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Technical Report

Status of Used Lead Acid Battery Management in Kingdom of Cambodia

Prepared by Project Team
Department of Environmental Pollution Control
Ministry of Environment

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TABLE OF CONTENTS

LIST OF PICTURES

LIST OF TABLES

ABBREVIATION AND ACRONYMS

A	Ampere
ILMC	International Lead Management Center
IT	Information Technology
L	Liter/Litre
LAB	Lead Acid Battery
MF	Maintenance Free
MoE	Ministry of Environment
NGOs	Non-Government Organizations
Pb	Lead
PPF	Personal Protective Equipment
RAPS	Remote Area Power Supply
SBC	Secretariat of Basel Convention
t	ton
TV	Television
ULAB	Used Lead Acid Battery
UNEP	United Nations Environmental Program

1.0 EXECUTIVE SUMMARY

In the Kingdom of Cambodia, used lead acid batteries (ULAB) are not normally managed in an environmentally sound manner and there is no specific government institution responsible for ULAB management[1]. Detailed legislation specifically targeting the management of ULAB does not exist, except for some related statutory instruments such as the Law on Environmental Protection and Natural Resources Management; the Sub-Decree on Water Pollution Control; and the Sub-Decree on Solid Waste Management. Unsound ULAB management has caused concern for the environment and population health in Cambodia and there is an urgent need to improve the management mechanisms based on sound environmental practices, otherwise, harmful and irreparable consequences will occur in the future. The adverse health effects are a particular concern because they become another obstacle in the application of the Poverty Alleviation Program, which is the main policy of the present Royal Government of Cambodia.

The main environmental and health threats arising from current practices are the release of hazardous materials from ULAB and flammable and obnoxious gas emissions. The materials released into the environment include lead oxides, lead sulfates and dilute sulfuric acid. These materials are released during various stages in the life cycle of the lead acid battery (LAB), including recharging, ineffective and inefficient ULAB recycling and residue disposal. These "unfriendly" activities are all contributors to the pollution of the soil, aquatic ecosystems, and sometimes, domestic air quality as well.

Besides the LAB recharging and ULAB recycling, the storage of ULAB in homes, workplaces and children's playground areas has resulted in large amounts of lead and acidic substances accumulating in places readily accessible to young children and worker's families. These small stockpiles might be a risk to them and the local communities.

The Kingdom of Cambodia was awarded a support project in 2003 from the Secretariat of Basel Convention (SBC), namely "*The Environmentally Sound Management of ULAB in Cambodia*". It was anticipated that this project would be implemented over a period of 9 months (01 December 2003 to 31 August 2004) under the close cooperation and assistance of the International Lead Management Center (ILMC). The survey of ULAB and its adverse effects in some cities and provinces is part of the work plan of the project.

The major objectives of the studies are to identify:

1) The importation and consumption of LAB in various sectors and the future trends in ULAB, including the ULAB trade flow.

2) The evaluation of local management practices for ULAB recycling and the disposal of any smelting residues.

3) Environmental, occupational and population health risks, and hazards resulting from the disposal and/or recycling of ULAB.

4) The shortcomings in ULAB management and recycling, and especially, requirements for legal instruments, capacity building, and future action plans, based on the recommendations from stakeholders.

[1] *It is under the cooperation of concerned ministries, but referred to as the Environmental legal tool. This task should be lead by the Ministry of Environment.*

This project could make a very important contribution towards alleviation of the widespread poverty in certain sections of the population and is consistent with the policies of the current Government of Cambodia. Essentially, the outcomes of the project can or will directly or indirectly:

1) Increase the incomes to ULAB collectors and formalize income to recyclers.

2) Provide the workers and the general public with an understanding of the necessary measures to prevent or avoid any adverse effects resulted from LAB recharging, servicing or ULAB recovery.

3) Prevent environmental pollution while maintaining socio-economic development based on environmentally sound procedures.

The desk-top study and technical field study are the two main activities of the project. The desk-top study comprised:

- Collection and identification of existing data/information related to ULAB from government institutions and the private sector.

- Collation and identification of any data or information gaps, including the assessment of existing ULAB management and any related statutes.

By agreement between the SBC, the ILMC and the Cambodian Environment Ministry, the technical field study was conducted in a selected sample of provinces and cities that have different socio-economic conditions of high, medium and low income families. In this regard, there are two cities, Phnom Penh and Sihanoukville, and two provinces, Battambang and Svay Rieng, that meet the criteria. These two cities and provinces were designated as representative samples to determine the trends throughout the country.

Between September and November 2000, the Meritec Group undertook a survey[2] of 200 villages and 3,000 households to establish energy use parameters in the rural areas of Cambodia so that government planners could determine electrification needs and formulate an appropriate government policy. The most surprising fact to emerge from this survey was that 55% of the households surveyed in the rural areas used automotive, truck or motorcycle LAB for their domestic electrical supply. The batteries are mostly used to power portable TVs and household lighting. However, LAB usage varied with Prey Veng Province leading with 92.6 % of the households surveyed using LAB and the remote sparsely populated provinces of Ratanakiri and Preah Vihear trailing with only 14 % and 17 % using LAB. This low uptake in these remote districts may be linked to poor TV reception and the use of dry cell batteries in the absence of battery recharging shops. Most encouraging, the survey also reported that 90% of the households confirmed that they would sell their old battery for recycling (about US$ 1) rather than dump it.

Armed with this knowledge, the inventory process in these provinces and cities was divided into two main sampling areas, that is, the urban and rural areas. The survey targeted sources such as:

(i) battery retail shops;
(ii) computer shops;
(iii) battery recharging/reconditioning shops;
(iv) scrap yards; and
(v) telecommunication stations, local communities and schools.

[2] http://www.recambodia.org/REAP National Workshop/02 - Cambodia Energy/Cambodia Energy Use Survey Report Summary by Meritec Ltd.pdf

The survey identified the different stages in the life cycle of LAB such as production, distribution and sale to institutional and private consumers, service life and end of life management. ULAB in Cambodia are not disposed of through the public waste collection system or waste dumping sites, because ULAB still has a value for waste pickers or scavengers. They can sell the ULAB to recyclers and/or ULAB merchants for export to other countries.

Low recycling technology with inappropriate facilities is being used in some areas of Cambodia and these operations threaten the environment and public health. Generally, the people working in these sources of pollution are generally limited in their awareness and knowledge of environmental protection and health care. When interviewed, those people responsible for the battery recharging and scrap yards, for example, generally did not seem to care about consumer and worker safety[3] at their premises. There were no access restrictions to anybody, especially children in the working areas of battery recharging shops, battery storage facilities and so on. In this regard, people could do any thing they wished and the children were free to play and run about the operational areas with their friends as they wished.

The outcomes of the Steering Group Meetings and the surveys identified that problems associated with unsound ULAB recycling practices and the inappropriate disposal of residues of ULAB recycling, are due to inadequate awareness and knowledge stemming from a lack of information and technical understanding. Environmentally sound LAB and ULAB management, so far, is still limited. There is no particular institution that is responsible for these matters and there is inadequate legislation and enforcement of existing national and international regulations.

As a conclusion, the preparation of Guidelines for the environmentally sound management of ULAB should be developed and implemented at the national level and the capacity building should be promoted, especially, technological transfer through exchange visits between some countries where similar projects or problems were resolved successfully with beneficial outcomes.

[3] *They are masks, gloves, goggles, etc.*

2.0 BACKGROUND

2.1 General Comments on the National Situation: Actual System and its Flaws

Outcomes of the desk-top study and site surveys indicated that battery recharging, servicing, reconditioning and small-scale ULAB recycling received little attention from Cambodian Government institutions. The exception being the control of the importation of lead based substances such as LAB for local demands, because Cambodia is not a country that can produce lead substances and LABs to support its needs.

All LAB and related raw materials are imp orted from various countries in the region, for example, Vietnam, Thailand, Japan, South Korea and Malaysia, albeit with different capacity and sizes. Imported LAB are also used for domestic and many other purposes, for instance, for domestic lighting, TV/Radio, pumping water (in terms of surface and ground waters), starting vehicle engines, torching wild animal/birds at night time, and marine fishing.

The useful life of a battery varies from eight months to twenty four months, based on quality, price and use.

The process of LAB recharging, servicing and ULAB recycling, requires the workers to operate procedures that are simple, but outdated and without any consideration for the environmental and the health impacts. Significantly, workers in the industry and those involved with it have never had any technical education from Government institutions, International Organizations or NGOs that adequately explain the correct procedures for LAB recharging, servicing or ULAB recycling.

LAB recharging, servicing and ULAB recycling requires properly managed improvements, otherwise, the negative consequences will not only pose a threat to the workers, but also to the environment and public health in the future. Workers and those people closely involved with the industry are facing possible lung and organ deterioration; severe diseases resulted from the absorption of toxic gases and the toxic effects of lead absorption.

In order to raise the awareness of those working in the industry and those involved or living close to LAB service centers or ULAB collection sites it is essential to implement a capacity building program, including a “train the trainer” module as a key factor for distributing technical knowledge from the central office to Municipal/Provincial Departments, including local communities.

2.2 Disposal and Recycling in Different Areas of the Country

The survey in designated areas substantiated that ULAB are not disposed of in public open areas or at dump sites because they still have some value, albeit small. The consumers sell their ULAB to waste collectors or scavengers, who operate in all urban and rural areas to collect ULAB. Generally, ULAB that are collected in this way are sold to local/central merchants for a low price, based on their capacity. These ULAB are either smelted locally by local/central merchants or exported for recycling, depending on the price in the regional markets.

There is no report that pinpoints the location of ULAB recycling in Cambodia or identifies a common methodology dealing with ULAB recycling. Among the four designated survey areas, the Task Team has only seen one small scale site that recycles ULAB in Battambang Province. ULAB recycling at the site in Battambang Province uses a crude old methodology without any environmental pollution control systems. Not surprisingly, residue occurring from this recycling process is being disposed improperly on the ground adjacent to the operational site, and of course, this disposal practice causes soil/water source pollution and has also killed some adjacent plants.

2.3 Waste Management and Environmental Protection

In the process of LAB recharging, apart from the liquid electrolyte[4] that is spilt on the ground or into some form of receptacle, there are no other major wastes to be seen in the operational areas. However, as mentioned above, the ULAB recycling in Battambang Province has shown many negative aspects as follows:

- The location of the site for ULAB recycling and its unsound practices is on open ground close to residential areas and villages.

- The smells associated with the gaseous acid fumes arising from the ULAB recycling process causes harmful effects to the local communities. This negative aspect of the operation was a source of complaint by communities and some of them were taken up and resolved by the local authority and government institutions.

- Residue management is generally not in compliance with any environmentally sound practice.

Significantly, up to now the lack of any residue disposal practice still persists and seems to attract less attention[5] from those involved and government institutions. Furthermore, a specific Regulation or Directive targeting ULAB management and recycling does not existed, and unfortunately, the environmental and health protection afforded under existing legislation is not being implemented. Based on these conclusions, the Ministry of the Environment (MoE), in cooperation with other concerned institutions should be promoting public awareness and capacity building for local populations as well as preparing particular legal instruments aimed at improving current ULAB management.

2.4 Occupational Health Practices and Policies

As stated above, occupational practices for LAB recharging, servicing or ULAB recycling are commonly inadequate and place the health of workers at risk. Workers behave in a way that ignores the use of safety equipment, and noticeably, they have never considered or been concerned with the adverse health impacts resulted from the way they operate, eat, drink or smoke when at work.

In every day practice, workers or those people involved in the industry do not use safety equipment during their normal operations. However, at least 20 percent of workers and those people involved in the industry recognized some negative consequences which are caused directly or indirectly by related LAB/ULAB occupations. This evidence has shown that the awareness and knowledge of workers and those people involved in the industry toward the negative health impacts is still very limited.

To promote good occupational health practices; a transparent policy together with a sound regulatory framework and specific guidelines for ULAB management should be developed in a scientific manner that mitigates and eliminates the serious potential risks and hazards to the environment and public health. To achieve this task, there is an urgent need to establish a National Policy for ULAB management and recycling. The future National Policy should:

- Identify the environmental and human health impacts based on the analysis of collected data and information.

[4] Dilute Sulfuric acid
[5] Environmental and health impacts

- Protect the environment and promote sustainability through legislation that secures sound ULAB recovery operations, defines responsibilities and accountability, surveillance and enforcement.

- Institutional arrangements and social participation, including the formation of administrative systems, public participation and information, stakeholder involvement, a role for the private sector and non-government organizations and voluntary initiatives.

- Building and strengthening the capacity of staff in the various Government institutions that are involved with LAB/ULAB management, and any agency that reports to the SBC/UNEP as required.

- To achieve these aims it is essential that a National Action Plan is devised and agreed by all interested parties.

3.0 MACRO-ECONOMIC AND LEAGL CHARACTERISTICS

3.1 Battery –Related National Supply and Demand

The number of ULAB generated annually for recycling and the numbers imported and exported in Cambodia were estimated through a desktop study that collected data from the Government agencies such as: Ministry of the Environment; Department of Customs, Ministry of Economics and Finance; Ministry of Commerce; and Ministry of Public Works and Transport.

The quantities of ULABs generated and recycled annually were calculated from the following data:

- Motor vehicles licensed annually;
- New and foreign used vehicles licensed annually;
- Average lifetime of automobile batteries – locally based data; and
- Year when battery was last changed.

3.2 Results of the Desktop Study

The data obtained from the Ministry of Public Works and Transport is shown in Table 1 below.

Table 1: Vehicles Licensed in Cambodia

Year	Type of Vehicle Licensed	No. of Vehicles(No. of Batteries per vehicle)	Total No. of batteries
1999	Truck	857 (1)	857
	Trailer	32 (1)×	32
	Omnibus	56 (2)+	112
	Minibus	56 (2)+	1008
	Car	8,072 (1)	8,072
	Motorcycle	20,147 (1)	5037◆
Total		**30,172**	**15,118**
2000	Truck	636 (1)	636
	Trailer	2 (1)	2
	Omnibus	39 (2)	78
	Minibus	657(1)	657
	Car	7,894 (1)	7,894
	Motorcycle	24,796 (1)	6199◆
Total		**34,024**	**15,466**
2001	Truck	626 (1)	626
	Trailer Omnibus	3 (1)× 71(2)+	3 142
	Minibus	593 (1)	593
	Car	6,117 (1)	6,117
	Motorcycle	43,690 (1)	10,923✸
Total		**51,100**	**18,404**

× One battery is used
+ Two batteries are used
◆ 1 motorcycle battery = 0.25 mass of typical automotive battery

✸ 1 motorcycle battery = 0.25 mass of typical automotive battery

2002	Truck	1,189 (1)	1,189
	Trailer	81 (1)	81
	Omnibus	182 (2)	364
	Minibus	903 (1)	903
	Car	7,510 (1)	7,510
	Motorcycle	16,956 (1)	4,239*
Total		**26,821**	**14,286**

3.2.1 Estimate of Number of ULAB Recycled in Cambodia Annually

The total number of ULAB estimated to be recycled annually is calculated as following:

Based on data obtained from the survey of local populations on:

(i) Average lifetime of automobile batteries by user – 1 year for cars

(ii) Last year of change of battery by vehicle – Approximately 50% of registered vehicles replace the batteries every year

The estimated total batteries to be recycled per annum including as follows:

a) In the year 1999:

Estimated number of batteries available for recycling: 0,5 x 15,118 = 7,559 units

At an average of 51 wt.% Pb (as metallic lead plus Pb compounds) per battery, each battery is 11,5 kg, so total lead content for recycling is 44,333 kg

b) In year 2000:

Estimated number of batteries for recycling: 0,5 x 15,466= 7,733 units

At an average of 51wt.% Pb (as metallic lead plus Pb compounds) per battery, each battery is 11,5 kg, so total lead content for recycling is 45,354 kg

c) In year 2001:

Estimated number of batteries for recycling: 0,5 x 18,404 = 9,202 units

At an average of 51wt.% Pb (as metallic lead plus Pb compounds) per battery, each battery is 11,5 kg, so total lead content for recycling is 53,969 kg

d) In year 2002:

Estimated number of batteries for recycling: 0,5 x 14,286 = 7,143 units

At an average of 51wt.% Pb (as metallic lead plus Pb compounds) per battery, each battery is 11,5 kg, so total lead content for recycling is 41,894 kg

3.2.2 Imports and exports of Lead, Acid and Battery into Cambodia

The import of lead, acid and batteries is the responsibility of the Department of Customs and Exercises, the Ministries of Economics and Finance in cooperation with the Kamcontrol Department, the Ministry of Commerce. Generally, the Lead, Acid and Batteries are imported from Vietnam, Thailand, Japan, South Korea, Malaysia, etc. Until now, there was no data available in the Country for the export of Lead, Acid and Batteries, only import data which could be obtained from the Department of Customs. The Lead, Acid and Batteries are only imported for domestic use and this has dramatically increased as shown in table 2 below:

Table 2: Import of Lead, Acid and Batteries

Item / Year	Lead (t)	Acid (L)	Battery(t)
2000	10,930	139,276	5,289,627
2001	110	1,999,770	4,663,883
2002	2,000	1,808,067	3,122,493
2003	10,109	965,280	4,126,590
Total	**23,148**	**4,912,393**	**17,202,593**

Source: Dept. of Customs and Exercises

3.3 Results of the Field Study

3.3.1 Battery Retail Shops

According to the information obtained from the questionnaires during the survey conducted in the remote and downtown areas of the different provinces and cities that covered 25 shops and 60 workers, the following data has been collated:

Table 3: Source – Survey of Battery Retailer Shops

1	Source of imported ULAB	37% from Japan, 33% from Thailand 18% from South Korea 12% from Vietnam and other country
2.	Number of battery sales: 1 to 5 6 to10 11 to 20 21 to 50	 63% 27% 9% 1%
3.	Collection of Used batteries at the retail outlets	2%
4.	Storage of Used lead acid batteries at the retail outlets - In paved area - At soil floor	 98% 2%
5.	Transportation of used batteries collected at retail outlets to recyclers - By hand cart - By bicycle	 40% 35%

	- By motorcycle - Others	15% 10%
6.	Batteries drained of electrolyte prior to transportation	60%
7.	Reconditioning of used batteries	2%
8.	Number of employees 1 to 2 3 to 5	 60% 40%
9. 10.	Age and service profiles 18 to 35 36 to 60 Hours of work - Less than 8 hours - More than 8 hours	 70% 30% 40% 60%
11	Personnel issued with special clothing - Glove - Masks - Goggles	 10% 10% 0%
12.	Eating and process areas segregated	95%
13.	Eating areas free of lead dust	95%
14.	Employees washing prior to eating	70%
15.	Workers understanding the risks of lead exposure	0 %
16.	Learnt about lead contamination from ULAB somewhere	0%
17. 18.	Attended a health awareness class about lead Understand about the effects of lead exposure on the: a) Environment; atmosphere, water, soil, eco-systems b) Population	0% 3% 3%
19.	Dealing with ULAB - Selling to scavengers - Burning - Recycling	 90% 9% 1%
20.	In your opinion, how should the problem of lead contamination from ULAB be solved - Wearing protective equipment - Do not know	 20% 80%
21.	Do you know of any lead contamination awareness programs run by any Governmental Institutions	0%
22.	Awareness of any incentive programs for returning used batteries for recycling.	0%
23.	Comments or suggestions for the Government Environmental Agencies that would help promote a sustainable environmentally sound and socio-economically acceptable solution to the recycling of ULAB - Workshop or Training on ULAB - Publicity about recycling ULAB	 90% 90%

3.3.2 Battery Recharging and Reconditioning

The majority of houses use the lead acid batteries for lighting, TV and so on, instead of the utility electrical supply due to its unreliability, especially in the remote areas of each province and town in the country. This usage has resulted in the number of battery recharging shops generally increasing from year to year. Unfortunately, the exact number of battery recharging shops is not available because an inventory has never been done before. In addition, a minority of recharging shops also engages in reconditioning the ULAB. However, that aspect of business has declined dramatically because most batteries cannot be repaired economically and the quality of a reconditioned battery is not very good. There is little data available about the reconditioning shops because the financial support was insufficient to focus on this sector, but they are included in the overall ULAB inventory. The information obtained perform the questionnaires during the survey conducted in the remote and downtown areas of the different provinces and cities from 30 shops and 40 workers gave the following data:

Table 4: Source – Survey of Battery Recharging and Reconditioning Shops

1	Used batteries collected at the recharging shops	5%
2	Used lead acid batteries stored at the recharging shops - On a paved area - On the soil floor	20% 80%
3	Used batteries collected at a recharging shop and transported to a collection site - By hand cart - By bicycle - By motorcycle - Others	 37% 40% 15% 8%
4	Batteries drained of electrolyte prior to transportation	70%
5	Reconditioning of used batteries	5%
6	Hours of work - Less than 8 hours - More than 8 hours	 40% 60%
7 8	Personnel issued with special clothing - Gloves - Masks - Goggles Eating and process areas segregated	 10% 15% 0% 50%
9	Eating areas free of lead dust	70%
10	Employees washing prior to eating	40%
11	Workers understanding the risks of lead exposure	0%
12	Learnt about lead contamination from ULAB in somewhere	0%
13	Attended a health awareness class about lead	0%
14	Awareness of the effects of lead exposure on the: - Environment; atmosphere, water, soil, eco-systems - Population	2% 5%
15 16	Contact with Lead Acid Batteries - Daily - 2-3 day per week Dealing with your ULAB and why - Selling to scavenger - Recycling - Burning	 95% 5% 95% 10% 2%

17	In your opinion, how should the problem of lead contamination from ULAB be solved - Wearing protective equipment - Do not know	 90% 10%
18	Do you know of any lead contamination awareness programs run by any Governmental Institutions.	0%
19	Awareness of any incentive programs for returning used batteries for recycling.	0%
20	Comments or suggestions for the Government Environmental Agencies that would help promote a sustainable environmentally sound and socio-economically acceptable solution to the recycling of ULAB - Workshop or Training on ULAB - Publicity to promote recycling of ULAB	 90% 90%

3.3.3 Recyclable Waste Collection Site

The information obtained perform the questionnaires during the survey conducted in the remote and downtown areas of the different provinces and cities, from 15 collecting sites with 150 workers in shown below in Table 5:

Table 5: Source – Survey of Used Lead Acid Battery Collection Sites

1	Used batteries collection at the waste collection site	100%
2	Used lead acid battery storage at the waste collection site - On a paved area - On the soil floor	 5% 95%
3	Used batteries collected at the collection site and transported to recyclers - By Truck - Others	 97% 3%
4	Batteries drained of electrolyte prior to transportation	98%
5	Hours of work - Less than 8 hours - More than 8 hours	 20% 80%
6	Personnel issued with special clothing - Gloves - Masks - Goggles	 60% 25% 0%
7	Eating and process areas segregated	70%
8	Eating areas free of lead dust	70%
9	Employees washing prior to eating	30%
10	Workers understanding the risks of lead exposure	0%
11	Learnt about lead contamination from ULAB somewhere	0%
12	Attended a health awareness class about lead	0%
13	Awareness of the effects of lead exposure on the: - Environment; atmosphere, water, soil, eco-systems - Population	 1% 3%
14	Contact with Lead Acid Batteries - Daily - 2-3 day per week	 80% 20%

15	Dealing with your used ULAB and why - Selling to scavenger - Recycling - Burning	 96% 1% 3%
16	In your opinion, how should the problem of lead contamination from ULAB be solved - Wearing protective equipment - Do not know	 70% 30%
17	Do you know of any lead contamination awareness programs run by any Governmental Institutions	0%
18	Awareness of any incentive programs for returning used batteries for recycling	0%
19	Comments or suggestions for the Government Environmental Agencies that would help promote a sustainable environmentally sound and socio-economically acceptable solution to the recycling of ULAB - Workshop or Training on ULAB - Publicity for the recycling of ULAB	 90% 90%

3.3.4 Recycling Operation

The information obtained from the questionnaires during the survey conducted at the recycling sites with 5 workers gave the following data shown in the table 6:

<u>Table 6</u>: Source – Survey of Used Lead Acid Battery Recycling Operation

1	Used lead acid batteries stored at the Recycling sites - On a paved area - On the soil floor	 1% 99%
2	Used batteries collected at the Recycling site transported to recyclers - By Truck - Others	 90% 10%
3 4	Batteries drained of electrolyte prior to transportation Hours of work - Less than 8 hours - More than 8 hours	75% 30% 70%
5	Personnel issued with special clothing - Gloves - Masks - Goggles	 20% 10% 0%
6	Eating and process areas segregated	70%
7	Eating areas free of lead dust	50%
8	Employees washing prior to eating	80%
9	Workers understanding the risks of lead exposure	0%
10	Learnt about lead contamination from ULAB somewhere	0%
11	Attended a health awareness class about lead	0%
12	Awareness of the effects of lead exposure on the: - - - Environment; atmosphere, water, soil, eco-systems - Population	 2% 3%

13	Contact with Lead Acid Batteries - Daily - 2-3 day per week	90% 10%
14	Dealing with your used ULAB and why - Recyc ling	100%
15 `16	In your opinion, how should the problem of lead contamination from ULAB be solved - Wearing protective equipment - Do not know Do you knowing of any lead contamination awareness programs run by any Governmental Institutions	 50% 50% 0%
17	Awareness of any incentive programs for returning used batteries for recycling.	0%
18	Comments or suggestions for the Government Environmental Agencies that would help promote a sustainable environmentally sound and socio-economically a cceptable solution to the recycling of ULAB - Workshop or Training on ULAB - Publicity for recycling ULAB	 90% 90%

3.4.4 Legal and Regulation Framework

Currently, the environmental laws and related sub-decrees already entered into force for the protection of human health and the environment, such as the Sub-decree on solid waste and hazardous substances and the Management and Sub-decree on Water Pollution Control, which were approved in 1999 by the Council of Ministers. However, these are not specific to Used Lead Acid Battery management, and they do not control the transboundary movement of ULAB. More importantly, the Basel Guidelines on the collection, storage, transportation, recycling and disposal of ULAB has not been introduced in any of the cities and provinces in the country, despite that fact that the Royal Government has accepted the Guidelines as a Party to the Convention.

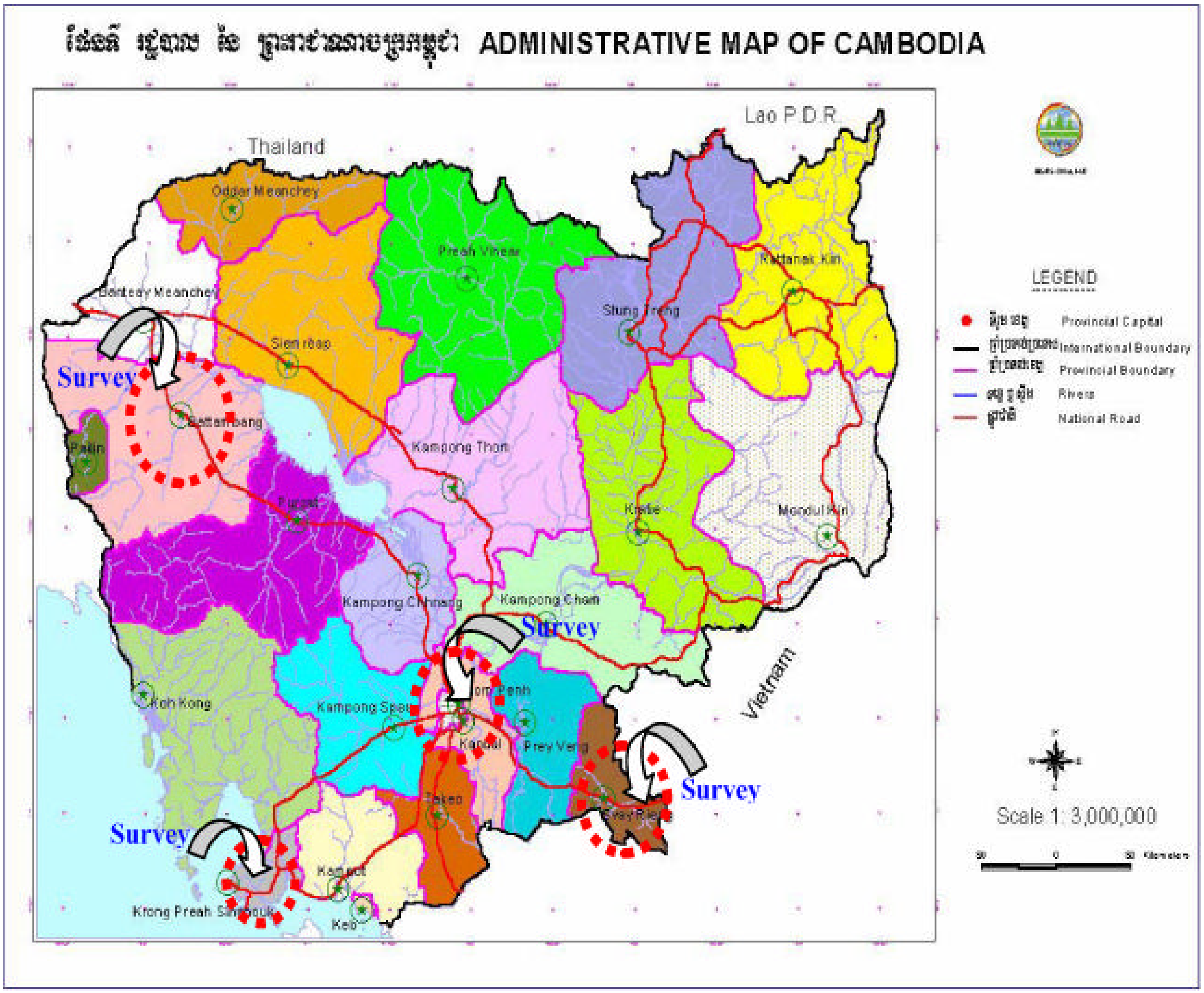
The matter of responsibility for the health and safety of the workers who are exposed to ULAB has to be resolved. Should it be the Ministry of Health or one of the other ministries concerned with ULAB? It is unclear where the responsibility lies and this is further compounded in the absence of occupational health monitoring and any specific laws or regulations on the safety of handling ULAB.

4.0 SELLING, RECHARGING AND RECONDITIONING, COLLECTION AND STORAGE, TRANSPORT AND RECYCLING PRACTICES FOR ULAB IN THE KINGDOM OF CAMBODIA

In this phase, all the data and information for the study were obtained through visits to both Government institutions and private sectors as indicated below:

- Ministry of the Environment;
- Provincial Environmental Departments;
- Battery Recharging, Collecting and Recycling Sites;
- Automobile Parts/ Battery Sales Outlets;
- Solar Energy Power Supply Company;
- Telecommunications Company;
- Provisional Authorities; and
- Public school

Picture 1: The Kingdom of Cambodia showing the Survey Areas



The findings of the study of this phase are summarized below:

4.1 Battery sales outlets

25 small automotive battery retail outlets were visited in the remote and downtown areas of Battambang Province, Svay Rieng Province, Sihanouk Ville and Phnom Penh. Generally, shops are selling new lead acid batteries for trucks, cars, motor cycles and domestic use (burglar alarms, back up systems, and so on).

Picture 2: Typical view of a battery shop in a remote and a downtown area

Each shop had a stock of 100 to 400 new and boxed lead acid batteries imported from Vietnam, Japan, Korea and Thailand. Some battery components are made by local people in Cambodia and these can be seen in picture No. 2. All the batteries on sale were good quality and branded names. The majority of the batteries appeared to be made with the latest maintenance free (MF) technology using lead/calcium alloys grids. Sales varied, but on average, the shops would expect to sell from 10 to 20 batteries per day in the downtown areas and 1- 5 in the remote areas of the provinces.

Picture 3: Lead plates and battery boxes for new LAB

Generally, shops did not take in ULAB in exchange for new battery sales and the customer was expected to take the ULAB with him or her when they left the shop. In the event that a ULAB was left on the premises, it would be removed by one of the many scavengers. At present, ULAB are not returned to sales outlets because there is no incentive for the buyer and there is limited storage place at the shops.

Picture 4: Battery spares and the acid used for topping up a new battery

The shops also service batteries, that is, the staff will test a battery to determine whether it needs to be replaced, topped up with deionized water or recharged. Many batteries in use still require the caps to be removed when being charged to permit the gases given off to escape to atmosphere. In some instances during charging the electrolyte can spill out of the top of the battery as the electrolyte “bubbles” fiercely. In these instances, and when batteries are being topped up, the owner had built a small bunded area to place the batteries in when being serviced to prevent spillage onto the paved area outside the shop. Usually, the shops had sufficient recharging units for about 20 batteries.

a) Environmental Impacts

It was the downtown retail shops with battery charging units that seemed to have the most acid spillage and caused bad smells as gases generated during charging escaped to atmosphere. The small bunded area designed to place the batteries when being serviced were contaminated by damaged batteries, but the premises were generally clean and tidy. It was clear that any acid spillage had been washed directly to the public drainage and sanitation system or allowed to percolate into the groundwater and channeled into the canal without any treatment contaminating the water (see picture 5).

Picture 5: The battery acid is allowed to run into the public drainage system

b) Occupational Health:

Generally, staff was not wearing gloves, goggles or masks testing or charging procedures or when the battery electrolyte was being prepared from the concentrated acid, despite the fact that the owner and the staff were aware of the risks of skin burns caused by the battery acid. None of the workers at the shop ever wore safety goggles and none are aware of the hazards associated with occupational lead exposure.

c) Recommendation for short - term improvement

Problems had been identified in the battery retail shops and improvements need to be made in order to prevent the damage to human health and the environment caused by ULAB. The recommendations are:

- Most of the staff, including the owner of the retailing shop has a lack of knowledge of the potential problems caused by the battery acid and the threat posed by lead to human health and the environment. Therefore, in the short term a training course on the safe handling and management of ULAB, including the risks of adverse health effects could help them prevent health problems and environmental damage.

- The public awareness about the hazards associated with ULAB and the benefits of recycling them in an environmentally sound manner is very weak, especially among the people living in the remote areas who are using LAB only at their home instead of the electricity. A health protection publicity program about ULAB though the media such as the TV, radio and so on, would really help to improve understanding and awareness and go a long way to reduce the risks of any harm to human health and the environment.

4.2 Recharging and Reconditioning of ULAB

30 battery recharging shops located in remote and downtown areas of Battambang Province, Svay Rieng Province, Sihanoukville and Phnom Penh were visited during the survey. These shops were engaged in servicing and reconditioning batteries and collecting ULAB for resale to the waste recyclers.

Picture 6: Typical a battery recharging shops in the downtown and remote areas

At present, ULAB collection is not a good business because the battery users are selling ULAB directly to the scavengers who will always come to their home to collect any ULAB. Generally, there are only 1 or 2 ULAB that can be bought from battery users every 2 to 3 months. There is only a small minority of shops reconditioning the ULAB, because the users prefer to sell the ULAB to a scavenger than pay for reconditioning. The battery charging aspect of the business has been declining in the downtown areas due to the increasing number of homes with a direct and reliable supply of electricity. On other hand, it had been increasing dramatically in the remote areas due to the increasing number of TVs, domestic lighting and other demands such as catching fish by electrocution and rat catching in the rice fields.

Forty to one hundred 12 volt automotive batteries are charged in series daily in the remote areas (see picture 7). Usually, a diesel generator is used to produce a DC current to recharge the batteries, especially in the remote areas, and this takes about 5 to 8 hours depending on number of batteries to recharge, the types and sizes. Normally battery acid consumption, to top up the electrolyte, is about 10 to 60 liters per month. Once recharged, a battery should normally last for 3 days, sometimes 5 days depending on the recharging technique, the demand on the battery, and the battery's age and quality.

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Picture 7: Batteries are charged in series

a) Environmental Impacts

In the remote areas, the recharging shop areas were mostly under a thatched or zinc roof and open on all four sides, although some premises were under cover, especially those that doubled as the family home where everyone eat together and the children played in and around the charging zone. The floor was the natural soil or wooden decking which allowed the acid to spill easily onto the ground through the gaps and holes between the slats. (See picture 8)

Picture 8: The battery acid is easily spilled onto the ground

It was easy to see that the soil around the shops was contaminated by acid spillage and leaks that have occurred during the recharging processes. Some battery acid had been poured into tanks or some other suitable plastic container and stored for reuse (see picture 9), but in most cases the acid drips and leaks onto the ground and finds its way into a drainage ditch near the shops.

Picture 9: Battery acid in containers and drums under a bed inside the house for reuse

In the downtown areas, the recharging shops are mostly to be found under the paved area of a block of flats. It was noticed that in some cases battery acid spillage drains directly to the public drainage system and that can result in contamination.

b) Occupational Health:

It is very important to wear personal protective equipment (PPE), such as gloves, goggles and masks, during the recharging process, due to the health risks posed by the safety hazards. Unfortunately, workers said that they found it inconvenience to wear PPE (see picture 10). Some workers had never worn PPE, but some just wear it when the battery acid bubbles due to a lack of understanding of personal safety (see picture 11). Interestingly, all the battery recharging workers, and some of those living close to recharging sites, recognized by themselves that there are increasing difficulties associated with skin burns and breathing problems. Furthermore, there is now a real concern among the task team because health and safety monitoring has never been carried out at battery charging and service centers.

Picture 10: No gloves, goggles or mask

Picture 11: Only a mask was worn

c) Recommendation for Short - Term Improvements

To resolve the main problems that affect all battery recharging workers and those living close to battery recharging shops throughout the country, the following steps are recommended to reduce health risks and threats to the environment:

- A training course on the Safe Battery Recharging Procedures and Sound Management of ULAB would minimize the suffering caused to workers by poor manual handling of the ULAB throughout the country.

- The dissemination of information to the public about ULAB hazards through media such as TV, Radio and newspapers would help them to understand the health and environmental risks and initiate actions to preventing the adverse effects caused by poor management of ULAB.

4.3 ULAB Collection and Storage Sites

15 of largest collection sites for recyclable wastes including ULAB were visited in the remote and downtown areas of Battambang Province, Svay Rieng Province, Sihanoukville and Phnom Penh Municipality. Most of the collection

sites were constructed on a plot with the soil as the floor or base, except for just a few sites that were constructed on paved areas.

Picture 12: View of typical recyclable waste collection sites

ULAB are collected by scavengers from small ULAB collection sites in various districts of the provinces and from local users. Usually, the scrap yard owner has his own collection network for ULAB all over the province and in many cases the neighboring province. The ULAB are transported by hand cart, bicycle, motorcycle and small truck to a recyclable waste collecting site. (See picture 13)

Picture 13: Vehicles and Bicycles are used to transport ULAB to the Recyclers

All ULAB are sold to merchants in Phnom Penh and then resold to dealers abroad for recycling. Before selling the ULAB they are stored in a secure room or compound together with other piles of recyclable waste. (See picture 14)

Picture 14: ULAB Secure Compound and Storeroom

Usually, scavengers drain the acid from the battery before selling it to the owner of the collection site because battery acid is not purchased. Most of the scavengers drain the electrolyte from the battery at the point of purchase to lighten the transport load, but some of them brought the whole ULAB with electrolyte to the owner asking him to drain the acid from the battery because the scavenger had not found a suitable place to drain it themselves.

a) Environmental Impacts

Generally, before selling the ULAB they are stored in a secure room or compound together with other piles of recyclable waste. Sometimes batteries were seen to be stored inside houses and on one occasion in a bedroom and under a bed. (See Picture 15).

Picture 15: The ULAB are stored inside the house and in the bedroom

The floor of the room or compound is just soil that could easily be contaminated by spillage of battery acid. (See picture 16).

Picture 16: Acid spillage on soil and paved floor storerooms

Battery acid drained directly into the ground, then found its way to a ditch and finally the public drainage and sanitation system, resulting in water contamination (see picture 17). There was no attempt to keep it in a tank or a container at the collection site. One of the most noticeable side effects of this poor practice was a bad odor in the storage room and around the premises.

Picture 17: Battery acid drained into the ground at the collection sites

b) Occupational Health:

Workers were not wearing any gloves, goggles or masks when handling ULAB, except for a few scavengers and an owner who was working on other waste materials (see picture 18). Such behavior is particularly disappointing because in one case, the owner and the workers were aware of the risks of skin burns caused by the battery acid and still did not wear gloves, but no one seems to be aware of the hazards associated with occupational lead exposure. Furthermore, the workers had never heard about any educational programs related to the management of ULAB introduced by the relevant governmental agencies or NGOs.

Picture 18: Some scavengers were wearing masks or gloves, but others were not

c) Recommendations for Short - Term Improvements

Many problems were identified and they need to be resolved immediately in order to protect the adverse effects caused by ULAB to human health and the environment.

- The careless storage of ULAB and electrolyte shows that workers, including the owners of the ULAB collection sites, are not aware of the hazards associated with the ULAB. Therefore, a training course on safety management and correct transportation procedures of ULAB would help them to minimize the risks that are posed by ULAB.

- The Basel Convention's International Guidelines for the Environmentally Sound Management of ULAB and the Convention's Regulations for the transboundary movement of hazardous waste are not in place. Furthermore, neither the Convention's regulations or the ULAB guidelines have ever been introduced to the people involved with ULAB. Therefore, the dissemination of the Basel Convention regulations for the transboundary movement of ULAB and its ULAB Guidelines would be very helpful to them and help to protect their health and eliminate the potential environmental damage caused by the illicit movement of ULAB.

4.4 Recycling Site

Only one small scale ULAB recycling enterprise was found and visited. It is located in Thmor Koul District, Battambang Province, at the north of the country approximately 300 km from Phnom Penh and built on a plot of land. This unit has been operating since 1999. For the first three years, this enterprise only milled plastics, including ULAB cases that were bought from other scavengers, but for the last two years the enterprise has been recovering the lead from ULAB (see picture 19). All the ULAB are transported from the recyclable waste collection site to the enterprise in an open vehicle.

Picture 19: The plastics milling machine

Picture 20: Ingots from the lead melter

The red caps and the white or black battery cases are separated from the plates at another site outside the enterprise and are milled separately (see picture 21). The scrap plastic is sold in Phnom Penh and then sold on in Vietnam and sometimes, depending on the prevailing price; it has been sold directly to Thailand for recycling. The price of scrap plastic varies. White and red scrap is more expensive than black plastic scrap (see picture 22).

Picture 21: Battery case separation site

Picture 22: Battery case scrap and caps

The recycling enterprise still has two separate lead smelting sites not located on the plot with the milling machine. The first one is a plot (60 x 100) surrounded by rice fields and about 8 km from the enterprise and 2 km from populated areas.

Picture 23: Views of the first and second lead melting sites

The ULAB breaking operation is manual. The lead bearing waste was placed on the ground near the smelting furnace (see picture 24). The battery cases are sent to the milling machine and the remainders, such as the plate separators, are put into a pile for incineration (see picture 25).

Picture 24: Battery cases after breaking

Picture 25: Battery separators after burning

The lead bearing waste is melted in the open and without any form of ventilation or extraction using a small crude melting furnace made from a length of metal tube about 1 m long and 0.4 m in diameter (see pictures 26 and 27). Charcoal is added to the leaded scrap as it is charged to the melting furnace in order to encourage reduction of some of the battery paste (lead oxide) to produce metallic lead (lead bullion).

This technique is crude, but is the basis of "smelting" where the "reducing" agents are mixed with the leaded scrap to produce metallic lead. Adding the charcoal does raise the level of lead recovery from the scrap battery contents.

Picture 26: Crude smelting furnace

Picture 27: The metal tube

After the first melting operation had been shut down temporarily, due to the complaints made by people living and working close to the operation, the melting furnace was moved to another site about 2 km from the first one and this is located at a small empty elevated plot of land surrounded by a vast rice field.

The lead output and the operating procedures were the same, but the battery breaking process was still carried out at the first smelting site. Right now, the second melting site would seem to be secure for the owner because nobody has complained yet.

a) Environmental Impacts

The environmental conditions at the enterprise and around the plot were not good due to a bad smell from the milling process and the piles of battery cases containing acid (see picture 28).

Picture 28: Bad smell at the enterprise

Picture 29: Contaminated soil

The breaking process area is under a corrugated zinc roofed hut open on all four sides. The floor is earth that is contaminated by spillage of the battery contents including the acid during the battery breaking process (see picture 29).

There are two big compounds close to the lead melting site with rubbish and waste burning in the open on the plot.(see picture 30). Ground and surface water either flows from the melting site into both compounds or the rice field during the rainy season. There were plenty of fish in the ponds and the fish are eaten by local people and the owner of the melter. Sometimes the water from the ponds has been drunk by the local people and used for irrigating farmland.

Picture 30: The two compounds near the melting furnace site

Furthermore, not only was a green tree close to the site becoming a white color and about to die, there were no wild animals present and a part of the thick metal furnace tube were also seriously corroded as pictures 31 and 32 show.

Picture 31: The corroded furnace tube

Picture 32: The green tree is now white

b) Occupational Health Practices:

The workers at the sites were working without gloves, goggles or masks during the separating and milling processes, although they had been issued with both gloves and masks, but for some reason, were not wearing them (see picture 33).

Picture 33: No gloves, goggles or mask

Picture 34: Palm burned by battery acid

Most of them were aware of the risks of burns to the skin caused by battery acid, but no one was aware of the hazards associated with occupational lead exposure. For instance, the ULAB breaking operation is manual and the workers were not wearing gloves, goggles or masks, resulting, not unexpectedly, in the palms of the hands visibly burned by the battery acid (see picture 34). The local people maintained they suffered from frequent headaches, found it very difficult to breath at night and there was a bad smell from the site. The workers not only suffered burns to the palms of the hands, but often had headaches, chest pains and breathing difficulties. Health monitoring, particularly blood lead monitoring is never done by the enterprise and it would appear that nobody takes responsibility for occupational health at the enterprise.

c) Retail and Collection of discarded batteries:

Only around 180 MT of ULAB are collected and taken to the enterprise annually for recycling. All the rest are collected and transported illegally to Vietnam or Thailand for recycling.

d) Recommendations for Short - Term Improvements

Several severe problems have been identified in the lead melting site that need to be resolved immediately in order to stop the threats to human life and the environment:

- The workers and neighbors are affected by lead and acid, therefore a temporary shut down of the lead melting site would be the best solution to eliminate the potential risks to the human health and the environment.
- Serious safety and health training is needed to educate ULAB melter staff in order to help them protect their heath and the environment.
- A training course for the Sound Management of ULAB is essential for local government officials. The course must include the obligations required of Cambodia under the terms of the Basel Convention for the transboundary movement of hazardous waste and the Guidelines for the ESM of ULAB.

4.5 Solar Energy Power Supply

Solar energy Remote Area Power Supply units (RAPS) have only recently been introduced in Cambodia due to the cost of the equipment. Consequently, only a few RAPS units have been installed by local people. Mostly they have only been installed with government assistance or through international organizations or NGO aid programs at public schools, parks, municipal buildings and bridges (picture 35).

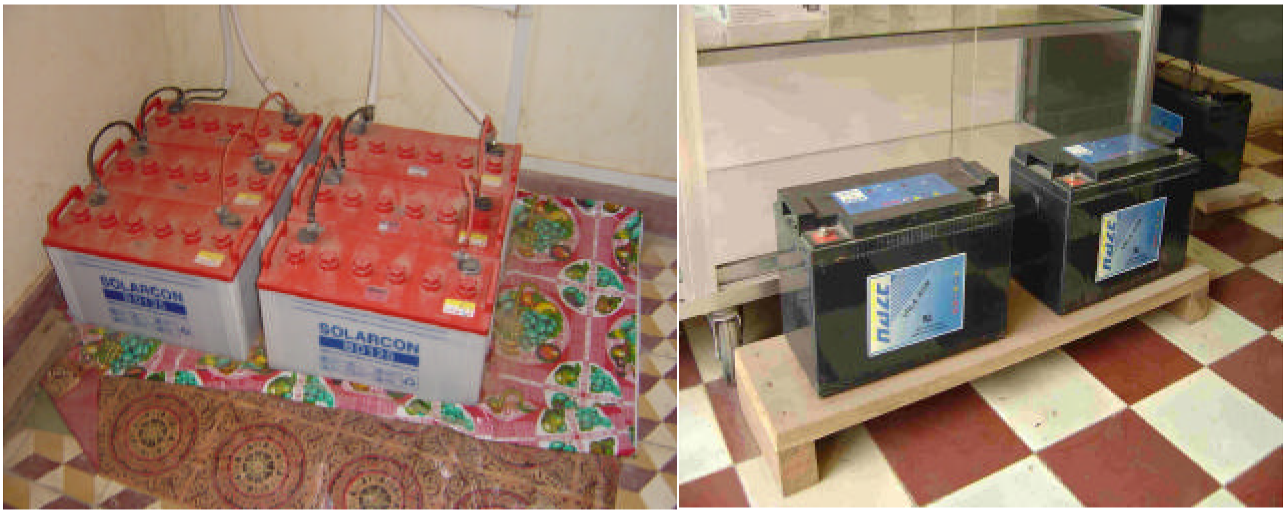
Picture 35: RAPS installed at a public school in Svay Rieng province

The RAPS consists of solar panels that convert sunlight into electrical power to charge specially designed deep discharge lead acid batteries. Generally, these batteries are used to provide AC electrical power for lighting, TVs, computers and IT equipment in place of the mains electrical supply when it is unavailable. Most of the deep discharge lead acid batteries are good branded names from Germany and Japan (picture 36). To date, around 10,000 such batteries have been imported into Cambodia by local private companies. These batteries are 50A, 70A, 100A, 120A and 200A and normally have an average life from 10 to 15 years, but in Cambodia its useful life is only 7 years only due to the hot climate.

Picture 36: Type of Deep discharge lead acid battery

*a) **Environmental Impacts:***

Normally, deep discharge lead acid batteries are stored in a secure room with ventilation controls. The floor of such a room is paved to prevent any spillage of battery acid damaging the surface or seeping into the ground (see picture 37). At the school in Svay Rieng province, it was noticeable that the storage room is clean and there was no acrid or foul smell.



Picture 37: Battery storeroom

b) Occupational Health:

Visibly, the deep discharge lead acid battery looks a good quality that could be used longer without frequently repair. Certainly, there was no evidence to the contrary. In addition, the people interviewed at places with RAPS are mostly well educated, and aware of the risks of skin burns caused by the battery acid and the hazards associated with occupational lead exposure. Furthermore, those who have to maintain and check the RAPS units are advised about the risks and trained regularly on ULAB handling.

c) Recommendation for short - term improvement

Currently, the management of ULAB is not perceived to be a problem, however some improvements need to be made as follows:

- In the past, cooperation between the MoE and Companies has not been that close, resulting in a lack of ULAB data detailing the amount of ULAB collected, transported and disposed of. If such information was recorded in the annual report that each company submits to the MoE it would help them to improve the knowledge base and decisions can then be made to improve the environmentally sound management of ULAB.

- The Basel convention regulations and the Basel Guidelines relating to ULAB have never been introduced to the Solar Energy Company; therefore the dissemination of the regulations by the MoE for the transboundary movement of ULAB using the practices outlined in the guidelines would be very useful to them and should help to protect human health and the environment.

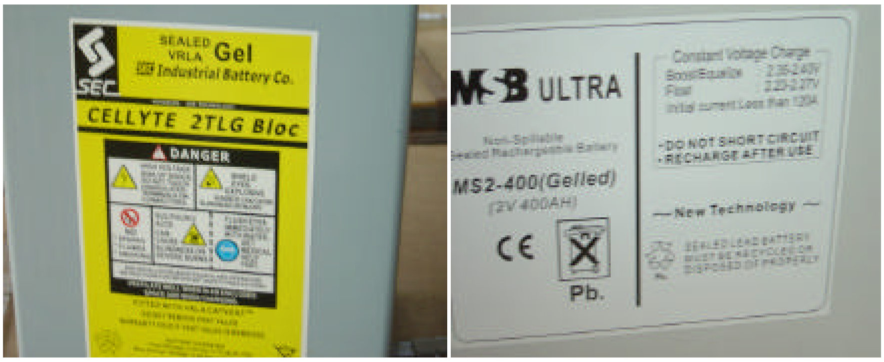
4.6 Telecom Company

Three of the major telecom companies, namely, Samart, Mobiltel and Camshin, were visited by the Team. Each company is using lead acid batteries and converters to produce the AC electrical power for phone operations. The number of stations and batteries are shown in the Table 1.

Table 1: Number of Stations and Batteries

Item	Number of stations	Number of batteries
Samart	132	3,69
Mobitel	200	5,760
Camshin	300	3,000

Noticeably, most of the batteries are branded names from Germany, Japan and Malaysia (picture 38).



Picture 38: Valve Regulated Gelled Batteries

a) Environmental Impacts

Environmental conditions are good. The Lead acid batteries are stored in secured places in the stations far away from populated areas. The floors of the rooms are paved to minimize spillage damage and contamination. The storages rooms are clean and there are no bad odors (picture 39).

Picture 39: Battery Storeroom

b) ***Occupational Health:***

Generally, employees were working carefully with the LAB using the protective equipment. Furthermore, they had been trained to handle LAB and ULAB safely.

c) ***Recommendation for short - term improvement***

Currently, the management of ULAB is not perceived to be a problem, however some improvements need to be made as follows:

- In the past, cooperation between the MoE and Companies has not been that close, resulting in a lack of ULAB data detailing the amount of ULAB collected, transported and disposed of. If such information was recorded in the annual report that each company submits to the MoE it would help them to improve the knowledge base and decisions can then be made to improve the environmentally sound management of ULAB.

- The Basel convention regulations and the Basel Guidelines relating to ULAB have never been introduced to the Telecoms company, therefore the dissemination of the regulations by the MoE for the transboundary movement of ULAB using the practices outlined in the guidelines would be very useful to them and should help to protect human health and the environment.

5.0 CONCLUSION AND RECOMMENDATIONS FOR A NATIONAL PLAN OF ACTION

The desk-top study and the field surveys clearly identify that the main problem areas associated with the environmentally sound management of ULAB are recharging, collecting and legitimate transport to the recycling plants. An isolated example of a "backyard" smelting operation could indicate that there may be others, but that is probably unlikely as the export trade in UALB is a thriving operation. These problems are exacerbated because of the inadequate knowledge and understanding of the people working in the sector of the potential health risks to themselves and the environment damage caused by the battery acid. The workers lack of understanding means that they have adopted poor safety operating practices when handling the lead acid batteries and none of the people involved in exporting the ULAB to Vietnam or Thailand follow the correct legal procedures or international conventions.

In order to protect and prevent risks to human health and damage to the environment caused by used lead acid batteries. The recommendations are:

1. Training courses on the Environmentally Sound Management of ULAB to be conducted in all provinces throughout the country. These courses must include information about the potentially harmful effects of the battery acid and the lead contained in the batteries to human health and the environment. There must also be an explanation of the proper handling procedures and recycling practices for ULAB. The prioritized participants are all those people who work in the ULAB sector.

2. The introduction of the Basel Guidelines for ULAB, including collection, storage, transport and recycling procedures. These should be undertaken by the Ministry of the Environment in consultation with other concerned Ministries.

3. The control procedures for the transboundary movement of hazardous waste, that is an obligation for Cambodia under the Basel Convention should be adopted immediately to control the export and disposal of ULAB. This can be included during the training courses on ULAB Management, conducted in all provinces throughout the country or through interactive media by the Ministry of the Environment.

4. The occupational health and environmental standards for recharging, collecting, transporting and ULAB recycling operations should be developed in collaboration with all stakeholders in order to protect the health and safety of workers as well as the general public.

5. The owners of retail outlets play an important role in a deposit system that can provide the incentive necessary for the return of ULAB, but, this system can only be implemented and succeed through a governmental sponsored initiative with public support and participation.

6. Due to the increasing volume of soil and water contaminated accumulated from year to year and caused by acid spillage at retails outlets, recharging stations, collection centers and ULAB recycling plants, some measures should be taken to introduce a used acid collection system in order to stop or at least minimize the risks and hazards to human health and environment.

In order to implement and achieve these recommendations, institutional and financial support is required, otherwise the problems posed by ULAB are unlikely to be resolved in the Kingdom of Cambodia.