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Recycling Used Lead Acid Batteries – A Model Life Cycle Approach

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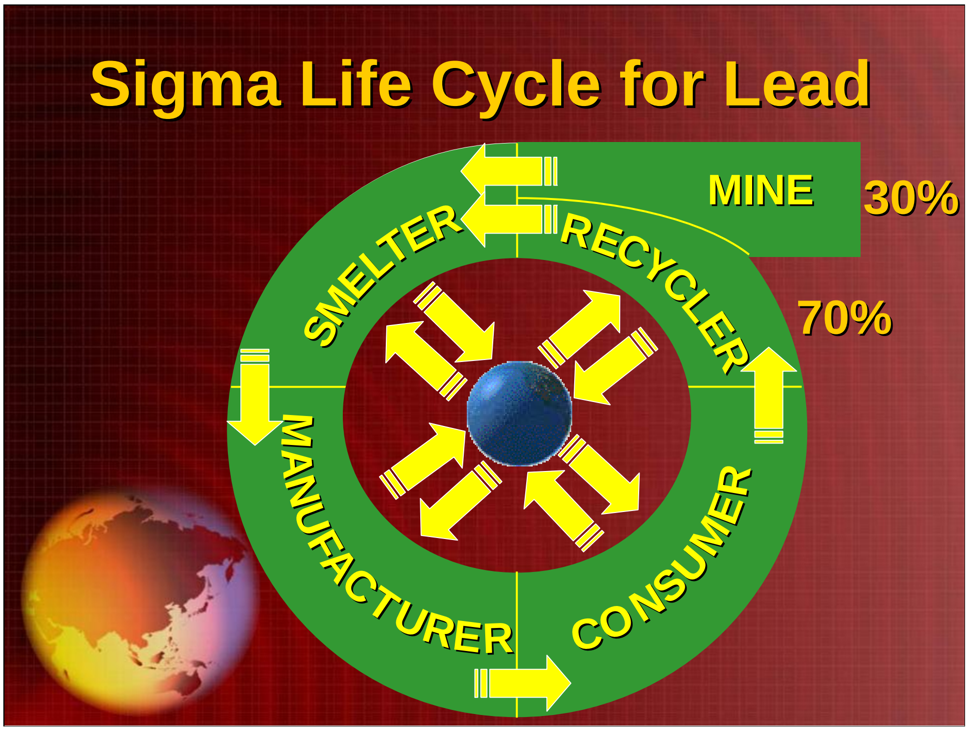


The Lead Life Cycle

The Lead Industry should be proud of the success of lead recycling. Lead is the most recycled metal commodity and you will often see this illustrated by the Mobius Loop.

However, Mining Operations, a vital component of the Lead Life Cycle, does not fit into the Mobius Loop, but it does provide a natural input into the Sigma Life Cycle Loop.

Lead ore enters the Sigma Life Cycle Loop when it leaves the mine for the smelter, and in the case of all lead products the next stage is manufacturing, then the consumer will use the product and after use, the recycler will recover the resource materials and the cycle is repeated.

Such is the success of Lead Recycling that over 70% of world Lead consumption is from secondary sources and only 30% from mining operations. No other metal comes close to these rates.

Benefits of Environmentally Sound Recycling of Used Lead Acid Batteries

It might be opportune at this point just to remind ourselves why recycling is so important and the benefits that ensue.

The first reason, and this is clearly demonstrated in the Sigma Loop, is that increased recycling rates for Lead Bullion reduce the dependence on mining and any subsequent environmental threats to natural habitats posed by such activities.

Additional resource materials such as the polypropylene cases and the battery acid can be recovered and reused or converted to other saleable products; for example Zinc Sulfate.

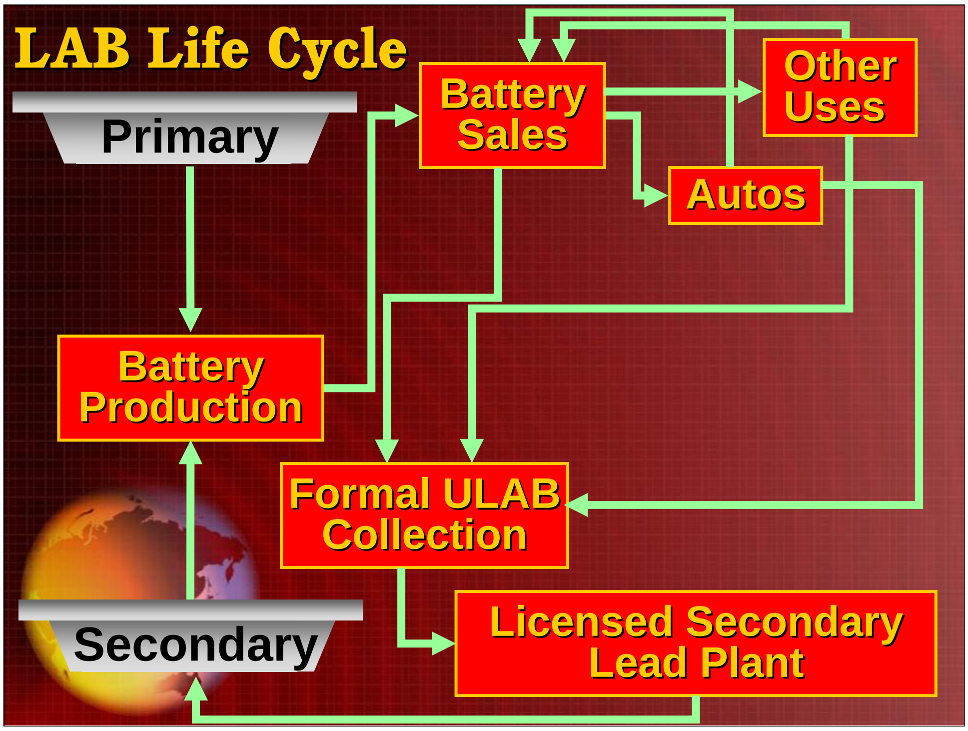
Sound recycling operations represent good environmental practice, especially for non-ferrous metals, as recycled materials normally require four times less energy to produce than primary commodities.

They also reduce the threat of environmental and population lead exposure from the "backyard" recycling that blights many communities in the developing world.

The burden of waste from illicit dumping of ULAB into municipal landfill sites is also eliminated.

Environmentally sound recycling also guarantees our legacy and protects the environment for future generations.

In addition there is a social dimension because recycling of ULAB creates "Green" jobs and provides an invaluable income for many small businesses and families.



Lead Acid Battery Life Cycle

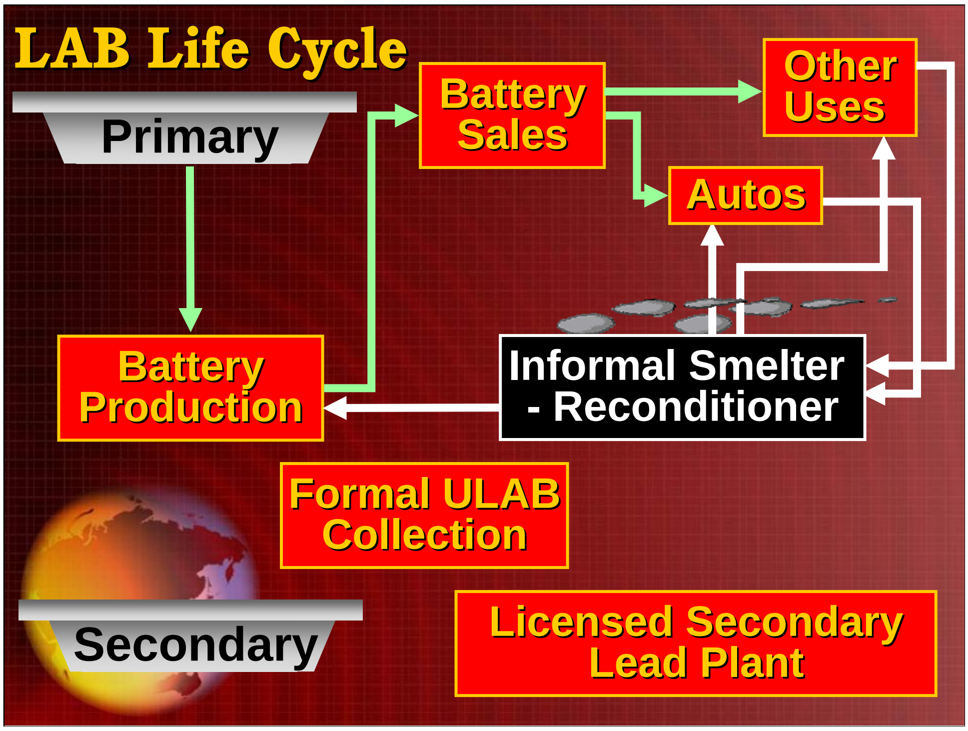
When we look at the Lead Industry today, we see over 80% of Lead consumption is in the manufacture of Lead Acid Batteries (LAB).

Primary lead is dispatched to the battery manufacturer and subsequently Lead Acid Batteries are delivered to the retailer. As we know, the bulk of battery sales are to the automobile sector, but some will be sold for other uses, such as Uninterrupted Power Supply (UPS) units for IT.

Used batteries are usually returned to the retailer for either a refund or a purchase discount and in turn the retailer will send the ULAB to a collection center for sorting and packaging. Some consumers will also send their ULAB directly to a collection center.

The collection center transports ULAB in bulk to a secondary smelter for recycling and the refined ingots will be sold to the battery manufacturer for the cycle to begin again.

This is the ideal scenario, but as we know, life and life cycles are not “ideal”.

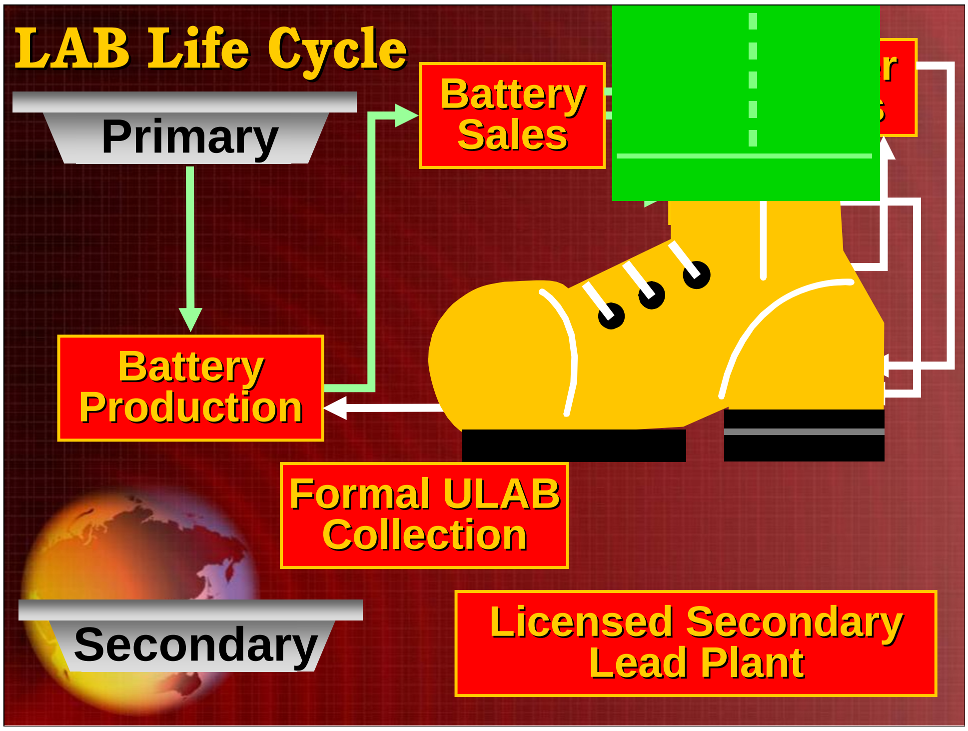


Lead Acid Battery Life Cycle

The lack of environmental controls and occupational health measures means that the informal sector can pay a premium for ULAB and maintain an unwanted presence in the lead acid battery life cycle.

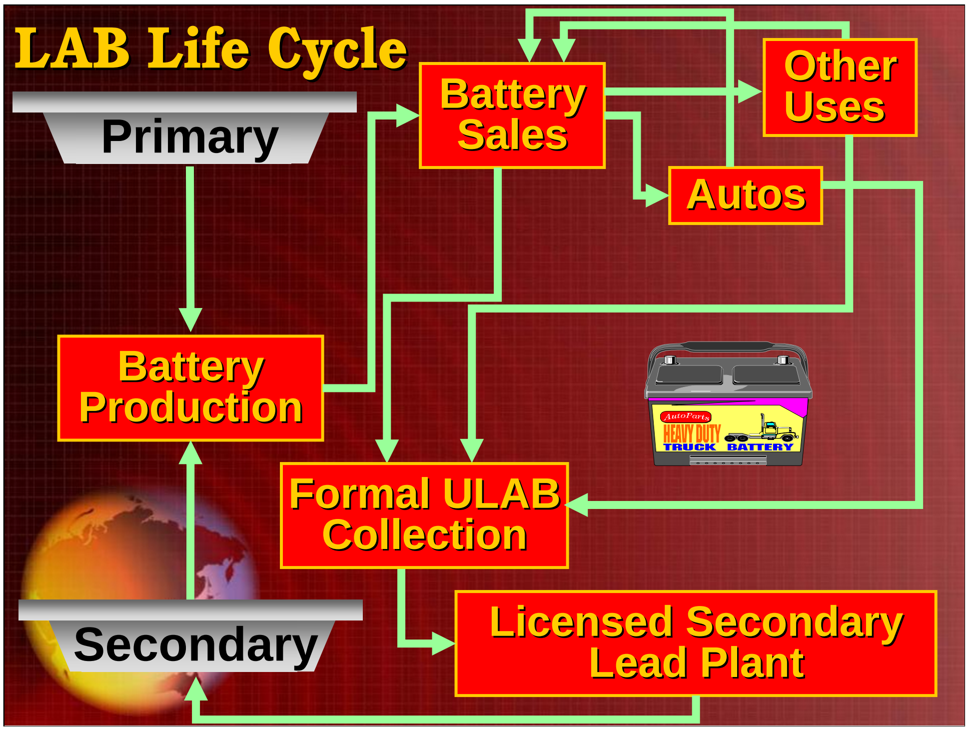
Not only are the "informals" a constant source of pollution, but they also deprive the licensed formal sector of valuable feed materials.

In every ILMC study of used lead acid battery recovery, the vast majority of lead exposure problems were caused by the poor recycling methods used by the "informal" sector.



Lead Acid Battery Life Cycle

However, improved co-ordination between Government Regulators, Enforcement Agencies and the introduction of incentive based ULAB return schemes has, in many instances "stamped" out the "informals".



Lead Acid Battery Life Cycle

It is interesting to note that not only have regulators and enforcement agencies paid more attention to the informal recyclers, but they have also been focused on the formal smelting operations in their pursuit of environmentally sound recovery of ULAB.

Well, it is fair to say that smelting poses the greatest potential threats to the environment and human health, but it is only one component in the life cycle of the Lead Acid Battery. What threats, challenges and opportunities do the other components pose?

If we take a holistic perspective of the life cycle, does each phase pose its own threats and if so what can be done to reduce or eliminate the risks?

Could each component contribute to the recovery process?

Well, let us examine Battery manufacture.

The Ideal Battery Manufacturing Recycling Criteria

From an environmental perspective there are a number of criteria that are key elements in the design of the ideal battery that will make the recovery phase much easier. Firstly, and this sounds obvious, but the materials used should be reusable or easily recycled for use in a new battery. With recycling rates for used batteries as high as 96% in many countries, you might think that that the industry already has a consistent design that is ideal, but unfortunately this is not the case.

Plastic Case Material

Washed polypropylene chips from used battery cases provide valuable additional income for the recycler. However, some battery case material is being produced from a range of cheaper durable co-polymer plastics that are impossible to separate economically from the polypropylene, thereby rending the plastic chips of little value and only fit to use as fuel. Ideally, all batteries should be made of the same plastic case material to maximize recovery and reuse. In his respect, rubber and metallic case material should be phased out except for instances where there is a specific need.

Acid Electrolyte

Over the years we have seen an increase in gelled electrolyte to reduce the risk of acid leakage and spillage. Furthermore, spirally wound and valve regulated batteries require the gelled electrolyte. The gelled electrolyte is difficult to remove from the battery paste prior to smelting and those secondary plants that de-sulfurize prior to smelting will have to re-equip themselves to deal with the increase in sulfur dioxide production and remove it from the waste gas stream prior to discharge to the atmosphere.

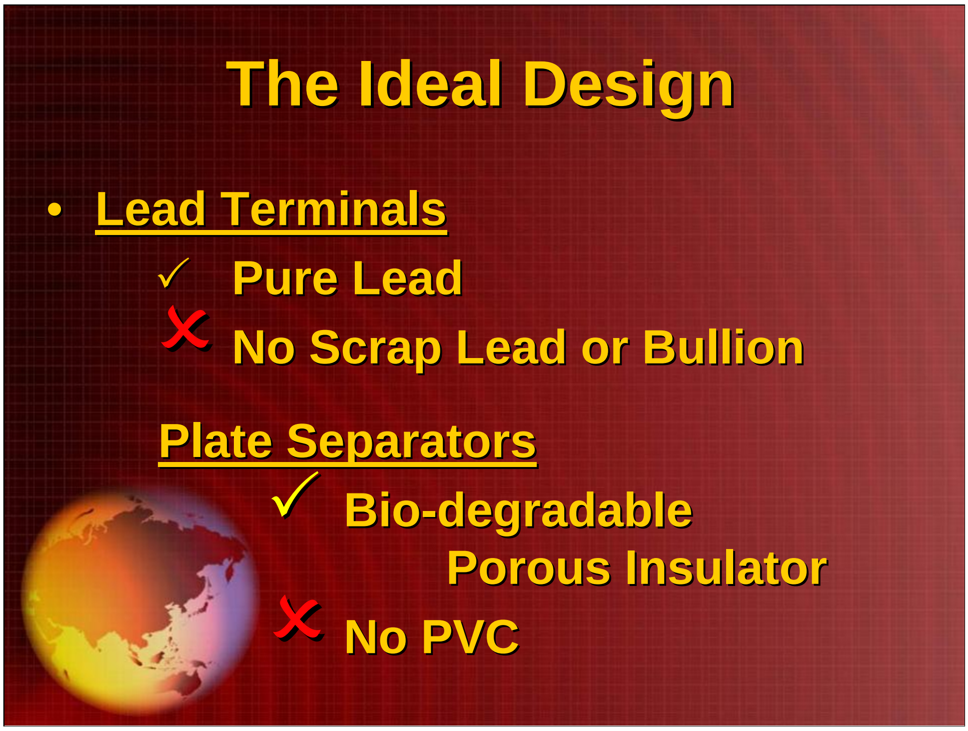
The Ideal Design

<u>Lead Plates</u>

New battery designs that increase power, reliability and extend battery life, in particular the valve regulated battery designs, usually demand the use of soft very pure lead for the grids. Whilst the use of pure lead in this instance eases recycling, the vast majority of batteries consumed are standard automotive SLI batteries requiring harder lead grids that can only be made from lead alloys. Many of these alloys have traditionally been made from either toxic or environmentally undesirable elements or in some cases inert elements that contaminate the secondary bullion and are uneconomic to recover during the recycling process. In order for secondary lead producers to compete with primary lead and command the best premiums, the recycled lead must be of a quality suitable for the production of lead oxide, used in the production of battery paste and calcium alloys for modern battery grids. Increasingly certain battery manufacturers are moving towards the use of elements, such as calcium and tin, not only because they enhance performance, but they are either easy to recycle or remove from the lead bullion during the refining stage and also represent no particular toxic or environmental threat. Further research is required in this area to balance battery performance with sound environmental criteria and recyclability.

<u>Battery Paste</u>

Current formulations for battery paste are ideal for the secondary industry and the likely changes on the horizons do not change this position.



The Ideal Design

<u>Lead Terminals</u>

The lead terminals are not critical to the chemical efficiency of the battery and only provide the link to complete the electrical circuit. Consequently the terminals are sometimes made from a low quality lead bullion and while this might minimize costs, if the bullion used to produce the terminals contains other elements that are either toxic or undesirable, these elements will add a further refining burden to the recycler. Ideally, the terminals should be made from Lead refined to the London Metals Exchange (LME) standard for 99.97% bullion to minimize contamination.

<u>Plate Separators</u>

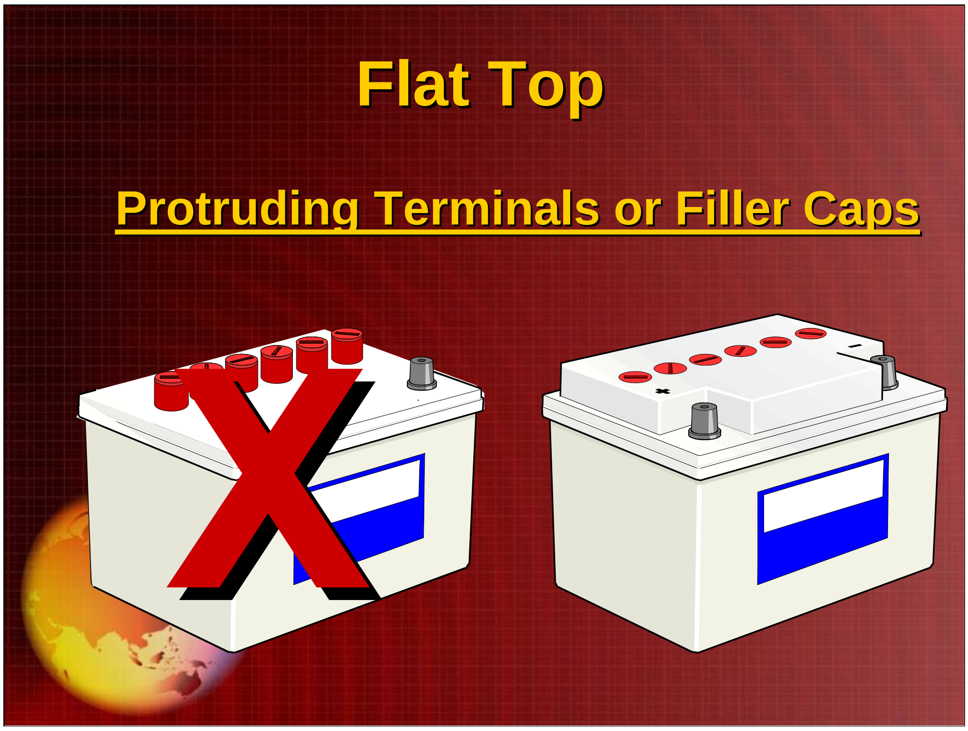
In the early days of battery manufacturing the plate separators were made of wood. Today they are produced from a multitude of plastics, paper and glass fiber. Whilst glass fiber presents some separation problems in the mechanical battery breakers, it does not present an environmental threat apart from adding to the inert slag burden. Virtually all of the plastic and paper separators are impossible to recycle economically and are really only suitable as a fuel supplement. Certain plastic separators, however, such as PVC (polyvinyl chloride) cannot be burnt as fuel because an acidic gas is generated and without an economic method to segregate PVC from the other separators, the whole of the separator waste stream is destined for landfill.

Design Debate!

Certain campaigners of sustainable development and promoters of cleaner production, advocate that automotive batteries should be easy to disassemble so that they can be recycled without the need for an energy intensive hammer mill.

But, the experience of the ILMC has been that automotive batteries that are easy to dissemble are more likely to be reconditioned by the informal sector than recycled in an environmentally sound manner – and reconditioning means cannibalizing one battery to repair others – this also means that the electrolyte is discarded as well as any unwanted plates, and workers and local populations are exposed to the oxide paste that is invariably lost to the environment.

So, it is the opinion of the ILMC that every effort should be made to design and manufacture batteries that are difficult to disassemble to discourage and prevent the proliferation of unregulated battery reconditioning and the adverse environmental impact and population exposure associated with such activities.



Flat Top!

Earlier this year I inspected a new batch of automotive batteries produced by one of the world's largest lead acid battery manufacturers and I could see that batteries are still being fabricated with protruding terminals and filler caps………… This means, very often, that when ULAB with protruding terminals or filling caps are stacked one on top of another, the base of the second battery is liable to puncture and acid will leak into the eco system unless contained.

What is required are batteries with "Flat Tops", that is, recessed filler caps and terminals to prevent any accidental puncturing of batteries when stacked on top of each other.

Eco Label

Finally, prior to leaving the manufacturing plant, all lead-acid batteries should be labelled in accordance with prevailing national and international regulations and with the international recycling symbol ISO 7000-1135, better known as the Mobius loop.

Furthermore, there should be instructions for the recycling of the battery when it is at the end of its useful life or a point of contact clearly displayed.

Each label should state, “lead-acid battery”, "Pb" or the words "LEAD", "RETURN and RECYCLE."

If possible the label should also have a bar code containing information about the place of manufacture, the date of production, the battery type and its components.

Battery Retailers

Next in the Life Cycle of the Lead Acid Battery are the Battery Retailers.

Now, it may seem obvious that ULAB should be collected at the point of sale by Battery Retailers ……….. In fact this is common practice in many countries, but in our studies in Central America, the Caribbean, Cambodia and the Philippines, it was evident that many local Lead Acid Battery (LAB) retailers did not collect ULAB and were content to leave them to the Informal Sector.

Inevitably, the "informals" will dispose of the electrolyte at the nearest river or pour it into the sanitation system in order to reduce the weight of the ULAB.

Far better for the Industry to encourage or provide incentives for all retailers to engage with the public and offer an environmentally sound ULAB return and collection service.

And at the sales interface there is an ideal opportunity to explain the risks posed by the "Informal" recovery sector and the threats to the environment and public health.

We all know that collecting ULAB presents collection and storage problems, but here are some examples of how these difficulties were overcome

ULAB Collection

In the Philippines and the United Kingdom wire mesh cages on wheels have been introduced in a number of locations. The cages are made of stainless or heavy gauge steel with an open mesh floor and wheels running on nylon bearings. The cages are chained to the outside of a shop or garage and the ULAB are placed inside the cage, which also has a lockable lid to prevent anyone removing a ULAB.

Use of a cage eliminates the risk of the build up of explosive gases and keeps the ULAB of the ground, enabling any spillage to be seen and the appropriate action to remove the contamination taken.

The cages can also be used to send the ULAB to the local collection center, provided they are secured to the inside of the vehicle used for transport. Such use of the cages also minimizes the need to handle the ULAB, thereby reducing the risk of accidents and personal injury.

In Manila these cages can be seen positioned adjacent to garages, repair shops and even in local communities.

Collection and Packaging

Alternatively, ULAB can be staked onto wooden pallets.

Prior to packing it is important to ensure that all the ULAB have their vent caps shut to avoid spillage during shipping. If possible replace a missing vent cap or seal the inspection hole.

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

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

Service Checks and Battery Maintenance

Most motorists will tell you that their batteries do not last long enough and this is especially true in hot climates and developing countries with older vehicle populations.

We also know that SLI batteries like to be fully charged and do not like being discharged below 80%.

Now, it is a fact that in many older vehicles the battery charging systems do not always operate at maximum efficiency and with the electrical demands of modern vehicles, SLI batteries are not necessarily fully charged during normal use. This situation, if allowed to continue will shorten battery life and lead to premature failure.

As an Industry we should be explaining to the public the benefits of regular service checks and improved battery maintenance, so that where there are service centers, they are used to good effect.

ULAB Inspection

Having just established that batteries are not always maintained in optimum condition, it will come as no surprise to you, that many ULAB are not actually at the end of their useful life, but are merely in need of recharging.

So, it is important to inspect and electronically test all ULAB to determine whether battery could be recharged and reused. This practice is a legitimate and worthwhile activity because firstly it ensures that any batteries still charged are identified and thereby reduces the risk of sparking during transit; and secondly it returns some batteries to the market without the need for recycling while earning the collector additional income.

I would hope that all ULAB are tested, but I have only observed this practice in Mexico City and Dakar and whilst I am sure that it is more common than that, such testing should be encouraged because the more ULAB we can reuse, the less the environmental impact

ULAB Collection Center

The base of the storage area must be acid resistant concrete or some other suitable flooring. If the store is under cover then an exhaust ventilation system must be installed, or simply a fast air renovation scheme, in order to avoid hazardous gas accumulation.

The storage area must have drainage channels that run into a collection sump.

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

Safety procedures must be observed and employees should be wearing goggles, neoprene gloves, neoprene boots and respirators should be available if necessary.

First aid kits should be available and it is essential to install an emergency shower for use when acid is accidentally sprayed onto the skin or in the eyes.

ULAB Recycling – Best Practice

At this conference there are many excellent presentations examining advances in the environmental performance of smelters and there is no need for me to detail this segment of the Lead Acid Battery Life Cycle, but when consideration is given to what constitutes Responsible Care in the context of Life Cycle management – your Model should be based on best practice and include:

✓Segregated work areas, so that process areas do not contaminate non process or eating areas

✓Comprehensive Health and Safety Polices

✓Medical surveillance for all operating personnel exposed to lead operations.

✓Waste water treatment facilities

✓Emission control procedures

✓Solid Waste Management of all smelting by-products and residues.

✓A community outreach program that keeps the surrounding population aware of the secondary lead operations through effective two-way communications.

Ten Golden Rules

And finally we pay the highest regard to the health and safety of those working in the Industry – So here are the Ten Golden Rules

I. Make respirators available, ensure they are worn during charging and tapping

II. Operators must only wear work clothes in the workplace

III. Shower after every shift and whenever contamination risks have been high

IV. Change into clean work-wear every day or shift

V. Avoid procedures that generate high levels of exposure

VI. Segregate working and clean eating areas

VII. Keep eating and drinking areas clean and lead free

VIII. Wash hands and face prior to eating at work

IX. Keep homes clean and lead free, do not take work-wear home

X. Do not smoke in a lead recycling plant