Good Practice Guide

For the separate collection and management of batteries and accumulators

Life "Green Batteries" Project

PROJECT BENEFICIARY:
REGION OF CRETE

PARTNERS:
NATIONAL AND KAPODISTRIAL UNIVERSITY OF ATHENS
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1 The problem of managing batteries and accumulators

Since 1780, when Alessandro Cont di Volta constructed the first battery, until today, the progress in the development and use of batteries and accumulators was exponential, following the general technological progress and the need for energy storage. The use of batteries is today so extended, that it would be almost impossible to imagine our every day life without them. A vast number of devices and applications such as mobile phones, watches, cars and motor bikes, children toys, laptops, palmtops and tv remote controls, need batteries or accumulators for their operation. According to their use and type, batteries and accumulators can be divided in a number of categories.

1.1 Types of batteries and accumulators

Batteries can be divided in two basic categories, according to their use:

Primary batteries (single use- non rechargeable)

- zinc
- alkaline
- button alkaline
- silver-zinc
- button zinc – air
- lithium ion

Primary batteries are usually batteries intended for household use, with applications in a large number of devices such as watches, remote controls, etc.

Secondary batteries (rechargeable)

- nickel - cadmium
- NiMH (Nickel metal Hydride)
- Lithium
- Lithium-Ion Polymer
- Alkaline rechargeable
- Titanium
- Lead SLI (starting, lighting, ignition – motor vehicle accumulators)
- Lead traction (electric vehicles)
- Lead stationary (UPS, generators)
- Nickel-Iron (Ni-I)
- Nickel-Zinc (Ni-Z)

In general, the categorization of batteries is a complicated task, leading to difficulties in the quantification of collection and management data. Small batteries include batteries and accumulators used mainly in household devices, such as watches, toys, mobile phones, etc. These batteries do not include car accumulators and accumulators for industrial use.

In Greece, at a practical level during the recent years, batteries and accumulators are categorized according to their weight. Therefore, batteries and accumulators with a weight <1.5 kg are classified as "small batteries", while the ones with a larger weight mainly include car and industrial use accumulators.

1.2 Impacts on human health from batteries and accumulators

Though batteries are very useful in our every day life, nevertheless they can cause significant impacts if they are not managed properly after the end of their life cycle. Batteries and accumulators contain certain chemical substances which can cause severe impacts on human health, when these are managed in a non controlled manner. Accumulators contain substances with corrosive properties (sulphuric acid), as also lead and other heavy metals, while small batteries, such as nickel cadmium and mercury batteries, also contain heavy metals.

Discarding batteries in the household waste stream increases the toxicity levels of the landfills, because of the heavy metals contained in the batteries. Heavy metals can pollute the underground water table, the soil and the water, leading to their penetration in the food chain, thus directly affecting human health (poisoning, carcinogenesis, eye problems, etc). Such impacts are also caused by the discarding of batteries and accumulators in uncontrolled spaces or in water receptors.

Therefore, it is the responsibility of the State, the local authorities, the business community and of the consumers to assure the environmentally sound management of our batteries, thus protecting our environment and health.

The following table presents the main impacts and symptoms caused to human health by exposure to certain heavy metals.

	Mercury	Cadmium	Lead
Exposure:	Through inhaling, swallowing and skin	Mainly through swallowing (food chain) but also through inhaling	Through inhaling, swallowing and contact
Absorption and accumulation:	In all human organs, including the brain and nervous system, liver and kidneys.	Mainly in kidneys, liver, bones and thyroid gland	Mainly in the kidneys
Symptoms:	Nervous irritation, impacts on vision and hearing, movement disorder, anorexia, vomit, lung diseases	Causing of serious diseases - carcinogenesis	Kidney problems, brain damages, severe impacts on children (learning difficulties, nervous behavior) and on pregnant women.

2 EU and national legislation on batteries and accumulators

Knowledge on the basic principles and provisions of EU and national legislation regarding batteries constitutes the necessary prerequisite for the efficient design and implementation of any individual or collective alternative management system for spent batteries. It has to be stressed here that environmental legislation today is mainly developed firstly at an EU level, through the adoption of Directives, Regulations and Decisions. Member States are further given a time limit in order to harmonize their national legislation with the relevant EU provisions. Regarding the management of spent batteries, specific Directives have been adopted, which are presented below, and which have been already transposed in the Greek legal order. Greek legislation is today fully harmonized with the relevant EU provisions on this subject.

2.1 EU legislation

Council Directive 91/157/EEC of 18 March 1991 on batteries and accumulators containing certain dangerous substances *(EE L 78 of 26.3.1991)* constitutes the first EU legislative intervention on the issue of the management of spent batteries and accumulators. The Directive provides that, starting from 1st January 1993, member states shall prohibit the marketing of:

- alkaline manganese batteries for prolonged use in extreme conditions containing more than 0,05 % of mercury by weight,
- all other alkaline manganese batteries containing more than 0,025 % of mercury by weight

Also, according to the Directive, Member States shall draw up programmes in order to achieve the following objectives:

- reduction of the heavy-metal content of batteries and accumulators,
- promotion of marketing of batteries and accumulators containing smaller quantities of dangerous substances and/or less polluting substances,
- gradual reduction, in household waste, of spent batteries and accumulators covered by Annex I,
- promotion of research aimed at reducing the dangerous-substance content and favouring the use of less polluting substitute substances in batteries and accumulators, and research into methods of recycling,
- separate disposal of spent batteries and accumulators covered by Annex I.

Within the framework of the aforementioned programs, Member States take the necessary measures aiming at the separate collection of batteries and accumulators with a view to their recovery and ultimate disposal.

In 1993, **Commission Directive 93/86/EEC** of 4 October 1993 was adopted, adapting to technical progress Council Directive 91/157/EEC on batteries and accumulators containing certain dangerous substances *(OJ L 264, 23.10.1993, p. 51-52)*. The Directive provided for detailed arrangements for the marking system concerning batteries and accumulators.

Finally, in 1998, **Directive 98/101/EC** provided for even stricter standards, imposing that, as of 1 January 2000, Member States shall prohibit the marketing of batteries and accumulators containing more than 0.0005% of mercury by weight. The same applies to appliances incorporating such batteries and accumulators.

2.2 National legislation

Law **2939/2001** (OJ 159 A), with the title **"Packaging and Alternative Management of Packaging and of other Products - Foundation of the National Organization for the Alternative Management of Packaging and Other Products (EOEDSAP) and other provisions"** provides, inter alia, for the management of batteries and accumulators. Article 17 of the Law provides that alternative management systems of batteries and accumulators have to be organized by the responsible parties, and also empowers for the adoption of a Presidential Decree, which will contain detailed provisions regarding the alternative collection and management of batteries and accumulators.

In 2004 the **Presidential Decree 115/2004 (OJ 80A/2004)** was issued, with the title "Replacement of the Joint Ministerial Decision (JMD) 73537/1438/1995 "Management of batteries and accumulators containing certain hazardous substances" (OJ B 781) and JMD 19817/2000 "Amendment of JMD 73537/1995" (OJ B963). " Measures, conditions and programs for the alternative management of used batteries and accumulators", transposing the provisions of the relevant EU Directives in the national legal order.

According to the aforementioned Law, the polluter pays principle is applied, fact which means that specific obligations are imposed to the producers and importers of various products, including batteries and accumulators.

The **general principles** for the alternative management of batteries and accumulators are the following:

- Prevention of waste from the management of batteries and accumulators
- Recovery – recycling
- The polluter pays principle
- The principle of joint responsibility of all parties involved in the batteries and accumulators marketing chain
- The principle of public information towards users and consumers
- The non discrimination principle of batteries and accumulators

Furthermore, it has to be stressed, that the implementation of the Presidential Decree affects the following **stakeholders**:

- The producers of batteries and accumulators
- The importers of batteries and accumulators
- Those who place batteries and accumulators in the market
- The recyclers of spent batteries and accumulators
- The local authorities
- The end users / consumers
- The public authorities
- Those who perform alternative management activities, meaning collection, transportation, temporary storage and recycling activities of spent batteries and accumulators

The Presidential Decree is applicable to all batteries and accumulators placed in the market and to all spent batteries and accumulators, imposing further quantitative targets concerning collection and recycling, specific obligations for importers and producers, as also the terms and conditions for the development of alternative management programs.

The targets set by the Presidential Decree are:

- By the 31st of December 2006 at least 30% by weight of all used batteries must be collected. This target has to be separately achieved for batteries containing more than 5 ppm of mercury.

- By the 31st of December 2006 at least 70% by weight of all used industrial and vehicle accumulators must be collected. This target has to be achieved separately for the accumulators containing cadmium.
- By the 31st of December 2006 at least 80% by weight of the collected batteries has to be recycled.
- By the 31st of December 2006 at least 80% by weight of the collected accumulators must be recycled.

According to the Presidential Decree, the producers, importers and recyclers of batteries and accumulators are obliged either to organize an **individual alternative management system** or to participate in a – licensed – **collective management system**. For the organization and operation of each individual or collective management system an administrative license is required, which is issued by EOEDSAP.

Participation in a collective management system also requires the deposit by the producer or importer of a specific fee, paid by him to the system. The producer or importer, through this payment and participation to the system, is relieved from his legislative obligations according to the Law, and can therefore mark his products with the official marking of the system.
According to the provisions of the Presidential Decree, collection, temporary storage, transportation and disposal of used batteries and accumulators together with household waste is prohibited.
Separate collection of spent batteries and accumulators is **mandatory** and shall be performed:

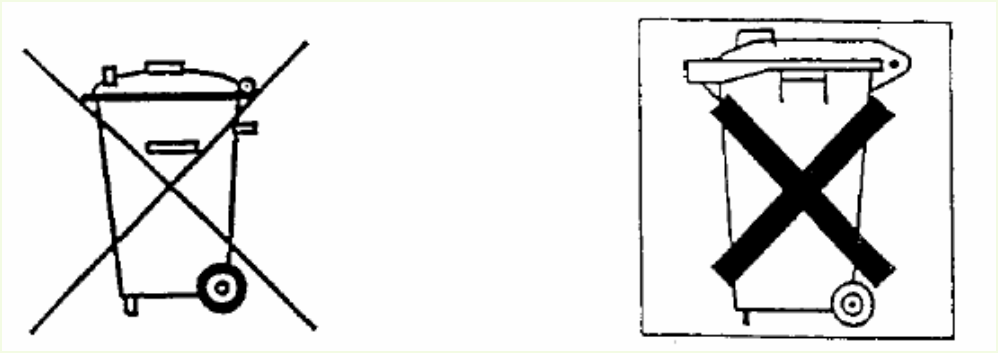
- For spent batteries, in special bins which have to be installed in municipal collection points, decided by the alternative management systems in cooperation with the local authorities, or at the selling points (shops, super markets, etc).
- For spent car accumulators, at the temporary storage bin located at the stores which have a license for selling and replacing of car accumulators.

The systems are obliged to cooperate with licensed collection companies, which perform alternative management activities (collection, transportation, temporary storage), and these companies have to deliver the collected batteries and accumulators to licensed recycling companies.

Finally, the Presidential Decree imposes obligations concerning the **marking of batteries and accumulators.** Batteries, accumulators, and, where applicable, devices which contain them, can be placed on the market only if they are properly marked.

The marking makes reference to the following:

1) To the separate collection and shall consist of one of the roll out containers crossed through, as shown below:



2) The heavy metal content. The symbol indicating the heavy-metal content shall consist of the chemical symbol for the metal concerned, Hg, Cd or Pb according to the type of battery or accumulator concerned
3) Possibly, the official logo of the system.

3 Management practices and models in EU Member States

The recycling of batteries and accumulators constitutes a challenge for all EU member states. In this Guide, the recycling programs operating in three EU countries are presented, namely:

UK
NETHERLANDS
ITALY

3.1. United Kingdom

MANAGEMENT OF BATTERIES

Country	United Kingdom
Recycling system	**REBAT**: Rebat stands for **RE**cycling **BA**tteries. The collection scheme was created to enable the British Government to satisfy the requirements of directive 91/157.
Types of batteries	The rechargeable battery types that REBAT collects are Nickel Cadmium, Nickel Metal Hydride and Lithium-Ion Batteries
Recycling rates	**Not available**
National Legislation	Statutory Instrument 232, 2/2/94.
Legal status of the organization	REBAT is an initiative managed by the British Battery Manufacturers Association (BBMA) to encourage collection of nickel cadmium batteries in the UK, as required under the EU legislation. The support of industry was requested, and the International Cadmium Association (ICdA) acted as secretariat. The main requirements of the UK/EC battery legislation include: ▪ Take appropriate steps to ensure that spent NiCds are collected separately with a view to their recovery and to the gradual reduction in household waste ▪ Ensure that NiCds and, where appropriate, appliances into which they are incorporated are marked in the appropriate manner. The marking must include indications as to the following points: separate collection; where appropriate, recycling; the heavy-metal content ▪ NiCds cannot be incorporated into appliances unless they can be readily removed, when spent, by the consumer.
Activities	**Collection:** A number of waste management companies collect NiCd in the UK. Following a competitive tendering process in the UK REBAT selected G&P Batteries as its recommended operator to manage the collection of batteries. G&P Batteries is the largest collector of waste non-lead acid batteries in the UK. The company is fully licensed to handle all types of non lead acid batteries, both rechargeable and single-use. The company is also able to supply collection bins, collect, consolidate and transport batteries to the recyclers. There is a range of individual collection schemes in the UK. When someone in the UK wants to dispose a NiCd battery responsibly, he can seek guidance either from the distributor where the battery was purchased, or the battery manufacturer or the appliance manufacturer. **Recycling:** There are no UK recycling facilities for portable rechargeable batteries. The batteries collected in the UK are shipped to France for recycling by S.N.A.M Loddon holdings Ltd is the handling agent for S.N.A.M. The company is licensed for the transportation of a range of battery types including - Nickel Cadmium (Ni-Cd),Nickel Metalhidryde (Ni-Mh), Lithium Ion (Li-Io) and Lead Acid batteries, that S.N.A.M. is specialized for processing. The company holds the following licenses:

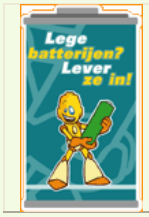
	– Special Waste Transfer Station Licence No: EH111/111a. – Special Waste Carriers Licence No: HAM408362.
Financial data : income – outcome	There is a free market base approach established in the UK. REBAT is activated as an administrative authority, setting in fact the rules and the competences of the market. A payment of a nominal sum is required for the membership to the group (REBAT) in order to cover the cost of meetings, administration, etc. The collection / delivery charges are based on the gross weight of the consignment. Charges vary depending on the cost of recovering the metals against the actual quantities recovered.
Dissemination activities	REBAT has advised its collection targets to the UK's Department of Trade & Industry who then communicated these to the European Commission.

Management of Accumulators

Country	United Kingdom
Recycling system	Free market
Recycling rates	estimated greater than 90%
Legal status of the organization	There is no organization. The system already in place achieves collection rates estimated at over 90%. This has been described as "a working but fragmented collection system, which can and does have weaknesses, particularly when the market value of lead is low" as in 1993, when the collection rate fell below an estimated 80%. There was then support from the lead industry to introduce a more formal collection system in order to ensure high collection rates even when the market price of lead is low. A further difficulty now faced in Britain is that UK Waste Regulations now require documentation and a fee to be paid for battery movement (£10 for 5 or more batteries): therefore, some small scrap dealers have stopped collecting batteries. The effect of this on overall recycling rates is not known. Even when the collection rate is over 90%, considered high by most, with an annual consumption of 100,000 tn of lead in batteries in the UK, this would mean that up to 10,000 tn of lead from this source is unaccounted for per annum. However, rather than being disposed of, most of this shortfall is believed to be stored in private garages etc., and should eventually enter the recycling system. There is clearly room for improvement. An organised collection scheme could improve return rates, though such a scheme would entail administration costs.
Activities	Spent batteries are usually returned to garages or suppliers of new batteries, or they are separated from waste at municipal dumps and from there returned to scrap merchants who sell them to lead smelters. It was deemed unnecessary to implement a formal system of battery collection: the only change in law was to require labelling. There are several companies dealing with the collection of used batteries. For example G&P batteries Ltd. operates the UK's largest nation-wide scrap lead acid battery collection service.
Financial data: income - outcome	There is no ecotax or surcharge. There is a tax connected to disposal to the dump. The income totally depends on L.M.E (London Metal Exchange). Economic instruments, such as a levy on batteries produced, could ensure that a reasonable price can be paid for scrap lead, even at times of low lead price on the world market; this fact would also be expected to improve collection rates. The lead industry would eagerly welcome any such development, because at times of low lead price, secondary production is not profitable (can even operate at a loss) and there can be shortages of spent batteries available.
Dissemination activities	No dissemination activities

3.2. Netherlands

MANAGEMENT OF BATTERIES AND ACCUMULATORS

Country	Netherlands
Recycling system	 ***Stichting Batterijen*** **(STIBAT)** was formed to enable Dutch battery manufacturers and importers to fulfil their legal obligation to collect and recycle spent batteries.
Recycling rates	The collection rate for 2001 came up to 70%. This rate seems to be stabilized in this level during the last years.
Types of batteries	Small batteries (responsible for collecting and recycling batteries that weigh up to one kilogram)
National legislation	Battery Decree 1993/1995
Legal status of the organization	Stibat executes a joint collection and processing plan on behalf of battery manufacturers and importers. When companies join the Stibat Plan, they comply thereby with the Batteries Disposal Decree of January 31, 1995, which holds them responsible for recovering batteries they market once they are spent. After the first Stibat Plan (1995-1998), the Stibat Implementation Plan II (1998-2003) was approved by the Minister of the Environment in 1999. The approval of that plan stipulates that 90% of all spent batteries must be collected separately in 2003. A new method for estimating the collection rate has also been approved. This method was developed co-operatively by Stibat, the National Institute for Public Health and the Environment (RIVM) and the Ministry of the Environment.
Activities	**Collection.** The collection is performed by municipalities and schools. More specifically, Dutch municipalities are responsible for separate collection of small chemical waste (scw), including batteries. There are several different collection systems in place, according to reports from the municipalities. In some towns, inhabitants can use a "green box", others have a "chemocar", and in others, the inhabitants bring their batteries to the municipal scw depot. Stibat also provides extra collection sites within town limits, to supplement municipal systems. Retail is also a significant supplementary collection channel for spent batteries in the Netherlands. At many supermarkets, photo shops, toy stores, department stores, telephone and electronics stores, do-it-yourself stores and household appliance stores, customers can drop off their spent batteries. Also, many elementary schools collect batteries. Even recreation facilities, such as campgrounds and bungalow parks, are becoming more and more environmentally conscious and are offering their guests places where they can drop off spent batteries. The batteries are picked up by Stibat approved contractors. These collectors pick up spent batteries from all Dutch municipalities, and store them temporarily in their depots. They conduct a preliminary inspection, pack the batteries in special plastic bins, and bring them to the central national depot which is also Stibat's sorting station.

	Sorting. All batteries that are collected by the municipalities are brought to Stibat's national depot, where the total Dutch battery intake weight is measured and recorded, and the batteries are pre-sorted based on their type and size to facilitate further processing. Sorting divides the batteries into several streams, the largest of which (about 60% of all batteries collected) is cylindrical consumer batteries (AAA's, AA's, C's and D's). These cylindrical batteries are further sorted by chemical type, such as: alkaline batteries, alkaline UV (lead-free), zinc carbon batteries, nickel cadmium /nickel metal hydride batteries, and mercury oxide batteries. These separate, pure battery streams meet the acceptance criteria of the specialized processors. The remaining battery streams are car batteries, electric fence batteries, batteries with soldered connections, rechargeable packs, batteries from Polaroid-type cameras, button cells in blister packs, battery-containing objects, and batteries that are contaminated. All these batteries are sorted visually according to their chemical composition so they can be transferred to specialized (mainly foreign) processing facilities where they are recycled. **Transportation to processing facilities.** All the batteries that were sorted at the sorting station are eventually shipped to specialized processing facilities in Western Europe, which recover the metals from the batteries. **Recovering of raw materials.** All the collected spent batteries are recycled at a number of different processing plants in Western Europe. For example, zinc carbon batteries are processed by Nedstaal in the Netherlands. Lead-containing batteries go to the Belgian company Campine in Beerse. The nickel metal hydride, nickel cadmium and lithium ion batteries (which are all rechargeable batteries), are processed at the French company SNAM in Lyon. Button cells are processed by the Swiss company Batrec. The following metals are recovered through recycling: zinc, steel, nickel, cadmium, lead and manganese. The remaining slag is used in asphalt road construction.
Financial data: income - outcome	**Income.** Stibat's income originates from the disposal fees paid by each participant. The fee is a set amount for each battery type. Strict monitoring is used to ensure that the fees are sufficient, and that a balance between costs and income is achieved. **Expenses.** The expenses Stibat incurs in efficient implementation of the Stibat Plan consist mainly of transport, sorting, and processing costs. Another source of expense is the public awareness campaigns that aim to increase the collection rate.
Dissemination activities	**"Empty batteries? Bring them in!"** is the motto for the national campaign that Stibat conducts year-round. The goal of the campaign is to continually motivate the public to drop off their spent batteries, both because this reminder is needed, and in order to inform people about where they can bring-in their batteries. Television and radio commercials have been run, text advertisements have been placed in many newspapers, magazines and newsletters, and posters have been hung in tram and bus stops, subway and train stations. Additionally Stibat develops a variety of community programs, such as recreation, school, retail and public awareness programs.

3.3 Italy

MANAGEMENT OF ACCUMULATORS

COUNTRY	ITALY
Recycling system	**Organized formal recycling system** **COBAT**
Recycling rates	above 95%
Legal status of the organization	COBAT is an association founded on the model of the public/private partnership: the public sector exercising the function of policy and control, the private sector entrusted with management. It has been instituted by Law (*COBAT, The "Official Recycling Association for Spent Lead Batteries and Lead Waste" is a non profit-organization instituted under Law 475/1988; its articles of association were approved by a Decree of the Ministry for the Environment and Industry published 16th May 1990).* The board of directors includes representatives from the Ministry of Industry and Environment. The Association currently includes: Recycling companies, Battery Manufacturers, Collection and scrap companies and Installers. According to the Law *"anyone in possession of spent lead batteries or lead waste is required to hand these over to COBAT either directly or by delivering them to agencies appointed by the Association"* *A modification of this law has been performed during the last years because there was an accusation that this law is against the principles of free market.*
Activities	COBAT collects spent lead batteries and transports them to its own recycling sites, where the sulphuric acid is neutralized and the lead metal recovered. The main steps followed are: ***Collection*** : vehicles with a capacity between 3.5 and 16 tons, ***Transportation*** : vehicles with capacity equal to or in excess of 28 tones ***Battery processing*** : 6 treatment plants
Financial data: income - outcome	• Income from a surcharge applied to the price of new batteries by manufacturers and importers and paid directly to the Association, which can then be recovered from each successive purchaser in the chain of distribution and ultimately from the end user. The fee on each battery ensures that the activity of collecting and recycling can be carried on in any trading conditions, irrespective of movements in the price of lead on international markets. Each year, with a specific decree, the Departments of the Environment, Industry, Commerce and Crafts define the amount, on the basis of the total number of new batteries produced and sold, as well as lead quotations on the L.M.E. • Income from the sale of spent batteries to recycling companies.
Dissemination activities	• institutional communication, aimed to publicize COBAT, its mission and the results obtained • environmental education addressing schools and young people and directed to promote new generations' awareness on ecological problems connected to industrial development • tailored communication directed towards specific users' categories with a higher risk of waste dispersion in the environment

4 LIFE Pilot Project: current situation and outcomes

4.1 Aims of the Project

The LIFE Green Batteries project, co funded by the EU Program LIFE ENVIRONMENT started in October 2002, aiming at the design and implementation of pilot separate collection and recycling system of batteries in Crete.
The separate collection and recycling system concerned two spent batteries streams, namely:

- Small batteries
- Car accumulators

In order to design this system, the annual quantities of batteries handled had to be estimated and the present situation regarding the management of spent batteries had to be analyzed. This data, as also the outcomes of the pilot project are presented below.

4.2 Accumulators

4.2.1 Current situation regarding the management of accumulators in Crete

Accumulators in Crete are mainly handled by electricians, car service stations, spare parts shops, vertical units dealing with car selling and repairing and also by gas stations.

The estimation of the total annual quantity of accumulators discarded in Crete was based on the following:

- Quantity of accumulators imported in Greece as a whole
- Number of vehicles circulating in Crete
- Inventory which was performed regarding all electricians and importers dealing with the replacement of car accumulators in Crete.

According to the aforementioned data, it was estimated that the quantity of car accumulators sold annually in Crete reaches a number of **1800 tn/year.**

The collection of accumulators was performed until recently mainly by scrap collectors on an isolated and not controlled basis, without having the relevant licenses. The accumulators' collection system was actually based on the high price of lead, fact which constituted the collection and reselling of used accumulators to factories dealing with the production of lead a profitable business. Nevertheless, because of the fact that the price of lead is not stable, considerable problems were encountered at times when the price of lead was particularly low, and therefore the lead recycling companies would pay low prices to buy used accumulators. During these time periods, scrap collectors stopped their collection, thus leading to the excessive storage of accumulators at the car service stations (in many cases in outdoor places) or to their uncontrolled discarding. The management of accumulators constitutes a very fragile market, involving various - and many times conflicting – interests of the stakeholders involved (car service stations, electricians, recycling companies, collectors). Considerable complaints were expressed by most companies dealing with the replacement of accumulators regarding the non-regular collection of the accumulators, which led to the excessive storage of accumulators at their store.

4.2.2 Design, foundation and aim of the alternative management system for accumulators

Already, during the third year of the implementation of the LIFE GREEN BATTERIES project, a national system for the management of accumulators was licensed by the competent authorities according to the new legislation. At the same time, given the will of the local stakeholders and authorities for the development of a regional management system, the stakeholders, authorities and partners of the project decided to design and develop a local collection and management system for accumulators, which would collect and recycle the quantities of accumulators handled in Crete, thus fully covering the existing deficiency for the management of such waste in the island.

So, in the framework of the LIFE GREEN BATTERIES project, the alternative management system of accumulators in Crete was designed, founded and licensed, currently operating as an LTD. company with the name "SEDIS-K – Collective System for the Alternative Management of Accumulators in Crete".

The aim of this collective alternative management system is the management of used accumulators in the island of Crete.
The importers of accumulators who merchandise accumulators in Crete as also one recycler participate in this alternative management system (SEDIS-K). Currently, eleven companies which import or recycle accumulators are shareholders in SEDIS-K, while more than 150 companies and professionals have signed declarations for their cooperation with SEDIS-K.

In detail, the aims of the SEDIS-K System are:

- The environmentally sound management of used accumulators in Crete according to the provisions of the relevant national and EU legislation.
- The compliance of the importers of accumulators in Crete with the provisions of the aforementioned Presidential Decree, according to which, the manufacturers, importers and recyclers of accumulators are obliged either to organize individual alternative management systems or to participate in collective alternative management systems.
- The information of the public and of the stakeholders involved in the accumulators' handling chain, regarding the problems and impacts arising from the uncontrolled discarding of these waste.
- Monitoring and control of the discarding of used accumulators in Crete.
- The collection and temporary storage of lead-acid accumulators in accordance to the national and EU legislation in force.

The specific target of the system is the achievement of the quantitative targets set by the Presidential Decree, regarding the quantities of accumulators handled in Crete by the Accumulator Importers of Crete.

4.3 Small batteries

4.3.1 Handling of small batteries in Crete

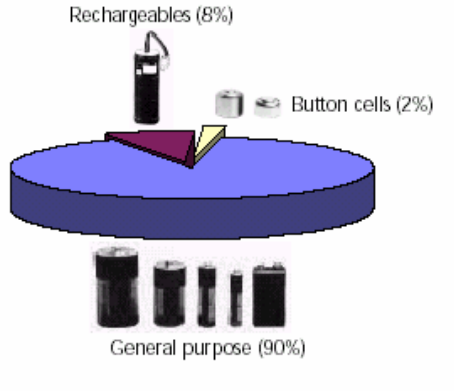
The production of batteries in Greece presents a considerable reduction during the last decade, mainly due to the severe competition by other countries. The Greek production of manganese batteries is very low, while the nickel-cadmium batteries and lithium batteries consumed in Greece originate almost exclusively from imports.

As far as the consumption of small batteries is concerned, the Greek market demonstrates an increasing trend in the consumption of nickel-cadmium and lithium batteries as also of small lead accumulators, while at the same time, mercury batteries tend to extinct.

Within the framework of the LIFE GREEN BATTERIES project, an assessment of the quantities of batteries discarded in Crete was performed, using a variety of methods, in order to obtain reliable and comparable results.
Data was collected on the basis of:

- Estimations of various organizations, such as associations of importers and recyclers of batteries, etc.
- Use of appropriate indicators based on data provided by the National Statistical Service of Greece.
- Use of questionnaires which were distributed in schools.

According to these data, the quantities of small batteries (including batteries and accumulators with weight less than 1.5 kg) sold in Crete in 2005 are estimated at around 190 tn, while the number of small batteries discarded annually reaches 9 batteries per year per family.



Market of batteries in Europe (source EPBA)

4.3.2 Collection and management of small batteries

Concerning the management of batteries, until recently, because of the fact that the operation of units dealing with the recycling of batteries was not viable, the development of a collection system anticipated a number of problems, thus not allowing the formulation of an organized collection system for batteries. During the years 2002 – 2004, isolated attempts took place, mainly by super markets and companies selling batteries, putting special collection bins at their stores.

At the same time, essential legislative changes took place, with the adoption of Law 2939/2001 "Packaging and Alternative Management of Packaging and of other Products – Foundation of the National Organization for the Alternative Management of Packaging and Other Products (EOEDSAP) and other provisions" which applies to packaging and to other special waste streams (batteries, accumulators, waste oils, and voluminous materials) and especially with the adoption of the Presidential Decree 115/2004 regarding measures, conditions and program for the alternative management of used batteries and accumulators.

According to the Packaging Law, the Polluter Pays Principle is fully applicable, which means that specific requirements and obligations are imposed on the producers and importers of various products, including batteries and accumulators. With the application of this legislative framework, the collection and recycling of batteries does not depend any more on the potential viability of the recycling system, but constitutes a direct obligation for the producers and importers of these products.

4.3.3 Foundation and cooperation with the alternative management system for small batteries

Within this framework of legislative obligations, the Association of Producers and Agents of Batteries in Greece has developed a licensed alternative management system under the name of "AFIS S.A."

The LIFE GREEN BATERRIES project partners came in touch from the first moment with the Association of Producers and Agents of Batteries in Greece, organizing a number of meetings and discussions, aiming to the design and development of collection and recycling system for small batteries in Greece. After the foundation of AFIS, a permanent cooperation was established between AFIS and the project partners in order to achieve the common goal, which is the effective collection and recycling of the small batteries.

4.4 Outcomes from the implementation of the pilot project

4.4.1 Data concerning the operation of the pilot project for accumulators

In the framework of the LIFE project, an inventory of **226** companies dealing with car accumulators was performed. These companies included accumulator importers, electricians, car engineers, vertical units selling and repairing cars and gas stations. All stakeholders were informed on the aims of the LIFE GREEN BATTERIES project, and, aiming at the development of an integrated management system for accumulators in Crete, **SEDIS-K** was founded, with the participation and cooperation of all stakeholders involved.

During the implementation of the pilot project **195** pallet boxes were distributed to companies dealing with car accumulators in the whole region of Crete. The categorization of these companies per Prefecture is shown in Table 4.1., while the dispersion of the companies in Crete is shown in Table 4.2. At the majority of the collection points one bin was distributed, with a few exceptions where 2 bins were installed. As shown in Table 4.2, 67% of the collection points is located in the 5 larger cities, namely Chania, Irakleion, Rethymno, Ierapetra and Agios Nikolaos. The remaining companies and collection points are dispersed in 35 different cities and villages throughout Crete, where in each of these places there is usually one such company operating. The division of the companies according to the type of their activities is presented in Table 4.3. The largest amount of companies participating in the program is the electrician shops, while the largest quantities are handled by the companies dealing with the import and merchandise of accumulators.

Table 4.1. Number of companies participating in the program per Prefecture

Prefecture	Number of companies
Herakleion	103
Chania	44
Rethymno	13
Lasithi	34

Table 4.2. Percentage of companies per city participating in the program

City	Percentage of companies %
Irakleion	37
Chania	16
Ierapetra	6
Rethymno	5
Agios Nikolaos	4
Siteia	4
Kissamos	3
Tympaki	2

Table 4.3. Number of companies per type of activity

Type of company	Number
Electricians	84
Car service stations	27
Merchandise of spare parts, motor oils, tires, etc.	31
Gas stations, car wash	25
Importers – resellers of accumulators	11
Vertical units	5
Other companies	8

The distribution of the bins started in 2005 and finished in 2006. The collection of the accumulators is performed by the appropriate truck, which possesses a pallet box and an electronic balance. The quantity of accumulators collected since October 2005 reaches the amount of **86 tons**. This quantity was collected from 55 collection points, and the mean quantity collected per point during this time period reaches 1.7 tons. Of course, the quantities collected vary significantly according to the specific collection point. The largest quantity (57%) was collected from the Herakleion area.

The main outcomes that can be derived from the operation of the pilot system are:

- The greatest number of collection points is located in large cities, where the collection cost remains low. Nevertheless, there is a significant number of collection points which demonstrate a wide geographical dispersion in the Crete region, thus resulting to considerable difficulties in the collection of accumulators from distant areas, with the existence of 35 different collection points where only one or two electrician companies are located.
- Nevertheless, collection of accumulators from every possible point where accumulators are replaced is imperative, in order to incorporate in the alternative management system all companies involved in the accumulators business, thus hindering the illicit trading of spent accumulators, which still constitutes the main handling procedure of spent accumulators.
- Changing of trends and behaviors which are connected to the trading of accumulators by illicit scrap dealers and in an uncontrolled way is very difficult, taking into account that this situation was profitable both for the scrap dealers and to the companies dealing with the replacement of accumulators. On the other hand, transportation of the

spent accumulators in accordance with the ADR provisions and following all legislative procedures (licenses, insurances, trained personnel) means the increase of the management cost, thus reducing the profit of the companies. Therefore, constant information of the companies involved and their active participation in the system are required in order to achieve the effectiveness of the accumulators' collection system. The sole use of command and control instruments, such as civil, penal and administrative sanctions is inadequate in these cases and the use of communicative instruments is required.

- The development of an alternative management system at a regional level, such as SEDIS-K, demonstrates considerable advantages, though time is required in order to achieve impressive results from the implementation of such systems.

The total quantity of accumulators handled by electricians and importers of accumulators in Crete reaches 650 tons, while the total quantity of accumulators handled in Crete is estimated at around 1,800 tons. The aims of the SEDIS-K system, as given also to the Greek Ministry of Environment, are, at the first stage, the compliance of importers in Crete with the relevant legislative obligations and, at a second stage, the coverage of the largest possible amount of accumulators handled in Crete. These targets are presented in Table 4.4. Naturally, these targets are way above the aims of the LIFE GREEN BATTERIES pilot project.

Table 4.4. Quantitative collection target of the SEDIS-K system

Year	Quantity (tons)
2005	50
2006	265
2007	480
2008	530
2009	580

4.4.2 Data regarding the operation of the pilot project for small batteries

The pilot system for the collection of small batteries in Crete was organized in cooperation with the national alternative management system "AFIS".
In the framework of the pilot program 851 big collection bins (10 lt) and 43 small ones (3,5lt) have been distributed and installed throughout Crete. The distribution of the bins was performed in the period between 3/2005- 6/2006. In detail, the number of bins per Prefecture and per type of activity is presented in the Tables below. It is clear that 70% of the bins is located in two big cities while 92% is actually located in the 5 largest cities of the island. The dispersion of collection bins in other cities is not as wide as in the case of accumulators, since bins have been installed in another 20 points in the island.

Table 4.5. Dispersion of bins per Prefecture

Prefecture	Number of collection points	Number of bins (3.5 lt)	Number of bins (10 lt)
Herakleion	189	42	360
Rethymno	115	1	147
Chania	204	0	243
Lasithi	70	0	101

Table 4.6. Dispersion of bins per city

	Percentage %
CHANIA	34
HERAKLEIO	34
RETHYMNO	19
AG. NIKOLAOS	3
IERAPETRA	2
SITEIA	2

Table 4.7. Dispersion of 10 lt collection bins per type of activity

	RETHYMNO	CHANIA	HERAKLEION	LASITHI	TOTAL
Public authorities	22	30	14	11	77
Educational institution	56	95	129	26	306
Hotels	34	12	19	26	91
Supermarket	5	35	10	6	56
Telecommunications - Photo shops	15	23	45	24	107
Shops - banks	11	33	124	6	174
Other	4	15	19	2	40
TOTAL	147	243	360	101	851

The outcomes derived from the operation of the pilot program are:

- The largest number of bins has been located in schools, where the awareness and interest for the collection of small batteries is greater.
- Also, a considerable number of collection bins is located in shops which sell batteries such as telecommunication companies and photo shops.
- The hotels in Crete have demonstrated considerable awareness and interest in the pilot program, especially since most of these hotels operate according to environmental standards (ISO 14001, ECOLABEL) and therefore consider recycling as an important parameter.
- The first results from the operation of the program show that most calls for the collection of batteries originate from educational institutions as also from commercial shops, where bins seem to be filled quicker. Hotels present a smaller number of calls, especially due to the fact that the operation of the program was during the winter months.
- Most collection points are located in big cities, fact which facilitates the collection of batteries. Namely, 50% of the calls originate from Herakleion while 12 % from collection points in Chania and 16% from points in Rethymno.
- The mean number of telephone calls for the collection of bins per month are 20, while the mean quantity collected per month reaches 550 kg, fact which means that, if the current collection rates continue, it is estimated that the annual collection of batteries will reach 7 tons, representing 4% of the total quantity of small batteries (with weight less than 1.5 kg) sold in Crete. This means that more communicative and public information actions are required in order to enhance collection and recycling rates.
- According to the above data there are telephone calls for example for the collection of 4 bins from Chania, 1 bin from Neapoli, 1 bin from Ierapetra and 3 bins from Rethymno. This means that, taking into account the small size of the bins (each bin weighs approx. 14kg), the collection of bins on a monthly basis is not feasible, both from an environmental and from an economic point of view. Therefore, either the collection has to be performed on a three month basis, or the collector has to collect also other types of waste at the same time.
- It should also be stressed that considerable difficulties arise from the licensing procedure provided for the collection and transportation of small batteries. Because small batteries are considered as hazardous waste, the transportation cost is excessive, since a special license for the collection and transportation of hazardous waste is required, as also the use of special boxes and vehicles, implementation of the ADR provisions, registry keeping, special insurance of the transport vehicle, trained driver, etc.

5 Designing a system for the recycling of batteries and accumulators: requirements and good practices

5.1 Design of the organization of a system for the collection and recycling of batteries and accumulators

The design and organization of system for the management of hazardous waste, like batteries and accumulators constitute a complex procedure depending on a variety of parameters, the most important of which is the effective management of the shareholders involved.
The stakeholders involved in the chain of marketing and management of batteries and accumulators are many, and each of them represents different and many times conflicting interests. The detection and analysis of the stakeholders involved and also of their interests and behaviors are very important for the correct design and for the effective implementation of every alternative management system. The stakeholder analysis has to accompanied by the promotion of their active involvement in the design of every system, since their involvement constitutes the necessary prerequisite for the effectiveness and achievement of the quantitative targets of the system.

The main stakeholders in the batteries management chain, as analyzed in the framework of the LIFE program, are:

- The producers and importers of batteries
- The retail market (shops for electronics, supermarket, electricians, gas stations, etc.)
- The existing collection network (for example scrap dealers)
- Recycling companies
- Transportation companies
- Consumers
- The public

In general, in order to facilitate understanding of the general framework of operation of every system, the following diagram is presented. The diagram demonstrates the flow of batteries/accumulators and also the flow of money between the main stakeholders involved in the management of batteries and accumulators.

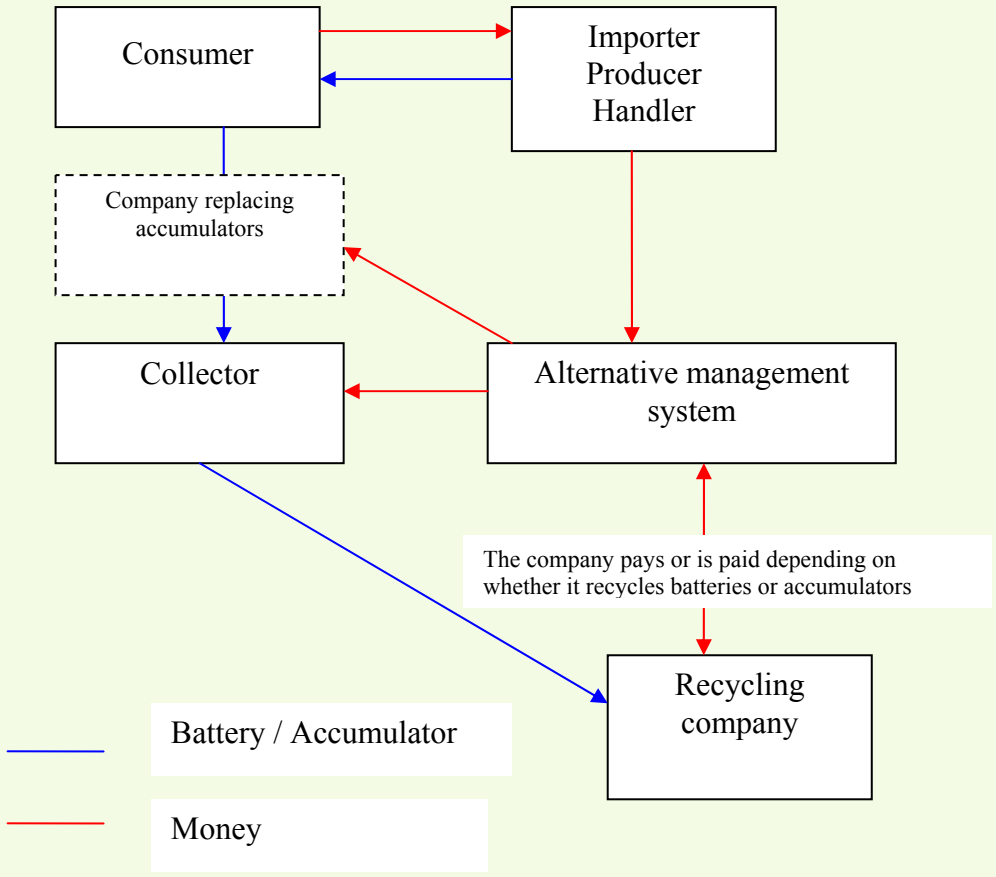


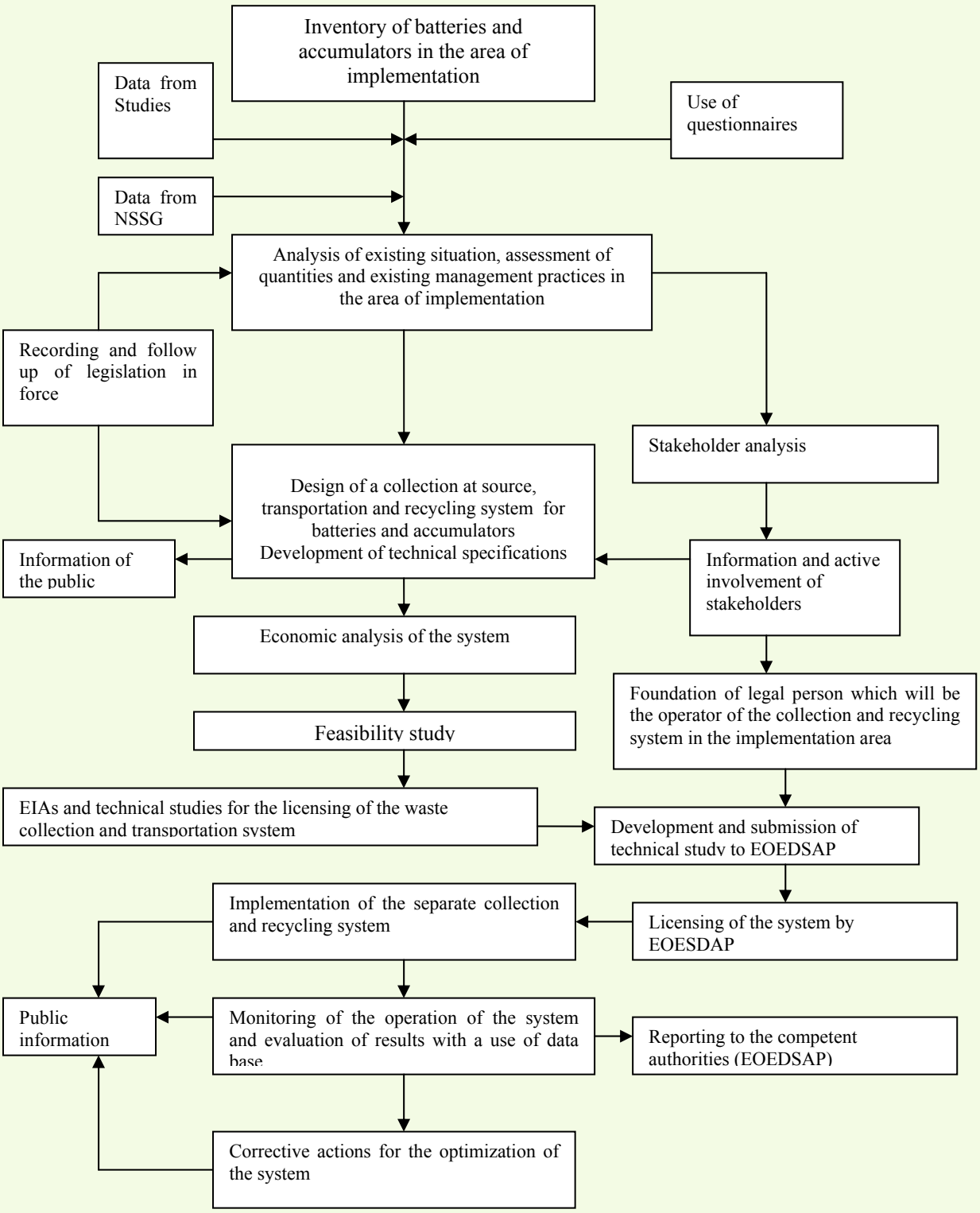
Diagram 4.1. Operation of an alternative management system for batteries and accumulators.

For the development of a collective management system one of the most important steps is the cooperation with the stakeholders involved and mainly with those stakeholders which have relevant legislative obligations and therefore constitute the milestone for the foundation and operation of the system.

After achieving the active involvement of the stakeholders, the design and development of the system follows, including a series of interrelated actions.

The main steps and actions that have to be followed for the development and implementation of such a system are schematically presented below.

DESIGN AND IMPLEMENTATION OF A COLLECTION AND RECYCLING SYSTEM FOR BATTERIES AND ACCUMULATORS



5.2 Licensing procedure for a batteries and accumulators management system

Batteries and accumulators are considered as hazardous waste according to the European Waste Catalogue and according to JMD 13588/7235/2006 (OJ 383B/28.3.2006) and therefore their collection and management is covered by the relevant legislation on hazardous waste:

- 16 06 01* lead batteries
- 16 06 02* Ni–Cd batteries
- 16 06 03* batteries containing mercury
- 20 01 33* batteries and accumulators included in points 16 06 01, 16 06 02 or 16 06 03 and mixed batteries and accumulators which contain such batteries

The licensing procedure for hazardous waste management, such as batteries and accumulators, as also the provisions for the development of a relevant alternative management system has been amended many times during the last years. According to JMD 13588/7235/2006:

- **An approval of environmental terms** is required for activities concerning storage, recovery and disposal, according to the provisions of Law 3010/2002. On the contrary, for the collection and transportation of waste an approval of environmental terms is not required.
- **A hazardous waste management license** is required:
  - For the treatment, recovery and disposal of hazardous waste.
  - For the collection, transportation and/or storage of hazardous waste.

  This stage follows the approval of the environmental terms, when this is required.

For the issuing of a license for the treatment, recovery, collection or storage, the submission of study is required. The study contains all necessary elements and data as also an insurance contract regarding the hazardous waste management activities.

The development of a collective alternative waste management system is ruled by the terms and provisions of the Presidential Decree 115/2004 (OJ 80A2004) "Replacement of the Joint Ministerial Decision (JMD) 73537/1438/1995 "Management of batteries and accumulators containing hazardous substances" (OJ B 781) and JMD 19817/2000 "Amendment of JMD 73537/1995" (OJ B963). "Measures, conditions and program for the alternative management of used batteries and accumulators"
For the licensing of a collective management system, the submission of certain documents and data to EOEDSAP is required, such as:

- Articles of Association of the legal person which organizes the system, as also the names of the shareholders.
- Data regarding the importers, producers and recyclers of batteries and accumulators, participating in the system.
- Aim and targets of the collective system.
- Spatial coverage of the system
- Selection and description of the alternative management methods.
- Feasibility study of the system.
- Preliminary agreements between the system and third parties, involved in the management activities (licensed recycling units, local authorities, etc.)
- Preliminary agreements for the intention of importers and producers of batteries and accumulators to participate in the system which is going to be licensed.
- Information campaigns and programs towards the users and the public, which the system intends to organize.

The whole dossier which is submitted is firstly examined by EOEDSAP and at the next stage it is forwarded to a commission, which issues an opinion. The commission is constituted of members of the associations of all stakeholders responsible for the management of all types of waste covered by the provisions of Law 2939/2001.

5.3 Technical specifications and good practices for waste management

The management of this type of waste (batteries and accumulators) has to follow certain specifications regarding:

- ✓ The correct temporary storage (for example, appropriate temporary storage of accumulators in the units involved in the replacement of accumulators, in order to avoid leaks of acids and lead oxides in the environment).
- ✓ The environmentally sound collection and transportation of waste from these units, in order to minimize accident hazards and dangers of leakages.
- ✓ The temporary storage in places which fulfill the relevant specifications.
- ✓ The environmentally sound recycling and final management

5.3.1 Good practices for the temporary storage of batteries and accumulators

The accumulators, and especially car accumulators, have to be managed very carefully, when they reach the end of their life cycle. The procedure that each one of us has to follow is very simple:

- Change your car accumulator only at car service stations which have a recycling bin and participate in an approved collective recycling system for accumulators.
- In case you change your car accumulator by yourself, you have to return your old accumulator to the car service station, which will send it for recycling.

At the car service stations, batteries are temporarily stored in a special recycling bin and will be further collected by the System and driven to the recycling unit.
Those who work at a shop or unit which replaces accumulators, have to comply with the following instructions:

- Store the accumulators in special storage bins within the unit, together with the contained electrolyte.
- Do not handle accumulators, which do not participate in an collective alternative management system
- Store the accumulators:
  - In indoor spaces, in order to avoid leakages due to weather conditions (cracking of the accumulator due to temperature changes, or leakages due to the rain).
  - Always inside special recycling bins, which cannot be eroded by the accumulators' liquids, in order to avoid leakages.
- Store the accumulators in upright position in piles, so that their liquids are not spilled.
- Do not put more than 5 accumulators on every pile.
- Check your storage bins regularly for cracks or leakages.
- In case of leakage on the floor, do not discard the liquids in the drainage system. Neutralize them using NaOH or lime before disposal.
- Accumulators should be sent for recycling at least once every six months.
- Maintain a register book for the handling of accumulators.

The following Table provides practical advice for the proper use of small batteries

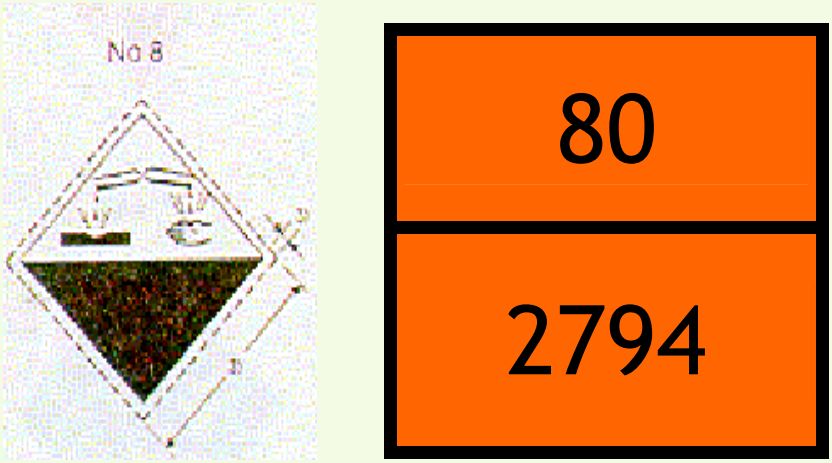
USEFUL TIPS FOR THE PROPER USE OF BATTERIES

RIGHT	WRONG
1. Use as much as possible rechargeable batteries.	1. Do not mix used batteries with new ones in the same device, because this reduces life expectancy of the new batteries.
2. Discard used batteries in the nearest special recycling bins.	2. Do not attempt to charge a battery, which is not rechargeable.
3. Always remove batteries from the devices you intend to store, since there is leakage hazard, which can thus destroy your device.	3. Do not place batteries, or devices containing batteries in places where overheating can be caused. Heat accelerates chemical reactions and will thus reduce life expectancy of the battery.
4. Always remove batteries from destroyed devices, watches, PCs, games, which you intend to throw away, and discard the batteries in the special recycling bins.	4. Do not place batteries together with metal objects, such as keys or coins, because this can cause a short circuit.
5. Always buy the exact number of batteries you need each time and not more, since the life duration of the batteries is limited.	5. Do not throw or sink batteries in water.
6. Clean thoroughly the contact points when placing the batteries, in order to avoid waste of energy.	6. Do not place batteries the wrong way in devices or chargers, as far as polarity is concerned.
7. Always follow the battery charging instructions provided by the manufacturer, both for the first and for every following charge. This will assist to achieve optimum performance of the battery.	7. Do not mix various types of batteries and do not place common batteries together with rechargeable ones in the same device. The device can be destroyed, the life expectancy of the batteries can be reduced and there is also a danger of explosion.
8. Always allow batteries to reduce their temperature in room temperature before recharging them. Charging efficiency is dramatically reduced at high temperature conditions.	8. Do not throw away devices or objects containing batteries. Remove the batteries first and then discard them in the special recycling bins.
9. Recharge the batteries when these are almost totally discharged.	9. Never throw batteries to the fire.
10. Discard rechargeable batteries in the special recycling bins, when these cannot be recharged any more.	10. Never leave batteries inside a device, when these are fully discharged.

5.3.2 Specifications, requirements and good practices for the collection and transportation of batteries and accumulators

The specifications for the organization of collection and transportation system regarding hazardous substances are mainly determined by the ADR requirements ("European Agreement concerning the International Carriage of Dangerous Goods by Roads " transposed in the Greek national legislation with the Ministerial Decision F/21099/1700/OJ 509B'/7-4-2000, as also by the relevant legislation on hazardous waste (JMD 73537/1438/1995, Presidential Decree 115/2004).
The general requirements for the transportation of hazardous waste include:

- Special requirements for the vehicle
- Fire extinguishers
- Various equipment (tool box, 2 yellow lights, necessary equipment required for the implementation of security measures, as for example, glasses, vests, gloves, spade, etc.)
- The driver has to posses a dangerous goods driving license
- Labels on the vehicle, where the upper number is the hazard identification number and the lower is the material identification number. The label must have minimum dimension 100 by 100 mm.



Labeling of dangerous load

- Signing of agreement with a collective management system
- Insurance contract concerning civil liability and covering damages towards third parties as well as environmental damages
- Special transport documents with reference on the following:

Waste*, UN code, class
With reference also to:
- *Description of carried object and number*
- *Total quantity of the carriage (volume or net weight)*
- *Name and address of the consigner and of the final recipient*

- Presence of a Dangerous Load Safe Transportation Consultant
- Circulation license, with reference to the category of the waste transported

In detail, the ADR provisions applicable for the transportation of batteries and accumulators are analyzed below.

5.3.2.1 ADR requirements for the transportation of lead accumulators

Certain ADR provisions are presented below, regarding the transportation of lead accumulators.

Waste categories:

2794 storage batteries, wet, filled with acid, electric storage
2795 batteries, wet, filled with alkali, electric storage
2800 batteries, wet, non spillable, electric storage

Class 8: Corrosive substances without subsidiary risk

Special provisions regarding packaging and transportation: *Code 295, Code 598, Code 238,* Packaging instruction P801α, Packaging instruction PP16, code VV14
Transportation category 3: maxim allowed quantity per carriage unit is 1000 pieces.
Hazard Identification Number: 80 corrosive or slightly corrosive substance

Packaging: The provisions of **P 801a** are applicable

Stainless steel or solid plastics battery boxes of a capacity of up to 1 m3 are authorized provided the
following provisions are met:
(a) The battery boxes shall be resistant to the corrosive substances contained in the storage batteries;
(b) Under normal conditions of carriage, no corrosive substance shall leak from the battery boxes and
no other substance (e.g. water) shall enter the battery boxes. No dangerous residues of corrosive
substances contained in the storage batteries shall adhere to the outside of the battery boxes;
(c) The battery boxes shall not be loaded with storage batteries to a height greater than the height of
their sides;
(d) No storage battery containing substances or other dangerous goods which may react dangerously
with one another shall be placed in a battery box;
(e) The battery boxes shall be either:
(i) covered; or
(ii) carried in closed or sheeted vehicles or containers.

For carriage in bulk the provisions of code **VV14** are applicable, according to which:

(1) Used batteries may be carried in bulk in specially equipped vehicles or containers. Large plastics containers shall not be permitted. Small plastics containers shall be capable of withstanding, when fully loaded, a drop from a height of 0.8 m onto a hard surface at -18 °C, without breakage.
(2) The load compartments of vehicles or containers shall be of steel resistant to the corrosive substances contained in the batteries. Less resistant steels may be used when there is a sufficiently great wall thickness or a plastics lining/layer resistant to the corrosive substances.
The design of the load compartments of vehicles or containers shall take account of any residual currents and impact from the batteries.
***NOTE**: Steel exhibiting a maximum rate of progressive reduction of 0.1 mm per year under the effects of the corrosive substances may be considered as resistant.*
(3) It shall be ensured by means of constructional measures that there will be no

leakage of corrosive substances from the load compartments of vehicles or containers during carriage. Open load compartments shall be covered. The cover shall be resistant to the corrosive substances.
(4) Before loading, the load compartments of vehicles or containers, including their equipment, shall be inspected for damage. Vehicles or containers with damaged load compartments shall not be loaded.
The load compartments of vehicles or containers shall not be loaded above the top of their walls.
(5) No batteries containing different substances and no other goods liable to react dangerously with each other shall be present in the load compartments of vehicles or containers (see "Dangerous reaction" in 1.2.1).
During carriage no dangerous residue of the corrosive substances contained in the batteries shall adhere to the outer surface of the load compartments of vehicles or containers.

Packaging instruction **PP16:**

For UN No. 2800, batteries shall be protected from short circuits and shall be securely packed in strong outer packagings.

5.3.2.2 ADR requirements for small batteries

Used Ni/Cd batteries are not subject to the ADR provisions, when their case is not destroyed and the provisions of 598b are satisfied.

Regarding small batteries, only the following categories are considered as hazardous for their transportation:

3090 *lithium batteries*
3091 lithium batteries built into/packed with equipment

Class 9: Miscellaneous dangerous substances and articles
Packaging group II: this packaging group contains substances demonstrating medium hazard.
Special provisions: *188, 230, 636, 287*

Special provision 188

Lithium cells and batteries offered for carriage are not subject to other provisions of ADR if they meet the following:
(a) For a lithium metal or lithium alloy cell, the lithium content is not more than 1 g, and for a lithium-ion cell, the lithium-equivalent content is not more than 1.5 g;
(b) For a lithium metal or lithium alloy battery the aggregate lithium content is not
more than 2 g, and for a lithium-ion battery, the aggregate lithium-equivalent content is not more than 8 g;
(c) Each cell or battery is of the type proved to meet the requirements of each test
in the Manual of Tests and Criteria, Part III, sub-section 38.3;
(d) Cells and batteries are separated so as to prevent short circuits and are packed in
strong packagings, except when installed in equipment; and
(e) Except when installed in equipment, each package containing more than 24 lithium cells or 12 lithium batteries shall in addition meet the following requirements:
(i) Each package shall be marked indicating that it contains lithium batteries and that special procedures should be followed in the event that the package is damaged;
(ii) Each shipment shall be accompanied with a document indicating that packages contain lithium batteries and that special procedures should be followed in the event a package is damaged;
(iii) Each package is capable of withstanding a 1.2 m drop test in any orientation without damage to cells or batteries contained therein, without shifting of the contents so as to allow battery to battery (or cell to cell) contact and without release of contents; and
(iv) Except in the case of lithium batteries packed with equipment, packages may not exceed 30 kg gross mass.
As used above and elsewhere in ADR, "lithium content" means the mass of lithium in the anode of a lithium metal or lithium alloy cell, except in the case of a lithium-ion cell the "lithium-equivalent content" in grams is calculated to be 0.3 times the rated capacity in ampere-hours.

Special provision 636:

(a) With the approval of the competent authority of the country of origin, the quantity of lithium or lithium alloy in each cell may be raised to 60 g and a package may contain up to 2500 g of lithium or lithium alloy; the competent authority shall determine the conditions of carriage as well as the type and duration of the test. If the country of origin is not a Contracting Party to ADR, the approval shall be recognized by the competent authority of the first country Contracting Party to ADR reached by the consignment. In such a case, a copy of the approval with the conditions of carriage shall be attached to the transport document. This approval shall be drawn up in an official language of the forwarding country and also, if that language is not English, French or German, in English, French or German, unless any agreements concluded between the countries concerned in the transport operation provide otherwise.
(b) Cells contained in equipment shall not be capable of being discharged during carriage to the extent that the open circuit voltage falls below 2 volts or two thirds of the voltage of the undischarged cell, whichever is the lower.
*(c) Packages containing used cells or batteries in unmarked packagings shall bear the inscription: "**Used lithium cells**".*
(d) Articles which do not meet the requirements of this special provision and/or special provisions 188, 230, as appropriate, are not to be accepted for carriage.

Packaging instruction P903

The following packagings are authorized:
Packagings conforming to the packing group II performance level.
When lithium cells and batteries are packed with equipment, they shall be packed in inner fibreboard packagings that meet the requirements for packing group II.
When lithium cells and batteries included in Class 9 are contained in equipment, the equipment shall be packed in strong outer packagings in such a manner as to prevent accidental operation during carriage.
***Additional requirement**: Batteries shall be protected against short circuit.*

Packaging instruction P903α

Non-approved packagings shall, however, be permitted provided that:
- they meet the general provisions of 4.1.1 and 4.1.3;
- the cells and batteries are packed and stowed so as to prevent any risk of short circuits;
- the packages weigh not more than 30 kg.

Additional requirement:
Batteries shall be protected against short circuit.

CODE ***V1*** : Packages shall be loaded on to closed or sheeted vehicles or into closed or sheeted containers.

5.3.2.3 Good practices for the collection, transportation and temporary storage

For the collection and transportation of car lead accumulators, the following instructions are suggested:

- The storage and transportation of accumulators in pallet boxes made of HDPE, which can be transported with a forklift vehicle, and which are of high endurance, so that they can be pilled, and finally, they should be of an appropriate size so they fit in a truck. The use of pallet boxes with a lid is suggested, taking into account that in many cases car service stations do not possess adequate space and, therefore, storage is performed in outdoor places.
- Use of a balance in order to be able to weigh the accumulator at every point
- Use of a vehicle which meets certain specifications.

The organization of the routing of the trucks is very important for the reduction of the transportation cost of this specific waste.

Temporary storage of accumulators has to be performed in a certain manner, in order to minimize wastewater. Within the temporary storage unit, accumulators have to be kept within special bins, until they are sent for recycling. The bins have to be constructed from durable materials, in order to avoid cracks and erosion by the weather conditions.

Additionally, the storage unit has to be an indoor facility meeting the appropriate technical specifications, so as, in the case of leakage, all wastewater to be collected in a certain point within the facility, thus avoiding dispersion in the outer environment.

The collection of small batteries has to be performed using small bins, with a size less than 10 lt, in order to avoid short circuit problems and also to avoid falling in the scope of the ADR packaging provisions. The packaging such be attractive, have low weight and cost. Different packagings used in various small batteries collection programs are presented below.

Luxembourg

Bakersfield Environmental Services Ltd, England

RBRC, USA

Midpoint international inc

Bristol

Grand Canaria

Jeantet Sarl Company

Veneta plastica Company
(AFIS – LIFE Project)

The main problem caused by the use of packaging which have such a small volume is the high collection cost, in cases of distant collection points. Therefore the use of small and attractive collection bins is suggested, which will be further emptied in a larger bin until a considerable volume for collection is reached.

5.3.3 Good practices for the management of accumulators

LEAD ACCUMULATORS

The main environmental impacts caused by the operation of a lead recycling unit as also the measures that have to be taken for the prevention of these impacts are presented below.

- ***Air pollutants***

Air pollutants are emitted due to the operation of the melting furnace and include incineration products and suspended particles, which contain a considerable percentage of lead.

The limit values regarding suspended particles and lead are determined by Presidential Decree 1180/81 and are:

Table 5.1 Emission limit values in the atmosphere

Lead	10 mg/m^3
Suspended particles (dusts)	100 mg/m^3

In order to reduce the emission of suspended particles and lead, the installation and operation of bag filters is required, preferably with a self cleaning mechanism, of a Pulse jet type, in order to be able to anticipate the considerable pollutant load. These systems have to assure reduction of emissions up to 99%, so that the emission of hazardous metals, such as lead, is avoided. The type of filters suggested is polyester with PTFE or PTFE overlay. The pre-treatment of the air, in order to reduce its temperature, is very important for the effective operation of the filter systems.

- ***Wastewater***

Wastewater in a recycling unit is usually produced at the accumulators' crashing stage, when the used electrolyte contained is removed. The usual method for the treatment of

these wastes includes the neutralization of the sulphuric acid and heavy metal sedimentation with the use of sodium hydroxide.

- ***Solid waste***

Solid waste produced by the recycling units can be usually reused within the unit or to be given for sale. In concrete, the plastic parts of the accumulators and the rust from the furnace usually constitute tradable byproducts, while the dust collected in the bag filters and the various residues can be re entered in the furnace for the recovery of the lead contained.

SMALL BATTERIES

The steps to be followed for the management of small batteries after their collection include their sorting based on their type, size, hazard category and the demands of the recycling companies, and further their transportation to the recycling units.

The batteries have to be sent to batteries sorting centers, where these are sorted according to their size (cylindrical, button type, cellular phone batteries, etc.) and to their chemical composition (zinc batteries, NiCd batteries, nickel metal hydride batteries, etc.). Various sorting methods have be developed. EPBA has developed an automated high speed sorting machine for batteries. The system is based on the use of electronic sensors and balances and on the manual removal of other waste.

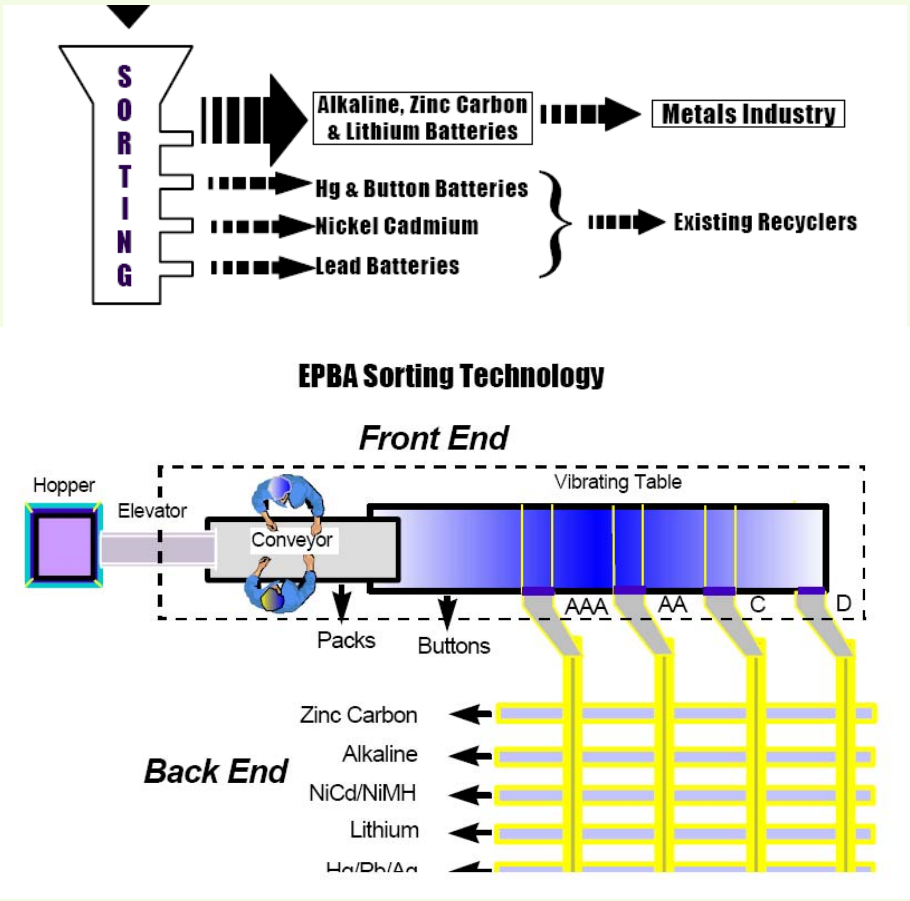


Illustration. EPBA proposal for the sorting of the batteries according to their type and size.

Small batteries can be recycled in order to recover the metals and is performed by various recycling companies in Europe, such as:

- SNAM (Lyon, France): recycling of NiCd batteries, nickel-metal hydride batteries, and Lithium-ion batteries
- Batrec (Switzerland): treatment of button type batteries
- Nedstaal (Netherlands): zinc carbon batteries
- Metal industries (alkaline, zinc and lithium)