# BASEL CONVENTION

## *"MOBILE PHONE PARTNERSHIP INITIATIVE"*

# GUIDANCE DOCUMENT

## ENVIRONMENTALLY SOUND MANAGEMNT OF USED & END-OF-LIFE MOBILE PHONES

**Second Draft**: June 15, 2005

# TABLE OF CONTENTS



## APPENDICES

## LIST OF FIGURES

## Abbreviations used in this Guidance Document:

| | |
|---|---|
| BAT | Best Available Technologies |
| BEP | Best Environmental Practices |
| BCRC | Basel Convention regional Centers |
| COP | Conference of Parties |
| DBBE | Decabrominated Biphenyl Ether |
| DfE | Design for the Environment |
| EMAS | European Eco Management Audit Scheme |
| EMC | Electromagnetic Compatibility |
| EMF | Electromagnetic Fields |
| EMS | Environmental Management System |
| EPR | Extended producer Responsibility |
| ESM | Environmentally Sound Management |
| EU | European Union |
| IEEE | Institute of Electrical and Electronics Engineers |
| ISO | International Standard Organization |
| LCT | Life Cycle Thinking |
| MPPI | Mobile Phone Partnership Initiative |
| MPWG | Mobile Phone Working Group |
| OECD | Organization for Economic Cooperation and Development |
| PPE | Personal Protective Equipment |
| RF | Radio Frequency |
| RoHS | Restriction of the Use of Certain Hazardous Substances |
| SAR | Specific Absorption Rate |
| TCLP | Toxicity Characteristic Leachate Procedure |
| TM | Transboundary Movement |
| UNEP | United Nations Environment Programme |
| WEEE | Waste Electrical and Electronic Equipment |

# 1.0 Introduction[1]

## 1.1 Purpose of the Guidance Document

This Guidance document summarizes the information contained in technical reports prepared by project groups 1.1, [2.1], 3.1,and 4.1A.The purpose of this guidance document is to provide information on how to manage used and end-of-life mobile phones from the time they are collected up to and including their refurbishment, material recovery and recycling. It should be considered as a complement to technical reports that were prepared by various project groups. The guidance document also addresses the issue of design considerations and rules that apply to transboundary movement of refurbished mobile phones destined for reuse, and those used and end-of-life mobile phones shipped for refurbishment, recovery and recycling. This guidance document, along with individual project reports, should be used to raise awareness of and to further implement good practice activities associated with different stages of environmentally sound management of used and end-of-life mobile phones. It can be used to transfer of current know how on: collection and transboundary movement of used and end-of life mobile phones, refurbishment of used mobile phones, and best practices for material recovery and recycling. As such the guidance document provides information for training to oversee the successful implementation of recommendations as developed by various project groups established under the Mobile Phone Partnership Initiative (MPPI). This information can be used by the Basel Convention Regional Centers (BCRC) to develop training material on different issues that have been covered in this guidance document, and to implement these via regional workshops.

The guidance document contains a modified introduction, taken from the project 4.1A report, executive summaries and recommendations from each of the individual technical reports, which have been adjusted to suit the objective of the overall guidance document. It provides guidance for the environmentally sound management (ESM) of used mobile phones with emphasis on reuse and recycling, and thereby diverting such end-of life products from final disposal operations such as landfills or incinerators. It is being developing in accordance with the decision reached during the of the MPWG meeting of the seventh meeting of the Conference of the Parties (COP 7) to the *Basel Convention,* and decision VII/4.

To these ends, this guidance document provides a general guidance with considerations pertaining to environmentally sound management of end-of-life mobile phones that include: collection, processing, refurbishment, recovery and recycling. It also provides guidance on reducing or eliminating releases to the environment from waste disposal and treatment processes. It is noted that each of these operations will employ best available techniques (BAT) and best environmental practices (BEP), so that any releases of toxic substances would be prevented or minimized.

Those who wish to implement environmentally sound practices for used and end-of-life mobile phones should also make use of these detailed technical reports, which are available from the Secretariat of the Basel Convention.

## 1.2 General provisions of the Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted on 22 March 1989, and entered into force on 5th of May, 1992. The Basel Convention emphasizes, amongst other principles, environmentally sound management of hazardous wastes, which is defined as taking all practicable steps to ensure that hazardous wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes. The Convention stipulates a number of objectives, including the following:

- The reduction of transboundary movements of hazardous and other wastes subject to the Basel Convention;
- The prevention and minimization of the generation of hazardous wastes; and
- The active promotion of the transfer and use of cleaner technologies.

These objectives are supported by a regulatory system for the monitoring and control of hazardous wastes that has been set up, and is displayed in the full text of the Convention. Some of the key elements of the regulatory system of the Basel Convention are: prior notice and informed consent, the prohibition to export to a country which is not contracting Party to the Convention, and the legal provisions for duty to re-import and the responsibility of Parties involved in the transboundary movements. One of the provisions under the Basel Convention, which places an obligation on the state of export to provide an advance notification and obtain approval from the importing and transit countries before any shipment of hazardous waste is initiated. It should be recognized that any country has the sovereign right to ban the entry or disposal of foreign hazardous wastes and any other wastes in its territory. In addition countries of export and import are required to assure themselves that wastes destined for final disposal or recycling will be managed in an environmentally sound manner. All transboundary movements should not be allowed to proceed if the exporting and importing countries believe that the wastes in question shall not be managed in an environmentally sound manner. Finally, each shipment of hazardous waste or other waste shall be accompanied by a movement document from the point at which a transboundary movement begins to the point of disposal**.** Once consents have been obtained, wastes must be transported with the appropriate packaging and labelling as required by international transportation rules (i.e. UNTDG).

Another provision in the Convention is the Article 11, which deals with other bilateral or multilateral agreements covering the control of transboundary movement of wastes. The Convention itself contains a provision that prohibits Parties to the Convention to trade in hazardous wastes and hazardous recyclables with non-Parties, unless there is an Article 11 agreement. This was introduced to prevent Parties from engaging with countries that do not adhere to rules and principles established by the Convention. Under Article 11.2, Parties are allowed to enter into bilateral agreements with non-Parties as long as such agreements do not derogate from the environmentally sound management of hazardous wastes as required by the Convention and that such agreements or arrangements stipulate provisions which are not less environmentally sound than those provided for by the Convention, in particular taking into account the interests of developing countries. These agreements or arrangements are to include: consistent scope of coverage, prior notification and consent, prohibition of shipments without consent, efforts to reduce transboundary movements, use of authorized facilities that operate in an environmentally sound manner, prohibition of exports where the country of import has prohibited such imports, shipments by only authorized persons, alternate measures for stranded shipments, and the use of tracking documents (as per Decision II/10 Annex).

## 1.3 What is Mobile Phone?

A mobile phone (sometimes called a cellular phone or a cell phone) is a small, sophisticated personal two-way radio. It sends and receives radio signals, carrying voice in personal communications with other mobile phones, and telephones. Mobile phones serve not just as a personal luxury or an addition to traditional line telephones, but also as a primary means of communication in areas of the world where a wired communication infrastructure is not in place.

Attention to design of a mobile phone for environmental considerations must begin with recognition of the dramatic evolution of that design over the last three decades. To be sure, the mobile phone manufacturers have responded primarily to the demands of consumers, usually for non-environmental reasons, but many of the changes have also had beneficial environmental effects.

The first and strongest demand of consumers was for greater portability. The first mobile phones were so large and heavy that they were usually installed only in motor vehicles, wired into their electrical systems. The first generation of truly portable phones was still large and heavy; they contained lead acid batteries, came with carrying bags with shoulder straps, and weighed upwards of 4 kg. But these devices progressed steadily to smaller, lighter models in the 1980s, and today mobile phone handsets typically weigh 100g or less, and are powered by a small battery.

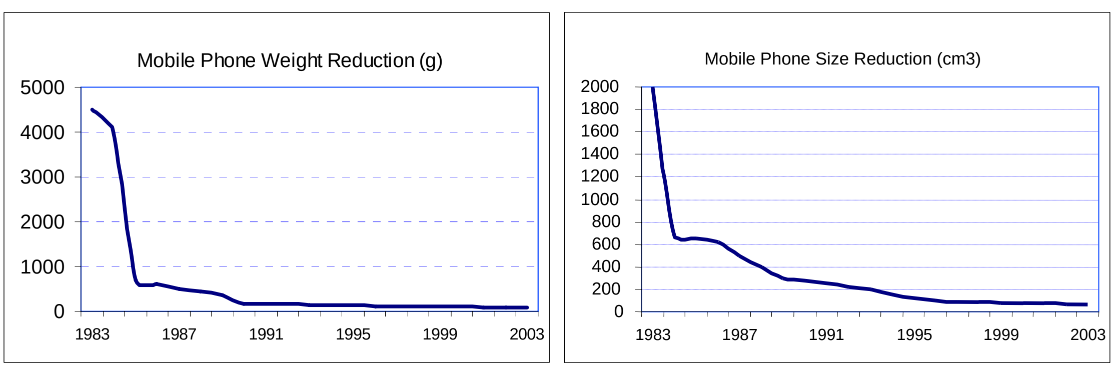



Figure 1: Weight and Size Reduction Chart

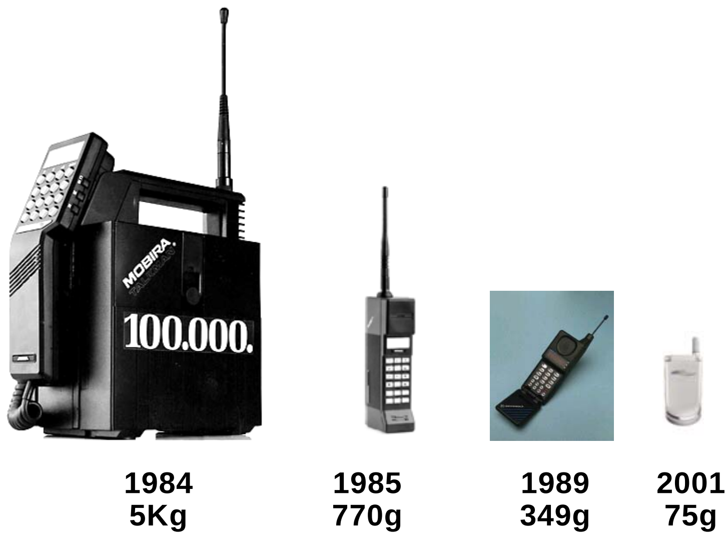



Figure 2: Weight and Size Reductions of Mobile Phones[2]

It is useful to know, in a general sense, how a mobile phone is made, and what it contains. Mobile phones are similar in composition to other electronic devices, made up of plastics, metals, ceramics and glass, materials as shown below in Figure 3. In more general terms, a mobile phone is made up of these basic components:

- A handset, which includes: a case (usually plastic), display or screen, monochrome or color, with a glass cover, keypad, and an antenna;
- A printed wiring board, which is inside the handset case, with integrated chips, resistors, capacitors and wires, making up the electronic brains of the phone;
- A battery;
- A microphone and a speaker.

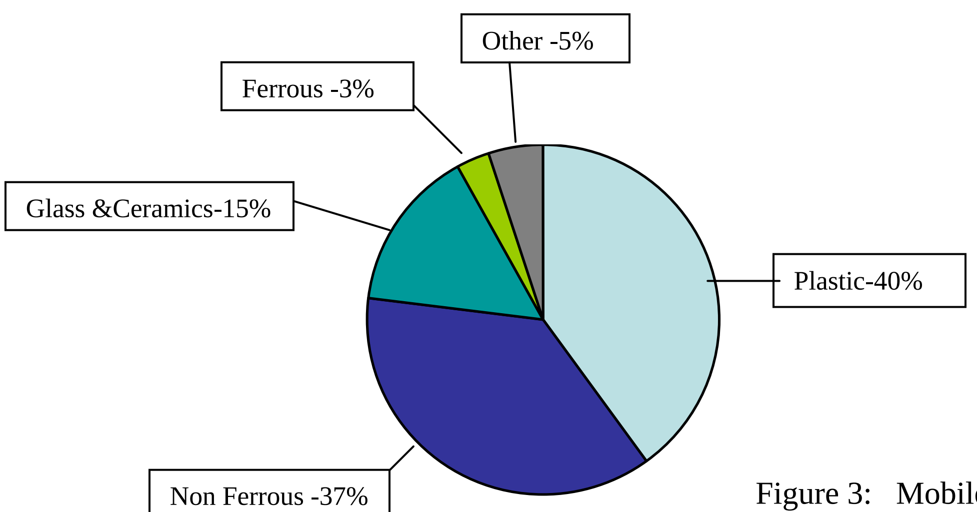



Figure 3: Mobile Phone Composition

None of these parts are particularly different from the parts of other electronic devices, such as computers or portable consumer electronic devices, either in their constituents or the way that they are made, except, of course, that they are quite small.

Mobile phones differ from manufacturer to manufacturer, and from model to model. Thus the substances in any mobile phone will be somewhat different from the substances in another. The following table identifies primary constituents, minor constituents, and micro constituents in a mobile phone. (Note that not all substances are used in every mobile phone, e.g. nickel or lithium battery, so numbers will not add to 100 %.)

| | |
|---|---|
| Plastics | 40% |
| Glass & Ceramics | 15 % |
| Copper and compounds | 15 % |
| Nickel and compounds | 10 % |
| Potassium Hydroxide | 5 % |
| Cobalt | 4 % |
| Lithium | 4 % |
| Carbon | 4 % |
| Aluminum | 3 % |
| Steel, ferrous metal | 3 % |
| Tin | 1 % |
| Minor (Br,Cd,Cr,Pb,Mn,Ag,Ta,Ti,W,Zn) | < 1% |
| Micro (Sb,As,Ba,Be,Bi,Ca,F,Ga,Au,Mg, Pd,Ru,Sr,S,Y,Zr) | < 0.1% |

A more detailed list of substances that are used in mobile phones can be found in Appendix 2.

This guidance document also considers accessories of mobile phones that are no longer used, which includes a battery charger, and it may include a carrying case, a separate speaker set in an earplug, a separate microphone, and other small devices that connect to the handset.

The battery of a mobile phone, contained in its own sealed plastic case, is removable from the mobile phone, and is one of three types, each named for the chemistry of the battery's active substances: lithium-ion – using a lithium-cobalt compound, or lithium-polymer, a similar battery chemistry, with a different electrolyte; nickel-metal-hydride – using a nickel hydroxide compound; or nickel-cadmium – using cadmium, which is an older type of battery chemistry with less energy density than lithium-ion and nickel-metal-hydride. It is rarely used now, but it is present in older phones that are still in use.

Everything in a mobile phone is solid-state – there are no moving parts or liquids that might be released in normal use. But it does contain small amounts of some substances that are hazardous, and that might be released into the environment if the phone is mismanaged at the end of its life. Exposure to substances of concern when managing end-of-life mobile phones is shown in Appendix 3.

## 1.4 Why mobile phones were selected for the first partnership?

The mobile phones were selected for the first partnership under the Basel Convention because:

- People in all countries can relate to this high-visibility product;
- Technology has global application;
- Recovery of electronic and electrical equipment is highly topical issue; and
- Limited number of mobile phone manufacturers, facilitating consensus-based project management.

Furthermore, all stakeholders have recognized the waste management challenges that are presented by large volume of mobile phones, even though it is a very small part of the total waste burden in civil society. The average citizen of an OECD member country generates 500 kg of waste per year,[3] the equivalent of five thousand mobile phone handsets. The European Commission has estimated that all electrical and electronic waste is about 4% of municipal waste,[4] for a total annual volume of six million tonnes in 1998 in the EU, with a projected doubling in twelve years.[5] Analysis of electrical and electronic waste collected in Switzerland indicates that mobile phones are only 0.12% of collected WEEE.[6]

However, the use of mobile phones has grown exponentially, from the first few users in the 1970s to 1.16 billion in 2002,[7] as shown below in Figure 4. It is growing to an anticipated nearly two billion in another five years,[8] and this growth creates waste when such phones reach their end-of-life. Sooner or later, all of them have to be discarded. And it is more often sooner, as mobile phones are usually taken out of use well before they cease to operate.[9] They are replaced by new phones because their owners want newer features, or the older phones are incompatible with new service carriers.

But this is not to say that mobile phones can be neglected at their end-of-life. While the size of an individual mobile phone is small their cumulative size is substantial. The total mass of all mobile phones that are produced worldwide is tens of thousands of tonnes per year, and with accessories there are tens of thousands of tonnes more. The fastest-growing market for new and used mobile phones takes place in many developing countries.

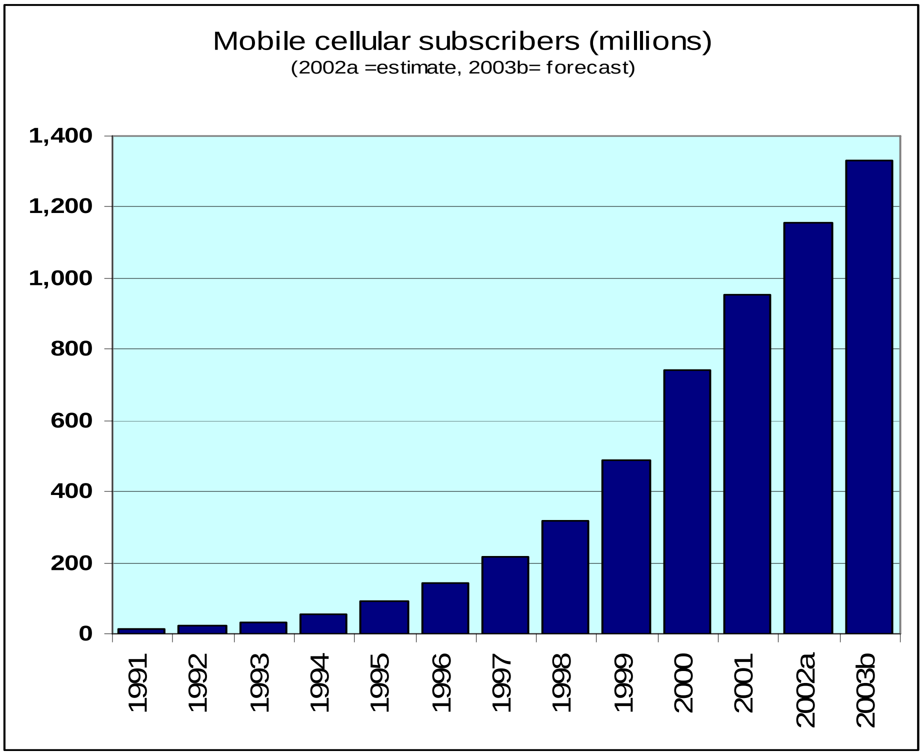



Figure 4: Mobile Phone Subscribers
Source: International Telecommunications Union (www.itu.int)
Key indicators of world telecommunications, 1991-2003

Also, one should remember that although mobile phones present no environmental or human health hazard in ordinary use, hazardous substances can be released into the environment from landfills, incinerators and recovery and recycling facilities if the phones are not properly handled. Special attention is needed by developing countries because these countries are not as likely to have adequate resources and waste management infrastructures to ensure used mobile phones are being managed in an environmentally sound manner. The mobile phones thus need to be managed in an environmentally sound way in order to minimize releases into the environment and threats to human health.

## 1.5 The Mobile Phone Partnership Initiative

As a reminder, some of the Basel Convention's goals include: waste prevention and minimization, reduction in transboundary movement, and environmentally sound management of waste to protect human health and the environment. Environmentally Sound Management, or ESM, is defined as "taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes."[10] The Basel Declaration on Environmentally Sound Management,[11] adopted in 1999, and the Strategic Plan of the Convention,[12] adopted in 2002, calls for establishment of partnerships between governments, industries and other non-governmental organizations to ensure practical application of environmentally sound management. Sustainable partnership is an important complement to, and not a substitute for, government actions.

Representatives of the world's foremost manufacturers of mobile phones - LG, Matsushita (Panasonic), Mitsubishi, Motorola, NEC, Nokia, Philips, Samsung, Siemens and Sony Ericsson – promptly responded to that call and in December 2002, at the sixth meeting of the Conference of the Parties to the Basel Convention, signed a declaration on sustainable partnership on the environmentally sound management of end-of-life mobile phones. They agreed to work with the Secretariat of the Basel Convention and joined with Parties and Signatories to the Convention to form the MPPI.

The overall objective of the MPPI is to promote the objectives of the Convention in the area of the environmentally sound management of end-of-life mobile phones. In particular, it should:

- Achieve better product stewardship;
- Influence consumer behavior towards more environmentally friendly actions;
- Promote the best re-use, refurbishing/material recovery/recycling/disposal options;
- Mobilize political and institutional support for environmentally sound management.

As such the Mobile Phone Working Group (MPWG) was established, with a mandate to elaborate its terms of reference and to propose a concrete work program. In developing its work program, MPWG took into consideration a number of waste management principles such as:

- Prevention and Minimization of waste at production stages, by implementing no-waste or low-waste technologies;
- Reduction of hazardous substances in processes and products;
- Reduction of waste requiring final disposal through environmentally sound reuse, recovery and recycling; and
- Environmentally sound final disposal of those wastes which can not be recovered or recycled.

In April of 2003 the MPWG discussed these issues[13] and decided to set up four projects to address its work program:

**Project 1: Reuse of Used Mobile Phones.** This project was to address the preferred option for used mobile phones, i.e., continue its life through reuse. The group responsible for this project is to develop a guidance document that is intended to encourage companies, which refurbish used mobile phones, to implement practices in an environmentally sound manner which will protect human health and the environment. It should facilitate a process whereby products re-entering the market comply with applicable technical performance standards and applicable regulatory requirements.

**Project 2: Collection and Transboundary Movement of Used Mobile Phones.** This project is to review successful collection schemes, including initial sorting of collected phones, separation of those that can be reused (with or without refurbishment) from those that are suitable only for material recovery and recycling. The group responsible for this project is to provide advice on programs, legislation and/or regulations for an effective collection of used and end-of-life mobile phones. The information should also provide the basis for setting up pilot projects of different collection and treatment schemes in selected regions. The group is also to review rules that may apply to transboundary movement of used and end-of-life mobile phones.

**Project 3: Recovery and Recycling of End-Of-Life Mobile Phones.** This project is to address environmentally sound processing of mobile phones for material recovery and recycling, beginning with the separation of handsets, batteries, and peripherals, and directing these materials to proper specialized facilities for treatment and recovery of constituents such as plastics and metals. The group responsible for this project is to develop a guideline on environmentally sound recovery and recycling of end-of-life mobile phones.

**Project 4: Awareness Raising and Training- Design Considerations.** This project is to address outreach efforts of manufacturers to promote design improvements that would assist in ensuring that end-of-life mobile phones are being managed in an environmentally sound manner. It covers such issues as: environmental improvements made in mobile phones since their invention, best practices currently employed by manufacturers, and recommendations for incorporating environmental considerations into design. The report, produced by this project group, should raise awareness of existing good practices, as well as provide environmental recommendations to be considered by mobile phone designers.

# 2.0 Design Considerations[14]

The purpose of this chapter is to raise awareness of environmental design issues of mobile phones. It recognizes the significant progress made by manufacturers in reducing the environmental impact of mobile phones over the past fifteen years, and those improvements that are currently being implemented. The future promises even greater and widespread use, with multiple new hardware and software technologies, all of which require Life Cycle Thinking to prepare for their manufacture, lifetime use, and end of life.

The project was to identify barriers and opportunities, and to challenge manufacturers to go beyond current thinking and to continue to implement improvements in the environmental design of mobile phones**.** It looked at the evolution of design changes since the introduction of modern mobile phone in the 1980s, such as dramatic reductions in weight and changes in battery chemistry, and the end-of-life environmental impacts of those design changes. It also considered current forces driving environmental design changes – substance restrictions and bans such as the European Union's Directives on the *Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS)* and *Waste from Electrical and Electronic Equipment (WEEE)* [15], as well as continuing customer environmental demands – and the mobile phone manufacturers' ongoing responses.

## 2.1 Executive Summary

It is recognized that, in fact, much progress has already been made in the design of mobile phones. Mobile phone design has changed dramatically since its beginning three decades ago as shown in section 1.3 of this Guidance Document. Its overall environmental impact is much less than before, in its use of material resources, its use of energy, and its end-of-life impacts. But while those changes were being made, the design must now take a view toward easing the collection reuse, refurbishment and recycling of hundreds of millions of used and end-of life mobile phones each year. It can help by incorporating reuse and recycling information in product marking, labeling of internal software, as well as moving toward further reduction of hazardous substances. In doing so it will make reuse, refurbishment, material recovery and recycling easier and extending the life of products. The Basel Convention itself has obligated its members to ensure that generation of hazardous wastes is reduced to a minimum (Article 4.2), and product design can play a significant role in achieving this goal. The most direct government mandate that presently affects the design of mobile phones is the European Union's RoHS Directive, which will ban six substances (lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls, and polybrominated diphenyl ethers)[16] from electrical and electronic devices, including mobile phones that are placed on the EU market after 1 July 2006. Of the six substances banned by the RoHS Directive, four of them - cadmium, mercury, hexavalent chromium, and polybrominated biphenyls - have no essential function in mobile phones and are not normally used, or can be easily replaced. Lead, however, has been more difficult to replace, and is still widely used as the most effective solder. But the major mobile phone manufacturers have long sponsored fundamental research and co-operative work with suppliers to identify lead-free and brominated fire retardants free alternatives that can maintain the quality and reliability needed in hand-held electronics.[17] This early work has resulted in some manufacturers producing mobile phones which use neither lead nor brominated fire retardants, and there are already mobile phones on the EU market and beyond, that meet the substance requirements of the RoHS Directive. Furthermore, some of these substances are also of concern in the material recovery and recycling operations, because they may be released into the environment during some recycling processes, and therefore must be managed in an environmentally sound way.

Additional improvements in the design stages and reduction of hazardous substances are required so that management of used and end-of life mobile phones could be facilitated and enhanced. This should be part of Life Cycle Thinking (sometimes called Life Cycle Approach), a concept to be applied by all manufacturers, so that personal communications, via mobile phones, will be environmentally sustainable for the future. It is not just a design concept. Figure 5, below, shows the steps that are taken when Life Cycle Thinking is applied to product design. Beginning with experience from previous products, knowledge of current material restrictions (such as the RoHS Directive), and general Design for Environment guidelines, a designer can set targets for improved environmental performance. Then, using software tools, the designer can quickly see how a product will affect energy consumption, resource depletion, greenhouse gas production, air pollution, toxicity etc. By trying different design solutions and inputting data to the software models, designers can visualize and assess how different material choices and manufacturing techniques change the environmental profile of their products.

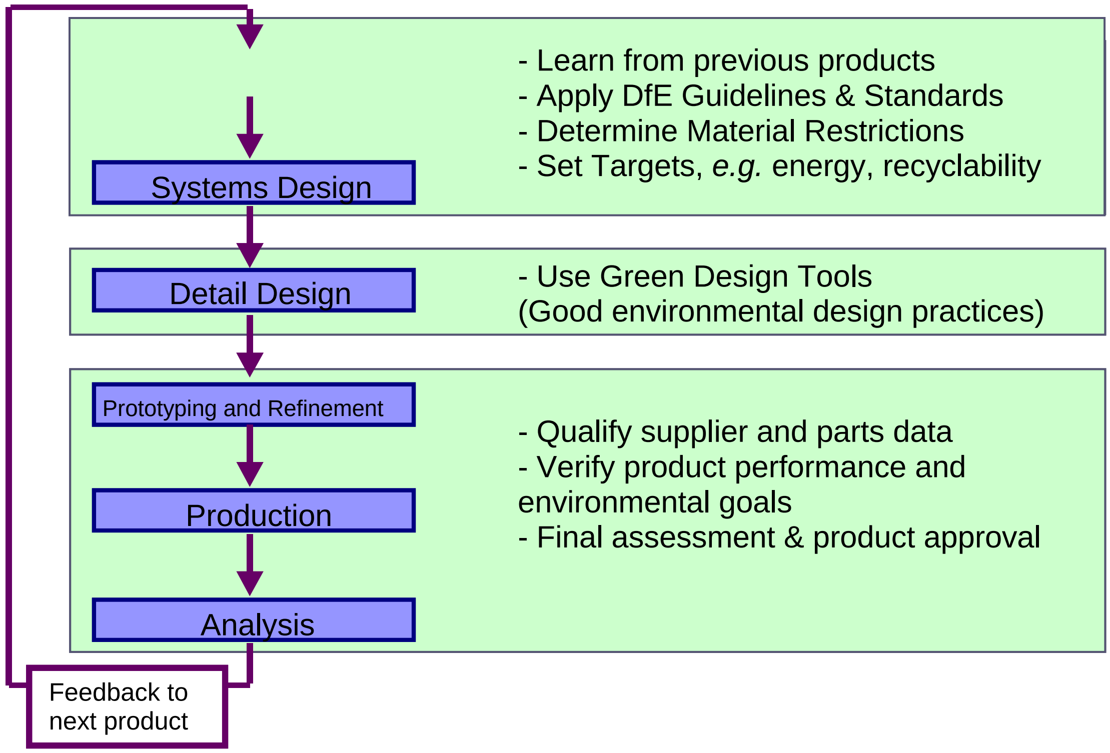



Figure 5: Steps in Life Cycle Thinking - Design

In addition, the Extended Producer Responsibility (EPR) concept is gaining global popularity, where producers take steps to properly manage their products at the post-consumer stage. It involves both sustainable product design (use of less toxic materials, use of recycled and recyclable materials, upgrade potential, and ease of disassembly for repair and recycling) and participation in takeback/recycling programs. It recognizes that manufacturers are in the best position to control the longevity, content, and recyclability of the products they design and market, and that is why this concept should be promoted. Finally EPR can be seen as an extension of the life cycle thinking, which is already applied by all manufacturers (Figure 5, above).

We all recognize the environmental achievements that mobile phone manufacturers have already made. It is clear that some manufacturers have been particularly proactive in their environmental thinking. We also recognize that some technical differences among mobile phones are legitimately based upon valuable proprietary innovations, special expertise of individual manufacturers, and differing needs of consumers. But some technical incompatibilities appear to be unnecessary, and give rise to generation of waste. This unnecessary generation of waste can be reduced or eliminated through design changes in mobile phones, either by making them compatible, through hardware or software, with all technical transmission technologies, or by incorporating a modular component that can be easily changed in order to make the mobile phone adapt to different transmission technologies.

Furthermore, a low energy mobile phone is desirable. A very energy-efficient handset will facilitate a wider choice of battery technologies, as well as renewable energy battery

charging sources such as solar cells and muscle power. Battery chargers are inefficient, and energy used to charge mobile phone batteries, even when they are fully charged but still connected to chargers (stand-by mode), greatly exceeds the energy used by those batteries in actual use.[18] A very low energy mobile phone could also reduce or eliminate the need for flame retardants.
Finally, it should be mentioned that the current rates of reuse, material recovery and recycling of mobile phones are quite low. As such any design improvement, as those mentioned above, should enhance material recovery and recycling options. In addition, recycling of mobile phone plastics for production of new plastics presently faces several barriers. An engineered plastic such as acrylonitrile butadiene styrene - polycarbonate (ABS-PC), which is used in mobile phone cases, should have positive economic value as a recyclable material. However, it is only true if it is collected in a reasonably large volume, and is free of other substances that would make it unsuitable for recovery processes. In addition, the presence of a brominated flame retardant may reduce the resale market and price for recovered ABS-PC, because many potential buyers do not want a flame retardant to be present.

Several major brandowners of electronic products have identified that they are committed to developing, financing and administering a country-wide program to divert e-waste from disposal by ensuring that it is properly recycled. This concept, commonly referred to as Extended Producer Responsibility (EPR), places the onus on producers to properly manage their products at the post-consumer stage. As an example, EPR has rapidly gaining much popularity in Canada and in other parts of the world, because it has a potential to stimulate producers to design longer-lasting, less hazardous, and more recyclable products. In Canada, EPR has already been applied to target a broad range of post-consumer product streams such as used oil, scrap tires, batteries, beverage containers and packaging.

Extended Producer Responsibility recognizes that brandowners and manufacturers are in the best position to control the longevity, content, and recyclability of the products they design and make. The application of Extended Producer Responsibility gives an incentive to manufacturers to design their products to minimize costs involved with a wide range of end-of-life management, including collection and recycling.

## 2.2 Recommendations

The project group 4.1A put forward a number of recommendations dealing with design considerations:

### 2.2.1 Transmission Technology and Hardware Incompatibility.

1. The unnecessary generation of waste should be reduced or eliminated through design changes in mobile phones, either by making them compatible, through hardware or software, with all technical transmission technologies, or by incorporating a modular component that can be easily changed in order to make the mobile phone adapt to different transmission technologies.

2. Manufacturers of mobile phones should take steps to eliminate waste caused by unnecessary transmission technology incompatibility. Effort should be made to adopt a single transmission technology protocol throughout the world, and design all new mobile phones in accord with such a universal standard.

3. A battery charger may weigh more than the handset, so this incompatibility can result in more than double the amount of waste generated at a mobile phone's end of life.[19] Again we note that some manufacturers have addressed this area of incompatibility by making a small number of chargers applicable to a broader range of their mobile phones. It is recommended that these efforts continue by all mobile phone manufacturers, and that they be expanded to a wider range of suitable devices within each manufacturer's product line, and also among the different manufacturers.

4. It is recognized that the charging of a battery, particularly a lithium-ion battery, requires care and special electronic circuitry to avoid damage, and that each manufacturer's concerns about brand quality and warranties are involved in possible cross-brand utilization of battery chargers and peripherals. It is nevertheless recommended that this area of potentially beneficial compatibility be investigated both within brands and among brands

### 2.2.2 Energy Use

5. Further efforts should still be made to design more energy efficiency phones, especially as phones support more functions. Energy consumption of handsets in actual use should continue to be reduced, through increasingly efficient electronic components.

6. Although energy consumption of battery chargers has been reduced by some manufacturers, it needs to be reduced further across the mobile phone manufacturing industry, through additional design improvements to reduce its inefficiency.

### 2.2.3 Design of Mobile Phones with Reuse, Material Recovery and Recycling in mind.

7. Manufacturers should continue to consider reuse and (if necessary) repair and refurbishment in their design changes, to facilitate repeated use by multiple consumers, and a much longer life before disposal.

8. The design changes should take into consideration material recovery and recycling, as it can have a significant impact upon material recovery and recycling at the end of a mobile phone's useful life. During the design phase manufacturers

should take into account issues of increased recyclability and reduction in toxicity.

9. The mobile phone designers and manufacturers should work specifically toward the goal of recovery of plastic mobile phone cases in order to recycle them. Elimination of paints for coloring, and substitution of pigments within plastic, will further improve material recovery and recycling economics for the separated plastic cases, because plastic with different pigments (but not paints) can be mixed and recovered as black plastic, which has a large market share. Furthermore, consideration should be given to greater consistency in material selection during the design stage for all mobile phones, which would allow plastics recyclers to eliminate sorting steps necessary to achieve compatibility of plastics types.

10. Beryllium and brominated flame retardants have has been identified as substances of concern during the processing of end-of-life mobile phones. Manufacturers should consider substituting beryllium in copper alloys, and brominated flame retardants in plastics used in mobile phones, with available alternative alloys or other materials that perform the same function.

11. Reusable parts such as fuel cell cartridges, soon to be used in mobile phones, can be designed and made for very long, widespread use and systems need to be put in place for their recovery and reuse.

### 2.2.4 Hazardous Substances.

12. Manufacturers should always take into account the likelihood of some environmental and human risk in the management and mismanagement of their mobile phones at end-of-life. Furthermore, it is recommended that manufacturers investigate the feasibility of replacing all toxic substance with benign substitutes.

13. Manufacturers should communicate with users, recyclers and others to determine such circumstances and exposures, and then set priorities among such hazardous substances, taking into consideration those six substances: lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls, and polybrominated diphenyl ethers, which have been banned by European Union RoHS Directive, for replacement, where possible, with alternatives that are more benign and fulfill the same functions.

14. It is recommended that all manufacturers require, by explicit contract terms and conditions, that all suppliers disclose the substances used in component parts and sub-assemblies, and comply with specifications set by the manufacturers for substances banned or restricted from use.

### 2.2.5 Life Cycle Thinking.

15. Manufacturers are to adopt Life Cycle Thinking, and apply it at the design phase of a mobile phone, which has arguably the greatest contribution to make to reduce environmental impacts during its lifetime.

16. Small and large manufacturers to continue to be involved in research activities to improve opportunities for material recovery and recycling of end-of-life mobile phones, and to improve environmental performance through a longer lifetime.

17. In applying the Life Cycle Thinking in product design, the manufacturers have identified a number of opportunities for improvements that should help refurbishment, material recovery and recycling of used and end-of-life mobile phones:

(A) To facilitate disassembly and separation of handsets:

- Minimize the steps necessary for disassembly;
- Minimize use of welds and adhesives;
- Reduce the variety and number of connections (*e.g.* fasteners and screws);
- Minimize the number of tools required for disassembly;
- Use re-openable snap fits for joining of plastic parts;
- Use designs that facilitate removal of modules for reuse;
- Use advanced materials for active disassembly.

(B) To facilitate production of new plastics:

- Limit the plastic types used throughout a mobile phone;
- When different plastics must be used, use combinations that are compatible with respect to material recovery and recycling;
- Mark plastics with plastic type labels;
- Avoid non-recyclable composites and coatings;
- Avoid incompatible coatings;
- Use molded-in colors and finishes on plastics, rather than paints;
- Avoid adhesive -backed labels, stickers or foams;
- Use labels and marks made from the same or compatible material used elsewhere in the product;
- Avoid metal inserts in plastic parts;
- Eliminate use of brominated flame retardants.

C) To facilitate recovery of metals:

- Eliminate or reduce use of hazardous substances.

# [3.0 Collection and Transboundary Movement[20] ]

## 3.1 Collection

The sub-chapter on collection schemes deals with assessment of best practices of collection schemes for used and end-of-life mobile phones. It reviews successful collection schemes, including initial sorting of collected phones, separating those that can be reused (with or without refurbishment) from those that are suitable only for material recovery and recycling. It identifies best practices, effective funding and logistics in setting up national/regional/international collection schemes for used and end-of-life mobile phones, especially in developing countries and countries with economies in transition. Furthermore, it is intended to encourage countries to set-up collection schemes that best suits their need so that most of, if not all, used and end-of-life mobile phones are being collected and diverted from final disposal operations such as municipal landfills (see Annex 7). In most cases such landfills are not equipped to deal with some of hazardous substances in mobile phones, as these substances could be released to the environment via leachate.

Finally, it provides guidance on environmental and health issues during the collection and storage of used and end-of-life mobile phones before they are being directed to refurbishment or material recovery and recycling facilities. It is geared for use by: environmental and other regulatory agencies and authorities, any organization that is interested in setting up a collection scheme for used and end-of life mobile phones, manufacturers, network operators, refurbishment and recycling facilities. Finally, this information should be of value to consumers who are required to take their used phones to collection centers.

### 3.1.1 Executive Summary

The project group 2.1 continues to deliberate this issue, and the work on collection is not finished

### 3.1.2 Recommendations

The project group 2.1 continues to deliberate this issue, and the work on collection is not finished

## 3.2 Transboundary Movement

This sub-chapter reviews the rules that are applicable to transboundary movement of used and end-of-life mobile phones. It provides guidance on implementation of control systems for transboundary movement of refurbished mobile phones destined for re-use and for transboundary movement of used and end-of-life mobile phones destined for refurbishment, material recovery and recycling.

It is geared for use by: environmental and other regulatory agencies and authorities, manufacturers, network operators, refurbishment and recycling facilities and any organization that is interested in the export or import of refurbished mobile phones for reuse, or those destined for refurbishment, material recovery and recycling facilities.

### 3.2.1 Executive Summary

The project group 2.1 continues to deliberate this issue, and the work on transboundary movement is not finished

### 3.2.2 Recommendations

The project group 2.1 continues to deliberate this issue, and the work on transboundary movement is not finished

# 4.0 Refurbishment of Used Mobile Phones[21]

This chapter deals with refurbishment of used mobile phones. It is intended to encourage companies that refurbish, repair and recondition used mobile phones to implement environmentally sound practices, which will result in the protection of human health and the environment. It is also intended to facilitate a process whereby mobile phones re-entering the market, to be reused, comply with applicable technical performance standards and applicable regulatory requirements.
It is stated in the technical guidance document, prepared by project group 1.1, that any refurbishment facility, that disassembles and or changes any part of the mobile phone (component, software or accessory), shall be responsible for the quality of the introduced component and workmanship of the activities carried out. When making any changes, the refurbisher shall make sure and take responsibility for ensuring that the product meets all relevant regulatory requirements relating to the market into which the product is to be resold. These shall include, but not be limited to telecom standards, product safety, EMC (electro magnetic compatibility), EMF (electro magnetic field) exposure limits (i.e. SAR) and producer responsibility.

## 4.1 Executive Summary

In this chapter information is provided on how to achieve high refurbishment standards, so that used mobile phones can be reused, and therefore extending their life. It is intended to encourage companies that refurbish or repair used mobile phones to implement practices in an environmentally sound manner, which will protect human health and the environment. In doing so, it should facilitate a process whereby products re-entering the market comply with applicable technical performance standards and applicable regulatory requirements.
The technical guidance document (prepared by project group 1.1) and this chapter deal with issues such as: product handling, evaluation and refurbishment(storage, cleaning of used mobile phones, disassembly, soldering, reassembly, use of authorized software, compliance with import requirements); handling and management of components and materials removed from used mobile phones; administrative measures and record keeping; plans to meet the objectives of environmentally sound management; relevant waste management permits, licenses, or other authorizations required by their countries regulatory authorities; training of personnel; inspections and monitoring; and providing guidance for the remarketing of refurbished mobile phones (compliance with operational standards, labeling requirements, compliance with import requirements).
The information should also assist those individuals, companies or agencies involved in collection schemes, transportation of used and refurbished mobile phones, and consumers who use the refurbished mobile phones Finally, any organization that is involved in buying or selling mobile phones for reuse should also find this information useful.

## 4.2 Recommendations

The project group 1.1 put forward a number of recommendations dealing with the refurbishment of used mobile phones:

### 4.2.1 Product Handling and Refurbishment

1. Facilities that refurbish used mobile phones should take steps to identify and sort used mobile phones that are to be refurbished from those that should be send to material recovery and recycling facilities due to being damaged, worn out, its age or performance.

2. Care should be taken to ensure that prolonging the life of a mobile phone does not result in the product exceeding the expected life of some of the components in the product (a problem not unique to mobile phones).

3. Refurbishment facilities should store and handle used mobile devices prior to their refurbishment in a manner that protects the mobile phones, and reduces the potential for releases of toxic substances into the environment and injuries to workers.

4. In general, only benign cleaning solutions should be used to clean used mobile phones. If not, refurbishers should use cleaning solutions in an environmentally sound, efficient and safe manner. Where applicable, local laws and regulations should always be adhered to.

5. When disassembling mobile phones (or components of such phones) the refurbishment facility should ensure the appropriate tools are used where necessary to prevent damage.

6. Care should also be taken to preserve the value of the component or material to a practical extent and protect workers and the environment.

7. Refurbishment facilities should ensure that any solder used during the refurbishment process is compatible with the original solder used within the mobile phone, and remains compatible with any substance restrictions in the destination market. Soldering joints should be of the same condition and quality as contained in the original product. All soldering activities should be undertaken in conformance with occupational health and safety requirements to minimize worker exposure to fumes and dust.

8. Refurbishment facilities should ensure that parts used in the refurbishment of mobile phones including electrical devices, cases and covers are of the type and design that will allow the mobile phones to comply with the rated operational characteristics specified by the original equipment manufacturer.

9. Replacement antennas should have the same part number as the original equipment, or otherwise not alter the mobile phones operational characteristics (including SAR) as specified by the original equipment manufacturer.

10. Replacement batteries should include the same safety circuitry and insulation found with the original equipment.

11. End-of-Life batteries and any associated circuit boards or electronic assemblies containing lead based solders are likely to be considered hazardous waste under the Basel Convention. Those removed during reassembly must be managed in an environmentally sound way and in accordance with the Basel Convention

12. Replacement chargers should include the same safety circuitry, insulation and filtering found with the original equipment.

13. The maximum power level for a particular model must not be exceeded as a result of refurbishment. Technical standards for mobile phones usually specify a maximum power level and an allowable tolerance above and below this nominal value.

14. Facilities should not add or update software for refurbished mobile phones that would change the rated operational characteristics specified by the original equipment manufacturer, as this may affect compliance of the mobile phone with standards for interference or for human exposure to radio frequency transmissions.

15. Where refurbishers are exporting refurbished mobile phones to other countries care should be taken to ensure compliance with the Basel Convention and its decisions (for Parties to the Basel Convention), all applicable laws governing product imports, technical standards, labeling, and health and safety requirements.

16. Used mobile phones resold into foreign markets should be packaged and handled in a manner that is consistent with their planned reuse.

### 4.2.2 Management of Components and Materials Removed from Used Mobile Phones

17. Refurbishment facilities should ensure that components and other materials removed from mobile phones, which are destined for reuse, are handled in a suitable manner that preserves their value.

18. Used mobile phone components and materials, not suitable for reuse, should be managed on site in a manner that preserves their value for materials recovery and energy recovery.

19. In the case of materials that can be used only for purposes of materials recovery and recycling, the facilities should handle the materials on-site so as to protect workers and the environment.

20. The refurbishment facilities should be encouraged to minimize the landfilling of used mobile phone components and materials and arrange for appropriate material recovery and recycling, where practicable.

21. The items removed from used mobile phones may include batteries, electronic components, circuit boards or other items that are likely to be considered hazardous waste under the Basel Convention. Those removed during reassembly must be managed in an environmentally sound way and in accordance with the Basel Convention.

22. Refurbishment facilities should be aware of the Basel Convention guidance documents on "Transboundary Movements of Hazardous Wastes destined for Recovery Operations" and on "Preparation of Technical Guidelines for the Environmentally Sound Management of Wastes subject to the Basel Convention."

23. Refurbishment facilities should handle residual materials on-site in a manner that protects against releases into the environment, and ensures that they are safely transported to an appropriate material recovery, recycling or disposal facility.

24. Facilities should first characterize their process residuals, using testing or by having knowledge of the materials and processes used at the facility.

25. If residuals are to be disposed of, the refurbishment facilities should ensure that the residuals are delivered to landfill or incineration facility that is suitable for the specific residual, properly authorized by relevant regulators, well-maintained, and well-operated.

26. Refurbishment facilities should also be aware of the Basel Convention technical guidelines for the identification and environmentally sound management of plastic wastes and for their disposal, technical guidelines on specially engineered landfill (D5), and the draft technical guidelines for the recycling/reclamation of metals and metal compounds (R4).

27. In the case of domestic movements, refurbishment facilities should ensure that all mobile phones, components (e.g. batteries), and residuals destined for materials recovery and recycling are prepared for shipment and transported in a safe and secure manner that complies with applicable hazardous materials and/or dangerous goods transport regulations of the country and/or region.

28. In the case of transboundary movements, refurbishment facilities should ensure that all mobile phones, components (e.g. batteries), and residuals destined for

materials recovery are prepared for shipment and transported in full compliance with the Basel Convention.

### 4.2.3 Administrative Measures and Personnel Training

29. Refurbishment facilities should maintain records of all mobile phones received and their disposition.

30. Records should be kept for a period that is consistent with relevant national or local regulations and practice.

31. Refurbishment facilities should have systems in place for defining specific ESM objectives, develop plans to meet the objectives, implement such plans, and monitor progress towards achievement of these objectives.

32. Refurbishment facilities should ensure that all of their employees are thoroughly familiar with proper procedures for carrying out their responsibilities during normal facility operations and emergencies.

### 4.2.2.4 Inspections and Monitoring

33. Refurbishment facilities dealing with products that are potentially hazardous to the health and safety of their workers and/or the environment are required to have processes, documented or otherwise, in place to ensure these products are regularly inspected and monitored, as required by regulatory authorities of their country.

### 4.2.5 Compliance with Regulatory, Operational and Import/Export Requirements

34. Refurbishment facilities dealing with products and materials that are defined by their country as being ‘waste’ are required to hold all relevant waste management permits, licenses, or other authorizations required by regulatory authorities of their country.

35. Refurbishment facilities should be in compliance with all applicable local regulations and permits or other authorizations that are related to the environment or human health and safety.

36. Where refurbishers or other parties are exporting refurbished mobile phones, care should be taken to ensure compliance with all applicable laws governing product trade.

### 4.2.6 Guidance for the Remarketing of Refurbished Mobile Phones/Mobile Products

37. Any organization that remarkets used mobile phones should ensure that these mobile phones continue to meet all applicable industry and government standards and requirements, including the original product's rated operational characteristics.

38. A refurbisher or other party who reconditions and repairs mobile phones should ensure that their practices are consistent with applicable telecommunications and other legislation. Labeling may be a requirement and such labeling may be on the mobile phone itself, or in the product packaging as determined by applicable regulations listed above.

39. Any party refurbishing or remarketing a mobile device should inform the subsequent purchaser that the product is used and/or refurbished, and provide contact information (e.g. name, address and telephone number) of the refurbishing entity and/or the company marketing the used or refurbished product. It should be noted that there may be specific labeling requirements via telecommunications or other regulations for such refurbished devices.

# 5.0 Material Recovery and Recycling of the end-of-life Mobile Phones[22]

This chapter provides guidance on best practices for the environmentally sound material recovery and recycling of end-of-life mobile phones. It is presumed that the segregation of those destined for reuse and refurbishment has already taken place. It addresses the recycling of all components of mobile phones, which includes: (1) the handset which is usually: a case (mostly plastic), display screen, keypad, antenna, printed wiring board, microphone and speaker, (2) the battery, (3) the battery charger and (4) other accessories such as: a carrying case, earphones and connecting cables.
It also addresses the adequacy of the present material recovery and recycling infrastructures and their capacity for the handling of the increasing number of mobile phones that will become obsolete and will be directed to material recovery and recycling facilities rather than to landfills, incinerators, or some other form of final disposal. Finally, it includes recommendations to national authorities regarding programs and policies that can be implemented to ensure that material recovery and recycling of end-of-life mobile phones is conducted in an environmentally sound, as well as economically efficient, manner.

## 5.1 Executive Summary

This chapter addresses the exposures and risks to human health and the environment, and notes that particular care is necessary to prevent exposure of workers and general public to substances of concern during material recovery and recycling processes that involve the generation of dust and fumes. Dusts may be generated during the shredding of mobile phones, during the subsequent handling of shredder outputs and during the handling and/or processing of smelter slags. Fumes may be generated during metal sampling and smelting processes, as well as during certain steps in plastic recovery and recycling, such as granulation. It notes that exposures to several substances are of particular concern: beryllium in dusts and fumes, and dioxins and furans generated from the burning of plastics. The potential eexposures to substances of concern when managing end-of-life mobile phones are listed in Appendix 3. This is particularly relevant since mobile phone material recovery and recycling processes, such as smelting, result in the generation of some residues that require disposal.

It is a fact that processing, and recycling of mobile phone handsets focuses on recovery of metals. In Appendix 4, a flow chart shows a process from collection of mobile phones up to recovery of precious metals and other materials. It always includes recovery of copper and precious metals, such as: gold, silver and palladium, due to their value. Some material recovery and recycling processes also result in the recovery of materials such as steel, aluminum/magnesium, tin, cobalt, lead and plastics, amongst others. Batteries, which must always be removed from the handset in the early stages of any environmentally sound material recovery and recycling process, can be safely recycled to recover iron, aluminum, copper, nickel, cobalt and cadmium, depending upon the battery type as well as the particular recovery process. A prerequisite step in the material recovery and recycling of mobile phones is the manual separation of batteries, in order to minimize contamination of other materials in subsequent material recovery and recycling stages as well as to maximize recovery of the substances contained in the batteries. Manual separation may also be used to separate certain accessories from mobile phone handsets and, in some cases, plastic parts may be separated for recycling. Mechanical separation, including shredding, crushing and size reduction followed by various separation techniques, can also be used. However, if these mechanical means are utilized, only devices that are designed for the processing of electronic scrap should be used, so that the loss of precious metals, as well as the emission of dusts generally, will be minimized.

Recovery of plastics from mobile phones for material recovery and recycling (as opposed to energy recovery) is not widely practiced at this time, due to the lack of viable techniques for separation of a plastic fraction of marketable quality. There is, however, ongoing research on the recycling of plastics from electronic waste that could make this option technically feasible and economically viable in the future. To recycle plastics (as opposed to their use in energy recovery), either a labour-intensive process for dismantling and sorting must be used to gain clean plastic fractions, or mechanical separation must be utilized, which may result in a plastic fraction that is contaminated with metals. It is thus important to promote the development of pre-processing technologies to help achieve greater efficiency for this intermediate step.

Mobile phones, in either whole form (minus batteries) or after manual or mechanical separation of components or materials, can be processed in specialized smelters where copper and precious metals such as: gold, silver and palladium, and other metals are recovered. Direct smelting of end-of-life mobile phones will permit the recovery of metals such as copper, precious metals (such as gold, silver and palladium) and most other metals (except iron, magnesium and/or aluminium); plastics will be used as a source of heat and also as a reducing agent. However, smelting of used mobile phones requires specialized equipment. Most smelters do not have the proper pollution control systems for the environmentally sound material recovery and recycling of electronic scrap. Electronic scrap, including mobile phones, contains plastics and halogens (i.e., chlorine and bromine) which, when burned, lead to the formation of dioxins and furans, which are highly toxic and carcinogenic. However, with proper smelting operation and pollution control equipment, controls can be put in place to assure the environmentally sound recovery of metals from mobile phones.

Although the environmentally sound management of end-of-life mobile phones includes the recovery of materials, particularly including copper and precious metals, it does not necessitate the recovery of every substance. Mobile phones are small, their disassembly is expensive, and even in large quantities they do not contain many substances that can be efficiently recovered in amounts that are economically significant. There is ongoing eco-efficiency research that examines the environmental and economic dimensions of the recovery process.

Also, pre-processing, material recovery and recycling facilities need to operate within a regulatory framework that establishes a balance between the necessity of environmentally sound management and economic efficiency. Thus, in developing the appropriate regulatory infrastructure for mobile phone material pre-processing, recovery and recycling facilities, Parties should take into account the size of the enterprise, the type and amount of scrap materials, as well as the nature of the operation. It is recognized that developing countries, as well as those with economies in transition, have the greatest challenges ahead in building the governmental and industrial infrastructures necessary in order to achieve the environmentally sound management of end-of-life mobile phones.

All mobile phone pre-processing, material recovery and recycling facilities should have an Environmental Management System (EMS) in place to ensure adequate control over the impact of the facility on worker and public health, as well as on the environment. This EMS could include ISO14001 or equivalent certified management systems, European Eco-Management Audit Scheme (EMAS), or other similar programs. The facility should operate pursuant to written procedures regarding operating methods for the plant and equipment, management system, control of site activities, measurement and record keeping, and implementation of site safety rules. The facility must comply with all applicable health and environmental regulations and be properly licensed by all appropriate governmental authorities. Written plans regarding emergency preparedness and financial assurance for emergencies and facility closure should also be maintained. The guidelines also address the need for plant personnel to be properly trained, as well as provided with appropriate personal protective equipment.

The development of ESM systems like the ISO14001 or equivalent for facilities in developing countries could be costly and not feasible. In this context, the BCRCs could have an important role to play in order to encourage the material recovery and recycling facilities to be certified by such management tools. BCRCs, which provide training and technology transfer on the environmentally sound management, should aim primarily at strengthening the capacity of governments of the regions in complying with the Basel Convention, its decisions and technical requirements of the environmentally sound management of wastes.

## 5.2 Recommendations

The project group 3.1 put forward a number of recommendations dealing with material recovery and recycling of the end-of-life mobile phones:

### 5.2.1 Goals and Objectives

1. Parties and Signatories to the Basel Convention are encouraged to implement policies and/or programs which promote the environmentally and economically sound material recovery and recycling of end-of-life mobiles phones.

2. Consistent with the Basel Ministerial Declaration on Environmentally Sound Management, used and end-of-life mobile phones should be diverted from final

disposal practices such as landfilling and incineration to a more environmentally sound practices of reuse, refurbishment, material recovery and recycling.

3. Environmentally sound material recovery and recycling practices, consistent with this chapter and guidelines prepared by the project group 3.1, should be utilized. All steps should be taken to ensure that unsound mobile phone material recovery and recycling practices are to be avoided, such as those where proper worker and environmental protections are not implemented (e.g. primitive and "backyard" operations) and those where there is no attempt to maximize material recovery.

4. Priority should be given to eco-efficient pre-processing, material recovery and recycling processes, while reducing the environmental impact of their production.

### 5.2.2 Development of Material Recovery and Recycling Infrastructure

5. The Basel Principles of self sufficiency, and least transboundary movement, as well as the necessity of economic efficiency, should be taken into account when considering investments in mobile phone material recovery and recycling facilities or operations, as well as when developing domestic policies for environmentally sound management.

6. Because conformance with these guidelines may mean an increase in material recovery and recycling costs, Parties, industry and other interested persons should collaborate to ensure that there is adequate financing for mobile phone material recovery and recycling initiatives.

### 5.2.3 Environmentally Sound Management & Facility-Level Guidelines

7. A regulatory infrastructure should be developed at an appropriate governmental level, and composed of legal requirements such as: authorizations, licenses, permits or standards and should:

- It should address facility operation, workers' health and safety, control of emission to air, land, water and waste management. The license or permit should describe and authorize specific facility capacities, processes and potential exposures;
- Require that facilities operate according to best available technologies while taking into consideration the technical, operational and economic feasibility of doing so;
- Encourage the development and implementation of environmental liability regime for material recovery and recycling facilities to prevent environmental damage;
- Encourage information exchange between facility managers and governmental authorities in order to optimize recovery operations;
- Move toward internalization of the costs of the environmentally sound management of end-of-life mobile phones;

- Encourage facilities to utilize environmental management systems, such as: ISO 14000 series, European Eco-Management Audit Scheme (EMAS), or other similar programs;
- Recommend that recycling facilities develop adequate monitoring, recording and reporting programs;
- Encourage recycling facilities to set up adequate employee training programs;
- Require that recycling facilities have an adequate emergency plan; and
- Require that recycling facilities establish an appropriate plan for closure and after-care, ensuring the financial means for such closure.

8. Mobile phone material recovery and recycling facilities should be certified by an independent environment sound management system, like ISO 14000 series, EMAS, or by an equivalent system. The procedures needed for pre-processing facilities to achieve certification/registration for international environmental sound management systems should be simplified.

9. The General Facility Guidelines, as shown in Appendix 5, should be implemented by all pre-processing, smelting, refining and other facilities that are involved in any aspect of mobile phone material recovery and recycling.

10. If shredding is utilized, mobile phone batteries should be removed prior to shredding.  Batteries should also be removed prior to any smelting or refining, and be sent to an authorized battery recycler.

11. Where mobile phones or their components are shredded or heated, measures to be implemented to protect workers, general public and the environment from dusts and emissions.  Such measures are to include: adaptations in equipment design or operational practices, air flow controls, personal protective equipment for workers, pollution control equipment or a combination of these measures.

12. Companies capable of pre-processing, smelting, refining or performing other steps in mobile phone material recovery and recycling should identify themselves to their competent authorities.  Competent authorities should inspect and verify that these companies are practicing environmentally sound management consistent with these recommendations, and guidelines prepared by project group 3.1.

13. Mobile phone collectors and pre-processors should perform due diligence to assure themselves that subsequent handlers and processors operate consistent with these recommendations, and guidelines prepared by project group 3.1.

### 5.2.4 Design for Material Recovery and Recycling

Design considerations with material recovery and recycling in mind are covered in section 2.2.3 of this report.

14. Beryllium and some flame retardants have been identified in this document as substances of particular concern during the processing of end-of-life mobile phones. Manufacturers should give consideration to the use of substitute materials that perform the same function.

15 Mobile phone manufacturers should collaborate to address the recyclability of plastics in mobile phones. Specifically, consideration should be given to greater consistency in material selection during the design stage for all mobile phones, which would allow plastics recyclers to eliminate sorting steps necessary to achieve compatibility of plastics types.

### 5.2.5 Future Collaborative Steps

16. Parties of the Basel Convention are encouraged to extend the role of BCRCs to develop training and technology transfer on environmentally sound material recovery and recycling of end-of-life mobile phones, in order to help developing countries and countries with economies in transition implement regulatory frameworks for the environmentally sound management of end-of-life mobile phones.

17. Legal, technical, and financial assistance should be provided to developing countries and countries with economies in transition to establish the appropriate legal, technical and social infrastructures necessary in order to achieve the environmentally sound management of end-of-life mobile phones.

18. An audit checklist, or similar tools, should be developed to assist Parties and others in performing inspections and audits based on guidelines developed by project group 3.1.

# APPENDIX 1

## Glossary of Terms

***Note**: These definitions were developed for the purpose of this Guidance Document and individual project reports and should not be considered as being legally binding, or that these definitions have been agreed to internationally. Their purpose is to assist readers to better understand this Guidance Document.*

**Basel Convention**: UNEP's Convention of March 22, 1989 on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, which came into force in 1992.

**Dismantling:** manual separation of components/constituents in a way, that recycling, reconstruction, or reuse of the component are possible.

**Disposal:** means any operations specified in Annex IV of the Basel Convention.

**EMC** - Electromagnetic compatibility (EMC) means the ability of equipment to function satisfactorily in its electromagnetic environment without either introducing intolerable electromagnetic disturbances to other equipment in that environment, or being adversely affected by the emission of other electrical equipment.

**EMF** - Electromagnetic Fields (EMF) are a combination of both electric and magnetic fields. EMF occurs naturally (light is a natural form of EMF), as well as a result of human invention. Nearly all electrical and electronic devices emit some type of EMF. Safety standards are applicable, but these may vary from country to country.

**Eco-efficiency** - producing economically valuable goods and services with less energy and fewer resources while reducing the environmental impact (less waste and less pollution) of their production. In other words eco-efficiency means producing more with less. It may include, for example, producing goods through recycling when that is more efficient, and more environmentally friendly, than production of the same goods with primary resources and methods.

**End-of-life mobile phone**: a mobile phone that is not suitable for continual use by a consumer, and which is destined for material recovery and recycling or final disposal. It also includes off-specification mobile phone which has been sent for material recovery and recycling or final disposal.

**Environmentally Sound management:** means of taking all practicable steps to ensure that used and/or end-of-life products, or wastes are managed in a manner which will protect human health and the environment against adverse effects

**Hydrometallurgical processing**: processing of metals in water or aqueous solutions, including acid leaching and precipitation.

**Incineration:** a thermal treatment technology by which municipal wastes, industrial wastes, sludges or residues are burned or destroyed at temperatures ranging from 1000*C to more than 1200*C (high temperature incineration used mainly to incinerate hazardous wastes) in the presence of oxygen resulting from the rapid oxidation of substances. Most of them have an air pollution control equipment to ensure the emission levels meet the requirements prescribed by the regulatory authorities.

**Integrated copper smelter**: a facility, or related facilities in the same country under the same ownership and control, that melts metal concentrates and complex secondary materials that contain - among others - copper and precious metals, using controlled, multi-step processes to recycle and refine copper, precious metals and multiple other metals from managed product streams.

**Landfilling:** the placement of waste in, or on top of ground containments, which is then generally covered with soil. Engineered landfills are disposal sites which are selected and designed to minimize the chance of release of hazardous substances into the environment.

**Leachate:** contaminated water or liquids resulting from the contact of rain, surface and ground waters with waste in a landfill.

**Life cycle management:** holistic way to consider the environmental issues associated with a substance, product or process from resource utilization, through manufacture, transportation, distribution, use, to waste management and disposal of residues from treatment or recycling operations.

**Material Recovery:** means relevant operations specified in Annex IVB of the Basel Convention.

**Mechanical Separation**: mechanical means to separate a mobile phone into various components or materials.

**Major repair:** repair of used and/or end-of-life mobile phones that will require a replacement of hazardous components.

**Minor repair:** repair of used and/or end-of-life mobile phones that will not require a replacement of hazardous components.

**Mobile phone**: (sometimes called a cellular phone or cell phone) is a small sophisticated personal two-way radio. It sends and receives radio signals, carrying voices in personal communication with other mobile phones, and telephones. It consists of the following components: a handset, which can include, but not be limited to: a case (usually plastic), display(s) or screen(s), monochrome or color, a keypad, an antenna and a camera module. Inside the handset case is a printed wiring board(s) (also called a printed circuit board), a battery(s), a microphone and a speaker(s).

**Printed wiring board:** also called a printed circuit board, with integrated chips, resistors, capacitors and wires, making up the electronic brain of the phone.

**Pyrometallurgical processing:** thermal processing of metals and ores, including roasting and smelting, remelting and refining.

**RoHS**: Directive of the European Parliament and the Council on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment.

**Reconditioning**: a process of returning a used mobile phone to a satisfactory working condition that can be inferior to the original specification. In keeping with this the quality of guarantee given to such mobile phones is less than that of remanufactured alternatives. For example, they may not have extended warranty where this is available for the new mobile phone. The warranty applies to the whole mobile phone, where this is taken to mean all major wearing parts.

**Recycling**: relevant operations as specified in Annex IVB of the Basel Convention.

**Refurbishment:** includes the reconditioning or repair of a used mobile phone undertaken with the intent of returning the mobile phone to service by a subsequent user. Refurbishment does not include the direct reuse of a used mobile phone that is not serviced beyond the cleaning of exterior surfaces.

**Refurbished mobile phone:** A repaired or reconditioned mobile phone, that is fully functional for its intended re-use, and meets product's original rated operational standard, without further repair or reconditioning.

**Remanufacturing:** a process of returning a used mobile phone to at least OEM original performance specification from the customers' perspective, and giving the resultant mobile phone a warranty that is at least equal to that of a newly manufactured equivalent. The giving of an equivalent warranty is important because it is evidence that the remanufactured mobile phone and the OEM product have similar quality standards. If extended warranties are available to new mobile phones they should also be available to remanufactured mobile phones.

**Repairing**: a process of simply fixing specified faults in a mobile phone. Generally, the quality of repaired mobile phones may be inferior to those of remanufactured and reconditioned alternatives. When repaired mobile phones have warranties, they are less than those of newly manufactured equivalents. Also, the warranty does not cover the whole mobile phone but only the component that has been fixed. Repair of a mobile phone may entail the discarding of a hazardous component such as a printed circuit board.

**Reusing**: a process of using a functional component from a used mobile phone. Typically, the quality of mobile phones from the reuse process varies widely because little if any work is undertaken on the donor component other than functional test to establish that it is operational before inserting it into the receiver mobile phone. It is simply a case of purchase with your statuary rights only. Reuse has its own hierarchy because a component that has been selected for the reuse option may in fact have higher value than a reconditioned one even though no work has been undertaken on it. Quality varies tremendously between reuse components.

**SAR**: stands for Specific Absorption Rate, which is the amount of Radio Frequency (RF) absorbed by the body. The unit of measurement is in Watts per Kilogram (W/Kg). SAR is determined, in laboratory conditions, at the highest certified power level of the mobile phone. When in use, the actual SAR can be well below this value due to automatic power control by the mobile phone. The SAR of each model of mobile phone is measured as part of the safety standard compliance process.

**Segregation:** Sorting out entire mobile phones from other (electronic) wastes for possible reuse or for treatment in specific recycling processes.

**Separation:** Removing certain components/constituents (e.g. batteries) or materials from a mobile phone by manual or mechanical means.

**Transport of Dangerous Goods:** UN Recommendations on the transport of dangerous goods which deals with classification, placarding, labeling, record keeping, etc. to protect public safety during transportation.

**Treatment:** means any activity after the mobile phone has been handed over to a facility for disassembly, shredding, recovery, recycling or preparation for disposal.

**Used Mobile Phone:** a mobile phone, that has been previously used by a consumer, and can no longer be considered, or sold, as new.

**WEEE Directive:** Directive of the European Parliament and the Council on Waste Electrical and Electronic Equipment.

**Wastes: s**ubstances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law.

# Appendix 2

## Substances Contained in MPs [23]

Mobile phones differ from manufacturer to manufacturer, and from model to model. Thus the substances in any mobile phone will be somewhat different from the substances in another. The following table indicates substances in three categories that may be useful: primary constituents, minor constituents, and micro or trace constituents. (Note that not all substances are used in every mobile phone, e.g. nickel or lithium battery, so numbers will not add to 100 %.)

| **Name of substance** | **Location in mobile phone** | **Typical % content of a mobile phone (including battery and peripherals)** |
|---|---|---|
| Primary Constituents: | | |
| Plastics | Case, circuit board | ~40% |
| Glass, ceramics | LCD screen, chips | ~15% |
| Copper (Cu), compounds | Circuit board, wires, connectors, batteries | ~15% |
| Nickel (Ni), compounds | NiCd or NMH batteries | ~10% * |
| Potassium hydroxide (KOH) | battery, NiCd, NiMH | ~5% * |
| Cobalt(Co) | Lithium-ion Battery | ~4% * |
| Lithium(Li) | Lithium-ion battery | ~4% * |
| Carbon © | Batteries | ~4% |
| Aluminium(Al) | Case, frame, batteries | ~3% ** |
| Steel, ferrous metal (Fe) | Case, frame, charger, batteries | ~3% |
| Tin(Sn) | Circuit board | ~1% |
| | | |
| | | * only if these battery types are used, otherwise minor or micro constituent |
| | | ** if aluminium case used, amount would be much larger, ~20% |
| Minor Constituents | | (typically less than 1%, more than 0.1%) |

| | | |
|---|---|---|
| Bromine(Br) | Circuit board | |
| Cadmium(Cd) | NiCd battery | |
| Chromium(Cr) | Case, frame | |
| Lead(Pb) | Circuit board | |
| Liquid crystal polymer | LCD screen | |
| Manganese(Mn) | Circuit board | |
| Silver(Ag) | Circuit board, keypad | |
| Tantalum(Ta) | Circuit board | |
| Titanium(Ti) | Case, frame | |
| Tungsten(W) | Circuit board | |
| Zinc(Zn) | Circuit board | |
| | | |
| <u>Micro or Trace Constituents</u> | | (typically less than 0.1%) |
| Antimony(Sb) | Case | |
| Arsenic(As) | Gallium arsenide LED | |
| Barium(Ba) | Circuit board | |
| Beryllium(Be) | Connectors | |
| Bismuth(Bi) | Circuit board | |
| Calcium(Ca) | Circuit board | |
| Fluorine(F) | Lithium-ion Battery | |
| Gallium(Ga) | Gallium arsenide LED | |
| Gold(Au) | Connectors, circuit board | |
| Magnesium(Mg) | Case | Note: If Mg used for phone case, amount would be much larger, ~20% |
| Palladium(Pd) | Circuit board | |
| Ruthenium(Ru) | Circuit board | |
| Strontium(Sr) | Circuit board | |
| Sulphur(S) | Circuit board | |
| Yttrium(Y) | Circuit board | |
| Zirconium(Zr) | Circuit board | |

# Appendix 3

## Exposure to Substances of Concern when Managing End-of-Life Mobile Phones [24]

- **Land Disposal**

Land disposal of mobile phones may place them in contact with co-disposed acids, and, over an extended period of time, the substances that are soluble in those acids may leach out. There has apparently not been research that indicates which substances will leach from a mobile phone, except for lead. There have been several studies indicating that electronic circuit boards will leach lead under landfill conditions simulated by the U.S. EPA Toxicity Characteristic Leachate Procedure (TCLP)[25].
If a landfill is not bound by an impermeable barrier, substances may migrate into ground waters, and eventually into lakes, streams, or wells, and raise a potential exposure to humans and other species. However lead does not tend to migrate in soil, but instead remains fixed to soil particles[26]. Thus lead exposure through drinking water due to leaching and migration to ground water is a minimal risk.

The greater risk of land disposal will be from migration of hazardous substances up the food chain and direct ingestion of contaminants, contaminated soil and water in landfills that are not controlled. Some landfills, particularly in poor regions, are visited by people, including small children, looking for valuable materials. The route of exposure will be almost entirely by ingestion, either directly through drinking water or through food that has previously absorbed or ingested substances of concern.

- **Waste Incineration**

Waste incineration of mobile phones will oxidize the plastic in the case and in the circuit board. Depending on the conditions, the oxidation of plastics may be incomplete, and hydrocarbon particles and other soot may be produced. This would be particularly true if the waste incineration were informal and completely uncontrolled, such as in metal drums or open burning, which might occur in poor regions. People might burn circuit boards, for example, to concentrate the metals in ash, for sale for metal recovery.

Some metals, including cadmium and lead, have relatively low melting temperatures and may melt during incineration and form fume or minute metal oxide particles, that will be carried into the incinerator exhaust with the air emissions. If these metals, and any other metals that are contained in mobile phones, do not melt at the temperatures of incineration, they will remain in bottom ash. That bottom ash, if disposed on land, may raise the concerns of exposure to hazardous substances described above. And leaching from ash in land disposal conditions may be substantially faster than leaching from solid mobile phones.

In addition, if incineration is not at a sufficiently high temperature, sustained for a sufficient time, the plastics and other hydrocarbons contained in a mobile phone may not be completely oxidized to carbon dioxide and water, and may combine with halogens to form new halogenated hydrocarbons, including dioxins and furans.

Whether waste incineration is informal and completely uncontrolled, or even somewhat better controlled, burning mobile phones will release substances of concern in air emissions, and to other environmental media in subsequent management of fly ash and bottom ash[27].

- **Metal Recovery**

The principal interest for metal recovery from mobile phones is in the recovery of the metal of greatest amount - copper - and the metals of greatest value - gold, palladium and silver. If mobile phone cases are made of aluminium or magnesium these metals are also of economic interest.

Processing for metal recovery may begin with shredding in dedicated 'e-waste shredders' to reduce a mobile phone to smaller size pieces, approximately 2 cm, if this is more suitable for feeding into a smelter. The shredding process will generate both high volume noise and some dust particles that may contain any of the substances in the mobile phone. Unless these particles are controlled, workers may be exposed to those substances by inhalation and ingestion. In normal shredding, however, the amounts of substances released in the shredding process are small. If batteries have not been removed before shredding, they will release caustic substances, and may cause electrical short circuits and fire, which may cause its own releases of toxic emissions.

The shredding process may be followed by material separation steps, to separate metals one from another, and the non-metals one from another. There are a variety of technologies employed for material separation, such as, magnets, eddy-current separators, and flotation. The dust particles that were created in the shredding process will continue to be present and will require control to prevent worker exposure. Separated materials with no market value would require disposal in authorised landfills or incinerators as appropriate.

The smelting process, which separates copper, other metals and precious metals from other materials, is a high volume, high temperature operation. Metal fume and metal oxide particulate may be released, exposing workers and downwind communities unless the emissions are controlled. The most problematic metal emission from smelting may be beryllium, but the concentration of beryllium in mobile phones is low enough to be controlled at very low concentrations, far below air quality standards. If hydrocarbons are present in materials being smelted, the process may release particles of incomplete combustion and, if halogens are also present, may release dioxins and furans. These releases can be controlled through properly engineered processes and emission control systems, but require attention and sound management.

Metal recovery from separated batteries will, like smelting, involve high volume, high temperature processes, and metal fume and metal oxide particulate may be released, exposing workers and communities. Cadmium is a component of NiCd batteries, has a low melting temperature, and will be easily emitted in furnace exhaust, most likely as cadmium oxide particulate. As with smelting, these releases can be controlled through properly engineered processes and emission control systems, but require attention and sound management.

Smelting will be followed by a number of metal-specific electro-refining, dissolution and precipitation processes (hydrometallurgical processes), in which individual metals are upgraded and refined to market grade. These steps may result in waste water that may contain high toxic metal concentrations and that, if not completely reused within the refining facility, will require attention and sound management.

The slag that is produced in the smelting process will also contain substances of concern. If it still contains relatively high concentrations of metals of economic interest, it should be reintroduced into the smelter, or into other smelting processes to recover these metals. Such continued smelting will have potential releases of fume and particulate, but will increase metal recovery and avoid landfill disposal. Slag may also be ground to a powder as a preparation for further metal recovery by selective leaching and precipitation of desired metals. These further processing steps may create potential exposures of workers to metal-containing dust, and waste water with high toxic metal concentrations, and should be controlled through properly engineered processes and sound management.

Slag is typically a silicate glass, and when it has been stabilized and made insoluble in high temperature processing it will not leach substances of concern, and may be safely used as a building or road construction aggregate. If slag has not been rendered stable and insoluble, its use on land or ultimate disposal in a landfill has the same potential for release of substances of concern described above.

- Plastic Recovery

Plastics from mobile phones have not been widely recovered as plastics yet, because few facilities can efficiently sort plastics into clean streams of a single type. In smelters with appropriate flue gas treatment, plastics may be utilised in the metal recovering process, where they serve as a source of heat and substitute for other hydrocarbon fuels and as a reducing agent. If mobile phone cases could be designed to be easily removed, and free of contaminating substances like paints, labels and metals, as well as collected in a reasonably large volume, the engineered plastics of mobile phones, usually an acrylonitrile butadiene styrene-polycarbonate (ABS-PC), could be recycled with a positive economic value. There is ongoing research on the identification and sorting of plastic, and this option may be economically viable in the future. Indeed, the well known German Frauenhofer Institute[28] has demonstrated in its pilot project launched in 2001/2002, called “RegioPlast”, that the recycling of plastic coming from electric and electronic waste is technically feasible and economically viable[29].

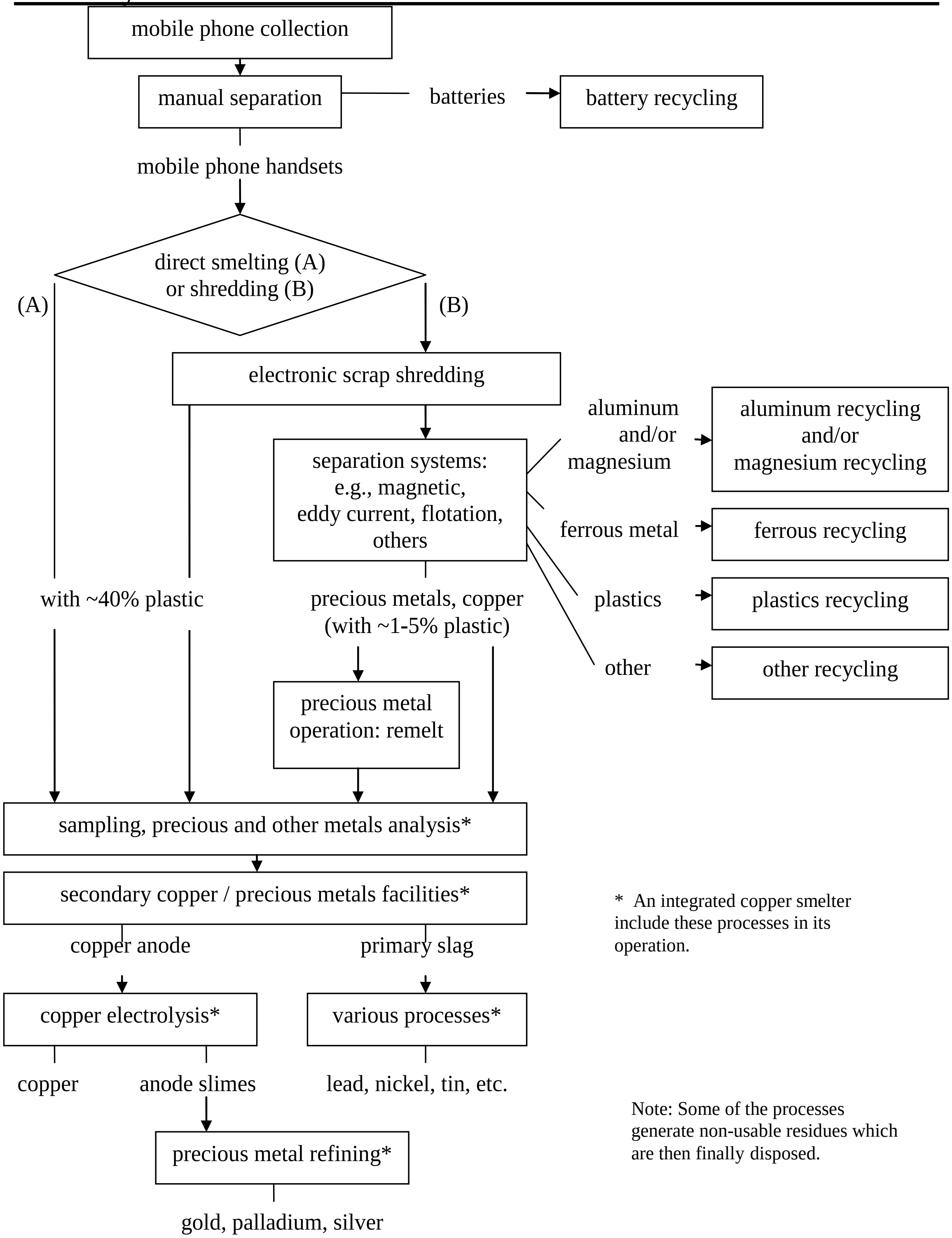
The plastic recovery process would begin with sorting of plastic types, which would not involve any exposure to hazardous substances.  Sorted plastic would then be granulated, a process that can generate heat and, if not properly managed, smoke and fire.

A plastic case may contain a brominated fire retardant, in all likelihood decabrominated biphenyl ether (DBBE). DBBE is an additive flame retardant, and some amount may be released from the plastic during the granulation process, but studies indicate that the amount would be small.

After granulation, the plastic will be moulded into a desired shape under elevated pressure and temperature, and there may be exposure to substances contained in the plastic, but this would be no different for the same type of plastic from other sources.

# Appendix 4

## Recovery of Precious Metals and Other Materials from Mobile Phones



# Appendix 5

## General Material Recovery and Recycling Facility Guidelines [30]

Mobile phones and their accessories will generally be treated by facilities that engage in raw material recovery and will thus require a higher degree of governmental environmental oversight in accordance with the environmental risks associated with their processing systems. Environmental management systems become an important aspect of these operating facilities.

- **Environmental Management System**

The material recovery and recycling facility should possess and maintain a documented environmental management system to ensure adequate control over impact on the environment. This EMS could include, but is not limited to, ISO14001 certified management systems.
The EMS system should also incorporate record keeping of shipping documents, bills of lading and chain of custody of material destined for downstream markets in the form of audits.
The facility should operate pursuant to written standards or procedures regarding operating methods for the plant and equipment, systems for management, control of site activities, site safety rules and requirements and methods for ensuring observation/monitoring (i.e., an overall operating/systems/safety manual).

- **Licensing/Permits**

The facility must comply with all applicable environmental regulations (international, federal, provincial and municipal):

- Material recovery and recycling facilities must be licensed by all appropriate governmental authorities;
- Require that facilities operate according to best available technologies, while taking into consideration the technical, operational and economic feasibility of doing so;
- Licensing and permits should be consistent with governmental, regional and local regulatory requirements. Specific permits required could be: storage permit, air emissions permit, water permit, hazardous waste permit, and those required to meet landfill and other disposal regulations. Processes should be in place to ensure continued compliance with the requirements of the permits.
- Legal requirements such as authorizations, licenses, permits or standards should address facility operation, workers' health and safety, control of emission to air, land, water and waste management. The license or permit should describe and authorize specific facility capacities, processes and potential exposures;

### ▪ Monitoring and Record Keeping

Recycling facilities develop adequate monitoring, recording and reporting programs. Such programs should be maintained to track:

- Key process parameters;
- Hygiene risk elements such as beryllium;
- Compliance with applicable regulations;
- Generation of any emissions or effluents; and
- Movement and storage of waste, especially hazardous waste.

The facility should have adequate record keeping systems to ensure compliance and have records of employee training, including health and safety, manifests, bills of lading, and chain of custody of all materials, emergency response plans, closure plans in case a plant or operation closes, record keeping policies, fire prevention and suppression procedures, equipment failure backup plan, and security plans.

### ▪ Emergency Planning

The facility should have a regularly updated emergency plan that provides guidelines on how to react to emergencies such as: fires, explosions, accidents, unexpected emissions, and weather related emergencies (e.g., tornadoes, hurricanes, etc). The emergency plan should also indicate what reporting and monitoring is required for specific instances. This plan should be communicated with local emergency response authorities.

### ▪ Occupational Health and Safety (best practises to ensure worker's safety)

The facility must comply with all applicable health and safety regulations (federal, provincial/state, and industry standards). The facility must ensure occupational health and safety of employees by:

- Providing continuous health and safety training of personnel;
- Providing ergonomic work areas with safe and effective tools;
- Avoiding heavy lifting where possible, and train employees to lift in a safe manner. In some cases lifting tools may be required;
- Making available and enforcing the use of personal protection equipment,
- Labelling of all hazardous materials;
- Safeguarding of dangerous mechanical processes;
- Avoiding exposure to unacceptable occupational risk, such as airborne dust and fume, through process dust collection systems;
- Periodic air monitoring to monitor elements of risk including but not limited to lead, cadmium and beryllium;
- Providing process fire suppression equipment and systems where appropriate; and
- Considering policies that prohibit eating food or smoking in process areas;
- Providing for worker health benefits/insurance, long-term disability and death benefits;

- Providing liability compensation for accidents: and
- Encourage the development and implementation of environmental liability regime for recycling facilities to prevent environmental damage;

- **Personal Protective Equipment**

The plant personnel to be provided with appropriate personal protective equipment (PPE) to ensure employee safety. The degree of PPE required will depend on the level of potential risk that the employee is exposed to and the type of equipment the employee works with:

- Eye Protection – safety glasses should be worn to prevent eye injuries. Eye wash stations should be available in areas easily accessible by employees and as regulated by local laws.

- Head Protection – hard hats may be required to be worn in certain areas, such as in proximity of overhead racks and around automatic dismantling machines and smelting furnaces.

- Hand Protection – if opening boxes, using safety knifes, handling sharp objects or using pallet jacks, gloves may be required. When manually dismantling material or handling chemicals, gloves should be also be worn. Gloves will help protect hands from cuts, scrapes, chemical burns and infection from blood borne pathogens.

- Skin Protection – in certain conditions such as working in proximity of furnaces, chemical equipment or some types of automated equipment, wearing a fire resistant work smock may be necessary to protect exposed skin from burns or chemical exposure.

- Foot Protection - steel toe shoes should be worn to prevent foot injuries from falling objects, pallet jacks, chemical spills, etc.

- Hearing Protection – ear plugs should be worn in work areas where prolonged noise exposure would lead to hearing damage.

- Respiratory Protection – dust masks or face masks should be worn in areas where there is a risk of dust inhalation.

- **Employee Training**

The facility should provide employees with periodic training to safeguard the occupational health and safety of the employee. The training should address safe work practises, required safety precautions and required personal protective equipment. Employees should be trained in the proper identification and handling of any hazardous material that may be present in incoming material. Training should be documented, recorded and updated as conditions merit.

- **Financial Assurance**

Recycling facilities should establish an appropriate plan for closure and after-care, ensuring the financial means for such closure.A financial instrument should be maintained that will assure that the facility is properly cleaned up in the case of:

- Major pollutant releases or gross mismanagement of end-of-life electronics equipment, components, and scrap; and
- Closure of the facility.

# Appendix 6

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[29] For more details see section 4.4.5
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