Manual.

The exporter will contact the competent authority of the State of export to obtain the notification and movement documents. Some examples of notification and movement documents for ULABs are found in Appendix 29.

### 4. Financial guarantees and additional legal requirements

As allowed by the Basel Convention, the competent authorities of the State of Import or the States of transit may request or impose specific additional conditions to allow the transboundary movement to proceed. Such conditions may be of a financial or legal nature. Therefore, it is strongly recommended that contact is made with the States of import and transit to ensure no specific financial guarantees or legal requirements are requested. In this regard, see Box B below.

This situation will evolve after the Basel Protocol on Liability and Compensation for Damage Resulting from Transboundary Movements of Hazardous Wastes and their Disposal (1999) is ratified. Financial guarantees will become a requirement for a transboundary movement of hazardous wastes to proceed. The Protocol will set the minimum financial guarantees per quantities of the hazardous wastes transported. However, the States may decide to establish higher financial guarantees as may be required under their national legislation. Therefore, it is recommended, once again, to anticipate the ratification of the Protocol, and check with the States of import and transit the financial guarantees that will or may be required to cover the transboundary movements of ULAB.

Box B: Example of legal requirements for transit. The case of Colombia

The import of toxic wastes is prohibited by the constitution of the Republic of Colombia. Nevertheless, transit is allowed, and the competent authorities  several conditions to be met to allow a transit to take place in the context of the Basel convention:

*1-. <u>The contract for the disposal of the wastes.</u>*

*2-. <u>An insurance policy.</u>*

*The insurance policy has to fulfil several specific requirements:*

*i) The insurance policy needs to cover the total duration of the shipment or shipments, until the disposal;*

*ii) The policy has to indicate the name of the person or entity insured;*

*iii) The insurance policy must establish in clear terms that it covers the damage caused to the natural resources because of a possible accident or contingency during the authorised movement.*

*3-. <u>An engagement letter for the transit of the hazardous wastes through Colombia.</u>*

*In this letter, the exporter has to state that the hazardous wastes will <u>not</u> be unloaded or transfered in any territory in the State of Colombia.*

Box C: Example of Insurance policy for used lead acid batteries.

For a transboundary movement of used lead acid batteries that was authorised through the general notification, the insurance policy shall state:

All relevant data and information about the insured person or entity.

The dates of validity of the insurance policy.

All the data about the transboundary movement.

The material that is insured:
**Example**: Containers with 153,50 tonnes of used lead acid batteries.

The total insured:
**Example**: Amount insured: 22.242,00 US$
Net premium: 48,93 US$

## 5. Environmentally Sound Movements

The transboundary movement of ULAB should be carried out in an environmentally sound manner as an obligation under the Basel Convention. The requisites for the environmentally sound transport of ULAB are described in chapter B. The important characteristics to follow include:

- ULAB should be stored in a secure compound prior to the movement.

- It is recommended not to drain the batteries because of the possible threats to human health and the environment. Nevertheless, in some states the law requires that for specified modes of transport[xli] that the sulfuric acid is drained; collected and treated separately. In which case, the battery electrolyte should be stored in a leak-proof properly labelled plastic container that is securely fixed during storage and packaged during transit to prevent any spillage.

- Packaging of Used Lead Acid Batteries: the packaging should be done in an environmentally sound manner as explained in chapter B, that is, stacked on wooden pallets no more than four high, with the vent caps shut to avoid spillage and, heavy duty corrugated cardboard between each layer of ULAB. Finally, the whole pallet and the ULAB should be wrapped tightly in plastic to minimise any movement during transport. While awaiting transport, the wrapped pallets should be stacked no more that two pallets high.
- The transport vehicle should also comply with the ESM and safety rules, as well as being correctly identified following international conventions and local

legislation. Ensure, where necessary, the correct labelling of the containers with the ULAB, and make certain the immobility of the pallets inside the vehicle.

## 6. Measures to facilitate compliance to the Basel Regime

The general notification that allows several shipments of the same waste stream over a maximum period of a year is especially recommended for ULAB.

The exporter should prepare signed copies of the notification for the competent authorities of the state of export, import and transit. One copy (some countries may require several copies) should be sent to the competent authority of the State of export that will send it to the other competent authorities concerned. If all States accept the import, the competent authority of the State of export shall issue a written authorisation. The exporter can also be asked to provide more data and information, and depending on the concerns of the different States, the authorisation will be issued with or without conditions. An example of the conditions that can be asked for is available in box A. The stages in the notification and authorization procedure can be found in Appendix 30.

The movement document will be completed by the exporter and signed by each carrier involved. Each carrier should then retain a copy signed by the successive carrier. When the shipment arrives at the disposer (recycler), the disposer shall then complete and sign the movement document and send certified copies to the exporter and the competent authority of the State of export, or any other competent authority as required by the national law of the country; usually three working days following the receipt of the ULAB. The competent authorities will check that the certification is consistent with the notification and other relevant documentation and may ask for clarification if it is not the case or take further action if necessary.

When the ULAB have been processed in the recycling facility, the recycler needs to complete the movement document by certifying that the ULAB has been recycled as set out in the notification, and to send the certification to the exporter and the competent authority of the State of export. Some countries also require such copies to be delivered to the other competent authorities concerned and to be sent out within 180 days of the receipt of waste. The competent authorities will check that the certification is consistent with the notification and other relevant documentation and may ask for a clarification if it is not the case or take further action if necessary. See Appendix 31 for an outline of the tracking procedure.

Finally, when the certification has been accepted, the competent authority has to return the financial guaranties arranged for the movement. The disposer keeps the original movement document for filing. The competent authority has responsibilities in the waste management process and to view and list of these and the sequence in which they are invoked see Appendix 32.

Box A: Criteria used by the competent authorities of the country of import for consenting to the import of ULAB

1. *The ULAB will be used as a raw material for the lead recycling or recovery industry in the State of import;*

2. *The transport of the ULAB should be carried out in an environmentally sound manner (see section B of this Manual). Any specific road, highway or area can be considered of any special value (biodiversity, etc), entailing the need to take specific measures.*

3. *Should the notification be a general notification, the exporter should notify to the Competent Authority the starting date of the shipments, the duration of the notification, the route to be used, the number of shipments, the total quantity as well as the approximate average quantity per shipment, the date of arrivals to destination ;*

4. *The recycling company should present to the competent authorities once a year (or any other requested date) the certification of compliance with the environmental legislation in place;*

5. *Each six months, a report on the hazardous materials/waste that are recycled and imported should be presented to the Environmental authorities;*

6. *Inspections from the Environmental Authorities can be done without warning at any moment of the year;*

One of the Parties concerned (State of export, State of transit, State of import) may wish to decide to keep the secretariat of the Basel Convention informed of the procedures as well as the implementation of the agreements between the parties.

For those smelters having to import ULAB to maintain feedstock, compliance to international agreement, including the Basel Convention, can impose serious cash flow problems as working capital requirements can stretch to over 6 months of debt.

The reason for this possible increase in working capital is the fact that the administrative requirements of Prior Informed Consent (PIC) and the necessary export/export licenses can and have taken up to six months to process. Normally ULAB due to be exported have to be purchased by the smelter at the point of sale and on the day of the sale, otherwise the ULAB will be sold to another smelter because there is a shortage of ULAB in the world. Such purchase arrangements mean that the ULAB are bought before the PIC procedure is followed and before any application for export/import licenses. It is a fact that where there are regular shipments of ULAB from one country to another, the time taken for PIC and export/import licenses to be issued is certainly less than six months and probably not more that a matter of weeks.

There is a lesson here for smelter managers. When ULAB purchases require compliance with the Basel Convention, PIC and export/import licenses, it pays to have the respective government agencies in both the exporting and importing countries aware of the likelihood of the transboundary movement of the ULAB. In addition, it would be sensible to make sure that the government agencies have all the customs forms they need and that the staff know how the PIC procedure works and what is required of them to expedite any application quickly. Attention to these points will be cost effective because interest payments on extended working capital requirements will be minimized. The time taken to transport the ULAB by ship or truck is often outside the control of the smelter manager, albeit it is important to note that working capital has to cover this period as well as the time taken for PIC and licensing.

What is apparent over the years is that the number of secondary lead smelters in the world is going down, while at the same time the capacity of the remaining smelters is increasing. This means that for a growing number of countries, ULAB will not be recovered through domestic smelters, but will be exported for recycling. The trend is undoubtedly for more regionally based recovery networks and an increase in the transboundary movement of ULAB at the regional level. For those regional smelters purchases of ULAB will be made from a number of countries and even with an efficient PIC and licensing administrative system it can be predicted that in an industry where margins are tight that many smaller smelters, particularly those in developing countries, will experience financial difficulties maintaining interest payments on working capital.

Consideration has, therefore, to be given to some form of financial assistance in the form of preferential interest rates, bank credits or export/import guarantees in order to reduce the risk of the smelter going into liquidation or secouring an environmentally unfriendly operation in the informal sector in order to cut costs and remain viable.

The lack of coordination between different organisations dealing with the transport of hazardous wastes has been identified and reported as one of the main problems for the transboundary movements of ULAB. The exporter should contact several institutions independently, but these institutions are not well coordinated. That lack of cooperation among them can cause delays in the transboundary movement as well as a potential increase of the illegal traffic that can arise from the lack of the documentation required or problems in the content of the documents.

As an example, the exporter may need to contact the following institutions:

- The fire brigade

A statement from this institution can be required for the transport of the ULAB. The document required should state that the vehicle has successfully passed a mechanical expertise and is in good state, identify the container in which the ULAB will be transported as well as the carrier in charge of the shipment.

- The Ministry of Environment

The exporter can be asked to present to the Ministry three different permits:

- ➢ The identification of the substances to be imported.
- ➢ The quantities to be imported classified by their origin and company, for a year period.
- ➢ Present the documentation of the carrier that will be in charge of the transport with the statement of the fire brigade.

- The Vice Ministry of transport

For each carrier that will be involved in the transboundary movement inside the country, the exporter can be asked to provide a document in which it the origin and destination of the transport as well as the property of the vehicle and the documents of the driver should be specified.

This example shows the independence of the different documents that can be required as well as the different institutions involved. This situation can cause a lack of coordination and fluency between the institutions to treat the documentation of the transboundary movement, and thus can cause delay or problems in the compliance to the legal requirements for the transboundary movement.

## 7. Illegal traffic

### 7.1 Definition of illegal traffic

For the purpose of the Basel Convention and in accordance with Article 9 of the convention, transboundary movement in ULAB would be considered illegal traffic under the following circumstances. If the movement was instigated:

- Without notification pursuant to the provisions of this Convention to all States concerned; or

- Without the consent pursuant to the provisions of this Convention of a State concerned; or
- With consent obtained from States concerned through falsification, misrepresentation or fraud; or
- In a manner that does not conform in a material way with the documents; or
- In a way that results in deliberate disposal (e.g. dumping) of the hazardous wastes or other wastes in contravention of this Convention and of the general principles of international law.

**7.2 Reasons for illegal traffic**

Depending on the regions concerned, the driving forces for illegal traffic can be varied in nature. For example, a category of transboundary movements that does not fully comply with the requirements of the Basel Convention may occur because of legal or administrative shortcomings, or economic constraints. Such ‘illegal movements’ may be characterized as being not deliberately criminal. In such instances, the exporters and the importers are known, the routes used can be traced, and possibly the quantities and frequency of the shipments concerned would be known to the competent authorities. Such ‘illegal traffic’ may take place for the following reasons:

1) Discrepancy, gaps in the national legislation of the countries concerned. This situation may create misunderstandings or negligence in the context of issuing permission for the transboundary movement to take place. Examples include different definitions of ULAB under national law, a lack of understanding of the hazardous waste categories, misconceptions about categorizing waste destined for recycling, lack of compliance to specific legal and financial requirements, etc.

2) Poor recycling of ULAB. ULAB are imported according to the national legislation of the countries concerned, but ULAB are not recycled in an environmentally sound manner. This includes a lack of, or expired official certification for recycling of ULAB by the authorities, uncontrolled ULAB recycling procedures, use of obsolete technology and processes for the recycling of ULAB entailing unsound management and disposal of ULAB or the process residues;

3) Non compliance to the Notification procedure. For administrative and economic reasons, the exporter and the importer decide not to comply with the Basel Convention control regime. Transport (by road for example) takes place quickly and often irrespectively of the conditions for the safe transportation of hazardous goods. Certain remote regions in many countries may not have the necessary customs posts to check the documentation.

A second category of ‘illegal traffic’ of ULAB that might take place may be criminal by nature. The most common forms of illegal traffic are those associated with contraband shipments for recycling in countries that require ULAB for smelting, but are prevented from importing them under national legislation. The most significant of such instances can be found in China where until 2002 there was a thriving trade in ULAB from Taiwan to China. (See Box D below). Also, one reasonfor smuggling ULAB may be to use the sulfuric acid for the illicit production of drugs.

Box D: Contraband Shipments of ULAB from Taiwan to China 2002

In August 2002, the Chinese Ministry of Foreign Trade and Economic Cooperation, the Chinese General Administration for Customs and the State Environmental Protection Administration issued a joint statement announcing an import ban would come into force on August 15[i] for a selection of items listed as "Banned Imports." Included on the list were leaded slag, drosses and ULAB.

The ban was enforced immediately and the same month in 2003 Taiwanese coast guards seized four people in a fishing boat attempting to smuggle about 30 MT of ULAB from Taiwan to the Chinese mainland for a fee of nearly US$ 1,800[ii]. It is a certainty that the Coast Guards and Environmental Agencies were aware of the activities of the smugglers and that such an illegal trade in ULAB was not uncommon.

Taiwan in a good source of ULAB with about 50,000 MT of ULAB to be recycled annually, but the rate of formal collection and recovery according to one licensed recycler in Taiwan is only about 60%.

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### 7.3 Preventive measures concerning illegal traffic

The actions to be taken in order to help prevent the illegal traffic of Used lead acid batteries, include:

- Harmonisation of national policies to ensure that transboundary movements of ULAB for recycling within the region concerned takes place in compliance with the obligations of the Parties to the Basel Convention and its guidelines.
- The establishment of economically sustainable regional mechanisms for the environmentally sound collection, storage, transport and recycling of ULAB
- Compliance to the Basel Convention obligations, taking into consideration existing bilateral and multilateral trading agreements, and strengthening the capacity of the stakeholders involved, including:
  - Training of border or port customs officials.
  - Increased monitoring of waste movements and inspection of hazardous wastes.
  - Bilateral and multilateral agreements for the control of any suspected illicit traffic of ULAB.

# Endnotes

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[iii] RAPS – Remote Area Power Supply – a Generic name for solar powered energy systems used in remote areas or rural communities without a grid electrical supply. Solar energy is stored in LAB. Internet: http://www.ilzrorapsperu.org/raps/raps_home.htm

[iv]http://www.recambodia.org/Downloadable/Downloadable%20Documents/Conference%20Proceedings/Cambodia%20REAP%20Workshop%201%20Presentations%20and%20Report%20-%20Jan%202002.zip

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[xiii] This is an approximation. The exact size of energy savings is a function of the distance ULABs travel to reach the recycling plant and the energy spent for transport. Michael E. Henstock, The recycling of non-ferrous metals, Ottawa, 1996, p. 171.

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**Appendix 2**

**Guidelines for the preparation of ULAB Country Project Report**

1. Introduction

Outline the background to the project, including objectives and the relevance of the recovery of ULAB to Environmentally Sound Management (ESM) and Sustainable Development (SD). Reference should be made to the relevance of the project to prevailing national legislation and international agreements, such as the Basel Convention and the transboundary movement of hazardous waste, that is, in the case of this project.

Describe the unique opportunity or feature of the project and explain the role of participating government agencies, companies, NGOs, International Bodies and technical support.

Budget constraints meant that only a certain number of representative groups and populations were surveyed and the results extrapolated to estimate the likely conditions across the country or region, then explain why certain areas of the country and specific section of the population and industry were chosen to be included in the survey.

2. Data and Information Gathering

Explain how data and information was collected, collated and analyzed. Specify the uses for Lead Acid Batteries (LAB), the sources, particularly if the LAB are imported. Detail the likely amounts of LAB consumed annually and the expected tonnages of ULAB generated each year.
Briefly characterize the size of each of the premises visited during field trips, the numbers employed, the numbers and type of batteries sold and whether informal activities were identified.

3. Legislative Framework

Set out the national and international laws and regulations governing the recovery of ULAB, how they are administered, monitored and enforced. In particular explain whether ULAB recovery operations are licensed, if the premises are inspected and under what regulations.

4. ULAB Disposal and Recovery

Summarize how the ULAB are discarded and where. If they are collected, explain what mechanisms are used, that is, legal or financial inducements, and by whom. Describe the prevailing recycling activities for ULAB in the major conurbations, the towns and villages across the various sectors using lead acid batteries, transport, computer systems and domestic households. Provide some indication if there is any possible informal activities.
As far as the socio-economic aspects of ULAB collection and reconditioning is concerned, it is very important that the survey provides an insight into the extent of these activities in the informal sector. Such an insight is necessary to appreciate the financial impact of preventing scavengers and others collecting ULAB for cash payments. Trying to deny people the opportunity to earn some money by retrieving discarded batteries will be a fruitless exercise unless other opportunities to earn money are introduced. Alternatively, advantage could be taken

of any skills in finding ULAB and every effort made to persuade those involved to deliver the ULAB to a licensed collection center for a payment.

5. Occupational and Population Health and Safety

Sum up the effects of ULAB recovery operations on the workers and the local populations. Clarify whether the workers and the population are aware of the environmental and health risks posed by ULAB, especially if they are not recovered in an environmentally sound manner.

6. Assessment of ESM

Determine whether the ULAB recovery is environmentally sound. Compare the procedures and mechanisms used against the practices set out in the Basel Convention Technical Guidelines. If the procedures conform, explain why and how the recovery process conforms to all aspects of ESM. If the recovery process is not environmentally sound, identify the shortcomings and explain what needs to be done to improve the environmental and health performance.

7. Recommendations

List and itemize any recommendations that will improve the ESM of ULAB recovery. Explain what needs to be done to implement the recommendations. Assess the options for short-term practical, feasible and affordable solutions for immediate improvements in the recycling of ULAB. State whether external finance, expertise or capacity building would accelerate the process. The following targets should be considered in this section:

i. The reduction of lead recovery in the informal sector;
ii. The increase of collection rates of domestically generated lead scrap;
iii. The definition of a role for the small recyclers;
iv. The enhancement of collection schemes;
v. The improvement of awareness of environmentally sound management (ESM) and the potential risks associated with occupational and population lead exposure;
vi. The identification of opportunities for regional co-operation.

Outline an analysis of the long-term restructuring options for the ESM of ULAB and the development of a suitable infrastructure to collect and funnel the ULAB to a sound recycling facility albeit that option may mean that the ULAB are exported to an overseas secondary lead plant. Single out the likely policy strategies to support such restructuring options and identify the legal, institutional, technical and economic requirements to enforce such policy strategies.

8. Conclusion

Summarize the findings described in the report.

9. Appendices

Place all data, visit reports, analyses, photographs and mathematical models in an Appendix folder attached to the report.

Appendix 3

**Used Lead Acid Battery Recycling Study Questionnaire**

No. ……..............

For the Ministry of Transport to obtain information about the number of vehicles and the trend in vehicle growth rates:

| **Year** | **Type of Vehicle** | **No. of Vehicles** | |
|---|---|---|---|
| **2001** | Car | | |
| | Minibus | | |
| | Motorcycle | | |
| | Bus | | |
| | Truck | | |
| **Total** | **Vehicles Licensed** | | |
| **Year** | **Type of Vehicle** | **No. of Vehicles** | |
| **2002** | Car | | |
| | Minibus | | |
| | Motorcycle | | |
| | Bus | | |
| | Truck | | |
| **Total** | **Vehicles Licensed** | | |
| **Year** | **Type of Vehicle** | **No. of Vehicles** | |
| **2003** | Car | | |
| | Minibus | | |
| | Motorcycle | | |
| | Bus | | |
| | Truck | | |
| **Total** | **Vehicles Licensed** | | |
| **Year** | **Type of Vehicle** | **No. of Vehicles** | |
| **2004** | Car | | |
| | Minibus | | |
| | Motorcycle | | |
| | Bus | | |
| | Truck | | |
| **Total** | **Vehicles Licensed** | | |

Appendix 4

**Used Lead Acid Battery Recycling Study Questionnaire**

No. ……..............

This questionnaire is designed to provide information for the desktop study about the number of IT and Security Batteries in use. It should be sent to the Department of Trade, Industry and Commerce, and major computer sales companies to ascertain annual sales data.

| Year | UPS Units | No. of UPS Units | Battery Life – Years |
|---|---|---|---|
| **2001** | Home PCs | | |
| | PC Networks | | |
| | Home Security Systems | | |
| | Industrial Security Alarms | | |
| **Total** | **UPS Units** | | |
| **Year** | **UPS Units** | **No. of UPS Units** | **Battery Life – Years** |
| **2002** | Home PCs | | |
| | PC Networks | | |
| | Home Security Systems | | |
| | Industrial Security Alarms | | |
| **Total** | **UPS Units** | | |
| **Year** | **UPS Units** | **No. of UPS Units** | **Battery Life – Years** |
| **2003** | Home PCs | | |
| | PC Networks | | |
| | Home Security Systems | | |
| | Industrial Security Alarms | | |
| **Total** | **UPS Units** | | |
| **Year** | **UPS Units** | **No. of UPS Units** | **Battery Life – Years** |
| **2004** | Home PCs | | |
| | PC Networks | | |
| | Home Security Systems | | |
| | Industrial Security Alarms | | |
| **Total** | **UPS Units** | | |

Appendix 5

**Used Lead Acid Battery Recycling Study Questionnaire**

No. ……..............

This questionnaire is designed to provide information for the desktop study about the number of IT and Security Batteries in use. It should be sent to the Government Agency responsible for the registration of boats, the Department of Trade, Industry and Commerce, major telephone companies and the government Development Agencies to ascertain annual sales data for Deep Discharge Batteries.

| **Year** | **Deep Discharge (DD) Batteries** | **No. of DD Batteries** | **Battery Life** |
|---|---|---|---|
| **2001** | Boats | | |
| | Recreation – Golf Carts | | |
| | Industrial – Fork Trucks | | |
| | Telecommunications | | |
| | RAPS | | |
| **Total** | **D D Batteries** | | |
| **Year** | **Deep Discharge (DD) Batteries** | **No. of DD Batteries** | **Battery Life** |
| **2002** | Boats | | |
| | Recreation – Golf Carts | | |
| | Industrial – Fork Trucks | | |
| | Telecommunications | | |
| | RAPS | | |
| **Total** | **D D Batteries** | | |
| **Year** | **Deep Discharge (DD) Batteries** | **No. of DD Batteries** | **Battery Life** |
| **2003** | Boats | | |
| | Recreation – Golf Carts | | |
| | Industrial – Fork Trucks | | |
| | Telecommunications | | |
| | RAPS | | |
| **Total** | **D D Batteries** | | |
| **Year** | **Deep Discharge (DD) Batteries** | **No. of DD Batteries** | **Battery Life** |
| **2004** | Boats | | |
| | Recreation – Golf Carts | | |
| | Industrial – Fork Trucks | | |
| | Telecommunications | | |
| | RAPS | | |
| **Total** | **D D Batteries** | | |

Appendix 6

**Used Lead Acid Battery Recycling Study Questionnaire**

No. ……..............

**Legal Requirements for the Recovery of ULAB, including the Basel Convention**

| | |
|---|---|
| 1. Country | |
| 2. Name of Government Agency responsible for the implementation of ESM programs or policies | |
| 3. What wastes are defined as hazardous? | |
| 4. What wastes are defined as non-hazardous? | |
| 5. For what wastes or waste streams does the Government require an ESM program or policy? | |
| 6. What are the main components of the ESM program or policies? | |
| 7. What are the titles of the respective legislation, regulation or code? | |
| 8. Does the government require authorization to operate recycling facilities dealing with hazardous wastes/waste streams? | |
| 9. What are the government standards for pollution control for the recycling of hazardous waste? | |
| 10. Are facilities required to monitor their emissions and are there measures proposed to deal with violations? | |
| 11. How is the environmental performance of the technology used at the recycling facilities for hazardous waste measured? | |
| 12. Are recycling facilities for hazardous waste required to regularly monitor their environmental impacts, eg. Flora and Fauna? | |
| 13. Is a hazardous waste recycling facility required to recruit staff that is suitably skilled or adequately trained? | |
| 14. Is a hazardous waste recycling facility required to have an emergency response plan? | |
| 15. What regulations ensure that appropriate action is taken in the case of accidental spillage or | |

| | |
|---|---|
| unacceptable emissions? | |
| 16. Do the recycling facilities have formal communications policies that include consultations with local communities? | |
| 17. What are the procedures for any “non conformance” of legislative and regulatory requirements? | |
| 18. Is there a program or policy that encourages or requires waste minimization in any industries/sectors? | |
| 19. What are the statutory regulations covering residual materials arising from the recycling process? | |
| 20. What are the main aims of the policy measures for hazardous waste producing sectors? | a. Elimination of hazardous waste<br>b. Minimization of hazardous waste<br>c. Containment of hazardous waste<br>b. Control of hazardous waste<br>e. Monitoring of hazardous waste |
| 21. Does the facility have a decommissioning plan and financial guarantees for any environmental damage? | |
| 22. Which Department is responsible for the control of the transboundary movements of hazardous waste and ULAB? | |
| 23. What procedures are followed for the import or export of ULAB? | |
| 24. How many tons of ULAB are exported per annum? | |
| 25. How many tons of ULAB are imported per annum? | |
| 26. Are you aware of any illegal imports or exports of ULAB? | |
| 27. What are the legal requirements for LAB labels? | |
| 28. Do the LAB produced or imported into the county comply with the laws for LAB labels? | |

Appendix 7

**Used Lead Acid Battery Recycling Study Questionnaire**

No. ……...............

**Domestic Use:**

| | | |
|---|---|---|
| 1 | Are there lead acid batteries in the home, including UPS units? | |
| 2 | If so, how many? | |
| 3 | What are lead acid batteries used for in the home?<br>• TV<br>• Lighting<br>• Refrigeration<br>• Computers<br>• Other uses | |
| 4 | What type of lead acid batteries are used in the home:<br>• 12 volt car batteries<br>• 12 volt truck batteries<br>• Deep cycle batteries<br>• Other batteries | |
| 5 | Were the LAB bought as new from a registered supplier? | |
| 6 | What is/are the make or brand of the battery/batteries | |
| 7 | Are the batteries reconditioned? | |
| 8 | How are the batteries recharged? | |
| 9 | How long do the batteries last? | |
| 10 | Are you aware of the health hazards that lead contamination and exposure can bring? | |
| 11 | What do you do with ULAB? | |
| 12 | Where do you take them? | |
| 13 | Are the ULAB collected or do you have to take them to a collector? | |
| 14 | Who collects ULAB? | |
| 15 | Are the ULAB recycled? | |
| 16 | Where are the ULAB recycled? | |

Appendix 8

**Used Lead Acid Battery Recycling Study Questionnaire**

No. ……...............

**Retail, Collection, Storage and Transport:**

| | |
|---|---|
| 1. Number of automotive battery retail outlets (00's, 000's, 0000's) | |
| 2. Are used batteries collected at the retail outlets? | |
| 3. What happens to used batteries collected at retail outlets? | |
| 4. How are used lead acid batteries stored at the retail outlets? | |
| 5. How are ULAB collected at retail outlets transported to recyclers? | |
| 6. Are batteries drained of electrolyte prior to transportation? | |
| 7. Are used batteries reconditioned? | |
| 8. Where are used batteries reconditioned? | |
| 9. Number of used battery collection centers | |
| 10. How are used batteries stored in the collection centers? | |
| 11. How is spillage contained in collection centers? | |
| 12. What are the transport arrangements from collection centers to the recyclers? | |
| 13. Are used batteries recycled in the country they are collected? | |
| 14. Are any used batteries exported for recycling? | |
| 15. What happens to used lead acid batteries that are not collected for recycling? | |

Appendix 9

**Used Lead Acid Battery Recycling Study Questionnaire**

No. ……...............

**Process:**

| Lead Recycling Plant | |
|---|---|
| 1. Lead bearing materials recycled | |
| 2. Annual quantity of recycled materials | |
| 3. Procedures for material collection | |
| 4. Facilities for the reception of materials | |
| 5. Procedures for sorting scrap materials | |
| 6. Mechanical or manual battery breaking | |
| 7. Battery component separation process | |
| 8. Separate component transport system | |
| 9. Scrap smelting process | |
| 10. Furnace(s) | |
| 11. Furnace charging system | |
| 12. Furnace combustion conditions | |
| 13. Furnace hygiene regime | |
| 14. Baghouse ventilation system | |
| 15. Furnace lead and slag tapping regimes | |
| 16. Slag treatment, storage and disposal | |
| 17. Refining process for the recycled lead | |
| 18. By-products segregation and storage | |
| 19. By-products treatment | |
| 20. Ingot casting procedures | |

Appendix 10

**Used Lead Acid Battery Recycling Study Questionnaire**

No. ……..............

**Environment:**

| Lead Recycling Plant | |
|---|---|
| 1. Chemical composition of the discard slag | |
| 2. Atmospheric discharge limits | |
| 3. Mean atmospheric discharge results | |
| 4. Surface water treatment prior to discharge | |
| 5. How is the battery acid neutralized? | |
| 6. How is the waste effluent discharged? | |
| 7. Standards for the discharge of effluent? | |
| 8. Lead content and pH for effluent | |
| 9. Is there a common drainage system? | |
| 10. How are raw materials stored? | |
| 11. 12 month wind speed and direction profile | |
| 12. Storage area ventilation system | |
| 13. Face velocities for extraction units | |
| 14. Baghouse maintenance regimes | |
| 15. Baghouse cleaning procedures | |
| 16. Chemical composition of the fume | |
| 17. Are by-product storage areas sealed? | |
| 18. Disposal method of the baghouse fume | |
| 19. How close is the population to the plant? | |
| 20. Who is responsible for the environment? | |

Appendix 11

**Used Lead Acid Battery Recycling Study Questionnaire**

No. ……..............

**Occupational Health:**

| Lead Recycling Plant | |
|---|---|
| 1. Number of employees | |
| 2. Age and service profiles | |
| 3. Labor turnover rates | |
| 4. Hours of work | |
| 5. What are the changing facilities? | |
| 6. What is the regime at the end of work? | |
| 7. Are personnel issued with special clothing? | |
| 8. How often is clothing washed? | |
| 9. Is process clothing washed at the site? | |
| 10. Are respirators issued and worn? | |
| 11. Are eating and process areas segregated? | |
| 12. Are the eating areas free of lead dust? | |
| 13. Do employees wash prior to eating? | |
| 14. Range and mean lead in blood levels | |
| 15. What is the lead in blood trend? | |
| 16. Is there a hygiene surveillance program? | |
| 17. Is there a respirator policy? | |
| 18. Is there a hygiene policy? | |
| 19. Do workers understand the risks of lead? | |
| 20. Who is responsible for occupational health? | |

Appendix 12

**Used Lead Acid Battery Recycling Study Questionnaire**

No. ……...............

**Awareness and Attitudes:**

| | |
|---|---|
| Name | |
| 1. What have you learnt about lead contamination from ULAB in ……………………………? | |
| 2. Do you know the effects of lead exposure on the:<br>a) Environment<br>b) Population | |
| 3. How often do you come into contact with Lead Acid Batteries? | |
| 4. What do you do with your used ULAB and why? | |
| 5. What do you think should be done with a used ULAB? | |
| 6. In your opinion how should the problem of lead contamination from ULAB be solved? | |
| 7. What incentives would encourage you to return a used battery to a collection center? | |
| 8. Do you know of any lead contamination awareness programs performed by any Government Institutions? | |
| 9. Has the information provided been effective in encouraging you to dispose of your ULAB in an environmentally sound manner? | |
| 10. How could these programs be improved? | |
| 11. Are you aware of any incentive programs for returning used batteries for recycling? | |
| 12. Do you use a Lead Acid Battery and if so, for what purpose? | |
| 13. How long does the LAB battery last? | |

**Singapore**

**The Management of Hazardous Waste[1], including ULAB**

The control of hazardous substances is governed by the Environmental Pollution Control Act (EPCA), the Environmental Pollution Control (Hazardous Substances) Regulations and the Environmental Pollution Control (Ozone Depleting Substances) Regulations. To minimize the risks from handling hazardous substances, industries which use large quantities of such chemicals are sited on off-shore islands or industrial estates which are located far away from residential areas. A license is required for any person who wishes to import, sell, export, purchase, store, and/or use any hazardous substance controlled under the Act. Under the terms of the Environmental Public Health (Toxic Industrial Waste) Regulations 1988, ULAB cannot be imported into Singapore for any reason. A permit is required for any person who wishes to purchase, store and/or use any hazardous substance, including ULAB, controlled under the Environmental Pollution Control (Hazardous Substances) Regulations. Transport Approval is also required for any person who wishes to transport hazardous substances, such as ULAB, in quantities exceeding those specified in the Environmental Pollution Control (Hazardous Substances) Regulations[2].

ULAB are designated in the List of Toxic Industrial Wastes[3] and all those involved in the collection of ULAB, even battery retailers and hardware stores[4], must be licensed under Annex 7 of the regulations[5], the Requirements for Toxic Industrial Waste Collectors[6]. The authorities in Singapore will check that ULAB collectors have adequate storage facilities including, containment areas, leak detection and warning devices, proper emergency action plans, neutralizing agents, handling gear, absorbent material and working procedures designed to prevent and mitigate any accidental spillage of battery electrolyte.

The export of ULAB from Singapore is governed by the Basel Convention for the transboundary movement of hazardous waste with strict attention paid to ensuring that the ULAB are shipped to an environmentally sound smelter.

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[1] Environmental Pollution Control Act (EPCA); http://app.nea.gov.sg/cms/htdocs/article.asp?pid=1228
[2] Control of Toxic Industrial Waste; http://app.nea.gov.sg/cms/htdocs/article.asp?pid=949
[3] Environmental Public Health Act (Chapter 95, Section 113), Environmental Public Health (Toxic Industrial Waste) Regulations, The Schedule; http://app.nea.gov.sg/cms/htdocs/article.asp?pid=2120
[4] List of Licensed Toxic Waste Collectors; http://www.nea.gov.sg/cms/pcd/tiwcollectors.pdf
[5] Annex 7; http://www.nea.gov.sg/cms/pcd/req_tiwc.pdf
[6] Requirements for Toxic Industrial Waste Collectors; http://www.nea.gov.sg/cms/pcd/req_tiwc.pdf

Appendix 14

**BATTERY COUNCIL INTERNATIONAL**
**PROPOSED MODEL BATTERY RECYCLING LEGISLATION**
**BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ________**

**..................................................................................**

Section 1. LEAD-ACID BATTERIES; LAND DISPOSAL PROHIBITED.

(a) No person may place a used lead-acid battery in mixed municipal solid waste, in any landfill, or municipal solid waste incinerator.

(b) No person shall dispose of a used lead-acid battery except by delivery to a retailer or wholesaler, or to a secondary lead smelter, or to a collection or recycling facility authorized under the law of (state) or by the U.S. Environmental Protection Agency.

(c) No retailer shall dispose of a used lead-acid battery except by delivery to the agent of a wholesaler or a secondary lead smelter, or to a battery manufacturer for delivery to a secondary lead smelter, or to a collection or recycling facility authorized under the law of (state) or by the U.S. Environmental Protection Agency.

(d) Each battery improperly disposed of shall constitute a separate violation.

(e) For each violation of this section a violator shall be subject to a fine not to exceed $_______ and/or a prison term not to exceed _______ days (as appropriate under state code).

Section 2. LEAD-ACID BATTERIES; COLLECTION FOR RECYCLING.

A retailer selling replacement lead-acid batteries in the state shall:

(a) Accept from customers, at the point of transfer, used lead-acid batteries of the same general type and in a quantity at least equal to the number of new batteries purchased, if offered by customers;

(b) Collect a deposit of at least $10.00 on the sale of an automotive type replacement lead acid battery that is not accompanied by the return of a used lead-acid battery of the same general type. All deposits shall inure to the benefit of the retailer unless the person paying the deposit pursuant to this subsection returns a used automotive lead-acid battery to the retailer within thirty days of the date of sale, in which case the deposit shall be returned to the customer; and

(c) Post written notice which must be at least 8-1/2 inches by 11 inches in size and must contain the universal recycling symbol and the following language:

(1) "It is illegal to discard a used lead acid battery.";
(2) "Recycle your used batteries."; and

(3) "State law requires us to accept used
lead-acid batteries for recycling in exchange for new batteries purchased."

Section 3. INSPECTION OF BATTERY RETAILERS.

The (appropriate state agency) shall produce and print the notices required by Section 2 and shall distribute such notices to all places where replacement lead-acid batteries are offered for retail sale. In performing its duties under this section, the division may inspect any place, building, or premises where batteries are sold at retail. Authorized employees of the agency may issue warnings and citations to persons who fail to comply with the requirements of Section 2. Failure to post the required notice following warning shall subject the establishment to a fine of $______ per day (as appropriate under state code).

Section 4. LEAD-ACID BATTERY WHOLESALERS.

Any wholesaler selling replacement lead-acid batteries shall accept from customers at the point of transfer, used lead-acid batteries of the same general type and in a quantity at least equal to the number of new batteries purchased, if offered by customers. A wholesaler accepting batteries in transfer from a retailer shall be allowed a period not to exceed 90 days to remove batteries from the retail point of collection.

Section 5. PLASTIC CODING.

Lead-acid battery cases shall not be required to bear an SPI, SAE or other resin identification code otherwise required for rigid plastic containers.

Section 6. DEFINITIONS.

For the purposes of Sections 1-5:

(a) The term lead-acid battery means a battery that:

(1) consists of lead and sulfuric acid;
(2) is used as a power source; and
(3) is not intended as a power source for consumer products.

(b) The term retailer means any person who engages in the sale of replacement lead-acid batteries directly to the end user.

(c) The term wholesaler means any person who sells replacement lead-acid batteries for resale.

(d) The term consumer product means any device that is primarily intended for personal or household use and is typically sold, distributed, or made available to the general population through retail or mail-order distribution. Such term does not include vehicles, motorcycles, wheelchairs, boats or other forms of motive power. The term does include, but is not limited to, computers, games, telephones, radios, and similar electronic devices.

Section 7. ENFORCEMENT.

The (appropriate state agency) shall enforce Sections 2 and 4. Violations shall be a misdemeanor under (applicable state code).

Section 8. SEVERABILITY.

If any clause, sentence, paragraph or part of this chapter or the application thereof to any person or circumstance shall, for any reason, be adjudged by a court of competent jurisdiction to be invalid, such judgment shall not affect, impair, or invalidate the remainder of this chapter or this application to their persons or circumstances.

* * *

**BATTERY COUNCIL INTERNATIONAL**
**401 North Michigan Ave.**
**Chicago, IL 60611**
**Telephone (312) 644-6610**
**Fax (312) 321-6869**

Appendix 15

**Testing a Lead Acid Battery**

A battery can be tested in more than one way, but the easiest methods are to measure the specific gravity of the battery electrolyte and battery voltage. Specific gravity (SG) measurement requires the use of a temperature compensating hydrometer and to measure voltage the use of a digital D.C. Voltmeter is essential.

You must first have the battery fully charged. The surface charge must be removed before testing. If the battery has been sitting at least several hours (I prefer at least 12 hours) you may begin testing. To remove surface charge the battery must experience a load of 20 amps for at least 3 minutes. Turning on the headlights to high beam will be enough. After turning off the lights, the battery is ready to be tested.

A fully charged battery has SG of 1.255 to 1.280. Fully discharged batteries have a SG between 1.110 and 1.130.

| State of Charge | Specific Gravity | Voltage | |
|---|---|---|---|
| | | **12V** | **6V** |
| 100% | 1.265 | 12.7 | 6.3 |
| *75% | 1.225 | 12.4 | 6.2 |
| 50% | 1.190 | 12.2 | 6.1 |
| 25% | 1.155 | 12.0 | 6.0 |
| Discharged | 1.120 | 11.9 | 6.0 |

Hydrometer SG readings should not vary by more than .05 between cells. Note that the SG of sealed LAB cannot be measured unless the battery has a built in hydrometer. Most well designed maintenance free batteries have a built in hydrometer that measures the SG of cell 1 of 6. However, it is possible to get a good reading from cell 1 and have a problem with other cells in the battery.

The sulfation of battery grids starts when the specific gravity falls below 1.225 or the voltage measures less than 12.4 (12v Battery) or 6.2 (6 volt battery). Sulfation hardens the surface of the battery plates reducing and eventually the battery's ability to discharge and be recharged.

Load testing is yet another way of testing a battery by removing amps from a battery to simulate starting an engine. Some battery companies display the amp load for testing on the battery label. A load test can only be performed if the battery is near or at full charge.

The results of your testing should be as follows:

Digital Voltmeters are recommended and should display the voltage is shown in the table above. The sealed valve regulated battery's voltage will be slightly higher in the 12.8 to 12.9 ranges. Voltage readings displayed in the 10.5 volts range on a charged battery indicate a shorted cell and that the battery should be replaced and sent to the recycler.

Appendix 16

# Material Safety Data Sheet

## 1. Identification of Waste Materials and the Company

| | |
|---|---|
| Product | Used Lead Acid Battery |
| Product Name | Jack Tarr Automotive Battery |
| Importer | The Best Recycling Company |
| Technical/Emergency Support | Telephone Numbers |

## 2. Composition/Information about the Materials in Transit

| | |
|---|---|
| Main components | Lead, Lead Sulfate, Sulfuric Acid (20%) |
| Other components | Polypropylene, |

## 3. Hazard Identification

| | |
|---|---|
| Lead Acid Battery | Electrical hazard if short circuited.<br><br>Battery can produce high current if the positive and negative terminals are short circuited which can result in sparks leading to fire hazard.<br><br>Maximum Voltage per battery 12 Volts. |
| Constituents | Lead and Lead Alloys toxic if ingested.<br><br>Sulfuric Acid – corrosive. If the battery case is broken acid leaks can damage skin and eyes on contact. Damage will also occur if in contact with materials and clothing. |

## 4. First Aid Measures

| | |
|---|---|
| Sulfuric Acid | Skin contact – flush with water, seek medical assistance if contact area is large or blisters form.<br><br>Eye contact – flush with plenty of water until medical assistance is provided.<br><br>Ingestion – flush mouth with water – give patient milk or sodium bicarbonate solution until medical assistance arrives. |

## 5. Fire-Fighting Measures

| | |
|---|---|
| In the event of fire | Keep containers cool by spraying with water<br><br>The plastic components may release toxic fumes, advisable to wear breathing apparatus. |

## 6. Accidental Release Measures

| | |
|---|---|
| Damaged batteries | Use goggles, rubber gloves and protective clothing to prevent direct contact with hazardous substances.<br><br>Have eyewash bottle and clean water available.<br><br>Put any damaged items into a plastic acid proof container and identify as a corrosive hazard.<br><br>Dilute any spillage with clean water and neutralize with sodium bicarbonate. |

## 7. Handling and Storage

| | |
|---|---|
| Precautions | Store in cool dry conditions out of direct sunlight.<br><br>When packed for transport the terminals should always be protected from short circuit. Do not store with items that could cause short circuit. Prevent sparks and naked flames in the vicinity.<br><br>Wear protective footwear - the batteries are heavy. |

## 8. Exposure Control & Personal Protection

| | |
|---|---|
| Precautions | Do not remove any ULAB from the packing or the containers.<br><br>Wear neoprene cloves when handling the packed batteries or any of the containers with ULAB.<br><br>Wear protective footwear - the batteries are heavy. |

## 9. Physical and Chemical Properties

| | | |
|---|---|---|
| Lead-Acid Battery | Some sealed and will not spill, some liable to leak. | |
| Lead | Appearance:<br>Colour:<br>Odour:<br>Flammability:<br>Density:<br>Solubility:<br>Melting Point: ºC (Boiling) | Solid<br>Silver-grey metal<br>None<br>None<br>11.34<br>None<br>327.4 ºC |
| Lead Sulfate | Appearance:<br>Colour:<br>Odour:<br>Flammability:<br>Density:<br>Solubility: (15ºC)<br>Melting Point: ºC (Boiling) | Powder<br>White<br>None<br>None<br>6.2<br>40mg/l<br>1,070 |

| | | |
|---|---|---|
| Lead Dioxide | Appearance:<br>(compressed as solid)<br>Colour:<br>Odour:<br>Flammability:<br>Density:<br>Solubility:<br>Melting Point:(Boiling) | <br>Powder<br>Brown<br>None<br>None<br>9.4<br>None<br>290° C |
| Sulphuric Acid | Appearance:<br>Colour:<br>Odour:<br>Flammability:<br>Density:<br>Solubility:<br>Melting Point: | Liquid<br>Colourless<br>Acidic<br>None<br>1.3 approx.<br>100%<br>114°C approx. (Boiling) |
| Plastics | Appearance:<br>Colour:<br>Odour:<br>Flashpoint:<br>Density:<br>Solubility:<br>Softening point | Solid<br>Various<br>None<br>400°C<br>0.9 – 2.6g.cm$^3$ at 25°C<br>None<br>95°C |

**10. Stability and Reactivity**

| | |
|---|---|
| Lead | Oxidizes (If battery case split and lead is exposed) |
| Sulfuric Acid | Corrosive |
| Plastic | Combustible |

**11. Toxicology**

| | |
|---|---|
| Lead and Lead Compounds | Toxic if ingested - seek medical help |
| Sulfuric Acid | Corrosive and irritant |

**12. Environmental**

| | |
|---|---|
| Lead Acid Battery | Do not dispose of battery in household/domestic waste.<br>Return complete battery for recycling.<br>Under no circumstances incinerate. |

**13. Recycling**

| | |
|---|---|
| Lead Acid Battery | Local regulations apply – consult Environment Agency for nearest recycling ULAB collection center. |

**14. Transport Regulations**

| | |
|---|---|
| Lead Acid Battery | Local/National/International regulations apply. |

BW/ILMC/Nov. 2002

– Material Safety Data Sheet –

**Valve Regulated Lead Acid Battery**

"Battery Non-Spillable 49 CFR 173.159 (d)"

## SECTION I

**Manufacturer's Name:**
East Penn Manufacturing Co., Inc.
Deka Road, Lyon Station, PA 19536

**Date:** September 2001

**Trade Name:** Gell; Absorbed Electrolyte, Sealed Valve Regulated Non Spillable Battery

**Telephone Number for Information**: (610) 682-6361

**Emergency Telephone Number: CHEMTREC**: 1-800-424-9300,
In Washington D.C. or outside continental U.S., call 1-202-483-7616

## SECTION II
## HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

| Hazardous Components Specific Chemical Identity (Common Name (s)) | OSHA PEL | ACGIH TLV | Range Percent By Weight | Average |
|---|---|---|---|---|
| Lead, CAS #7439921 | 0.05 mg/m$^3$ | 0.05 mg/m$^3$ | 60-75% | 67% |
| Sulfuric Acid, CAS #7664939 | 1.00 mg/m$^3$ | 1.00 mg/m$^3$ | 5-15% | 10% |
| Antimony, CAS #7440360 | 0.50 mg/m$^3$ | 0.50 mg/m$^3$ | 0-0.1% | <0.1% |
| Arsenic, CAS #7440382 | 0.01 mg/m$^3$ | 0.01 mg/m$^3$ | 0.01 % | <0.1% |
| Polypropylene, CAS#9003070 | N/A | N/A | 2-10% | 4% |
| Calcium, CAS#7440702 | 1.0 mg/m$^3$ | 1.0 mg/m$^3$ | 0-0.1% | <0.1% |
| Tin CAS #7440315 | 2.0 mg/m$^3$ | 2.0 mg/m$^3$ | 0-0.1% | <0.1% |

## *SECTION III*
## PHYSICAL/CHEMICAL CHARACTERISTICS

**Electrolyte (Sulfuric Acid):**
**Appearance and Odor:** Clear, Odorless, colorless liquid
**Boiling Point**: 235 – 240$^o$ F
**Evaporation Rate (Butyl Acetate=1):** less than 1.0
**Melting Point**: N/A
**Solubility in Water:** 100%
**Specific Gravity ($H_20$=1):** 1.270 – 1.330
**Vapor Density (AIR=1):** Greater than 1
**Vapor Pressure (mm Hg):** 10

## SECTION IV
## FIRE AND EXPLOSION HAZARD DATA

**Flash Point (Method Used):** Non-Flammable
**Extinguishing Media:** Class ABC extinguisher,
**Flammable Limits**: *Hydrogen Gas
**LEL**: 4% **UEL** 74%
**NOTE: $CO_2$ may be used, but not directly on the cell. The thermal shock may cause cracking of the battery case and/or cases**.
*** Hydrogen gas may be generated during battery charging.**

## SECTION V
## REACTIVITY DATA

**Stability:** Stable **Condition to Avoid:** Prolonged overcharging, sources of ignition

**Incompatibility (Materials to Avoid):** Sulfuric Acid: Contact with combustibles and organic materials may cause fire and explosion. Also reacts violently with strong reducing agents, metals, strong oxidizers and water. Contact with metals may produce toxic sulfur dioxide fumes and may release flammable hydrogen gas.

**Hazardous Decomposition of By-Products**: Sulfuric Acid: Excessive overcharging or fire may create Sulfur trioxide, carbon monoxide, sulfuric acid mist, sulfur dioxide, and hydrogen.
Lead Compounds: Contact with strong acid or base or presence of nascent hydrogen may generate highly toxic arsine gas.



## SECTION VI
## HEALTH HAZARD DATA

**Route(s) of Entry**: Not Applicable under normal use.
**Carcinogenicity:**
Sulfuric Acid: The International Agency for Research on Cancer (IARC) has classified "strong inorganic acid mist containing sulfuric acid" as a Category 1 carcinogen, a substance that is carcinogenic to humans. This classification does not apply to liquid forms of sulfuric acid contained within a battery. Inorganic acid mist (sulfuric acid mist) is not generated under normal use of this product. Misuse of the product such as overcharging, may result in the generation of sulfuric acid mist.
Lead Compounds: Lead is listed as a 2B carcinogen, likely in animals at extreme doses. Proof of carcinogenicity in humans is lacking at present.
Arsenic: Listed by National Toxicology Program (NTP), IARC, OSHA and NIOSH as a carcinogen only after prolonged exposure at high levels.
**Signs and Symptoms of Exposure:** Avoid contact, with absorbed electrolyte (sulfuric acid) may cause irritation of eyes, nose and throat. Contact with eyes and skin causes irritation and skin burns. Absorbed electrolyte is corrosive.
**Medical Conditions Generally Aggravated by Exposure:** Pregnant women and children must be protected from lead exposure.
**Health Hazards (Acute and Chronic):** Do not open battery, avoid contact with internal components. Internal components include lead and absorbed electrolyte. Electrolyte is corrosive and contact may cause skin irritation and chemical burns.
**Emergency and First Aid Procedures: (contact with electrolyte)**

1) Flush contacted area with large amounts of water for at least 15 minutes. Remove contaminated clothing and obtain medical attention if necessary. Eye wash and/or emergency shower should be readily available.
2) If swallowed, give large volumes of water. **DO NOT** induce vomiting, obtain medical treatment.

## *SECTION VII*
## *PRECAUTIONS FOR SAFE HANDLING AND USE*

**Steps to be Taken in Case Material is Released or Spilled:** Electrolyte material is corrosive. Contains sulfuric acid. Neutralize any spilled material. Reference 1996 North American Emergency Response Guidebook, #154.
**Waste Disposal Method:** Lead-acid batteries are completely recyclable. For information on returning batteries to East Penn for recycling, contact your East Penn Representative. Dispose of any collected material in accordance with local, state or applicable federal regulations.
**Precautions to be Taken in Handling and Storing**: Store away from reactive material as defined in Section V, Reactivity Data. Place cardboard between layers of stacked batteries to avoid damage and short circuit. Do not allow metallic materials to simultaneously contact both terminals.
**Other Precautions**: If battery case is broken, avoid direct contact with internal components. Keep away from ignition sources during charging.

## SECTION VIII
## CONTROL MEASURES

**Respiratory Protection (Specific Type):** N/A
**Ventilation**: Must be provided when charging in an enclosed area.
**Protective Gloves**: Recommended
**Eye Protection**: Recommended
**Other Protective Clothing or Equipment:** N/A
**Work Hygienic Practices:** Good Personal hygiene and work practices are recommended.



## SECTION IX
## OTHER REGULATORY INFORMATION

| **NFPA Hazard Rating** | **Sulfuric Acid** | **Lead** |
|---|---|---|
| Health (Blue) | 3 | 3 |
| Flammability (Red) | 0 | 0 |
| Reactivity (Yellow) | 2 | 0 |

Note: Sulfuric acid is water-reactive if concentrated.

**U.S. DOT**: The Non-Spillable lead acid battery complies with the provisions listed in 49CFR173.159(d) therefore must not be marked with an identification number, such as UN2800, or a hazard label, such as corrosive. Also, having passed IATA/ICAAO special provision A67, these batteries are not subject to the air dangerous goods regulations.

**RCRA**: Spent lead-acid batteries are not regulated as hazardous waste when recycled. Spilled sulfuric acid is a characteristic hazardous waste, EPA hazardous waste number D002 (corrosivity).

**CERCLA (Superfund) and EPCRA (Emergency Planning and Community Right to Know ACT)**

a) Reportable Quantity (RQ) for spilled 100% sulfuric acid is 1000 lbs.
b) Sulfuric acid is a listed "Extremely Hazardous Substance" under EPCRA with a Threshold Planning Quantity (TPQ) of 1000 lbs.
c) EPCRA reporting required for batteries if sulfuric acid is present in quantities of 500 lbs or more and/or lead is present in quantities of 10,000 lbs or more.

**California Prop 65:** Battery posts, terminals and related accessories contain lead and lead compounds, and other chemicals known to the state of California to cause cancer and birth defects or other reproductive harm. **Wash hands after handling.**

For additional information concerning East Penn Manufacturing Co., Inc. products or questions concerning the content of this MSDS please contact your East Penn representative.

This information is accurate to the best of East Penn Mfg. Co.'s knowledge or obtained from sources believed by East Penn to be accurate. Before using any product, read all warnings and directions on the label.

Appendix 18

(Sample) Bill of Lading

| | |
|---|---|
| Date: | |
| Number of batteries: | |
| Transporter's Name and Address: | |
| Receiving Location's Name and Address: | |
| Generator's Name and Address: | |

Appendix 19

**Environmental Technology Assessment**[7]

In 1993, UNEP DTIE launched a new program on Environmental Technology Assessment (EnTA). The EnTA Manual and Primer were published in 1995, and have since been used in a variety of international workshops and several studies concerning different industrial technologies. The work is in part based on earlier experience with Technology Assessment in several national jurisdictions.

Environmental Technology Assessment (EnTA) is an analytical tool, designed to ensure that the decision making processes related to technology adaptation, implementation and use are sustainable. EnTA promotes the use of technology assessment to encourage Cleaner production and discourage the use of hazardous technologies and the unsustainable production and consumption patterns they perpetuate. The assessment process looks at the costs of the technology, the monetary benefits, and its environmental, social and political impacts.

The goal of EnTA is to assist in making informed choices on technologies that are compatible with sound environmental performance; through the use of EnTA more information is gained about new technologies and potential environmental problems and costs can be identified and avoided from the outset.

The key elements include:

- Description of the technology – the goal it intends to satisfy, the stakeholders, characteristics of the technology, etc.;
- Assessment of the environmental pressure and impacts of using the technology – resource, labour, infrastructure and supporting technologies required;
- Evaluation of environmental risks and the significance of the impacts, including societal impacts;
- Comparative assessment of alternative technologies, supporting technologies, and impacts;
- Evaluation of societal descriptors and trends;
- Recommendations on technology choices.

More conventional analytical tools such as Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) fail to address issues at the higher tiers of decision making, while the EnTA, a flexible, informal approach to technology related decision making is well positioned to fill this gap.

The full EnTA Training Manual, entitled "Anticipating the Environmental Effects of Technology, A manual for decision-makers, planners and other technology stakeholders", can be assessed on the Internet at:

http://www.unep.or.jp/ietc/Publications/Integrative/EnTA/AEET/index.asp

[7] UNEP's 7th Interntational High-level Seminar on Cleaner Production, Prague, Czech Republic, April 29 – 30, 2002. "*Strategies to Implement MEAs – Background Paper"; S.P.Chandak, Co-ordinator, Cleaner Production, UNEP DTIE. Internet -* http://www.uneptie.org/pc/cp7/PDFs/measpaper.pdf

# Helpline

If you suspect lead poisoning in a child or adult
(or your pets or livestock):

Contact your doctor (or veterinarian) to obtain a blood sample to test for lead

NOTE TO DOCTOR

The blood must not be allowed to clot:
EDTA anti-coagulant recommended

For further information or Blood Lead Testing contact:

Department of Chemistry
Analytical Research Laboratory
The University of the West Indies
St Augustine, Trinidad

Phone: (868) 645-3232 to 3234, Ext 2091, 2273

The University of the West Indies

# Safe Recovery Practices for Lead Acid Batteries

The University of the West Indies serving -
Anguilla, Antigua & Barbuda, Bahamas, Barbados,
Belize, British Virgin Islands, Cayman Islands,
Dominica, Grenada, Jamaica, Montserrat,
St. Kitts/Nevis, St. Lucia,
St.Vincent & The Grenadines,
Republic of Trinidad &Tobago.

### *What is a Lead Acid Battery?*

- *A device designed to store and discharge electrical energy, through chemical reactions involving lead, lead oxides and sulfuric acid.*

### *Uses of Lead Acid Batteries*

- *Essential for starting, lighting and ignition in motorcycles, cars, trucks, tractors, boats and aircraft.*
- *Provides motive power in forklifts, submarines and other battery powered vehicles.*
- *Provides electrical back-up power (back-ups e.g. UPS for computers, Telecommunications, security systems*

### *Composition of a Lead-Acid Battery*

- *Each battery consists of a number of plates (3) connected together in series, to form a cell, which is connected to other cells to constitute the battery.*
- *Each cell produces 2 volts, so six cells connected in series constitutes a 12 Volt battery (5).*
- *Each cell contains lead grids coated with lead oxide (2) and a solution of dilute sulfuric acid as electrolyte (4).*
- *An average car battery consists of 9-12 kg of lead, lead alloys and lead components, 3-4 litres of sulfuric acid and a plastic case (1).*

### *Hazards of Lead Acid Batteries*

- *Once a battery can no longer retain a charge, it is discarded and its lead and acid contents may enter our environment if handled incorrectly.*
- *Certain battery components are toxic and corrosive.*
- *Lead poisoning or acid burns can result from broken battery cases, during Servicing and recycling.*

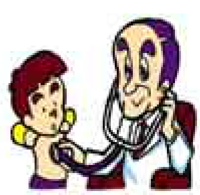
### *Health Effects of Lead*

*Two types of Lead Poisoning can occur:*

- ***Chronic Lead Poisoning**: caused by prolonged exposure to low concentrations < 1% of lead (weeks to years).*

*Chronic effects include:*

- *Damage to the human brain and nervous system*
- *Reduced ability to learn (especially in children)*
- *Decreased growth and stature of children*
- *Increased risk of hypertension*
- *Anaemia & weakness*
- *Colic (gastrointestinal disorders)*



- ***Acute Lead Poisoning**: caused by ingestion or inhalation of high concentrations of lead > 1% over a short period of time (days to weeks), or lower concentrations over long periods of time.*

- ***Effects of severe (Acute) Lead Poisoning include:***
- *Numbness or paralysis of hands and feet*
- *Irreversible damage to kidneys.*
- *Epileptic seizures*
- *Coma & Death*

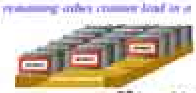
### *Why Recycle Lead -Acid Batteries?*

- *Lead, polypropylene and the acid from Lead Acid batteries can be recycled, but must be done in a safe manner to prevent lead/acid pollution and possible lead poisoning.*
- *By safely recycling Lead-Acid batteries lead and sulfuric acid are prevented sulfuric from contaminating the atmosphere , soil and water supplies.*
- *The recycling of Lead Acid batteries reduces the need to exploit the earth's natural resources for battery manufacture.*

### *Safety in Battery Recycling*

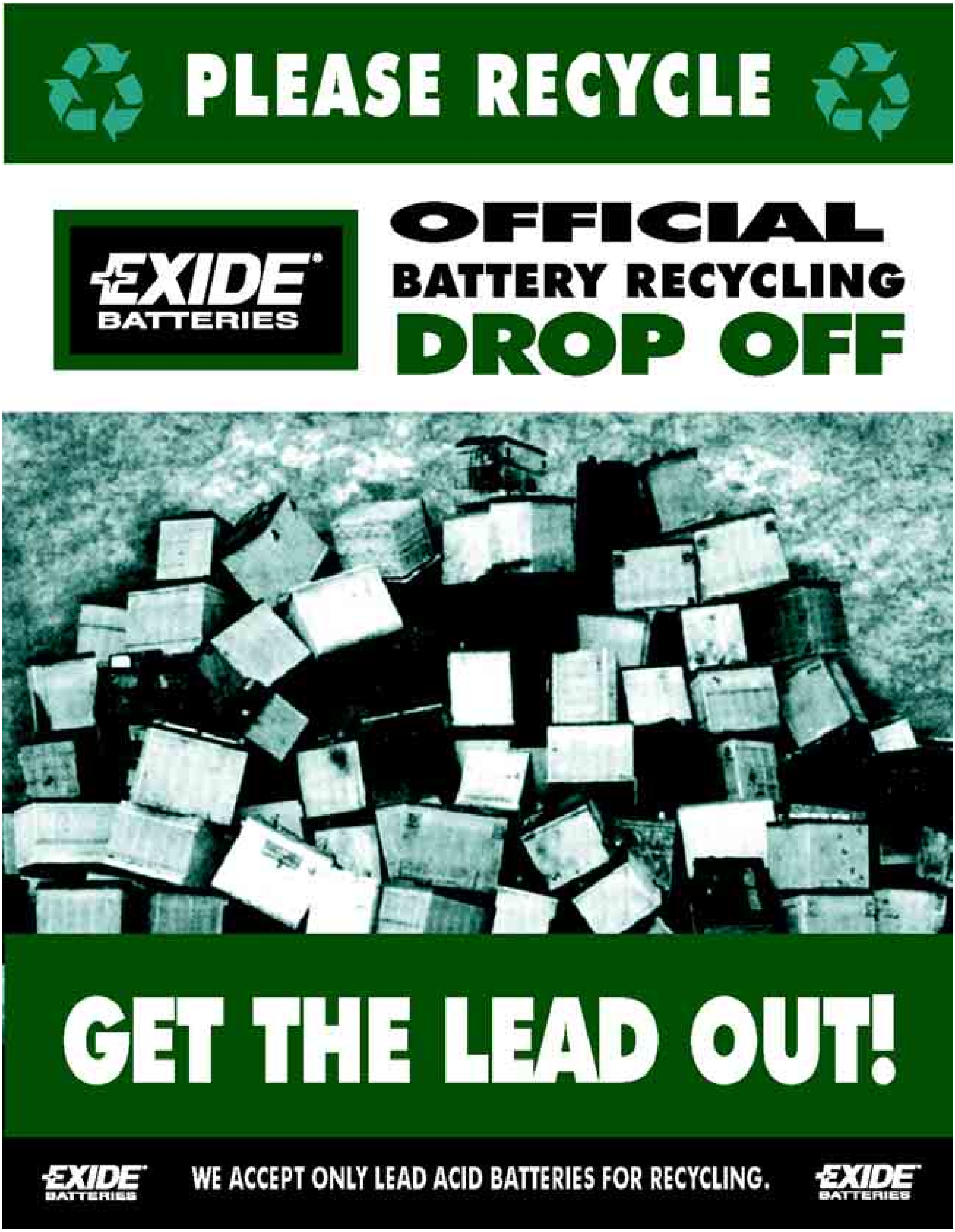
- *Return your old battery for recycling to a recycling centre (e.g. Automotive Components Ltd. or its agents )*
- *Avoid storage of old or defective batteries. Return them for recycling as soon as possible.*
- *Store batteries in an upright position to avoid spillage of corrosive sulfuric acid.*
- *Do not expose discarded batteries to the sun because the cases will eventually crack and acid will leak and contaminate the environment with lead and sulfuric acid.*
- *Do not dispose of batteries with household garbage or in street waste bins, since they can eventually contaminate water supplies.*
- *Do not drain battery acid onto the ground or into rivers, drains or sewers, since it can contaminate the soil and waterways with lead and sulfuric acid.*
- *Do not open or break batteries to recover the lead, since most (>50%) of the lead cannot be recovered by simple melting of the metal components and the remainder can contaminate the environment.*
- *Do not dispose of batteries by burning, since the remaining ashes contain lead in a highly toxic form that is hard to dispose of safely.*

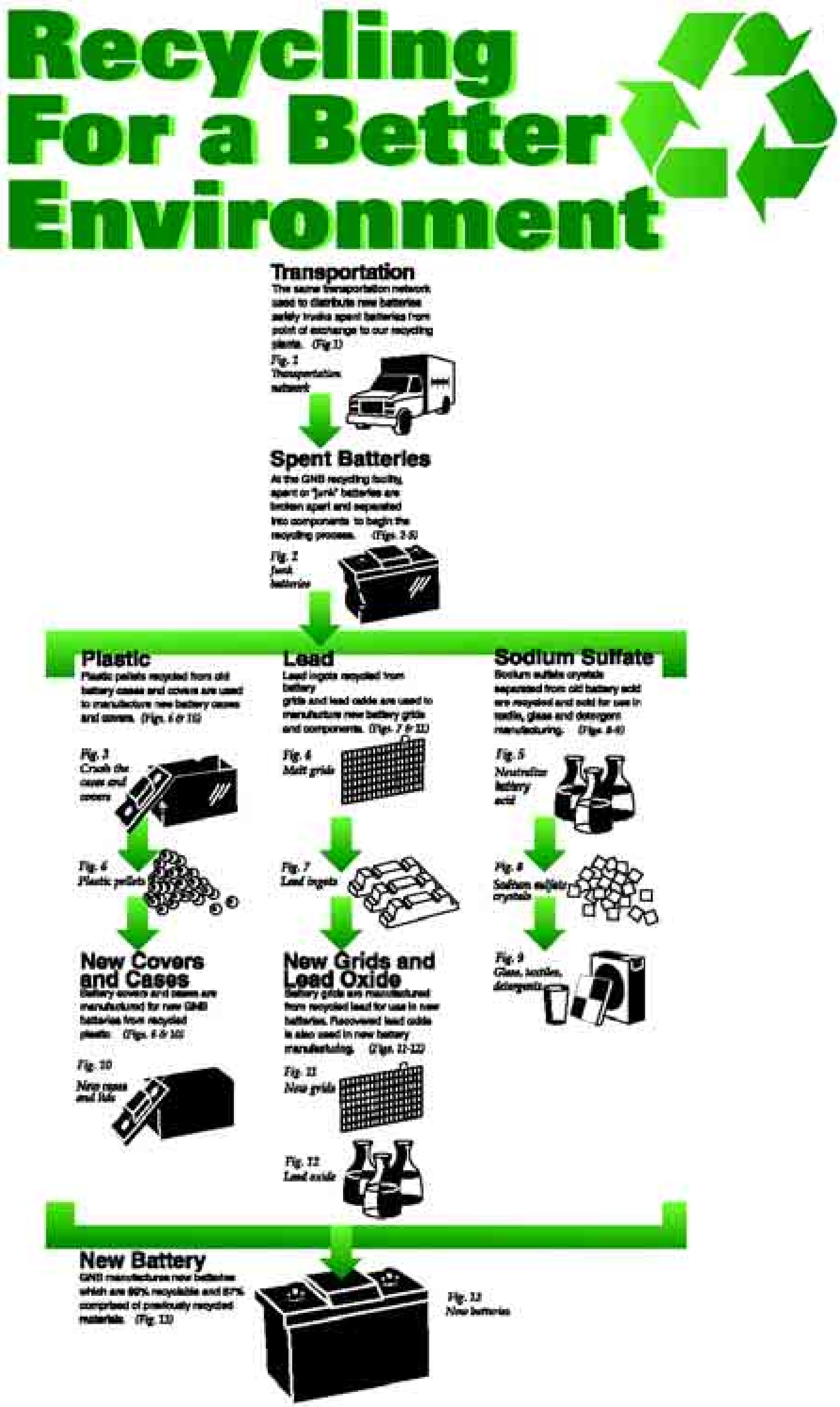
### *Safety Precautions for Battery Recyclers*



- *Store batteries on pallets on a concrete base and in a covered area.*
- *Use protective neoprene gloves, and eye protection while handling batteries.*
- *Wash hands and body thoroughly after handling Lead Acid batteries.*
- *Undergo an annual medical check including a blood lead test.*
- *Operate battery recycling areas from residential areas to avoid exposing others, especially children to the toxic effects of lead.*

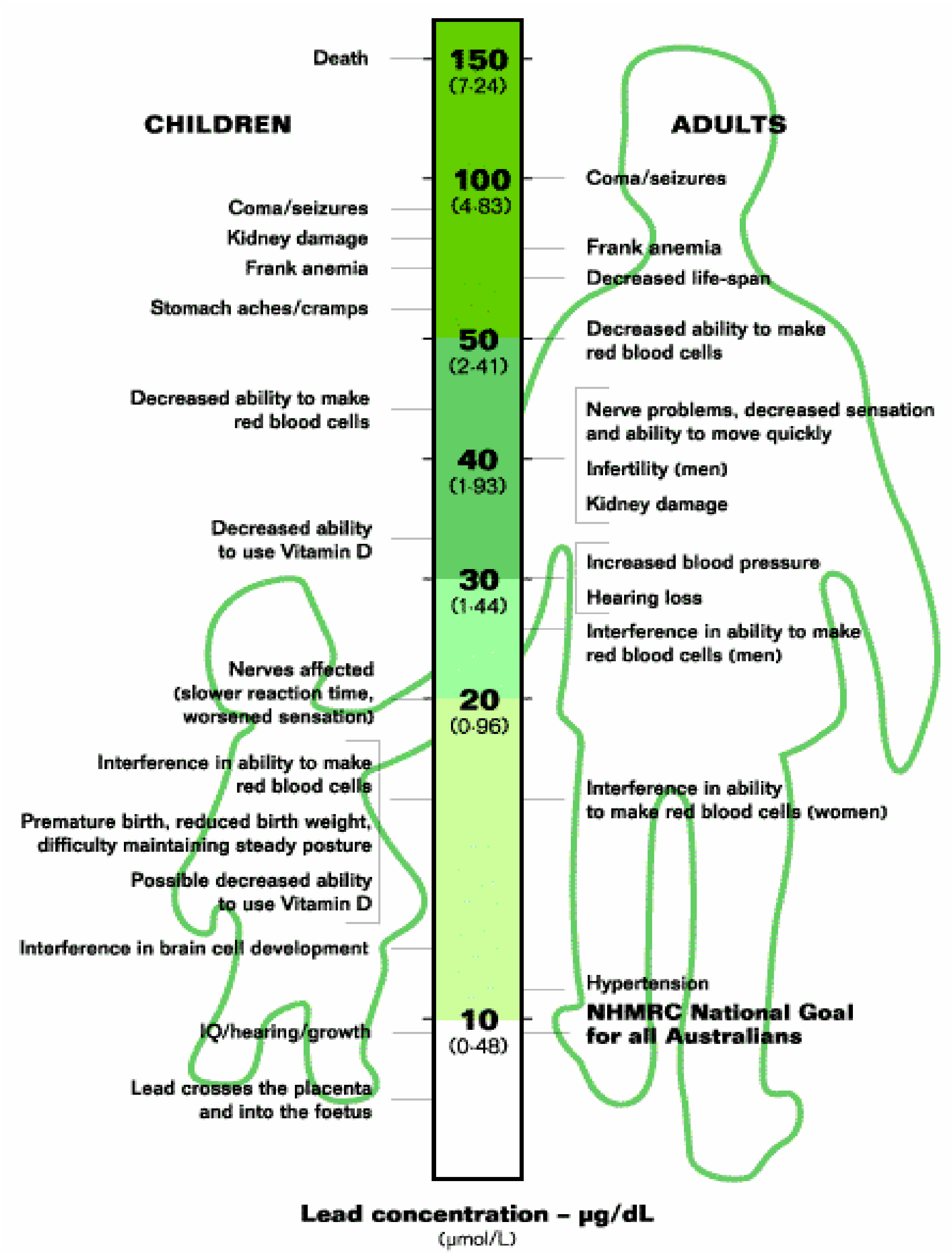
Appendix 21


PLEASE RECYCLE
EXIDE BATTERIES
OFFICIAL
BATTERY RECYCLING
DROP OFF
GET THE LEAD OUT!
EXIDE BATTERIES
WE ACCEPT ONLY LEAD ACID BATTERIES FOR RECYCLING.
EXIDE BATTERIES



Recycling For a Better Environment
Transportation
The same transportation network used to distribute new batteries safely trucks spent batteries from point of exchange to our recycling plants. (Fig.1)
Spent Batteries
At the GNB recycling facility, spent or "junk" batteries are broken apart and separated into components to begin the recycling process.
Fig. 2
Junk batteries
Plastic
Plastic pellets recycled from old battery cases and covers are used to manufacture new battery cases and covers.
Lead
Sodium Sulfate
Sodium sulfate crystals separated from old battery acid are recycled and sold for use in textile, glass and detergent manufacturing.
Fig. 3
Crush the cases and covers
Fig. 5
Neutralize battery acid
Fig. 7
Lead ingots
Fig. 8
Sodium sulfate crystals
New Covers and Cases
Battery covers and cases are manufactured for new GNB batteries from recycled plastic.
New Grids and Lead Oxide
Battery grids are manufactured from recycled lead for use in new batteries. Recovered lead oxide is also used in new battery manufacturing.
Fig. 9
Glass, textiles, detergents
Fig. 10
Fig. 11
New grids
Fig. 12
Lead oxide
New Battery
New batteries

*Health Hazards and Lead Exposure*



ABS-CBN Main

# Bantay Baterya Project

Bantay Baterya Project

The Bantay Baterya project aims to create a sustained public awareness on the health and environmental hazards posed by the indiscriminate disposal and handling junk batteries. It also seeks to provide a long-term mechanism significantly reduce the number of improperly disposed off junk batteries and to ensure a steady supply of raw materials for the production of new batteries as well. Bantay Kalikasan, the environmental program of the ABS-CBN Foundation, Inc., in partnership with the Philippine Recyclers, Inc (PRI) and the Environment Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR) in one concerted effort will aim to promote environmental preservation through a massive recovery and recycling campaign on pollution-causing junk batteries all over Metro Manila and contiguous provinces and municipalities.

How Do We Do This?

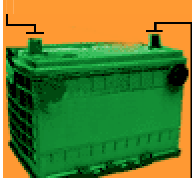
Through the primary efforts of the PRI, which operates a government-approved lead recycling plant, reprocessing junk batteries in an environmentally safe manner would be made possible. PRI, the first and largest lead recycler in the Philippines, is certified to ISO 14001, the international standard for environmental management systems. PRI currently maintains, two junk battery depots in Metro Manila, which can serve as both collection centers and temporary storage facilities before the batteries, are brought to their recycling plant in Marilao, Bulacan.

With Bantay Kalikasan at the helm of a massive information and education drive, realization of our objectives are highly probable. Further, Bantay Baterya have full enforcement and support of the EMB-DENR, being one of the first projects under the Philippine Environmental Partnership Project (PEPP) of the government.

Our Target

There are about 2.1 million lead-acid batteries consumed annually. This translates to almost 40,000 metric tons of batteries being disposed of every year. Of the estimated 200,000 batteries consumed each month nation wide, 60% are collected by the PRI. Twenty percent (20%) goes underground to illegitimate smelters, which are capable of recycling only the lead of the battery and not the acid powder-from lead. Bantay Kalikasan's goal is to recover the remaining 20% or 40,000 batteries disposed off indiscriminately each month.

Proceeds from Bantay Baterya Project support various Bantay Kalikasan projects including the Save the La Mesa Watershed Project, "Bantay Usok" Anti-Smoke Belching campaign and its Environmental Hotline operations.




Contact ABS-CBN Bantay Kalikasan at: 415-2227 / 410-9670






Welcome to Recycle City! There's lots to do here - people and places to visit and plenty of ways to explore how the city's residents recycle, reduce, and reuse waste.

To get started, just click on any section of Recycle City that you want to tour, or click on the Dumptown Game. You can create your own Recycle City scavenger hunt or go to the Activities area and see other ways you can explore Recycle City.

When you leave this place, you'll know much more about what you can do to help protect the environment. If you need to print a section of Recycle City, you can save paper by using the printer-friendly version.

In October of 2003, we made some updates to Recycle City, thanks to feedback from recyclers around the world! Check out what's new in Recycle City!

Have fun!

P.S. Click here to read about the history of Recycle City
Go to Recycle City! | About Recycle City's Founders |

Appendix 26

# Recycling Poster Contest






It's often difficult for children not to feel helpless when they are confronted with "the big issues" and are unable to do anything about them. But for the eleventh year in a row the DEP and PA Department of Education have come together to sponsor the annual Recycling Poster Contest and offer children a chance to become involved. The theme of this years contest was "The Many Roles of Recycling and Composting and Their Influence on Natural Resources".

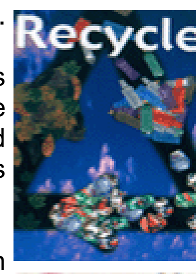
Of the nearly 6,000 entries only twenty-six students, grades 1-12, are selected to have their posters printed on the calendar. There are two winners from each grade, a first and second place, and two grand prizewinners whose posters adorn the front and back covers of the calendar.

The winners of the contest were honored last December in Harrisburg for their achievements. Each was presented with their original artwork, matted and framed, and took a moment to pose for pictures. Some were even granted citations by Legislative Representatives.

But probably the most exciting moment for the kids was after the ceremony when they were able to sign autographs for their frenzied fans. Walking up to the long table where the kids were seated and busy signing autographs you could see the ear-to-ear grins on them. They were taking questions about their artwork and posing for a few more pictures. By the end of the afternoon festivities, most of the students had learned to field questions and work a crowd like true professionals.

While sitting down and talking to some of the artists about the

## Hear From The Artists




Themes from a sponge paint artist


A young artist describes his work


Carl Hursh talks about the kids


content of their finished products, their answers carried a simple, but clear message about the importance of recycling and composting. Several of them went into great detail, explaining the process and benefits of composting. The kids all had a great time, and have accompanied their knowledge in composting with a great deal of pride for what they have done.

Visit the DEP web site
Visit the DOE website

- Get GreenWorks free eNews


Patty Vathis discusses the program

Appendix 27

**Case Study: The experience in Trinidad and Tobago in investigation and remediation of lead-polluted sites has resulted in the following collaborative framework:**

- Reporting of lead contamination can be made to the Public Health Division of the Ministry of Health (MoH), The Environmental Management Authority (EMA), or the Department of Chemistry, University of the West Indies (UWI), St. Augustine. The ongoing research in lead pollution, poisoning and soil remediation allows UWI to become involved in site investigation as part of its research programme.
- Once a report is received, a site visit is arranged by the EMA or MoH, who both have the authority to enter and assess a suspect site. UWI is usually requested to accompany the EMA and/or MoH personnel on the site visit, to investigate the site for lead contamination. Sampling and lead analyses are undertaken on behalf of the regulatory authorities, but the results may be used by UWI for its research and publication. The publication of results is important, not only in providing UWI to become involved in socially relevant research, but also to publicize the results internationally, for the benefit of others similarly affected.
- Public health and environmental laws thus provide the legal framework for regulatory agencies (MoH, EMA) to take action, once a site is reported and identified as lead-polluted. UWI's involvement is based on research activities on lead in the Dept. of Chemistry.
- These activities require the use of personnel and resources to visit suspect sites, collect samples for analyses, as well as to undertake follow-up visits, if results indicate such need. These costs are at present borne by the taxpayer and the university, since no effective legal framework exists in Trinidad & Tobago for cost recovery from polluters.

Plate 3: Lead Smelter Waste Used as Landfill

For example, the incident in East Trinidad in 1993, in which a squatting site was polluted by lead smelter waste used as landfill, resulted in the hospitalization of >50 children, one of whom subsequently died. The cost of testing, remediation, relocation and re-housing of residents, and administrative costs is estimated to have cost local taxpayers >US$ 1M.

The system still has the following disadvantages which require urgent correction:

- Lack of appropriate funding for site remediation and the prompt release of funding for these activities are major weaknesses which require correction. Governments must be convinced that remediation of lead-contaminated sites is a matter of urgent importance and to provide the necessary resources for these tasks as soon as possible. Arguments for such actions should be based on cost-benefit analyses, to include the costs of long-term health effects on children, contamination of waterways, crops and foods and their effects on public health, as against the costs to the society of not taking action on the problem.

- Legislation governing cost recovery for lead pollution and poisoning must be enacted, to discourage further pollution and to allow the costs for site investigation and remediation to be recovered from individuals or companies responsible for such pollution and poisoning.

- The present framework for action in Trinidad is effective, mainly because UWI is currently involved in research on lead pollution and poisoning, as well as provides quality- assured blood lead analyses, in collaboration with the Centers for Disease Control and Prevention of the USA.

- However, similar collaborative systems or capabilities may not exist in other countries. Thus, there is need for appropriate alternative systems to be developed, to allow each regulatory body (EMA, MoH, etc) to develop its own capability to assess and take action on lead-contaminated sites, but in collaboration with each other.

  This will involve capacity building, through training in blood lead analyses to confirm lead poisoning, and site assessment to determine the need for site remediation. The methods required for site remediation, while site-dependent, may be developed and applied using regional expertise.

  (The Department of Chemistry at UWI St. Augustine is willing to provide such training, once funding can be sourced to allow participants to attend the training program, and to cover the costs of such training)

- Involvement of academic institutions such as universities must be encouraged, to allow for flexible and rapid responses to any reports of lead contamination. Research into systems of site investigation and remediation in the region can allow the development of appropriate strategies and systems that can allow this region to solve its own problems. Such systems can also be provided to other countries with similar problems.

It is therefore recommended that regulatory authorities in each country develop their own systems for investigation of lead pollution and poisoning, in collaboration with their academic institutions, to maximize the use of their respective resources and minimize duplication of effort.

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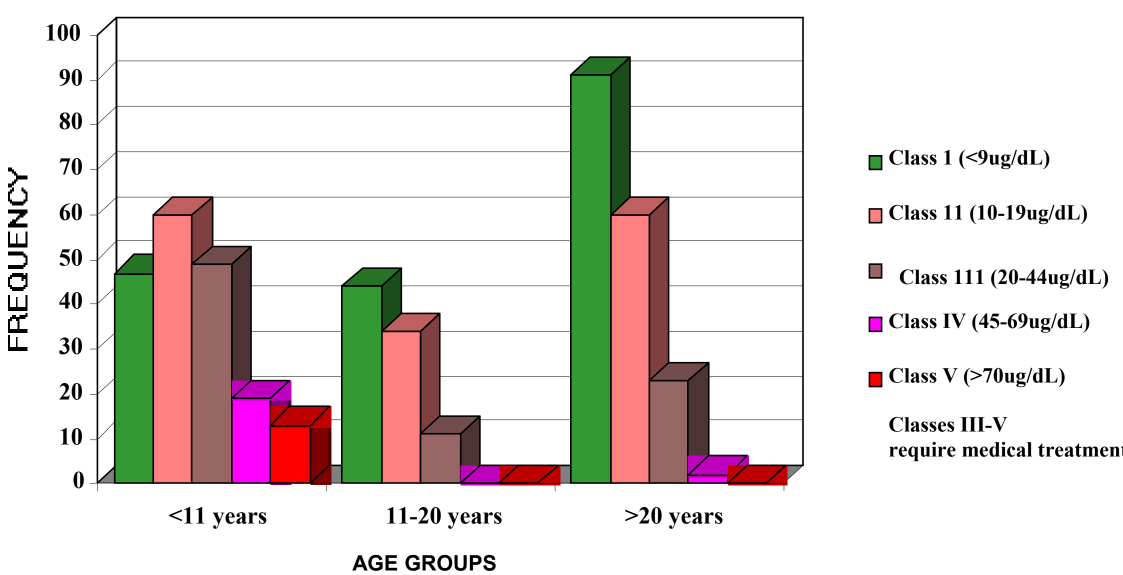
Plate 1: Poor Handling Practices of ULAB

Figure 1: Lead Poisoning of Children and Adults from Lead Smelter Waste

Blood lead profiles and classes of poisoning of adults and children in East Trinidad, 1993



**Process Emission Controls**

Furnace gases and lead fume, together with dross dusts, must be captured and contained. There is a variety of methods to do this, but the most effective are filtration plants.

Fabric collectors remove particles by straining, diffusion, and electrostatic charge. The fabric may be constructed of any fibrous material, either natural or manmade, and may be spun into a yarn and woven or felted by needling, impacting or bonding. The best modern bag is made of Teflon in a form that will capture sub-micron particles, but this material has a high initial cost. Regardless of construction, the fabric presents a porous mass through which gas is passed uni-directionally such that the dust particles are retained on the dirty side and the clean gas passes through. A non-woven or felted fabric is more efficient than a woven fabric of identical weight, because the void areas (pores) in the non-woven fabric are smaller. A specific type of fabric can be made more efficient by using smaller fiber diameters, by a greater weight of fiber per unit area or by packing the fibers more tightly. For non-woven construction, the use of finer needles for felting also improves efficiency.

An alternative to the filter bag is an electrostatic precipitator. In these baghouses a high potential electric field is established between discharge and collecting electrodes. The discharge electrode is a small cross-sectional area, such as a wire or piece of flat stock, and the collection electrode is large in surface area (e.g. a plate). The gases to be cleaned pass through the electric field that develops between the electrodes. At a critical voltage, gas ionization takes place at or near the surface of the discharge electrode. Ions having the same polarity as the discharge electrode attach themselves to neutral particles in the gas stream as they flow through the precipitator. These charged particles are then attracted to a collecting surface where the dust particles lose their charge. The captured particles can then be easily removed by washing, vibration or gravity.

Chamber or spray tower collectors consist of a round or rectangular chamber into which water is introduced by spray nozzles. The principal mechanism for air cleaning is impaction of dust particles on the liquid droplets created by the nozzles. These droplets are separated from the air stream by a centrifugal force or impingement on water eliminators. Wet centrifugal collectors comprise a large portion of the commercially available wet collector designs. This design utilizes centrifugal force to accelerate dust particles and impinge them upon a wetted collector surface.

Wet dynamic precipitators are a combination fan and dust collector. Dust particles in a contaminated air stream impinge upon rotating fan blades that are moistened with water from aerosol spray nozzles. The dust particles impinge upon the water droplets and are trapped along with the water by a metal cone; while the cleaned air makes a turn of 180 degrees and escapes from the front of the specially shaped impeller blades. Contaminated effluent from the water cone goes to the water and sludge outlet and the cleaned air goes to an outlet section containing a water elimination device. The orifice type of wet collector design has the air flowing through the collector and in contact with a sheet of water in a restrictive passage.

As a further stage to ensure the removal of any small particles of dust, flue gas can be directed to a Venturi-type Dust Collector. At both inlet and outlet of this type of collector, dust is covered by condensate through adiabatic expansion and collected by sprayed water that is circulated via tanks installed at the inlet and outlet respectively. This system is also a useful preparation for the removal of traces of sulfur dioxide by passing the gases through an absorber tower where the sulfur oxides are removed by contact with circulating water sprayed into the tower.

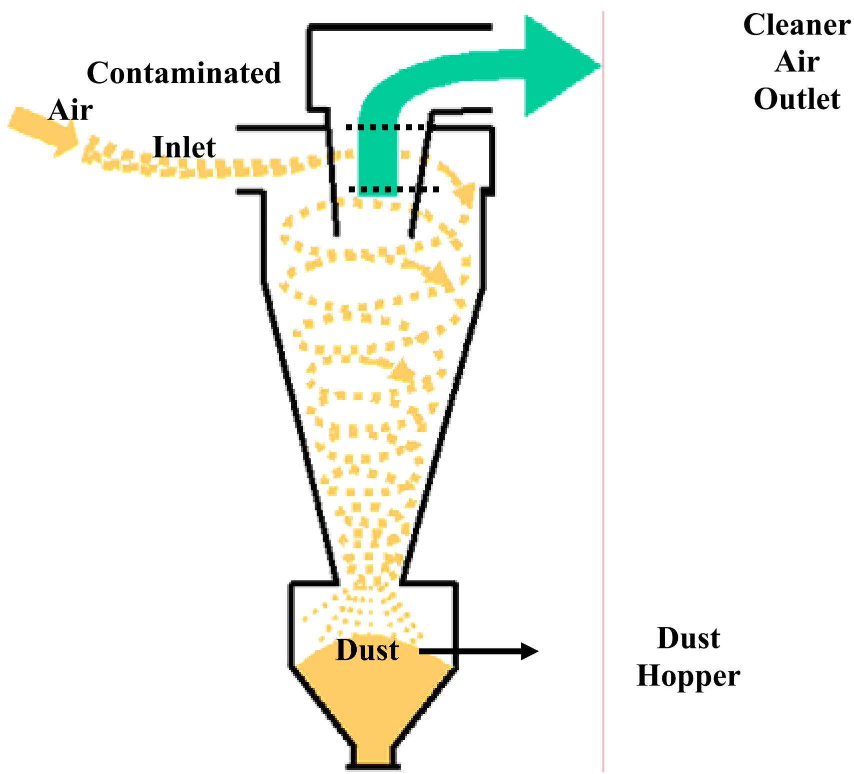



Fig 1: Cyclone dust separator

Many plants still employ cyclone dust collectors either as a first stage separator for the heavier dust particles or in series to achieve a high level of separation, prior to entry into a baghouse filtration plant for a final treatment before release to atmosphere.

The operation of a cyclone is very simple, but effective. Contaminated air enters the cyclone at a high velocity and under its own momentum is spun around the cone in a circular motion that has the effect of throwing the dust particles against the cone wall. As the cone narrows, large particles spin into the hopper where the dust can then be discharged into a container through a valve in the base. Smaller particles, typically less than 10 microns, will run back up through the center of the cyclone and discharge through the outlet for further treatment.

Appendix 29

Republic of Chile – Notification and Movements Form

REPUBLICA DE CHILE
MINISTERIO DE SALUD

N° 030209

## NOTIFICACION DE MOVIMIENTOS TRANSFRONTERIZOS

**1.- PAISES RELACIONADOS CON EL MOVIMIENTO**

| PAIS DE EXPORTACION | PAISES DE TRANSITO (indicar puertos) | PAIS DE IMPORTACION/DESTINO |
|---|---|---|
| CHILE | PERU-CALLAO | VENEZUELA |

**2.- EXPORTADOR**

Nombre: SOC.EXP E IMP.CHILE METAL LTDA.
Dirección: RIVAS 1026 SAN MIGUEL
Persona a cargo: ELIECER MUÑOZ DIAZ
Teléfono: 56-2-5553647 Fax: 56-5547972

**3.-TIPO DE NOTIFICACION:**

A i) Un movimiento ☐
ii) Movimientos múltiples ☒
B i) Disposición final ☐
ii) Operación de recuperación ☐

**4.- DESTINATARIO:**

Nombre: FUNDICION DEL CENTRO C.A.
Dirección: AV.MILAN ED.NAPEVEN LOS RUICES SUR CARACAS, VENEZUELA
Persona a cargo: JORGE NIETO
Teléfono: 58-212-2578022 Fax: 58-212-2577336

**5.-Número total estimado de embarques:** 20

**6.-Cantidad total estimada:** 4.500 TN

**7.-Período en que se realizará la exportación:** 2003-2004

**8.- GENERADOR:**

Nombre: SOC.EXP E IMP.CHILE METAL LTDA
Dirección: RIVAS 1026 SAN MIGUEL
Persona a cargo: ELIECER MUÑOZ DIAZ
Teléfono: 56-5553647 Fax: 56-2-5547972

**9.- ELIMINADOR DE LOS DESECHOS:**

Nombre: FUNDICION DEL CENTRO C.A.
Dirección: AV.MILAN ED.NAGEVEN LOS RUICES SUR CARACAS, VENEZUELA
Persona a cargo: JORGE NIETO
Teléfono: 58-212-2578022 Fax: 58-212-2577336

**10.- ELIMINACION DE LOS DESECHOS:**

Lugar de eliminación: AV.MILAN ED. NAGEVEN LOS RUICES SUR CARACAS VENEZUELA
Método de eliminación: RECUPERACION DE METALES.
Código (D y/o R): R-4

**11.- TRANSPORTISTA**

Nombre: MARITIMA VALPARAISO
Dirección: AV. NUEVA TAJAMAR N°481 LAS CONDES, SANTIAGO CHILE
Persona a cargo: GINA ARANCIBIA
Teléfono: 56-2-2036780 Fax: 56-2-2036779

**12.- MEDIOS DE TRANSPORTE**

Aire ☐ Tierra ☐
Agua ☒

**13.- DESECHOS**

Nombre y composición química de los residuos:

BATERIAS USADAS Y SECAS

Número Y: 31 Número H: 61-11 Clase NU: 6 Número NU:
Estado físico a 20°C: sólido ☒ líquido ☐ gas ☐ otro ______
Tipo de envase:

**14.-DECLARACION DEL EXPORTADOR:**

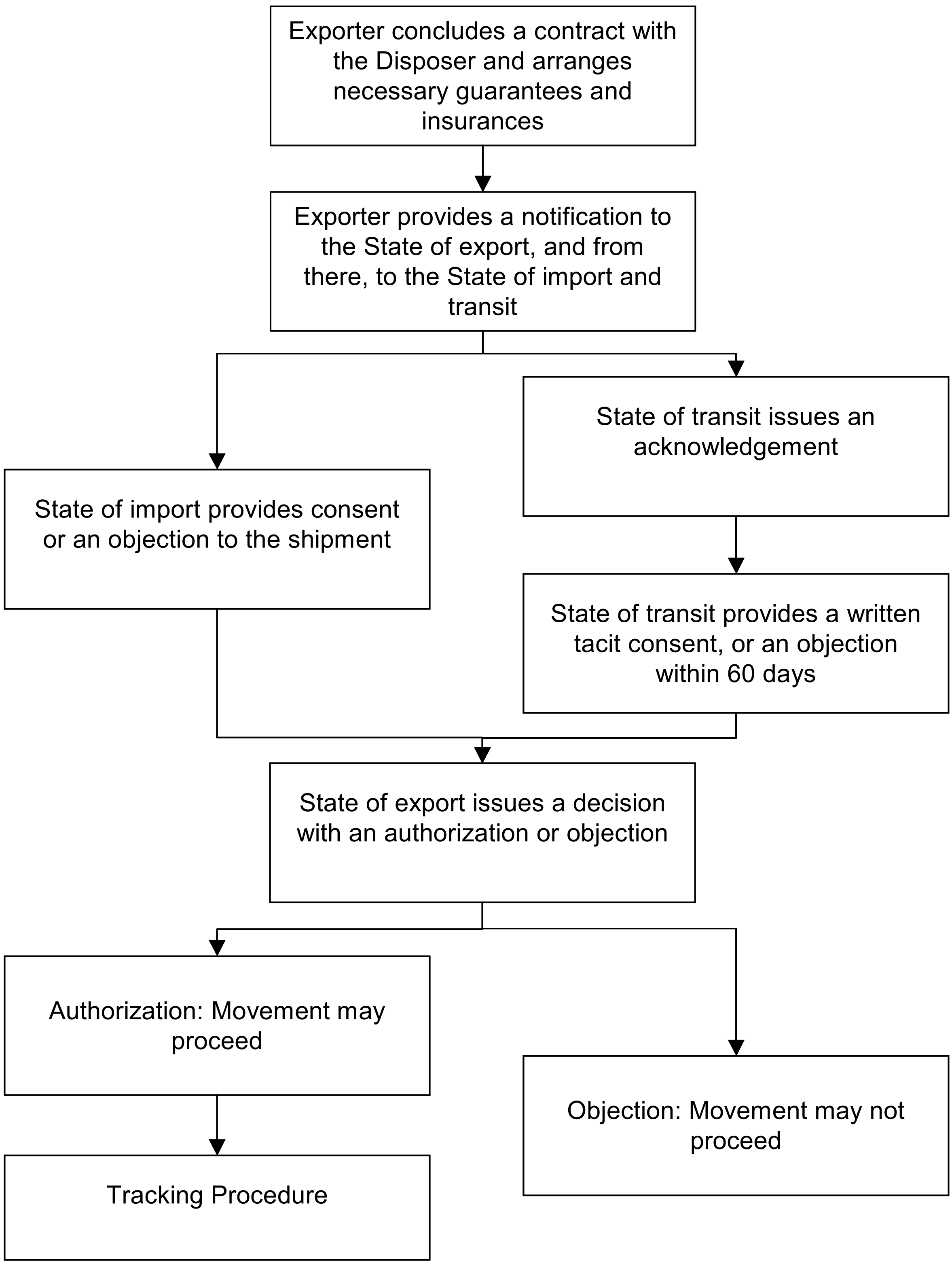
Certifico que la información antes proporcionada está completa y es correcta y es la mejor información que conozco sobre la materia. También certifico que existen obligaciones contractuales legales con el destinatario o eliminador de los residuos y aseguro que existen o existirán al momento de la exportación seguros comprometidos:

Nombre: ELIECER MUÑOZ DIAZ
Firma:
Fecha: 04/11/2003
C.I.: 12.205.013-0

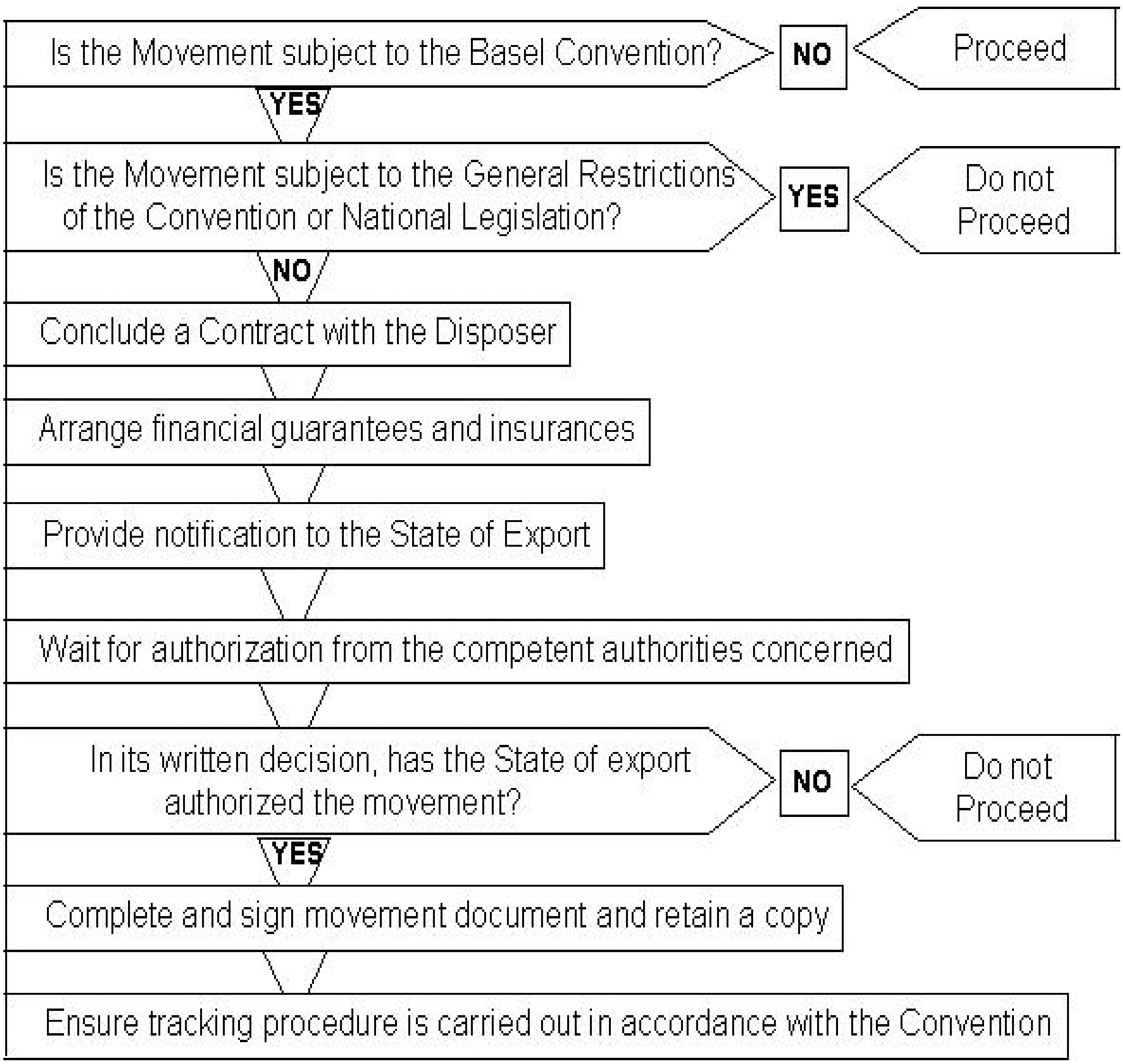
MINISTERIO DE SALUD, MAC IVER 541, SANTIAGO, CHILE.

Appendix 30

**Notification and Authorizations Procedure**



**Tracking Procedure**



**Responsibilities of the Competent Authority of the State of Export**

**Step 1 Determine whether the waste is subject to control under the BC:**

- Is the material considered as waste (ref. section 2.1)?
- Is the waste considered to be subject to the control procedures under the Basel Convention (ref. section 2.2)?

**Step 2 Distribute forms to exporter/waste generator Step 3 Check the notification**

Check if the notification is duly completed. If not, return the notification to the exporter/generator and ask that the missing information be provided. The competent authority may decide not to proceed with the notification if it has immediate objections.

**Step 4 Transmit the notification to other competent authorities**

If the notification has been duly completed and there are no immediate objections to the movement, transmit copies of the notification to:

- The competent authority of the State of import
- Each competent authority of the State of transit, if any.

**Step 5 Ensure that the movement is allowed by the competent authorities of the States of transit.**

Find out whether the State of transit has decided not to require prior written consent for transit of the waste concerned. If not required, the competent authority of the State of transit shall have 60 days after receipt of the notification to object to the proposed transit of waste. If no objection has been lodged, the State of export may allow the movement to proceed through the State of transit after the 60-day period has passed. In case prior written consent is required, the competent authority of the State of transit shall issue a written response to the notifier within 60 days following receipt of the notification.

**Step 7 Ensure that the movement is allowed by the Competent Authority of the State of import.**

Ensure that the competent authority of the State of import has issued its written response and has confirmed the existence of a contract between the exporter, that the movement does not contravene national legislation and the movement has been authorized.

**Step 8 Issue a decision in writing.**

Issue a decision consenting to the movement with or without conditions, denying permission for the movement or requesting additional information. The proposed movement can be authorized only in the absence of objections from the competent authority of the State of export and on the part of the other competent authorities concerned. In the case of a general notification, authorization can be given for a maximum period of one year.

**Step 9 Follow the Tracking Procedure**

See appendix 31

**Appendix 33**

***Bibliography and useful links***

*Capacity Building Training Modules*

Battery Basics for 12-volt Lead Acid batteries - developed by Kevin R. Sullivan, Professor of Automotive Technology, Skyline College, San Bruno, California. A 33 page online guide, 531KB - http://www.autoshop101.com/trainmodules/batteries/101.html.

Battery Service for 12-volt Lead Acid batteries - developed by Kevin R. Sullivan, Professor of Automotive Technology, Skyline College, San Bruno, California. A 35 page online guide, 478KB - http://www.autoshop101.com/trainmodules/batservice/101.html.

Automotive Batteries, 741KB - http://www.autoshop101.com/forms/h6.pdf.

**Model Legislation to Promote ULAB Recovery**

Proposed Model Battery Recycling Legislation - Battery Council International, http://www.batterycouncil.org/BCIMODEL.pdf.

**Used Lead Acid Battery Deposit Refund Schemes**

Canada, British Columbia - Lead-Acid Battery Collection, Transportation and Recycling Program, http://wlapwww.gov.bc.ca/epd/epdpa/ips/batt/index.html.

US EPA – Yosemite – Deposit Refunds Schemes in the US, Section 5.3 – Lead Acid Batteries,http://yosemite.epa.gov/ee/epa/eermfile.nsf/Attachment+Names/EE-0216a-2.pdf/$File/EE-0216a-2.pdf?OpenElement.

The Next Generation of Market-Based Environmental Policies, Robert N. Stavins and Bradley W. Whitehead, Discussion Paper 97-10 November 1996, pages 40 –42. http://www.rff.org/Documents/RFF-DP-97-10.pdf.

**Case Study**

UNCTAD – A Review of Options for Restructuring the Secondary Lead Acid Battery Industry in the Philippines, http://r0.unctad.org/trade_env/docs/info-fv.pdf.

**The Control of Lead at Work**

These regulations, first introduced in 1980, have been updated and improved, though powers invested in the Secretary of State for the Environment under the Health and Safety at Work Act of 1974. Indeed, the latest update for the CLAW Regulations was introduced in 2002 using the Act 1974.

The updated version of the Code can be downloaded at;

http://www.legislation.hmso.gov.uk/si/si2002/20022676.htm

This code is comprehensive and whilst some of the values for personal lead exposure might be meaningless in the absence of suitable lead in blood testing and analyzing facilities, the procedures are relevant to any lead smelting operation.

**www.basel.int**

**Secretariat of the Basel Convention**
**International Environment House**
15 chemin des Anémones
1219 Châtelaine, Switzerland
Tel : +41 (0) 22 917 82 18
Fax: +41 (0) 22 797 34 54
Email: sbc@unep.ch


UNEP

Sales Number E.04.III.D.32, ISBN 92-1-158652-6

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is the most comprehensive global environmental agreement on hazardous and other wastes. It has over 160 Parties and aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes.

The Basel Convention regulates the transboundary movements of hazardous and other wastes and obliges its Parties to ensure that such wastes are managed and disposed of in an environmentally sound manner. The Convention covers toxic, poisonous, explosive, corrosive, flammable, ecotoxic and infectious wastes. Parties are also expected to minimize the quantities that are transported, to treat and dispose of wastes as close as possible to their place of generation and to prevent or minimize the generation of wastes at source.

The Basel Convention has 13 Basel Convention Regional Centers in the following locations: Argentina, China, Egypt, El Salvador, Indonesia, Nigeria, Russian Federation, Senegal, Slovak Republic, South Pacific Regional Programme, South Africa, Trinidad and Tobago, Uruguay. They deliver training and technology transfer for the implementation of the Convention.

The Basel Convention came into force in 1992.