E-book for

Waste Electrical and Electronic Equipment (WEEE) Recycling Industry in Hong Kong

Enhancing the Environment, Health and Safety (EHS) Awareness

「中小企業發展支援基金」撥款資助
Funded by SME Development Fund

工業貿易署
Trade and Industry Department

Organizer

香港電子業商會
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Published: May 2016

AN E-BOOK FOR SMES ON THE GOOD EHS PRACTICE GUIDELINES IN WEEE RECYCLING

About this E-book

With funding support by the Trade and Industry Department, HKSAR Government, the Hong Kong Electronic Industries Association (HKEIA) as the organizer, collaborated with the Green Manufacturing and Eco-Design Research Group of the Hong Kong Polytechnic University (Department of Industrial and Systems Engineering), the implementation agent, and implemented a project on “Enhancing the Environment, Health and Safety (EHS) Awareness of the Waste Electrical and Electronic Equipment (WEEE) Recycling Industry in Hong Kong”.

This programme aims to assist Hong Kong SMEs in understanding and enhancing the EHS requirements in WEEE recycling industry and adopting the good practices for implementing effective and sustainable recycling technologies in their businesses. In view of this objective, a varied range of activities have been carried out, such as seminars, gap analysis, training workshops, and an E-book on good practical guidance and the website for dissemination of information. Serving as a practical reference for the local recycling industries, this e-book collates and presents information on the good EHS practices employed in Korea and Germany in collection, transportation, storage and treatment of e-waste, procedures for recycling of specific regulated e-waste, upcoming legal regulations in HK, feasible guidelines for implementing good EHS practices within recycling industry in HK as well as industry experience sharing by experts.

Acknowledgements

We would like to thank the following organizations and people for their support and contribution to this E-book (in alphabetical order):

Mr Jihwan Park, Korea Electronics Recycling Cooperative (KERC), Korea
Mr Peter Heßler, URT Umwelt- und Recyclingtechnik GmbH, Germany
Mr Youngjin Suh, Samsung Electronics, Korea
Prof. Hyunsoo Kim, Kyonggi University, Korea

Local Companies:

Bolton Resources Co., Ltd
Cheong Hing Refinery Works Limited
Golden Link International Enterprise Limited
KingStay Development Co., Ltd

Preface

E-waste is a growing concern and its management is one of the major global challenges. Governments intend to control disposal of e-waste effectively and ensure minimum or no environmental and health impacts. Landfilling of electronic products, substandard processes for recycling, harmful reagents used in treatment of e-waste, toxic emissions while handling e-waste and unsafe working conditions for workers involved are the key areas that need attention. Increase in carbon emissions is largely due to improper recycling practices followed for treatment of e-waste. Environment, health and safety are significant elements of efficient WEEE recycling in order to preserve the environment and protect the people involved.

While using advanced technologies for recycling, the recycling companies need to also ensure reduced energy consumption and emissions from these technologies. Enhancing EHS measures is also a key to improve working conditions of the workers involved. Existing global WEEE recycling practices with sound processes and sustainable technologies could be a guidance for HK recycling industry. Korea and Germany are recognized as the two countries which currently employ such good EHS practices and will serve as guidelines for the HK WEEE recycling industry.

In view of this existing challenge, the Hong Kong Electronic Industries Association (HKEIA) has taken the initiative to support local small and medium enterprises (SMEs) to gain sufficient knowledge and awareness in establishing effective WEEE recycling methods considering EHS measures in collection, transportation, storage and treatment of WEEE. The scope of this project is limited to recycling practices of only regulated e-waste and fractions of some electronic products as these products largely contribute to environmental and social impacts on the planet and the people respectively.

Throughout this project, I am pleased to see that many local recycling companies have been showing tremendous interest to learn more at the beginning, to participate in questionnaire survey conducted during the project, and finally showing inclination towards enhancing EHS practices within their businesses. Adopting to Korean and German practices, I believe Hong Kong recycling industry can grasp this opportunity with the assistance of this project and this e-book to improve EHS practices within the industry, reduce toxic emissions, increase competitiveness among recycling industries, and most important of all protect the planet and the people.

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Table of Contents

Abbreviations

CCFL	Cold cathode fluorescent materials
CFC	Chloro flouro carbon
CO_2	Carbon dioxide
CRT	Cathode ray tube
EHS	Enhancing the Environment, Health and Safety
EM	Electromagnetic
EOL	End-of-life
EPD	Environmental Protection Department
EPR	Extended Producer Responsibility
E-waste	Electronic waste
GWP	Global Warming Potential
Hg	Mercury
HKEIA	The Hong Kong Electronic Industries Association
ICT	Information and Communication Technology
JRC	Jeju recycling centre
KERC	Korean Electronics Recycling Cooperative
LCD	Liquid crystal Display
MERC	Metropolitan electronics recycling centre
MoE	Ministry of Environment
NIR	Near Infrared
ODP	Ozone depletion potential
PC	Personal computer
PCB	Printed circuit board
PRS	Producer responsibility scheme
SHMS	Safety and Health Management System
SMEs	Small and Medium Enterprises
TV	Television
WDO	Waste disposal ordinance
WEEE	Waste Electrical and Electronic Equipment
WEEETRF	WEEE treatment and recycling facility
WMC	Waste Management Centre

1 Introduction

This chapter presents the background and development of e-waste recycling industry in HK, the need for an efficient recycling system complying the EHS needs, upcoming legal regulations for developing effective WEEE recycling locally, and finally the implementation plan of this project in order to achieve the final objective of establishment of a competent WEEE recycling industry with minimum or no damage to health and environment.

Chapter 1: Introduction

1.1 Background and Development of E-waste Recycling Industry in Hong Kong

Electronic waste (e-waste) has become a growing concern globally, especially in countries like Hong Kong (HK) that has such a limited geographic area. With a reputation of being called one of the world's most tech-savvy cities, it contributes greatly to the increasingly dangerous and complicated e-waste stream. It is a fact that house-holds and corporates in HK generate more than 70,000 tonnes of E-waste through Information and Communication Technology (ICT) equipment every year. A considerable amount of the generated e-waste is exported to China and the remaining are landfilled, both of which are unsustainable options. Consumption is the biggest driving force behind e-waste, but going along the trend consumption of ICT products is only going to increase in the future. With the aim to firstly reduce and then eliminate unsustainable disposal options like exporting Waste Electrical and Electronic Equipment (WEEE) and landfilling, a long term development of WEEE related recycling industry should be carried out in HK locally. Moreover, treatment and recycling of WEEE in these recycling facilities should be carried out efficiently since e-waste stream involves toxic substances which when not handled properly is harmful to both environment and the human lives involved. Hence it is necessary for HK to implement the mandatory producer responsibility scheme (PRS), to manage the environmental challenges stemming from e-waste treatment. Mandatory PRS is a key tool which plays a crucial role in e-waste management in HK, proposed by the Environmental Protection Department (EPD) of HK. In order to implement the same, the Hong Kong SAR Government is going to build a Waste Management Centre (WMC) which is expected to process 30,000 tonnes of WEEE generated in Hong Kong (information on www.epd.gov.hk/epd/eindex.html), while the remaining 40,000 tonnes of WEEE need to be handled by other local SMEs collectors or recycling companies. In addition, the Environmental Protection Department (EPD) are planning to amend the Waste Disposal Ordinance (Cap. 354) (WDO) such that –

(a) For treatment, reprocessing and recycling of regulated e-waste, a waste disposal license will be required and will only be granted if the operator can demonstrate that the processes adopted are environmentally sound;

(b) For storage of regulated e-waste, a storage site operator will also have to obtain a waste disposal license under the WDO and comply with terms and conditions imposed thereunder.

The regulated five types of WEEE that EPD proposed under mandatory PRS, are: (i) washing machines, (ii) refrigerators, (iii) air conditioners, (iv) television sets and (v) computer products viz. computers (i.e. desktops, laptops and tablets), printers, scanners and monitors (collectively as "regulated electrical equipment").

1.2 Need for Proficient WEEE Recycling Industry Practices in Hong Kong

The WEEE handling techniques and practices followed in the recycling industries in Hong Kong still have some space for improvement when compared to other developed countries. The local Small and Medium Enterprises (SMEs), WEEE collectors and recycling companies are not very much familiar with the environmental, health and safety (EHS) issues that has to be considered while handling WEEE. In a long run, it will create a considerable impact on their operation and will even hinder them from obtaining waste disposal license. Above all lack of knowledge about EHS related issues will lead to more dangerous impacts on people and the environment, as it involves health & safety of many lives working in the recycling industries. Therefore, SMEs must have sufficient knowledge and awareness on effective WEEE handling methods considering EHS issues in collection, transportation, storage and treatment of WEEE. In order to help the local WEEE recycling industries in terms of creating awareness about the need for a proficient WEEE treatment and handling practices within the context of EHS issues, the Hong Kong Electronic Industries Association, as the principle organizer, with the funding of Trade and Industry Department, collaborated with the Green Manufacturing and Eco-Design Research Group of the Hong Kong Polytechnic University (Department of Industrial and Systems Engineering), the implementation agent, and implemented a project on "Enhancing the Environment, Health and Safety (EHS) Awareness of the Waste Electrical and Electronic Equipment (WEEE) Recycling Industry in Hong Kong".

This project conducted overseas studies, produced videos, conducted a gap analysis, compiled an e book and organized seminars and workshops. A detailed description of the overseas studies, seminars and workshops are given in Section 1.4. The primary objective of the project was to strengthen the knowledge and awareness of SMEs involved in recycling of WEEE in HK which will consequently enable them to follow efficient WEEE handling practices and address EHS and technology related issues within the industry more effectively.

1.3 Upcoming Legal Regulations for Effective WEEE Recycling in Hong Kong

The mandatory producer responsibility scheme (PRS) scheme based on the "polluter pays" principle will be fully implemented. The HKSAR government is preparing the necessary legislative proposals for the regulatory framework. Simultaneously, practical experience is being gained by voluntary recycling programmes. Funding is obtained for the LegCo for the development of WEEE treatment and recycling facility (WEEETRF) which is very essential for the implementation of the mandatory PRS scheme.

The mandatory PRS will be regulating five types of products, namely (i) washing machines, (ii) refrigerators, (iii) air conditioners, (iv) television sets and (v) computer products viz. computers (i.e. desktops, laptops and tablets), printers, scanners and monitors (collectively as "regulated electrical equipment"). These will cover around 85% of the WEEE generated locally. Proper treatment and storage are the 2 main features of mandatory PRS among others. Licensing control under the waste disposal ordinance (WDO) will be established to increase the control over disposal of e-waste and to improve the environmental performance of the treatment and storage of WEEE.

1.4 Implementation Plan for Establishment of a Competent WEEE Recycling Industry in Hong Kong

As a starting point two overseas visits were conducted to understand and explore the EHS practices employed within recycling facilities in Korea and Germany. The outcome of these visits, practical experience sharing by experts from those countries and techniques to adopt the identified good practices are collated and presented in this section.

1.4.1 Explore Good EHS Practices used in Germany and Korea by Industrial Visits

Overseas studies were conducted in Korea and Germany to understand the good EHS practices adopted by the WEEE recycling industries there. An overseas study in Korea was conducted in late December 2014 to understand the good EHS practices employed within WEEE recycling industries there. WEEE collection station, a few WEEE logistics distribution centers of famous electronics and electrical companies, and some environmental organizations were all visited during the study in Korea in order to recognize the practices currently followed there. An abridged version of the visit can be viewed from the HKEIA website.

Another overseas study was conducted in Germany in late April 2015, again used to explore and comprehend the good EHS practices used within WEEE recycling industries there. The places visited during this study include several WEEE recycling companies in Germany. An abridged version of the visit can be viewed from the HKEIA website **http://www.hkeia.org/EHS/index.html**.

1.4.2 Industry Experience Sharing by Korean Experts

This subsection presents the industry experience of Korea in the areas of collection, transportation, storage and treatment of WEEE in Korea. This industry experience sharing will provide some guidelines for local recycling industry to understand the need and significance of environmental and safety aspects within WEEE collection transportation, storage and treatment operations and facilities.

The following four key areas are touched upon in this section.

a. WEEE Collection

Korean government's EPR (Extended Producer Responsibility) has been regulated since 2003. WEEE have been collected and recycled over 198,000 tons per year. Large Waste Disposal Fee W 10,000 is being charged on heavy electronic products collection. KERC directly manages 2 recycling centres namely Metropolitan electronics recycling centre (MERC) and Jeju recycling centre (JRC) and indirectly cooperates with 7 recycling centres. Domestically, in 2003, Korean government made EPR regulation that manufacturers of consumer electronics (CE) should take responsibility to properly recycle certain amount of disposed end-of-life (EOL) products that they have produced. Three original channels have been used for collecting disposed WEEE in Korea.

- ✓ Take-back (Old for New), conducted by Producers
- ✓ Buying Stickers (Charged), conducted by local authority
- ✓ Sell to Junk Dealer, conducted by local junk dealers, illegal dismantling is majorly associated with this choice of WEEE collection.

WEEE is inconvenient to dispose of for various reasons, but is a very useful resource. Hence in Korea new collection methods are implemented. Active participation and cooperation from local government is very important in promoting the new collection scheme. Major request comes through the phone channel. Many customers know this service through local government. Cooperation of local government was exhibited by providing local governmental depository site for new collection service. Trends of reservation calls are also showing a positive growth and consequently the amount of WEEE collected also increases.

Proper EHS practices are maintained in Korea in order to prevent musculoskeletal diseases and accidents during collection of e-waste. More details of the same can be found in section 2.1.

b. WEEE Transportation

Logistics and supply chains of WEEE collection contribute significantly to the carbon emissions. Active logistics which involves packaging, transportation, storage and cargo working all contribute tremendously towards many environmental impacts. The short life spans of the ICT products, makes disposal and recycling the weaker phases in the supply chain management. Improper storage and dismantling also add up to the trouble. Hence green logistics considering sustainability is adopted within WEEE collection in Korea by many companies including popular brand like Samsung. Easy disposal, exact counting, reduction of CO_2 and banning of illegal export are the key points considered for green logistics in WEEE collection.

Proper EHS is maintained in transportation of WEEE by popular brand like Samsung in Korea. Not more than 2 storeys of WEEE are stacked while transporting and the e-wastes are tightly fastened to prevent accidents from falling down while commuting. A bar code system is employed and scanned once the equipments are shipped and the information is updated into the system for tracking and reference. A similar procedure is maintained while receiving WEEE in the recycling centre as well.

Besides the logistics system operated by producers and sellers like Samsung, Ministry of Environment(MoE) and Korean Electronics Recycling Cooperative(KERC) also outsource companies like Recycling logistics in order to manage door to door transportation from customers to recycling centres for free. Individual/corporate outsourcing, Recycling centres' cargo truck, and logistics system of producers are some of the ordinance maintained by the Korean government to ensure a safe transportation system for WEEE.

c. WEEE Storage

Storage facilities are also well maintained meeting the EHS measures in Korea. Again Korea has a well maintained storage facility (warehouses) with proper roofing and flooring made of cement and asphalt which will prevent the WEEE being stored from getting damaged due to external factors. Bar code information system is used in storage sites also ensure safe storage and prevent loss of WEEE. The items are also stored according to their categories for easy processing later. Ware houses are managed by producers like Samsung, LG, Daewoo as well as by the KERC and local governments. Currently collaborative operation of public and local depository is in practice in Korea. A picture of storage warehouse maintained by Samsung is shown below.

Fig 1.1 A Storage warehouse in Korea

d. WEEE Treatment

Besides proper collection, transportation and storage, WEEE treatment is the most important phase considering the maximum involvement of workers and the excessive exposure to harmful substances where health and safety is more important. Again Korea, has proper treatment facilities meeting the EHS needs. Both conventional and advanced recycling technologies are used in Korea for effective recycling and ensuring the EHS of workers involved simultaneously. WEEE and the corresponding treatment facility requirements for a safe recycling followed in Korea is presented below.

Table 1.1 Treatment facility requirements for a safe recycling followed in Korea

Product	Requirements
Air conditioners/ Refrigerators	• Facility to collect refrigerant material and waste oil • Device to measure the quantity of refrigerant collected • Shredding facility capable of shredding to 50mm or less • Sorting facility capable of sorting ferrous and non-ferrous metals more than 90% • Storage facility capable of measuring the refrigerant material quantity that is stored
Washing machines	• Shredding facility capable of shredding to 50mm or less
TV, monitors	• During removal of front and back glasses, dust collection facility and a closed space to collect fluorescent material is needed • Storage facility to keep the fluorescent material closed
Printers	• Dust collection facility to collect toner material

Overall the industrial experience sharing in Korea emphasizes the environmental aspects of WEEE recycling and how green logistics and the effective WEEE collection scheme has increased the collection rates of WEEE in Korea and reduced carbon emissions. The efforts made to ensure EHS of workers involved in collection, transportation, storage and treatment of WEEE in Korea is also found to be very effective.

Industry Experience Sharing by German Expert

This sub-section presents the industrial experiences of Umwelt- und Recycling Technik GmbH (URT) recycling technology, on how technology and their practical implementation can help SME WEEE recyclers to meet the EHS requirements in collection, transportation, storage and treatment of WEEE.

a. WEEE Collection

The recycling companies in Germany ensure collecting WEEE from customers immediately once they receive a phone call from the customer. The collection of WEEE are carried out in sealed vessels & taping of poles of Lithium batteries to avoid leakage and accidents. WEEE collection points are also set up for easy collection.

b. WEEE Transportation

Similar to collection, transportation is carried out in sealed vessels & taping of poles of Lithium batteries is ensured. Trucks or Cargos which are safe during adverse weather conditions like rain and snow are used in Germany.

c. WEEE Storage

The flooring and roofing of warehouses are well maintained meeting the EHS measures. The flooring is made of asphalt. Arrangement and orientation of WEEE is done with care for easy access further.

d. WEEE Treatment

The detailed description of EHS related requirements and measures while treating equipment/sub parts including Batteries ,Fridge ,Toner cartridge, LCD Screen, Light bulbs and Lamps, , PCB Hand dismantling, Precious metal recovery, PCB mechanical treatment, Hydro metallurgic process, Cable recycling, is given in Section 5.2. A few key aspects considered by URT in refrigerator and LCD panel treatment are presented below.

CFC in End of Life (EOL) treatment of refrigerators is one of the major causes of increasing Global Warming Potential (GWP), hence Refrigerator pretreatment is done with great care, especially the removal of oil and refrigerants is done properly to avoid spilling of oils. Effective treatment of cooling agent CFC 12 in compressors and blowing agent CFC 11 in foam of refrigerators will considerably reduce CO_2 emissions. Highest CFC recovery percentage of 97% is confirmed by well-known auditors in Germany.

Besides, mercury emissions during the treatment of LCD TVs/monitors are very toxic and its treatment is properly done with effective EHS measures in URT. Only 100 µg/m^3 of Mercury is allowed by the German government as emission. 13 proper EHS adhered steps are included in treatment of LCD panels, and is carried out in a dismantling table with certain parameters suitable for treatment in URT. Other fractions like copper, aluminum, ferrous metals, stainless steel, plastics, boards and many others are manually dismantled.

Fig 1.2 Containing up to 500 µg Mercury in one capillary

Overall proper collection, transportation and treatment in cabins along with protective clothing for workers involved is ensured, also strictly no hand dismantling is done in Germany. Considering the kind of environmental, health and safety issues associated in recycling WEEE, it is recommended that the wise option is to REUSE, but also it has to be accepted that it is quite a challenge. It is also insisted that while recycling, the workers must ensure usage of protective clothing, be aware of warning symbols and lastly hygiene factor in these work places is very important, since chances of incorporation of any kind of poison is more in this work atmosphere. Prohibition of eating in work places is also strictly recommended by Germany.

Adoption of Good Practices

From the previous sub sections, we can understand that there lies a dire need for a competent WEEE recycling practice in HK. In order to achieve such efficient industrial practices, it is recommended to adopt some of the existing good practices being employed in countries like Germany and Korea. The good practices starting from collection of disposed E-waste, followed by transportation, storage and basic treatment has to be essentially adopted for developing an efficient recycling practice which is safe for the human lives involved and the environment. Understanding the EHS related issues associated with recycling of WEEE is the first step, further to which implementing the good practices to ensure safety of the people involved and the planet in a larger sense is the key towards developing effective recycling facilities in HK.

In order to achieve this, we collated the good EHS practices employed in Korea and Germany at different stages of E-waste treatment starting from collection through transportation, storage and basic treatment. We present the collated information in the following chapters which will enable HK recycling industry to adopt these good practices. Finally, we also present the feasible guidelines that can be adopted by the HK recycling industry in Chapter 7 under 4 sections namely, collection, transportation, storage and treatment to provide a useful insight to the industry people who wish to adopt good recycling practices.

Chapter 2

This Chapter presents the existing good EHS practices in countries like Korea and Germany in collection of WEEE. The major commonalities and differences among the practices followed are listed.

Chapter 2: Collection of E-waste

2.1 Existing Good EHS practices in Korea

2.1.1 EHS Practices in Collection Processes

In Korea, EHS is ensured in every step of the collection process. The EHS related measures followed in Korea are listed below.

EHS within Collecting WEEE from Customers:

- Preventing musculoskeletal disease
  - Work as pairs for handling heavy products
  - Use and cart and lift

Fig 2.1 Work as pairs

Fig 2.2 Work as pairs

Fig 2.3 Use lift

Fig 2.4 Wear gloves

- Accident prevention
  - Wear safety shoes and gloves (rubber)

2.1.2 WEEE Collection Practices/System

The WEEE collection practices in Korea were presented in brief previously in section 1.4.2. In this section we present a detail description of the good EHS practices employed in Korea while collecting E-wastes. E-wastes have been collected and recycled over 181,000 tons per year in Korea. Providing various return options for consumers are the starting point for a good WEEE collection process. In Korea three such options are provided for customers.

- Old for New
- Paid Return (Buying Sticker)
- Door to Door

Collecting the WEEE followed by transportation to the recycling facilities are the major operations involved and there are various stake holders who are responsible for these operations. The operational responsibilities are listed below.

Table 2.1 Operational responsibilities in Korean WEEE collection

Types	Operational Responsibility		
	Collection	Transport	Recycling
Case 1. Old for New	Producer	Producer	Recycler
Case 2. Paid Return	Customer	Local Authority	Recycler
Case 3. Door to Door	Scheme	Scheme	Recycler

Case 1: Old for New (Take back)

This is conducted by the producers. Once the consumers purchase a new product and after the installation process, the producer takes back the old product from the house, transports it to the retailers, warehouse and then to the recycling centre. Their performances account for 70% of total amount of collection.

Case 2. Paid Return (Buying stickers, Charged)

This option is carried out by the local authority. The customer needs to buy stickers, local authorities will collect items with the stickers stuck on it and transport it to the local depository and then to the recycling centre. Their performances account for 5% of total amount of collection.

Case 3. Door to Door

This option is managed by the KERC scheme. The customer needs to make a reservation by phone call. Free collecting service is provided by the KERC and MoE. Notice schedule of visiting date and time is provided to the customer and the WEEE (mainly for large size, but small size ones such as Personal Computer(PC), phone etc. can be collected with large ones) are collected and transported to governmental depository and then to regional recycling centre on consignment basis.

New collection methods implemented in Korea are "Free Collecting Service" Conducted by Ministry Of Environment (MoE) & Korea Electronics Recycling Cooperative (KERC) which includes the following processes.

- Reservation (Internet, Phone call, SNS)
- Check booked date and provide collecting worker's information
- Notice schedule of visiting date and time
- Collect WEEE (Household Appliances)
- Transport to governmental depository and store
- Transport to regional Recycling centre

The target WEEE is classified as single, set and Quantity Discharge items (more than 5 small items) for collection service.

Different cycles of new collecting service are:

- 3 times/week
- 2 times/week
- 1 time/week

Amount of WEEE collected through the new collection scheme in 2015 is 22 times more than that of the year 2012 and 2.3 times more than that of the year 2014.

2.2 Existing Good EHS Practices in Germany

2.2.1 EHS Practices in Collection Processes

In Germany, 500000 tonnes of WEEE including small and large scale appliances are being treated every year. The EHS related aspects in every step of the handling process is taken care of and ensured is at its best in order to avoid any dangerous problems.

2.2.2 WEEE Collection Process/System

Similar to Korea providing options to customers to return back the WEEE is considered to be the starting point of collection process in Germany also. The collection method involves phone call from the customer to the recycling agency / company, who send their means of transport depending on the size of the equipment to collect it from the customer from the WEEE collection points and bring it back to the recycler.

2.3 Major Commonalities & Differences Between the German and Korean Good Collection Practices

Table 2.3 Major Commonalities and Differences between German and Korean collection practices

Major Commonalities	Major Differences
• Both have effective and faster collection methods • Providing options to customers is the starting point	• Phone call from the customer is the only existing practice in Germany • 6 effective methods are involved for collection in Korea

Chapter 3

This Chapter presents the existing good EHS practices in countries like Korea and Germany in transportation of WEEE. The major commonalities and differences among the practices followed are listed.

Chapter 3: Transportation of E-Waste

3.1 Existing Good EHS Practices in Korea

3.1.1 EHS Practices in Transportation of WEEE

The EHS related measures followed in Korea during transportation process are listed below.

EHS in Transportation of WEEE:

- Pollution Prevention
  - Only roof trucks are used for transportation
  - Cleanliness maintained
- Accident prevention
  - Do not stack more than 2 storeys of WEEE on pallet
  - Securely fastened with straps to prevent WEEE from falling

Fig 3.1 Truck with roofing

Fig 3.2 Maintain only 2 storeys

Fig 3.3 Strap the equipment to avoid accident/fall

- Loss Prevention
  - Special sealing with tags on the doors of the trucks to prevent loss of WEEE before reaching the recycling centre (this is followed by Samsung)
  - Barcode system is used for tracking the number and types of WEEE carried in the truck

3.1.2 WEEE Transportation System

E-waste transport system in Korea for the 3 collection options presented above is discussed below.

1. Take-back (Old for New) (Managed by Suppliers)

Producers and sellers operate "logistics" on their own for collection (take-back) (e.g., Samsung & LG Electronics Logistics)

2. Local government (Charged, buying sticker)

Local governments have different city's ordinance → various routines (e.g., Individual/corporate outsourcing, recycling centre's cargo truck, logistics system of producers, etc.)

3. Door to Door (for free, managed by KERC)

MoE and KERC operate transport system on consignment basis for Door to Door service (Outsourcing company: Recycling Logistics, RCL)

Table 3.1 Features and Benefits of the Logistics system used in the 3 cases

	Case	Features	Benefits
1.	Take-back (Old for New) - Logistics system of producers & sellers	• Transporting the WEEE from customers' home to recycling centre or facilities • It is one of the efforts to achieve the mandatory recycling targets in Korea	• For large-size H.A, take-back system occupies most of the collection and transport • Collection and transport failures are very rare because accurate collection and transport (take-back) happen simultaneously with installation of new H.A
2.	Logistics system of local government	• Transporting the WEEE from customers' home to recycling centre or facilities • Means of transportation for transporting WEEE are imperfect - Carry WEEE using various routines • Price of stickers are differ depending on the respective local governments	• It helps to prevent transfer of H.A. towards the informal recycling sectors

3.	Logistics system of KERC (Door to Door)	• Transporting the WEEE from customers' home to recycling centre or facilities • RCL has 100 local centers which conduct transport system for WEEE nationwide	• From the year 2012 to 2014, collection and transport results showed a growth rate of 940% • In the same period, customer's satisfaction showed 98.8% and 99.8%, respectively • Nationwide, people's response towards free transportation service for WEEE collection was very positive

3.2 Existing Good EHS practices in Germany

EHS Practices in Transportation of WEEE

The EHS related measures followed in Germany during transportation process are listed below.

EHS in Transportation of WEEE:

- Pollution Prevention
  - ➢ Fully weather proofed trucks are used to protect from rain or snow
  - ➢ These types of trucks will protect leakage of hazardous substances from the WEEE being transported due to penetration of rain water.

3.3 Major Commonalities & Differences Between the German and Korean Good Transportation Practices

Table 3.2 Major Commonalities and Differences between German and Korean Transportation practices

Major Commonalities	Major Differences
• **Only licensed / permitted trucks can transport WEEE** • **Weather proof trucks with proper roofing is used** • **Proper strapping of WEEE to prevent falls**	Good sealing method is followed by Samsung a popular brand in Korea

Chapter 4

This Chapter presents the existing good EHS practices in countries like Korea and Germany in WEEE storage. Facilities in the storage site operations and EHS aspects of WEEE storage are presented. The major commonalities and differences among the practices followed are listed.

Chapter 4: E-waste storage site

4.1 Existing Good EHS practices in Korea

4.1.1 EHS Practices in Storage Facilities

The EHS related measures followed within storage sites in Korea are listed below.
EHS in WEEE storage:

- Accident Prevention
  - Do not stack more than 2 storeys of WEEE on pallet
  - Maintain a clean atmosphere in the ware houses
  - Fasten e-wastes using ropes to tighten and avoid falling down while stacking
  - Provide health check up to workers involved regularly
  - Always keep training materials and manual related of EHS for worker reference in work place and must be readily accessible also.
  - Emergency rescue plan and immediate reporting of accidents should also be made feasible for workers to protect their lives.
- Weather proof covering and impermeable surfacing
  - Preventing rain/snow's damages
  - Storage facilities must have the waterproofed roof
- Reducing storm/typhoon's damages
  - Posts are fixed by steel frames
- Preventing water pollution by runoff
  - sites are laid with asphalt concrete
  - Provision of Spillage collection and liquid pollutant blocking facilities
- Prevention of Loss of WEEE
  - Barcode & information system are used in warehouse
  - Allow entry of authorized persons only

Barcode and information system employed involves the following steps.

- WEEE Arrival
- Scan barcode
- Data processing
- Upload information

4.1.2 Storage Site Operations

In Korea, WEEE that are collected and transported, are gathered at storage sites and from there WEEE are ready for distribution to recycling centre or recyclers, accordingly. WEEE are categorized by items in the depository

Operation status of storage sites in Korea:
Currently there are 2 types of storage sites in Korea.

1) Warehouse (managed and used by producers)
   - Producers like Samsung, LG operate almost 130 warehouses nationwide in Korea.
2) Public or Local depository (by public or local governments)
   - KERC and local governments operate almost 230 depositories

The public and the local depositories are collaboratively operated and shared currently in Korea. Hence the WEEE from door to door and sticker scheme uses a shared storage depository before being sent to the recycling centres.

4.2 Existing Good EHS Practices in Germany

4.2.1 EHS Practices in Storage Facilities

The EHS related measures followed within storage sites in Germany are listed below.
EHS in WEEE storage:

- Weather proof covering
  - To prevent damage due to rain or snow
  - Storage facilities must have waterproofed roof wherever appropriate
- Preventing water pollution by runoff
  - Asphalt concrete is used for flooring as it is impermeable
- Storage orientation and arrangement
  - Refrigerator is controlled under regulations

4.3 Major Commonalities & Differences between the German and Korean Good Storage Practices

Table 4.1 Major Commonalities and Differences between German and Korean Storage practices

Major Commonalities	Major Differences
• Weather proof warehouses to withstand extreme weather conditions • Floors laid with asphalt concrete	• Well adopted bar code system and height limitation in Korea • Strict regulation especially for refrigerators for proper orientations and arrangement inside warehouses in Germany

Chapter 5

This Chapter presents the existing good EHS practices in countries like Korea and Germany in basic treatment of WEEE including those of disposing e-waste. Treatment Facilities, treatment operations in general as well as for specific types of regulated e-waste are explained with pictures and flowcharts. The major commonalities and differences among the practices followed are listed.

Chapter 5: Basic Treatment Including those of Disposing E-Waste

5.1 Existing Good EHS Practices in Korea

5.1.1 Treatment Facilities

To ensure health and safety of workers:
Personal safety equipment depicted below is specially designed to ensure health and safety of workers.

Fig 5.1 Personal safety equipment of workers

Devices for EHS:
For the Air conditioners and heaters, the device temperature is maintained properly considering the health of workers.

Fig 5.2 Air conditioner/heater pipe

Fig 5.3 Air conditioner/heater

Fig 5.4 Movable fan

The safety equipment is located in best locations to ensure workers safety.

Fig 5.5 Earplug bucket

Fig 5.6 AED (Auto External Defibrillator)

Fig 5.7 Helmet Storage

Recycling centres maintain convenient facilities including rest area, work table and visual system to ensure health and safety of workers.

Fig 5.8 Rest area

Fig 5.9 Work table with fume hood

Fig 5.10 Monitoring System

5.1.2 Treatment Operations in General

a. ***Safety and Health Management System of recycling centres in Korea***

Contents

- Aim and coverage of SHMS
- General term & policy
- Plan for operation
- Operation & performance
- Internal inspection and review

Purpose of the SHMS in RECYCLING CENTRE

- Set the SHMS in order to achieve reduce and prevent SH accidents

Standard reference

- ISO 14001
- OHSAS 18001 Many internal and external regulations, guidelines, and agreements are included with above two references

SHMS was operated based on over 25 specific procedures and guidelines. It is strongly recommended to keep SHMS.

1. OHSAS Manual
2. SH management policy
3. Procedure of risk evaluation
4. Procedure of compliance evaluation
5. Procedure of management by objective
6. Procedure of education and training
7. Procedure of intercommunication evaluation
8. Procedure of document management
9. Procedure of SH management
10. Response Procedure of emergency situation
11. Monitoring procedure

:

:

25. Guideline for safety usage of forklift

b. *Introducing regulations related to safety and health*

1. High-Pressure Gas Safety Control ACT

Fig 5.11 Manage refrigerant recovery equipment and gas barrel

2. Safety Control of Dangerous Substances ACT


Fig 5.12 Control dangerous substances like glass, fine dust, and ink

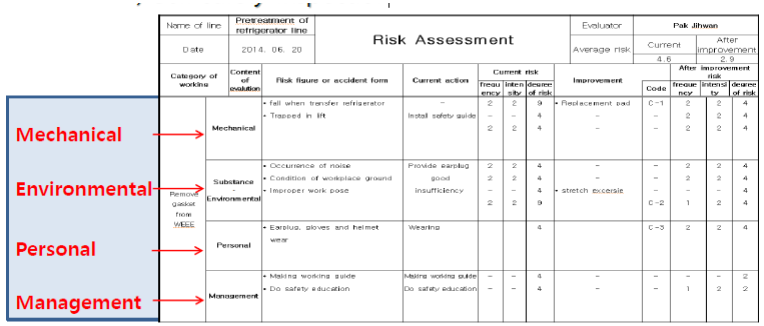
3. Framework ACT on Fire Service


Fig 5.13 Prevent or handle fire accident

4. Occupational Safety and Health ACT


Fig 5.14 Prevent industrial accident and make safe working environment

c. Self-safety inspection



Name of line	Pretreatment of refrigerator line	Risk Assessment	Evaluator	Pak Jihwan
Date	2014. 06. 20		Average risk	Current 4.6 / After improvement 2.0

Category of working	Content of evalution	Risk figure or accident form	Current action	Current risk: Frequency	Intensity	degree of risk	Improvement	After improvement risk: Code	Frequency	Intensity	degree of risk
Remove gasket from MBE	Mechanical	• fall when transfer refrigerator • Trapped in lift	– / Install safety guide	2 / 2	2 / 2	9 / 4	• Replacement pad –	C-1 –	2 2	2 2	4 4
	Substance · Environmental	• Occurrence of noise • Condition of workplace ground • Improper work pose	Provide earplug / good / Insufficiency	2 / 2 / – / 2	2 / 2 / – / 2	4 / 4 / 4 / 9	– / – / • stretch excersie	– / – / – / C-2	2 / 2 / – / 1	2 / 2 / – / 2	4 / 4 / 4 / 4
	Personal	• Earplug, gloves and helmet wear	Wearing			4		C-3	2	2	4
	Management	• Making working guide • Do safety education	Making working guide / Do safety education	– / –	– / –	4 / 4	– / –	– / –	– / 1	– / 2	2 / 2

Fig 5.15 Self-risk assessment report

An evaluation of self-risk assessment prevents accidents and arouses worker's attention before an accident takes place.

d. RECYCLING CENTRE fire manual and preventive education

To show guidelines for an outbreak of fire in RECYCLING CENTRE:

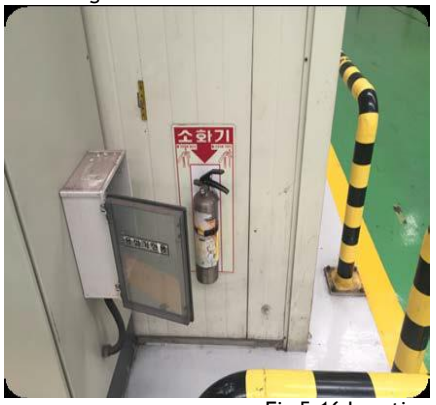


Fig 5.16 Locations of fire extinguisher

Fig 5.17 Training on how to use fire extinguisher

Educate mandatorily to all workers about the locations of fire extinguisher and how to use a fire extinguisher

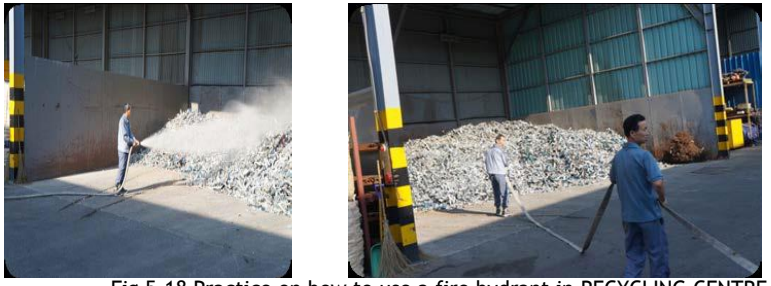


Fig 5.18 Practice on how to use a fire hydrant in RECYCLING CENTRE

Fig 5.19 Personal practice on how to use a fire extinguisher

Fig 5.20 Fire manual (audiovisual) education

The workers are educated about fire prevention and fire manual using audio and visuals, further to which they sign the completion confirmation document.

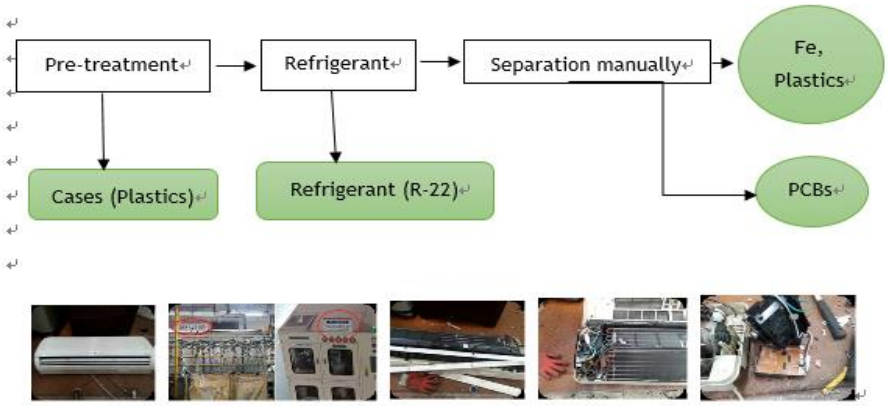
5.1.3 Treatment Operations of Specific Types of Regulated E-waste

In this section recycling processes involved in the treatment operations of specific types of WEEE are described using pictures and flow charts in the following sequence:

- Air-conditioners
- Refrigerators
- Washing Machines
- CRT TVs/Monitors
- LCD TVs/Monitors
- Desktop Computers
- Printers
- Small and medium size home appliances

a. Air Conditioners

Recycling of ACs include pre-treatment of cases followed by refrigerant recycling and finally separation of iron, plastics and PCBs manually. Before refrigerant recycling, sorting of types of refrigerants used must be carried out initially.



Manual Dismantling

Fig 5.21 Recycling of ACs

b. Refrigerator

Recycling starts with pretreatment (refrigerant, PCB, comp motor etc.) followed by shredding, crushing and magnetic separation to extract iron (Fe). Eddy current separation is carried out to obtain plastics and non-ferrous metals. Nonferrous metals include Al and Cu. Plastics include ABS/PP.

Fig 5.22 Pretreatment Process

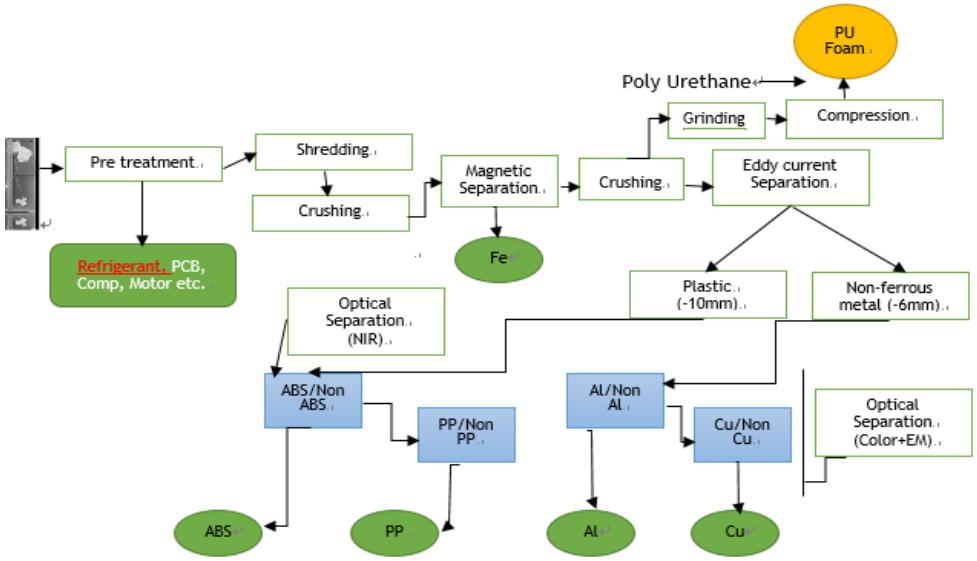


Fig 5.23 Recycling of Refrigerators

Fig 5.24 NIR Sorting (Plastics)

Fig 5.25 Color+EM sorting (Cu, Al)

The overall procedure involved in recycling Refrigerators is given below:
Pretreatment → Shredding → Automatic sorting

c. Washing Machine

The processes start with pretreatment followed by shredding and magnetic separation to extract Iron (Fe) and ABS/PP.

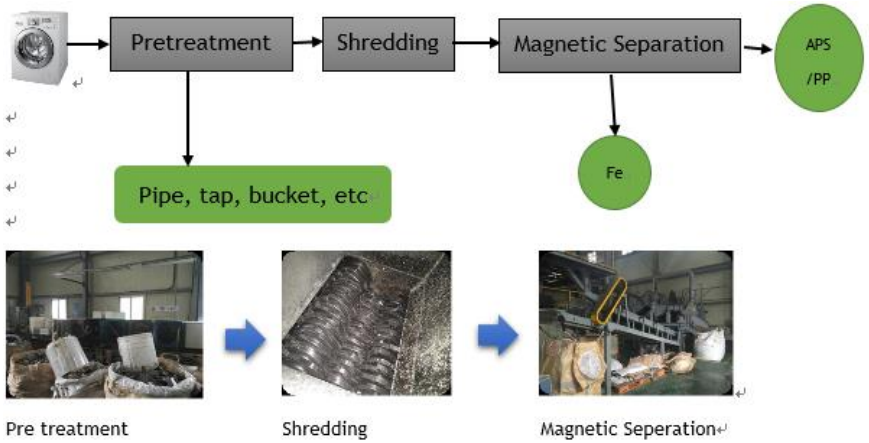


Fig 5.26 Recycling of Washing Machine

The pretreatment process includes

- Door (Pl, PCBs)
- Pipe, Tap
- Inner bucket
- Compressing bucket

The overall procedure involved in recycling washing machines is given below:
Pretreatment → Shredding → Automatic sorting

d. CRT TVs/Monitors

Recycling of TVs with CRT monitors start with pretreatment (back case & motors) followed by funnel cutting for fluorescent material removal, finally separation of glass and plastic is done manually.

Fig 5.27 Back-cover removal & Funnel cutting

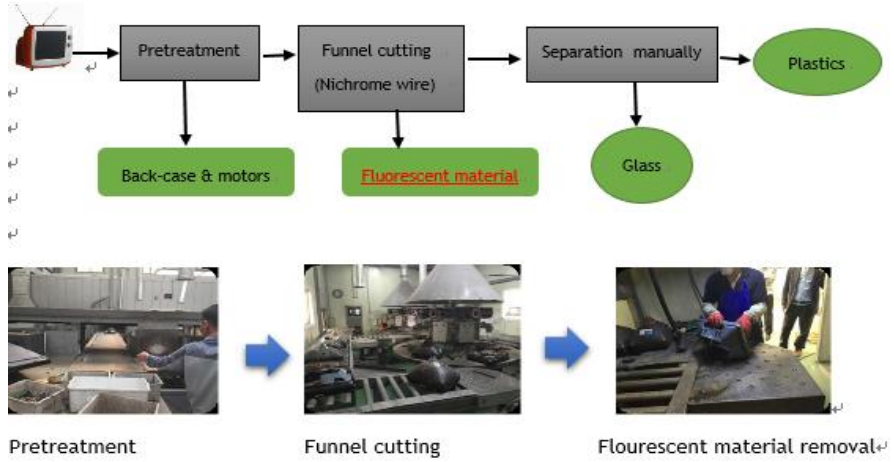


Fig 5.28 Recycling of CRT TVs/Monitors

The overall procedure involved in recycling CRT TVs is given below:
Pretreatment → Cut/Disassemble/Shred CRT→ Cleaning.

e. LCD TVs/Monitors

Recycling processes include pre-treatment of cases & cables, cold cathode fluorescent lamp and finally separation carried out manually to extract plastics and glass.

Fig 5.29 Pretreatment

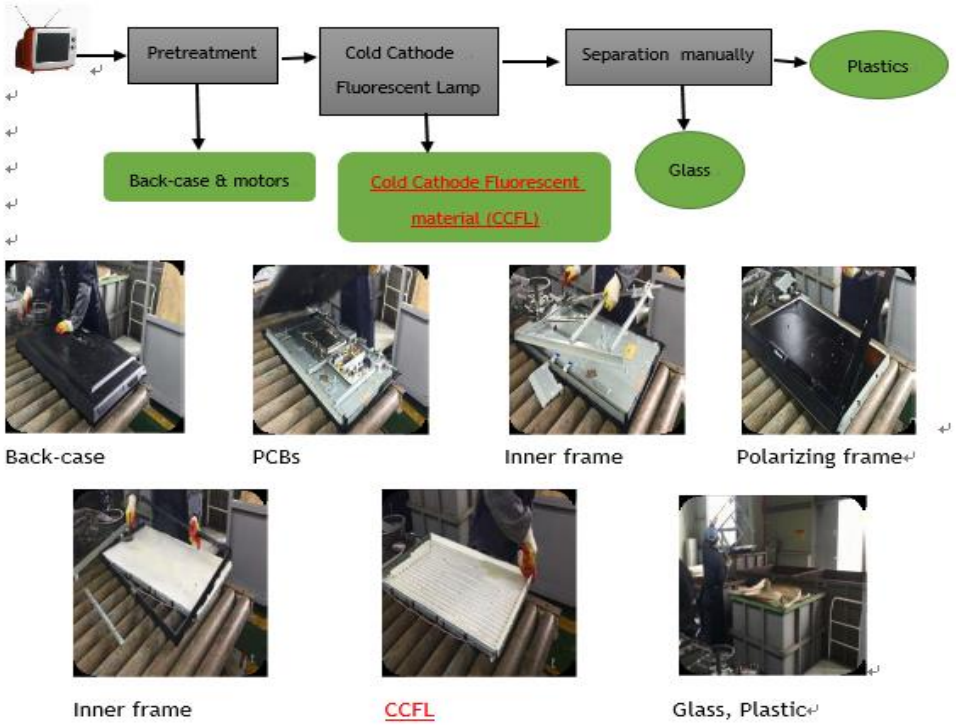


Fig 5.30 Recycling of LCD TVs/Monitors

f. Personal Computer

Recycling of PCs include pre-treatment of cases, cables etc. followed by separation of iron, plastics and PCBs manually.

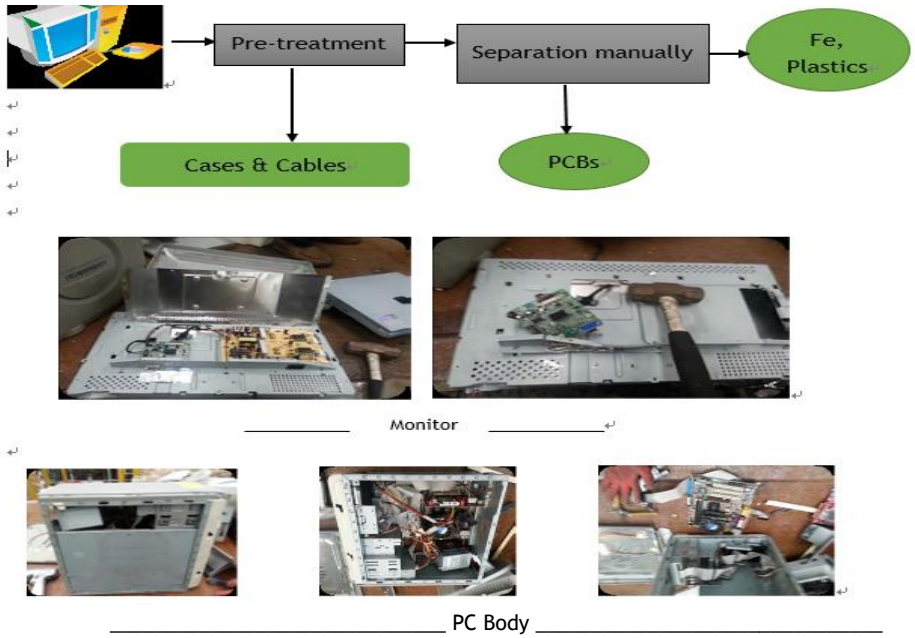


Fig 5.31 Recycling of Personal computer

g. Printers

Dust collection facility is maintained for collection of toner material while treating printers.

h. Small and medium size home appliances

For the above category, dismantling is done manually or mechanically.

Manually is done by feeding (hopper) and mechanically is done by magnetic separation using shredder. Most recyclers manually disassemble small and medium size appliances. Only a few recyclers partially use shredders and sorting machines for mechanical dismantling.

Manual Dismantling

Fig 5.32 Feeding (Hopper)

Fig 5.33 Manual dismantling

Mechanical dismantling

Fig 5.34 Shredder

Fig 5.35 Magnetic separation

5.1.4 Introducing Recycling Technologies in recycling centre

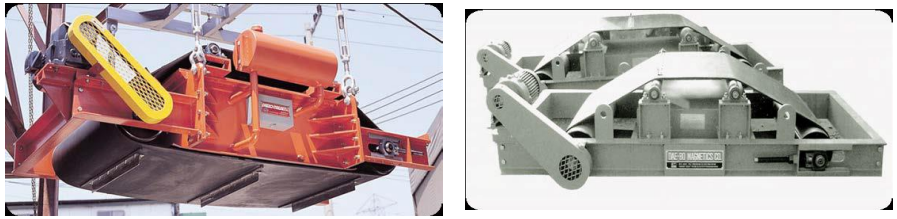
a. Comminution

Fig 5.36 Comminution technologies

Purpose:

- Makes easier handling of WEEE
- For size reduction in order to make optimum particle size during separation

b. Separation



Electromagnetic separator Permanent magnetic separator

Fig 5.37 Magnetic Separation technologies

Purpose:

- Can use eddy current separator easily
- To separate ferrous metal

1. Separation (Eddy current)

Fig 5.38 Eddy current separation technologies

Purpose:

- To separate non-ferrous metals and plastics
- Separate low and high intensity particles also

2. Separation (Screening)

Fig 5.39 Screening separation technologies

Purpose:

- Collecting particles which have similar size
- To make easier separation by adjusting particle size

3. Separation (gravity)

Fig 5.40 Gravity separation technologies

Purpose:

- To separate heavy(metal) and light(Urethane) particles
- To separate Al and Cu by density difference

4. Separation (Optical)

Near Infrared

Fig 5.41 Near Infrared (NIR)

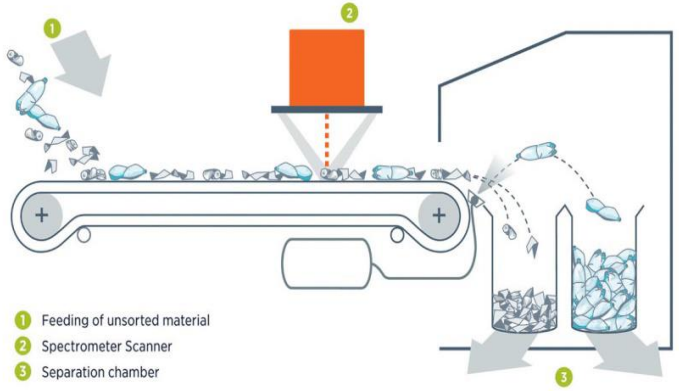


Fig 5.42 Optical Separation (NIR)

Purpose:

- To separate ABS and PP by wavelength range difference
- Various plastics can be sorted by NIR
- NIR sensors record each distinctive spectrum of plastics

CCD/EM (Color + Electro-magnetic)

Fig 5.43 Color+Electromagnetic

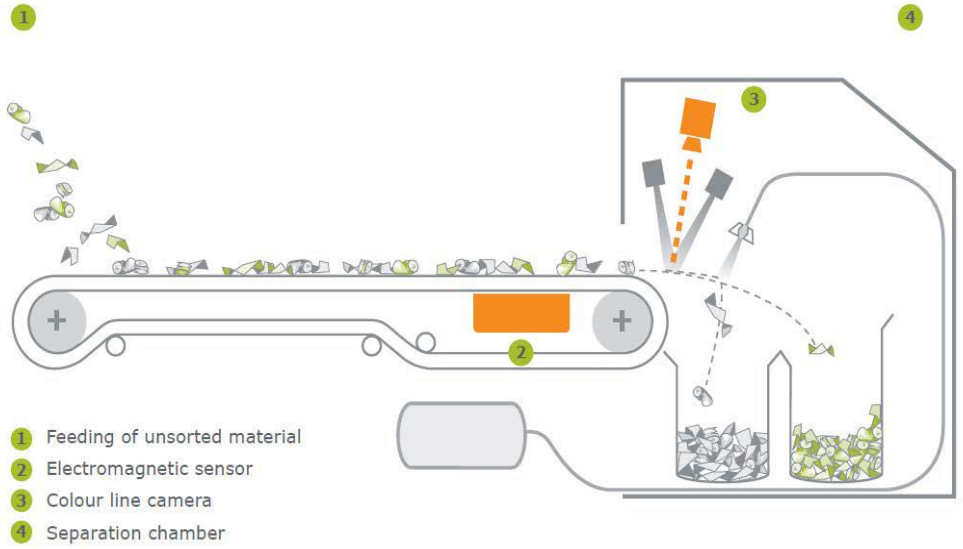


Fig 5.44 Optical Separation (Colour + Electromagnetic)

Purpose:

- To separate Al and Cu by color and electromagnetic difference
- Non-ferrous materials (Cu, Al) can be sorted by electromagnetic and color difference

5.1.5 Summary of WEEE Treatment Practices in Korea

A summary of EHS measures, recycling processes and recycling technologies used for large and small house hold appliances are presented below in Table 7.

Table 5.1 Summary of WEEE Treatment practices in Korea

Categories	Summary
EHS Measures	• Operation of Safety and Health Management System(SHMS) in recycling centres • SHMS was constructed based on ISO 140001, OHSAS 18001 • Provision of self-safety Inspection • Provision of recycling centre fire manual and preventive education • Enforcement of the following 4 regulations to ensure EHS in recycling centres 1) High Pressure Gas Safety Control ACT 2) Safety Control of Dangerous Substances ACT 3) Framework ACT on Fire Service 4) Occupational Safety and Health ACT
Recycling Processes	• AC-Pretreatment, refrigerant recycling and manual separation • Ref-Pretreatment, shredding and automatic sorting • WM- Pretreatment, shredding and magnetic separation • CRT- Pretreatment, shredding and cleaning • LCD- Pretreatment,CCFL and manual separation • Small & Medium size-Manual (feeder) and mechanical (shredder and magnetic) dismantling
Recycling Technologies	• Comminution: Shredder, hammer, and impact type • Separation: Gravity, eddy-current, screening, and optical (NIR and CCD/EM)

By recycling e-waste effectively Korea has achieved a considerable increase in the recycling volume per person and a number of other environmental performances like resource recovery, reduction of CO_2, and energy saving. Job creation is also an important advantage of e-waste recycling.

5.2 Existing Good EHS Practices in Germany

5.2.1 Treatment Operations in General

The EHS related efforts carried out in WEEE recycling facilities in Germany are explained in brief in this section for a number of equipment/sub products. Further in this section 2 recycling of specific electronic products, refrigerators and LCD TVs are presented in much detail.

a. Refrigerators

- Refrigerants and blowing agents are the huge sources of GWP and ODP, hence treatment in sealed and automatic plants is recommended.
- Within the fridge, spilling of oils and refrigerants inside the compressors due to improper treatment is flammable and explosive.
- Proper suction has to be done, and workers must wear proper work clothing and use proper tools.
- Fridge foam treatment must be done by shredding in vacuum atmosphere. This will enable no dust and CFC emissions

b. LCD TVs/Monitors

- Mercury is the dangerous component which has to be handled carefully.
- Proper collection, transportation and treatment in cabins with mercury suction and absorber along with protective clothing for workers involved is recommended.
- Using potassium permanganate as an adsorbent acts as a police filter which will change its color when there is mercury in the airflow, is also recommended as a second step.

c. Printers

- Toner powder is very fine and respirable, hence must be emptied into vacuum cabins only.
- This will avoid breathing of this powder by the workers involved and also explosion risks associated.

d. Other Fractions/Parts of Electronic Products

Batteries

- Emissions during fire, dangerous gas disposal and huge fire accidents due to improper storage are the causes.
- Collection and transportation in sealed vessels & tapping of poles of Li batteries is recommended.

Light bulbs and lamps

- Similar to LCD screen, mercury is the most toxic component and has to be handled carefully with proper collection
- Transportation and treatment in cabins with mercury suction and absorber along with protective clothing for workers involved.

Printed circuit boards

- Separation of batteries and mercury switches in ergonomic work station is recommended.
- Protective clothing and proper working tools are mandatory.

Cable recycling

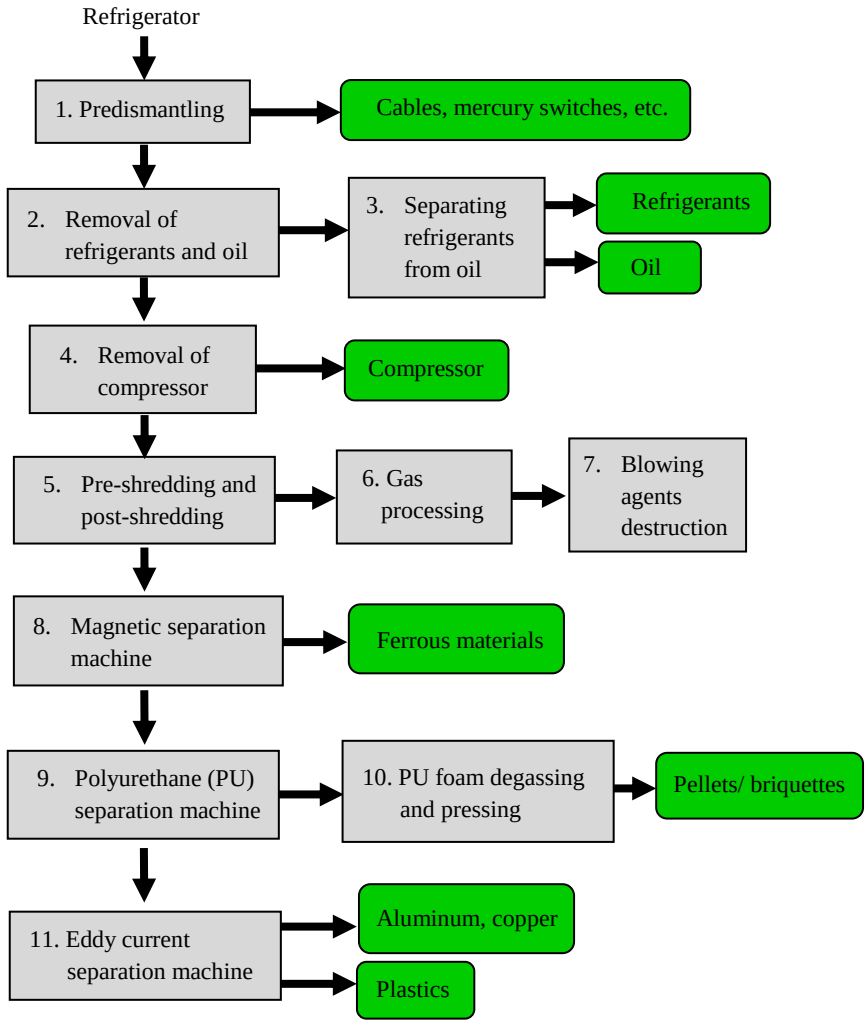
- Cable recycling is done manually in few places.
- The proper schematic process includes hand sorting, pre shredding, and secondary shredding finally followed by a segregation and separation technique.

5.2.2 Treatment Operations of Specific Types of Regulated E-waste

a. Refrigerators

Refrigerants and blowing agents (e.g. CFCs, HCFCs, etc.) in end of life refrigerators can cause global warming and ozone depletion. Therefore, they should be carefully removed without leakage during treatment operations.

A typical procedure involved in treatment of refrigerators in Germany is depicted below:



More pictures showing the treatment steps are illustrated below.

Fig. 5.45 Step 1: Predismantling

Fig. 5.46 Fractions removed, e.g. cables, mercury switches

Fig. 5.47 Step 2: Removal of refrigerants and oil

Fig. 5.48 Step 4: Removal of compressor

Fig. 5.49 Sealed shredding through air lock gates

Fig. 5.50 Step 6: Gas processing

Fig. 5.51 Step 7: Blowing agents destruction

Fig. 5.52 Step 9: PU separation

Fig. 5.53 Foam degassing

Fig. 5.54 Pellet cooling and discharge system

Fig. 5.55 Iron fraction

Fig. 5.56 Pellet fraction

Fig. 5.57 Plastic fraction

Fig. 5.58 Aluminum fraction

The whole above mentioned operation is monitored by a control station and visualized process. Highest CFC recovery rate of 97% can be achieved in Germany.

Fig. 5.59 Control station

Fig. 5.60 Visualized process

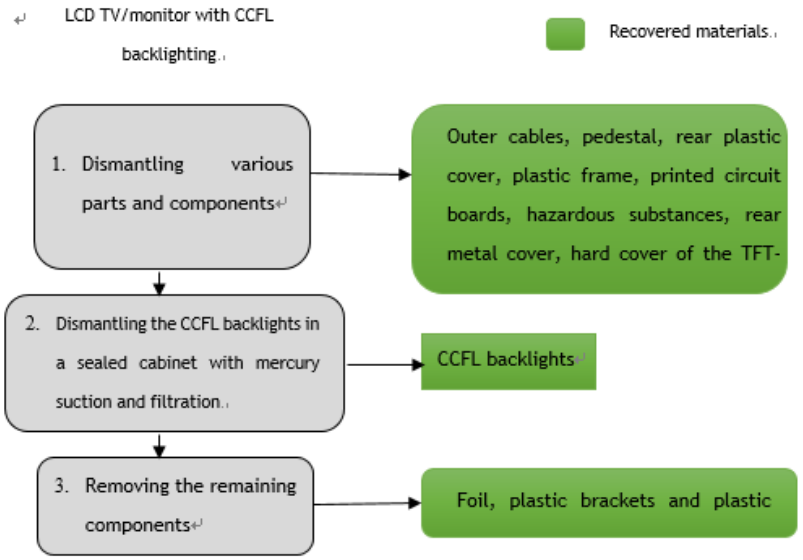
b. CRT TVs/Monitors

- Water spraying device is used to spray onto the CRT TVs. This step will protect the workers from inhaling toxic substances.
- In few recycling sites, the exhaust system is built under the WEEE conveyor belt system, so that the hazardous gases escape underneath and don't affect the workers.

C. LCD TVs/Monitors

The back frame with capillaries in LCD which is found at its EOL after dismantling, contains up to 500µg mercury in one capillary. Mercury is an extremely toxic substance that has to be carefully handled. Emission of mercury by breaking the capillaries of TV sets reaches up to 2000µg concentration.

The treatment steps involved in handling LCD TVs in Germany is depicted below:



The treatment procedure involved in hand dismantling of the LCD monitors are depicted using pictures below.

Step 1: Cutting Outer Cables

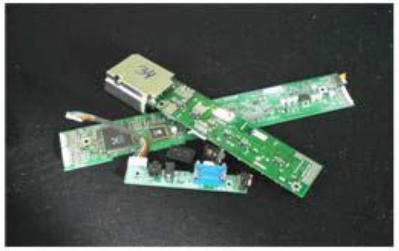
Step 2: Disassembling of the pedestal

Step 3: Disassembling the rear plastic cover

Step 4: Disassembling the plastic frame

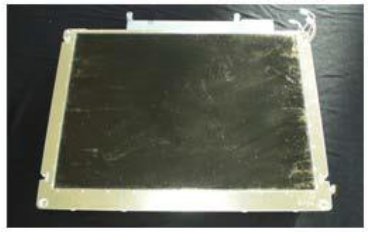
Step 5: Disassembling the boards

Step 6: Disassembling the hazardousmaterials

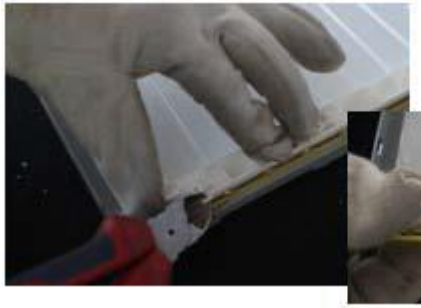


Step 7: Disassembling the rear metal cover

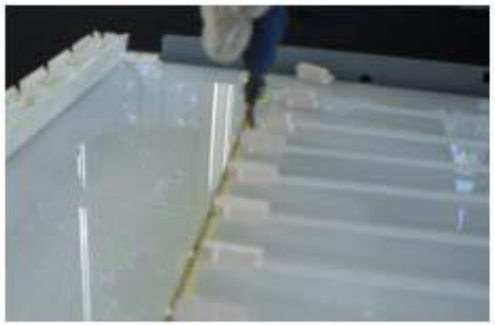
Step 8: Disassembling the hard cover of the TFT panel for further treatment



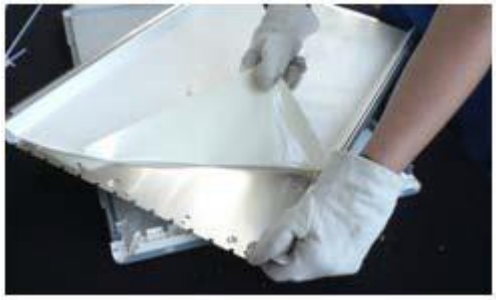
Step 9: Disassembling the LCD backlight, this is the most hazardous step



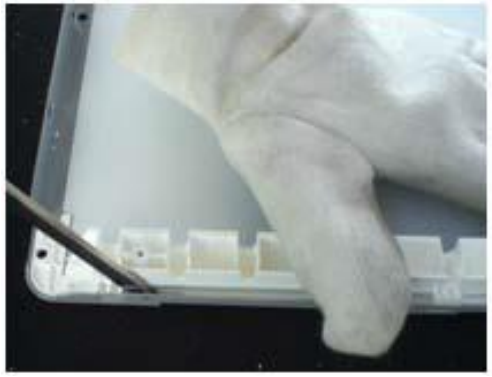
Step 10: Pinching the light if necessary



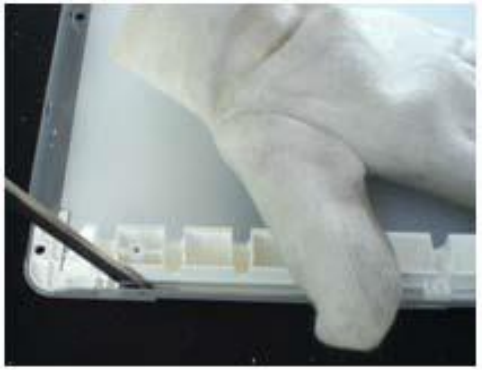
Step 11: Removing the foil



Step 12: Removing the plastic brackets

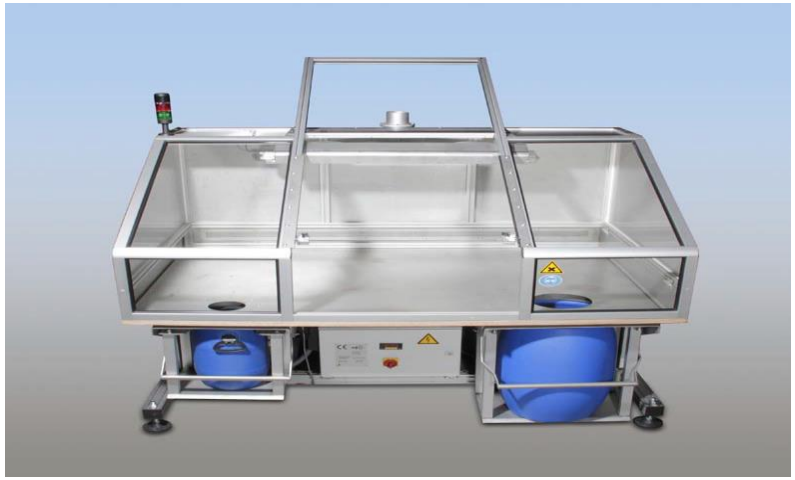


Step 13: Removing the plastic panels



For the above depicted dismantling process of LCD monitors, a **dismantling table** with capillary shredder is used in Germany. The picture of the table is given below. The main idea for using this table is to ensure protection of the dismantling staff from mercury emissions (only 100µg/m³ is allowed by legislation in Germany).

Fig 5.61 Dismantling table



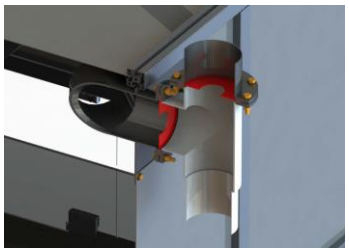
The **integration suction system** (250m^3 / hour) in the table and **integrated activated carbon filter system** are depicted below.

2-stage filter for mercury saturation checking:

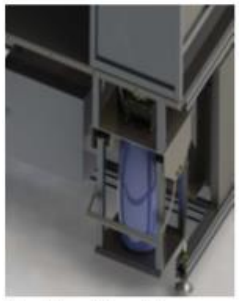
- Potassium permanganate ($KMnO_4$) is used as an adsorbent
- Color changes if there is any mercury in the airflow

Clean air exhaust system is also essential to ensure that the air exhaust is clean for the dismantling table.

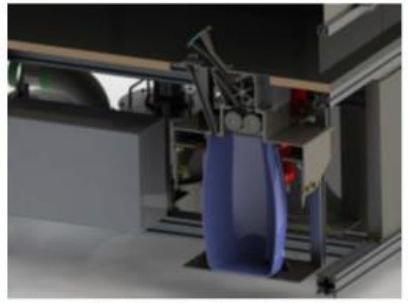
- Total suction volume: 250 m^3/h
- Circulating air: approx. 70 % (clean air after 2-stage activated carbon filtration)
- Exhausted air: approx. 30 % (clean air after 2-stage activated carbon filtration)



A **capillary shredder** is integrated into the dismantling table to shred the CCFL capillary after manual dismantling and its advantages are described below.



Capillary Shredder



Section drawing of the integrated shredding system

Advantages:

- Controlled 100% destruction of ALL capillaries dismantled
  - Collection of 100% of steaming mercury in filter system
- Reduction of the volume of capillaries
  - Easy and safe transport to mercury recycler
- Easy fraction handling (undestroyed capillaries may be longer than 1 meter)

Sectional drawing in detail of capillary shredder includes:

- Feeding system (above table)
- Fraction discharge (barrel)

5.3 Major Commonalities & Differences between the German and Korean Good Treatment Practices

Table 5.2 Major Commonalities and Differences between German and Korean Treatment Practices

Major Commonalities	Major Differences
• Effective treatment procedure with safe working conditions for workers meeting EHS requirements • Appropriate personal protection for workers, emergency measures and training given to workers involved	Onsite dismantling with aid of facilities like dismantling tables in Germany

Chapter 6

This Chapter presents the gap analysis conducted in order to understand the operational difficulties involved in WEEE recycling in Hong Kong and enable good EHS practices in the future.
The basic survey and on -sire reviews conducted in 6 recycling companies are presented in detail with pictures.
The differences between EHS related practices followed in Hong Kong, Korea and Germany are also presented.

Chapter 6: Gap Analysis

A gap analysis was conducted to measure the performance gap of practices in E-waste recycling, particularly with regard to EHS, between Hong Kong and foreign countries (e.g. Korea and Germany)

6.1 Objectives of the Gap Analysis

- To identify the operational shortages and the appropriateness of applying emerging technologies to tackle the EHS problems within e-waste handling processes in Hong Kong
- To identify the major barriers to achieve the good EHS practices
- To consolidate practical ways for upgrading the operational processes in Hong Kong with the application of emerging and affordable technologies from the existing good practices in Korea and Germany

To help the local SMEs to have a better understanding on the "Gap Analysis" in this Chapter, a Chinese version (in Windows PowerPoint presentation format) is attached in **Appendix A**.

6.2 How the Gap Analysis was performed?

6.2.1 A basic survey (initial review) carried out in Hong Kong

A basic survey (initial review) was carried out starting from the middle of November 2014 till early December 2014 to understand the existing practices of WEEE collectors and recyclers of local SMEs in terms of EHS aspects. We had used three methods for conducting the survey (1) visiting the companies (2) emailing an online survey and (3) making phone calls wherever there was no response for emails. We had sent out 50 questionnaires and received 11 answered questionnaires in return. The total response rate was 22%. A summary of the findings in the basic survey (initial review) can be found in **Appendix A**.

6.2.2 Overseas studies in Korea and Germany

An overseas study in Korea was conducted in late December 2014 to explore the good EHS practices within WEEE recycling in Korea. The places that were visited include WEEE collection station, some WEEE logistics distribution centers of famous electrical and electronics companies in Korea, as well as some environmental organizations in Korea.
Another overseas study in Germany was conducted in late April 2015 to explore the good EHS practices within WEEE recycling in Germany. The places that were visited include several WEEE recycling companies in Germany.

6.2.3 On-site in-depth reviews and advices to adopt EHS good practice in recycling related companies in Hong Kong

To further investigate the operational deficiencies found within recycling companies in Hong Kong, identify the major barriers and success factors in obtaining a waste disposal license under WDO, and consolidate practical ways in upgrading the operational processes in Hong Kong, six (6) WEEE recycling-related SME companies were chosen to carry out on-site in-depth reviews and provide professional advices in order to adopt EHS good practice in their companies. Among these 6 companies*, the business nature of four (4) companies were recycling of computers and their peripheral products. The fifth company was a downstream recycling company in which one of its businesses was refining the waste printed circuit board. The last company is a company which only collected e-wastes and re-distributed them. For each company, one to three visits were carried out. The first visit was to conduct an on-site review of the EHS practices in those companies. The second visit (if needed) was to give professional advices and consolidate practical ways for upgrading the EHS practices within the operations referring to the overseas EHS good practices. The third visit (if needed) was to follow-up to see if EHS good practices could be carried out practically within the recycling operations of those companies. There were cases where the second and third visits were combined, depending on the business nature and availability of those companies.

After investigating the situations of WEEE collection and recycling process in Hong Kong, Korea and Germany, a gap analysis in the performance of practices in WEEE recycling, particularly in terms of EHS aspects, between Hong Kong, Germany and Korea was carried out.

***** Table 9. Details of the Companies which Participated in On-site in-depth Reviews

	Company	Business nature	Treatment scope among the five types of regulated WEEE
1	A	E-waste collection and recycling	Mainly computers and their peripheral products
2	B	E-waste collection and recycling	Mainly computers and their peripheral products
3	C	E-waste collection and recycling	Mainly computers and their peripheral products
4	D	Metal refinery	Waste printed circuit boards
5	E	E-waste collection and recycling	Computers and Printed Circuit Board Assemblies
6	F	E-waste collection (& re-distribution) only	All types of WEEE

Appendix A gives the details of the on-site in-depth reviews of companies A, B, C, D.

6.3 Review of Current Operations of WEEE Recycling Industry in Hong Kong

6.3.1 Operational conditions of recycling companies

6.3.1.1 Initial Review (Basic Survey)

Among the 11 respondents, most of the companies do computer recycling, followed by recycling of TV, air-conditioners, refrigerators and printers in that order. Fewer companies recycle washing machines and scanners. Only one company carried out CRT treatment.
Most of the WEEE are from commercial and industrial sectors, followed by household, while still some of them are imported WEEE. Most of the collection and recycling companies only do basic treatment for the WEEE, then export to other places for further treatment.

6.3.1.2 In-depth on-site reviews and advices

Four (4) out of the six (6) companies we had visited, recycled computers and their peripheral products mainly among the 5 types of regulated WEEE. Only one company was a downstream recycling company in which one of its businesses was to refine the waste printed circuit board. And one company focused only on the collection of e-waste.

6.3.2 EHS management of recycling companies

6.3.2.1 Initial Review (Basic Survey)

Most of the medium-sized companies have certifications in ISO14001, while some of them have ISO9001 and OHSAS 18001. It is a good practice to obtain such certifications to ensure that their EHS can reach a certain standard. The raw data received from the 11 companies in the initial review can be found in **Appendix A**.

6.3.2.2 In-depth on-site reviews and advices

Among the 6 companies we visited, 3 companies have certifications in ISO14001 and OHSAS 18001, while two even was certified in R2 standard (an USA electronics recycling industry's certification scheme). The other 3 companies do not have any of the above certifications.

6.3.3 Environmental monitoring of recycling companies

6.3.3.1 Initial Review (Basic Survey)

Most of the companies (nine out of 11 companies) do not have regular environmental monitoring on the exposure to hazardous substances in air and water, this leads to an EHS problem for the workers involved in recycling operations. There are chances that they may be exposed to hazardous substances such as chemicals and heavy metals which could threaten their life and health. Lack of noise monitoring would also pose a threat to the workers in terms of affecting their hearing abilities.

6.3.3.2 In-depth on-site reviews and advices

All 6 companies we visited do not have air monitoring measures and only 1 company had checked noise level earlier.

6.3.4 Collection/transportation/storage (including simple sorting)

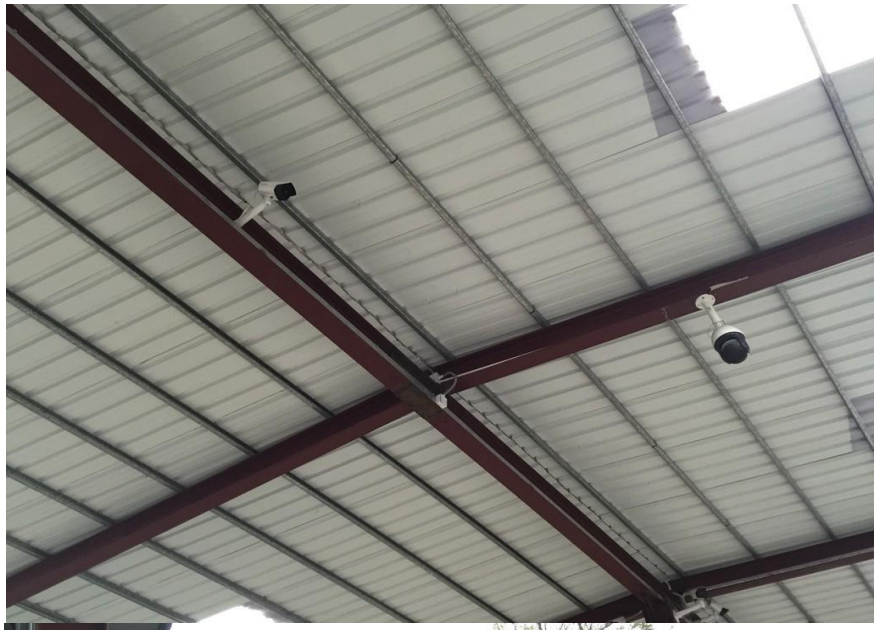
6.3.4.1 Initial Review (Basic Survey)

Most of the companies provide collection, transportation, storage, sorting and basic treatment of WEEE. Most of the companies have proper cover and fixed WEEE tightly without falling during WEEE transportation. However, only half of them have their WEEE stored in proper collection and storage houses with proper covering to protect against all weather conditions. This would pose threat to the environment by contaminating the soil and water system.

6.3.4.2 In-depth on-site reviews and advices

For the 6 companies we visited, we only focused on storage, sorting and basic treatment since collection and transportation will not be regulated under the proposed mandatory PRS. Basic treatment is discussed in Section 6.3.5. Storage and sorting part are described below.

Storage (including simple sorting)
All the 6 companies we visited had roofed structure and floor with impermeable surface. Three companies had a maximum stack height for stored e-wastes. 4 out of 6companies had suitable e-waste classification and WEEE was categorized according to their types.



6.3.5 Basic treatment

6.3.5.1 Initial Review (Basic Survey)

Capacitors inside printed circuit board (PCB)

Most of the companies do not remove capacitors from the PCBs, this may lead to an EHS problem to the workers and the environment because some of the PCBs have hazardous materials that pose threat to human health

Plastics

Almost all responded companies follow proper handling of plastics and do not burn the plastics that lead to the release of toxic substances.

Computers

Most of the companies only collect the basic dismantled computer main board and hard disk. They do not further treat those parts but directly transport them to other treatment organizations.

CRTs

There is only one company that dismantles CRT while this company adopts good EHS measures in CRT dismantling.

Printers

Most of the companies do not further treat the separated cartridges while only directly transport them to other treatment organizations.

Scanners

Most of the companies do not handle and treat the scanners.

LCD monitors

Almost all of the companies do not handle and further treat LCD monitors. Only one company replied that it handles LCD monitor but does not follow enough EHS measures while handling the LCD monitors.

Refrigerators and air-conditioners

Only half of the respondents claim that they remove the refrigerants firstly while dismantling refrigerators and air-conditioners. Small portion of the respondents replied that they would remove oil from refrigerators and air-conditioners. This may lead to EHS problems to the workers and the environment as the refrigerants and oil contain hazardous materials that will harm the workers and the environment.

Washing machines

For the companies that treat washing machines, most of them are unaware that the relay switch of old type of washing machines may contain toxic mercury and large portion of them do not remove the relay switch first. This may lead to EHS problems to the workers and the environment.

6.3.5.2 In-depth on-site reviews and advices

Four (4) out of the six (6) companies we visited, mainly recycle computers and their peripheral products among the 5 types of regulated WEEE and one company is a downstream recycling company in which one of its businesses is refining the waste printed circuit board. As such, only treatment of computers and their peripheral products are discussed below. One company is a company for WEEE collection only, no treatment operations existed there.

Capacitors inside printed circuit board (PCB)

The aforementioned 4 companies do not remove capacitors from the PCB because they stated that the capacitors inside PCBs are not harmful according to the information of their suppliers.

Printers

Only one company dismantles printers and cartridges inside are removed first and then transported to other companies for further treatment.

6.3.6 Protection of personnel

6.3.6.1 Initial Review (Basic Survey)

Most of the companies provide uniform to their workers, this is a good practice to protect the workers from having contact with hazardous substances from WEEE. Most of the companies provide basic personal protective equipment (PPE) to their workers, such as gloves, masks, safety shoes and ear plugs etc. However, during our visit, many workers did not wear ear plugs even in a high noise working environment

6.3.6.2 In-depth on-site reviews and advices

All the 6 companies we visited had provided suitable personal protective equipment in the operation sites. The workers in four companies were observed to wear suitable PPE during operations. The remaining company was not in operation during our visit; however, the employer stated that suitable PPE will be used by workers. For body check, only 2 companies provide regular body check to its workers.

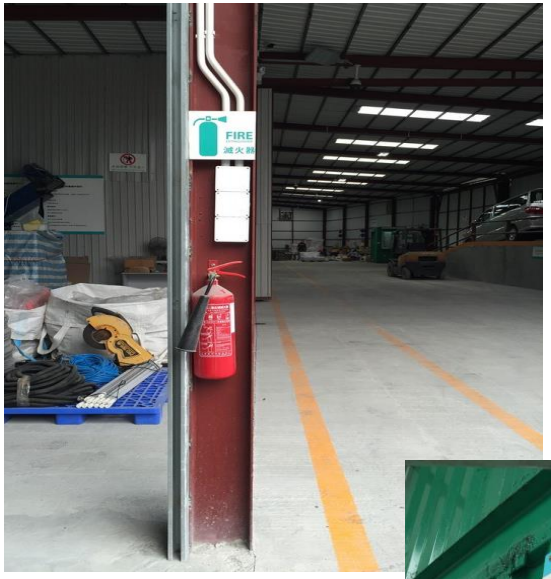
6.3.7 Preparation for emergency

6.3.7.1 Initial Review (Basic Survey)

Only five out of 11 companies had first aid trainings. Other emergency preparations were not investigated in the basic survey

6.3.7.2 In-depth on-site reviews and advices

Three (3) out of six (6) companies we visited had suitable and enough emergency preparation, such as drawing up of an emergency plan, enough resources for dealing with emergency, reporting of incidents and the actions to be taken in response to an emergency and training of staff to respond to an emergency



6.3.8 Training

6.3.8.1 Initial Review (Basic Survey)

8 out of 11 companies provided safety training to their new staff and also recycling safety instructions to their workers, while three companies did not.

6.3.8.2 In-depth on-site reviews and advices

Three (3) out of Six (6) companies we visited had given enough and suitable EHS trainings as well as basic treatment trainings for their workers. The other three companies need to improve their EHS trainings as well as treatment trainings.

6.4 Gap analysis in EHS Practices of WEEE Recycling Industry between Hong Kong, Korea and Germany

Table 10. Gap analysis in EHS Practices of WEEE Recycling Industry between Hong Kong, Korea and Germany

	Hong Kong	Korea	Germany
Collection	• Better and more collection methods are needed for effective collection • Transfer rate may not be fast enough	• Four well adopted collection modes for effective collection • Fast transfer rate: within 24 hours	• Effective collection methods, such as collection from households directly
Transportation	• No specific truck required for transporting WEEE • Not all trucks for WEEE transportation are weatherproof • May not have proper fixing for WEEE inside trucks • Do not have good sealing method like Samsung	• Only permitted truck can transport WEEE • Weatherproof truck for WEEE transportation • Proper fixing for WEEE inside trucks • For Samsung, good sealing method for WEEE on trucks	• Only permitted truck can transport WEEE • Weatherproof truck for WEEE transportation
Storage	• No height restriction so far (to be legislated soon) • SMEs may not adopt barcode system for WEEE tracking • Some storage places may not be weatherproof	• Height restriction for safety • Well adopted barcode system for WEEE tracking • Weatherproof storage place	• Weatherproof storage place • Strict regulation on storage orientation and arrangement of WEEE, for example refrigerator
Sorting	• Have some separations to a certain extent • May not have handling methods as good as Korean practices	• Good separation for different types of WEEE • Different handling methods for different types of WEEE according to their characteristics	• Good separation for different types of WEEE • Different handling methods for different types of WEEE according to their characteristics
Basic treatment	• Some companies may not have proper treatment procedures with EHS considerations in certain types of WEEE	• Proper treatment procedures with EHS considerations	• On-site dismantling and device using procedures • Proper treatment procedures with EHS considerations
Personnel protection	• Body check is usually not provided • Some companies have provided appropriate personal protective equipment, but some workers may not use in actual situations	• Body check provided to workers before job and during job • Appropriate personal protective equipment provided to workers	• Appropriate personal protective equipment provided to workers
Emergency measures	• Some companies do not have good emergency measures	• Emergency measures are provided, e.g. water tank for fire safety	• Emergency measures are provided, e.g. water tank for fire safety, oil leakage handling

Training	• Some companies do not have enough suitable trainings on EHS and WEEE dismantling procedures	• Suitable trainings for proper WEEE dismantling procedures with proper EHS considerations	• Suitable trainings for proper EHS trainings and WEEE dismantling procedures

6.5 Major Barriers to Achieve EHS Good Practices

6.5.1 Lack of formal EHS guidelines

For the four recycling related companies that we carried out on-site reviews and advices, two companies performed better on EHS aspects while the other two needed more improvements. For the two companies that performed better, both companies had adopted ISO14001 environmental management system and one company had adopted R2 standard (an electronics recycling industry's certification). Therefore, these two companies had more knowledge and guidance in EHS aspects.

However, currently there are no formal EHS guidelines developed for WEEE recycling industry in Hong Kong. Therefore, WEEE recycling industry in Hong Kong does not have enough EHS procedures to follow and does not know how to improve their EHS levels.

6.5.2 Financial concerns

For the company that needed the most improvements, it is a small company which had financial concerns in certifying ISO14001 and R2 standard, therefore, it had less guidelines and does not know how to improve EHS practices from before. Besides, the WEEE recycling companies might also have financial concerns while carrying out some EHS practices, such as installation of some environmental monitoring devices such as air monitoring device. For example, automatic shredding devices and dismantling table for mercury suction used in Germany for LCD monitors treatment may be expensive for some local SME WEEE recycling companies.

Chapter 7

This Chapter presents the feasible guidelines for implementing good EHS practices within the WEEE recycling industries in Hong Kong. The good EHS practice guidelines are provided for collection, transportation, storage, sorting and treatment of WEEE.

Chapter 7: Feasible Guidelines for Implementing Good EHS Practices within HK Recycling Industry

In this section we consolidate the feasible and practical guidelines that can be implemented in the HK recycling centres based on our visits to understand the good practices employed in Germany and Korea. These guidelines will enable better and effective recycling operations ensuring health and safety of the workers and simultaneously contribute less or no emissions. These guidelines will also help the SMEs involved to especially upgrade their existing EHS practices in recycling centres. Similar to other sections, the guidelines are also presented in 4 sections namely collection, transportation, storage and treatment of e-waste.

To help local SMEs (including their front-line workers) to better understand the guidelines in section 7.3 and section 7.4 which are the guidelines on storage and treatment of e-wastes, an expanded version in Chinese is attached in **Appendix B** for easy reference.

7.1 Collection of E-waste

7.1.1 Feasible EHS Practices

- Work as pairs and use cart or lift while handling heavy products to protect the workers involved form being affected by musculoskeletal diseases.
- Ensure that the workers wear suitable personal protective equipment, proper shoes and gloves to prevent accidents from happening.

7.1.2 WEEE Collection Methods to Improve Recycling Rate of WEEE

Similar to Korea and Germany collection from customers should be the good starting point for any collection process. The transfer rate must be enhanced definitely for effective and quick collection. More options should be provided to the customers like phone call, internet booking to take back WEEE etc. Besides producer responsibility being tightened, local authorities, government and SMEs involved in recycling play a crucial role in stabilising WEEE collection in HK.

7.2 Transportation of E-Waste

7.2.1 Feasible EHS Practices

Logistics plays a very crucial role in handling WEEE, as the customers involved find it very difficult and time consuming to return the WEEE to the recycling centres, which consequently turns into unsafe landfill. Hence an effective transportation of WEEE is very essential especially in HK to avoid e-waste being sent to landfill.

Pollution prevention and accident prevention are the two main aspects in transportation of WEEE that need attention.

- Preventing emission or leakage of hazardous substances from WEEE
  - Using roof-truck to transport WEEE that can withstand extreme weather conditions
- Accident prevention
  - Fork lift trucks should be used to lift up the pallets with WEEE to put into the WEEE transportation trucks whenever possible
  - WEEE should be tied up properly during transportation to prevent from falling down, for example, bind straps and containers can be used

7.3 Storage of E-waste

The roofing and flooring of the warehouses or the storage facilities where the WEEE are being stored is of utmost importance. The sorting, labelling and stacking height of the WEEE within the warehouses are also important aspects to be considered for proper storage. It is important to make sure that the storage operations adhere to EHS measures in order to ensure safety of workers and reduce chances of accidents.

7.3.1 Storage Facilities

- Prevention of emission or leakage of hazardous substances from contaminating underground water or soil
  - Weatherproof covering for appropriate areas, e.g. proper roofing, marquee, or in some cases simple closed or covered containers
  - Impermeable surface flooring, e.g. asphalt, concrete
  - Spillage collection and liquid pollutant blocking facilities
- Prevention of damage and theft of regulated WEEE and components stored
  - Allow entry of aauthorized personnel only into the storage site
- To protect the health and safety of all the employees and workers in storage site
  - Suitable fire emergency facilities that comply with regulation of fire safety
  - Suitable personal safety equipment and protection devices, e.g. gloves, face masks, protective clothing, safety shoes, protective helmets, etc.

7.3.2 Storage Operation Guidelines

- To protect the safety and health of the workers involved and reduce the chances of accidents and injuries
  - Always maintain cleanliness in the storage location, containers and other parts of the warehouses
  - Maintain a maximum storage height to stack up WEEE which is safe
  - Suitable measures to be carried out to prevent WEEE from falling, e.g. using ropes for tightening, stack in huge containers, etc.
  - Provision of health check up on a regular basis (annual check-up is recommended) for the workers involved

- To maintain good storage orientation
  - WEEE should be sorted and stored according to different types in different portions of the site or containers, with labels to identify waste classification
- To prevent loss of WEEE
  - Barcode labelling and maintenance of an information system is encouraged. The bar code stuck on each regulated e-waste, pallet and container and the corresponding information system updated will prevent loss of WEEE.
- To ensure adherence to EHS aspects
  - Suitable EHS trainings to relevant employees when they start their job and repeated trainings for all employees at the storage site at regular intervals in important aspects like: proper movement of WEEE, safety in operating WEEE storage-related equipment such as forklift trucks
  - Employee training materials and EHS information shall be made available at the work place or easily accessible to employees in the form of notices or hand books.
- To protect the lives of all the employees on site in case of emergency
  - An emergency plan to address all probable emergency situations, e.g. fire injury, release of toxic substances.
  - Provision for immediate reporting of incidents and quick responsive actions should be taken to address the emergency situation
  - Training should be provided to staff in order to help them act during emergency situations at regular intervals.

7.4 Basic Treatment Including those of Disposing E-Waste

7.4.1 Treatment Facilities

- Prevention of emission or leakage of hazardous substances from contaminating underground water or soil
  - Weatherproof covering for appropriate areas, e.g. proper roofing, marquee, or in some cases simply closed or covered containers
  - Impermeable surface flooring, e.g. asphalt, concrete
  - Spillage collection and liquid pollutant blocking facilities
- Prevention of damage and theft of regulated WEEE and components stored
  - Allow entry of aauthorized personnel only into the storage site
- To protect the health and safety of all the employees and workers in storage site
  - Suitable fire emergency facilities that comply with regulation of fire safety
  - Suitable personal safety equipment and protection devices, e.g. gloves, face masks, protective clothing, safety shoes, protective helmets, etc.

7.4.2 Treatment Operations in General

- Suitable EHS trainings to relevant employees when they start their job and repeated trainings for all employees at the treatment site at regular intervals on important aspects like: EHS risks involved during operations and treatment of WEEE and proper procedure to be followed while treating WEEE
- Employee training materials and EHS information shall be made available at the work place or easily accessible to employees in the form of notices or hand books.
- Provision of health check up on a regular basis (annual check-up is recommended) for the workers involved
- An emergency plan to address all probable emergency situations, e.g. fire injury, release of toxic substances, medical emergency, adverse weather conditions etc.
- Provision for immediate reporting of incidents and quick responsive actions should be taken to address the emergency situation
- Training should be provided to staff in order to help them act during emergency situations at regular intervals.

7.4.3 Treatment Operations of Specific Types of WEEE

a. Air Conditioners

- Sorting of types of air conditioners (according to the types of refrigerants used) should be carried out.
- All liquids (refrigerants and oil) that contribute to contamination of separated fractions during or after the treatment process, should be removed using appropriate devices in order to prevent leakage of harmful substances.
- Oil should be carefully separated from all refrigerants, if oil leakage is recognized, appropriate measures must be taken to avoid explosion
- The amount of refrigerants collected and stored should be measured correspondingly.
- The collected refrigerants can be transported to other qualified companies for further treatment.
- The concentration of “controlled substances” (e.g. CFC) should be measured inside different locations of the treatment sites. If the concentration exceeds the maximum concentration limit, an alarm should be set up to indicate the same and the site should stop its operation.
- During treatment of hydrocarbons (HC) appliances, ban on ignition sources must be labelled and ban on entry by unauthorized persons should be enforced as precautionary measures, considering the danger involved due to the flammability of hydrocarbons

b. Refrigerators

- Electrical plugs should be separated first and dismantled since the mercury containing components inside the refrigerators have to be treated first on entering the treatment site.
- Sorting of types of air conditioners (according to the types of refrigerants used) should be carried out.
- All liquids (refrigerants and oil) that contribute to contamination of separated fractions during or after the treatment process, should be removed using appropriate devices in order to prevent leakage of harmful substances.
- Oil should be carefully separated from all refrigerants, if oil leakage is recognized, appropriate measures must be taken to avoid explosion
- The amount of refrigerants collected and stored should be measured correspondingly.
- The collected refrigerants can be transported to other qualified companies for further treatment.

- The concentration of “controlled substances” (e.g. CFC) should be measured inside different locations of the treatment sites. If the concentration exceeds the maximum concentration limit, an alarm should be set up to indicate the same and the site should stop its operation.
- During treatment of hydrocarbons (HC) appliances, ban on ignition sources must be labelled and ban on entry by unauthorized persons should be enforced as precautionary measures, considering the danger involved due to the flammability of hydrocarbons
- The blowing agent (e.g. CFC) inside the PU foam should be removed. The PU foam can be compressed to form briquette in order to prevent dust emissions.
- Refrigerators identified as containing ammonia must have the ammonia extracted and transferred to a suitable container after disposal

c. Washing Machines

- Pretreatment should be primarily carried out first in order to remove pipes, taps and buckets
- Further to which shredding, magnetic separation machines must be to separate plastics and iron.

d. CRT TVs/ Monitors

- Fluorescent coatings must be removed and collected from CRT panel glass separately and must be stored in a sealed container.
- Special care and attention must be given to ensure prevention of uncontrolled emissions of fluorescent and other coatings, as well as glass dust into the surrounding air which can contaminate the breathing zone of treatment facility operators and result in health risks and damage.
- During de-pollution operations CRT, CRT glass can be separated from the rest of CRT display appliances

e. LCD TVs/ Monitors

- Suitable dismantling device should be employed for mercury suction during CCFL removal.
- Mercury steam leakage must be strictly restricted and not allowed
- Mercury should be stored in closed containers.

f. Personal Computers

- Pre-treatment should be first carried out to remove cases and cables.
- Further to which PCBs, Iron and plastics are separated manually.
- PCB hand dismantling and mechanical treatment are also recommended procedures.

g. Printers

- Toner / ink cartridges must be removed from printers primarily, and the toner powders must be stored in vacuum cabins to prevent inhalation by workers.
- These should then be sent to other qualified companies for further treatment.

Chapter 8

This Chapter presents the features of the mandatory PRS scheme. The scope, proper treatment and efficient collection of regulated WEEE are presented in this section.

Chapter 8: Updated Information on the Implementation of Mandatory PRS Regulations on WEEE from the Environment Bureau

Features of the mandatory PRS

a. Scope of Regulated Electrical Equipment

The mandatory PRS will be regulating five types of products, namely (i) washing machines, (ii) refrigerators, (iii) air conditioners, (iv) television sets and (v) computer products viz. computers (i.e. desktops, laptops and tablets), printers, scanners and monitors (collectively as "regulated electrical equipment"). These will cover around 85% of the WEEE generated locally.

b. Proper Treatment of Regulated Electrical Equipment

Licensing control under Section 16 of waste disposal ordinance (WDO) will be applied. The proposed WEEETRF and the local Recyclers who undertake recycling have to obtain a waste disposal license. Under the proposed licensing control, a waste disposal license will only be issued when the operations (including dismantling and detoxification) can demonstrably be conducted in environmentally sound procedures to turn regulated e-waste into reusable materials. The purpose of this licensing control is to enhance the control over disposal of e-waste. However, in order to avoid undue impact on recyclers and their operations, disposal of regulated e-waste on land or in premises with an area of not more than 100 m^2 will be considered eligible for exclusion.

The licensing control established will also improve the environmental performance of WEEE storage sites. Currently the storage sites in New Territories are not in good shape, hence in the future it is proposed that, a storage site of regulated e-waste will have to first obtain a license and for that purpose have to satisfy certain housekeeping requirements related to the safety and environmental conditions at the site concerned. For example, there should be a roofed structure and paved areas, a maximum stack height, fire prevention and security measures as well as record-keeping arrangements. There are also some exemptions like:

- Storage in premises of multi-storey buildings – The reason being these are already well maintained buildings with hardware requirements.
- Small quantity of stockpiling - Regulated e-waste with a total volume of not more than 50 m^3 is allowed. As a rough indication, that is the approximate quantity of e-waste usually stored in a 40-feet cargo container.

c. Efficient Collection of Regulated Electrical Equipment

Sellers must have an efficient removal service. The removal service plan has to be endorsed by the Director of Environmental Protection ("DEP") under which "for every piece of new regulated electrical equipment purchased by a consumer, an equivalent old product can be removed from a premise designated by the consumer for proper disposal at no extra charge to the consumer". Landfill disposal ban and Charging of recycling fee are also established to enhance regulation of e-waste.

d. Latest information of the Ordinance on Regulated Electrical Equipment

The latest "Promotion of Recycling and Proper Disposal (Electrical Equipment and Electronic Equipment) (Amendment) Ordinance 2016 (dated 23 March 2016) can be found from the website: http://www.legco.gov.hk/yr15-16/english/ord/ord003-2016-e.pdf.

The deliberations during the development of this Ordinance can be found from the "Report of the Bills Committee on Promotion of Recycling and Proper Disposal (Electrical Equipment and Electronic Equipment) (Amendment) Bill 2015" dated 26 January 2016 which can be found in the website:
http://www.legco.gov.hk/yr14-15/english/bc/bc04/reports/bc0420160203cb1-489-e.pdf.

Chapter 9: Concluding Remarks

This e-book collates the various dimensions of e-waste recycling in HK, while adopting existing good EHS related e-waste recycling practices and technologies being used in Korea and Germany. The background and need for an efficient recycling industrial practice in place is emphasized. The practical experiences of the experts from Korea and Germany related to existing good practices in those 2 countries are also collated. The existing good practices in Korea and Germany during collection, transportation, storage and treatment of e-waste are described in details with pictures and flowcharts. A comparison of the practices was also carried out and presented. Feasible Guidelines for implementing good EHS practices within HK recycling industry that stemmed from the existing good practices in Korea and Germany were identified and listed. The upcoming legal regulations on the implementation of mandatory PRS regulations on WEEE from the Environment Bureau are also stated for reference.

The existing challenges, opportunities and technologies involved in recycling practices, as well as the significance and the ways to ensure EHS of the involved stakeholders are highlighted in this e-book and we believe this will provide useful insights for SME recyclers in HK who intend to conduct WEEE recycling in a responsible and eco-friendly way and adopt environmental related regulations.

APPENDIX A: Gap analysis to measure the performance gap of practices in E-waste recycling, particularly with regard to EHS, between Hong Kong and Korea and Germany (PowerPoint presentation in Chinese)

香港廢電器電子回收業
環安健整體分析
- 現況及展望

26/2/2016

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內容摘要

* 背景
* (一) 香港廢電器電子回收業的環安健現況
* (二) 韓國廢電器電子回收業的環安健典範
* (三) 德國廢電器電子回收業的環安健典範
* (四) 香港,韓國及德國環安健措施的比較
* (五) 香港廢電器電子回收業實行環安健典範的困難
  (六) 提升香港廢電器電子回收業的可行方案
* 總結

背景

* 香港每年~70,000 噸廢電器電子產品
* 建議的香港五類受管制電器的範圍
  * (i) 洗衣機、(ii)電冰箱、(iii)空調機、(iv)電視機及 (v)電腦產品(包括電腦、打印機、掃瞄器及顯示器)

* 環保署根據《廢物處置條例》
  * 引入發牌管制:貯存、處理、再加工和循環再造
  * 加入許可證管制，使進口和出口受管制電器廢物均須有許可證

(一)香港廢電器電子回收業的環安健現況

* **(A) 基本調查**
  * 11/2014 – 12/2014
  * 包括廢電器電子回收公司探訪(4間)、 網上問卷(4間)及電話訪問(3間)
  * 共11間廢電器電子回收公司接受調查
* **(B) 深入探討廢電器電子回收/回收有關公司的環安健現況及給予提升環安健的意見**
  * 11/2015 – 2/2016
  * 共4間
  * 2-3 次探訪

基本調查 –
(1) 作業情況

* 11間廢電器電子回收中小型企業(中小企)公司:
  * 電腦回收(10間)
  * 電視回收(9間)
  * 冷氣機、雪櫃及打印機回收(8間)
  * 洗衣機回收(7間)
  * 只有1間處理CRT電視/屏幕

基本調查 –
(2) 環安健管理

* 11間回收公司中
  * ISO14001認證(8間)
  * OHSAS 18001認證(5間)
  * R2電子回收認證(2間)

基本調查 –
(3) 環境監測

* 11間廢電器電子回收公司:
  * 有進行空氣監測(1間)
  * 有進行噪音監測(6間)
  * 工人可能曝露於廢電器電子的有害物質
  * 操作時的噪音可能影響工人的聽覺

基本調查 –
(4) 貯存

* 只有一半受訪公司的廢電器電子的貯存地方是完全全天候覆蓋
* 有一半受訪公司只有部分的貯存地方是全天候覆蓋
  * 陽光曝曬及雨水或令當中廢電器電子中的有害物質釋出

基本調查 – (5) 處理廢電器電子產品

廢電器電子產品	處理方法
電腦	一些公司會作基本拆解, 然後把零部件如線路板, 金屬及塑膠運往其他公司處理 一些公司收集已拆解的電腦零部件, 作簡單處理, 再運往其他公司處理
列印機	大部分公司把拆解出來的墨盒運往其他公司處理
掃瞄器	大部分公司沒有處理掃瞄器
CRT電視/屏幕	只有一間受訪公司處理 (包括拆解及除毒), 該公司在運作時已有相當的環安健措施
LCD電視/屏幕	大部分公司沒有處理, 只有一間表示有處理, 但拆解時未有使用水銀吸收設備
冷氣機、雪櫃	5間受訪公司表示處理冷氣機及雪櫃時會把雪種抽出來
洗衣機	會處理洗衣機的受訪公司表示未有先移除繼電器(relay switch) 開關, 舊式洗衣機繼電器開關可以含有水銀

基本調查 – (6) 保護員工的措施

* 11間受訪公司有提供
  * 手套(11間)
  * 口罩(10間)
  * 工作服、安全鞋、護眼罩(8間)
  * 耳罩、安全帽(7間)
* 但探訪時有員工在高噪音環境下未有配戴耳罩

基本調查 – (7) 緊急情況的預防及對應措施

* 約三分二受訪公司有提供防火訓練予員工
* 只有約一半受訪公司有提供急救訓練予員工

基本調查 – (8) 訓練

* 一般工作安全健康訓練, 如人力提舉/搬運(6間)
* 機器/設備的安全操作(6間)
* 正確使用個人防護裝備(7間)

(B) 深入探討-(1) 作業情況

* 4間廢電器電子回收/回收有關的中小企於5類受管制電器中
  * 3間主要回收/處理電腦及其周邊產品
  * 另1間屬於廢電器電子回收的下游公司，負責收集、處理及加工電子廢料

(B) 深入探討-(2) 環安健管理

* 4間廢電器電子回收/回收有關的中小企:
  * 2間公司有ISO14001 及 OHSAS 18001的認證
  * 其中1 間有R2認證

(B) 深入探討-(3) 環境監測

* 空氣監測
  * 1間公司有進行空氣監測, 其餘3間表示會考慮
* 廢水監測
  * 1間公司有進行廢水監測
* 噪音監測
  * 1間公司有進行噪音監測

(B) 深入探討-(4) 貯存及分類

* 貯存
  * 4間公司的貯存地方都是全天候覆蓋及使用防滲漏地面
  * 3間公司有貯存堆疊的高度限制
* 分類
  * 3間公司有適當的廢電器電子產品的貯存分類

(B) 深入探討-(5) 處理(包括拆解及除毒)

* 線路板組裝
  * 沒有先去除當中的電容器,因為有3間公司表示根據線路板組裝供應商的資料,要處理的電容器不含有害物質
* 打印機
  * 1間表示有處理打印機，會先移除墨盒，然後送往其他公司處理

(B) 深入探討-(6) 保護員工的措施

* 個人防護裝備
  * 4間公司也有提供予員工,如手套、口罩、安全鞋及耳罩等
* 身體檢查
  * 其中1間公司提供身體檢查予員工

(B) 深入探討-(7) 緊急情況的預防及對應措施

* 其中三間公司有良好的緊急情況的預防及對應措施
  * 緊急情況的對應計劃
  * 足夠資源去處理緊急情況
  * 訓練員工對應緊急情況
  * 對應緊急情況的事後報告

(B) 深入探討-(8)員工的環安健訓練

* 其中3間公司有良好的環安健訓練及廢電器電子處理訓練
* 另外1間公司已在建議下設立環安健訓練及廢電器電子處理訓練

(二)韓國廢電器電子回收業的環安健典範

* (1) 貯存及分類
* (2) 處理(包括拆解及除毒)
* (3) 保護員工的措施
* (4) 緊急情況的預防及對應措施
* (5) 員工的環安健訓練

韓國-(1)貯存及分類

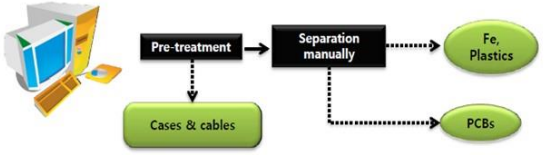
* 貯存地方
  * 全天候覆蓋，使用防滲漏的地面，如混凝土
* 貯存高度限制
  * 不會堆疊超過兩層卡板的廢電器電子產品
* 不同類型的廢電器電子產品有不同的貯存方法
  * 大型的:放在卡板上，並作適當包裹
  * 小型的:放在特定的籠內，一個籠只貯存一種廢電器電子產品
* 把條碼貼在每一件廢電器電子產品及卡板上，以作識別，方便追蹤

韓國 –(2)處理(包括拆解及除毒)

* 電腦
* CRT電視/屏幕
* LCD電視/屏幕
* 雪櫃
* 冷氣機
* 洗衣機

韓國 -處理電腦

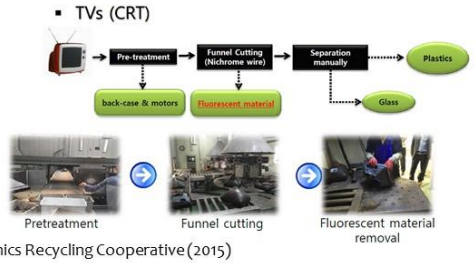
* 先把外殼和電線拆除
* 再把線路板、金屬和塑膠分開



來源: Korea Electronics Recycling Cooperative (2015)

韓國 -處理CRT電視/屏幕

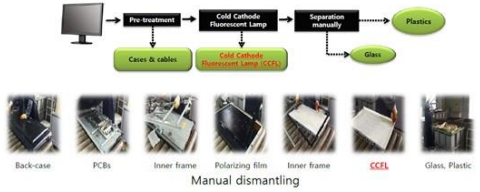
* 先把後殼和馬達拆除
* 切割錐管玻璃後，把螢光粉吸走
* 螢光粉會貯存在密封器皿



來源: Korea Electronics Recycling Cooperative (2015)

韓國 -處理LCD電視/屏幕

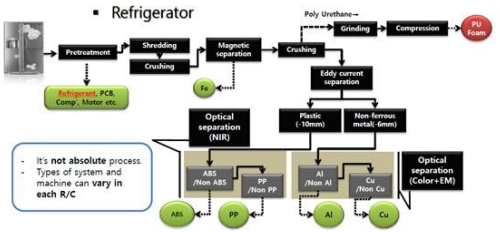
* 先把外殼和電線拆除
* 再小心把冷陰極熒光燈(CCFL)移除



來源: Korea Electronics Recycling Cooperative (2015)

韓國 -處理雪櫃

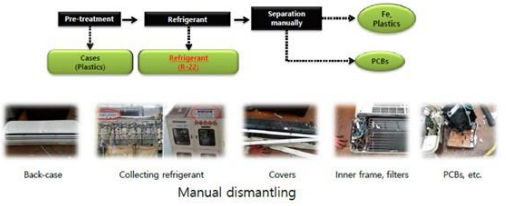
* 先把雪種,廢油,線路板,馬達抽出
* 有裝置來量度抽出雪種的量



來源: Korea Electronics Recycling Cooperative (2015)

韓國 -處理冷氣機

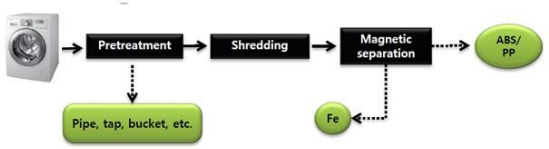
* 先把膠殼拆除，然後把雪種,廢油抽出
* 有裝置來量度抽出雪種的量



來源: Korea Electronics Recycling Cooperative (2015)

韓國 -處理洗衣機

* 先把喉管、內桶等拆除
* 破碎後把金屬和塑膠分開



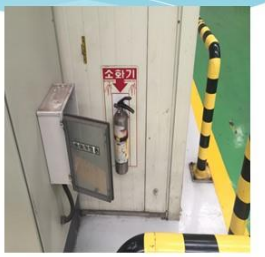
來源: Korea Electronics Recycling Cooperative (2015)

韓國 –(3) 保護員工的措施

* 提供適當的個人防護裝備予員工, 如安全帽、保護衣、眼罩、手套、口罩、安全鞋及耳罩等
* 員工入職前提供身體檢查，如聽力測試
* 入職後每年提供一次身體檢查

韓國 –(4) 緊急情況的預防及對應措施

* 員工防火訓練
* 火警發生時的對應方法，滅火筒及消防喉的使用方法等
* 訓練完成後會簽名確認



韓國 –(5)員工的環安健訓練

* 員工入職時公司會提供
  * 廢電器電子的拆解訓練
  * 環安健訓練

(三)德國廢電器電子回收業的環安健典範

* (1) 貯存及分類
* (2)處理(包括拆解及除毒)
* (3)保護員工的措施
* (4)緊急情況的預防及對應措施
* (5)員工的環安健訓練

德國 – (1) 貯存及分類

* 貯存地方
  * 全天候覆蓋，使用防滲漏的地面，如混凝土
* 不同類型的廢電器電子產品有不同的貯存方法
  * 大型的: 放在卡板上，並作適當包裹
  * 小型的: 放在特定的籠內, 一個籠只貯存一種廢電器電子產品
* 把條碼貼在廢電器電子產品，以作識別，方便追蹤
* 擺放廢電器電子產品(如雪櫃)的方向和排列，有嚴格規定

德國 – (2) 處理(包括拆解及除毒)

* CRT電視/屏幕
* LCD電視/屏幕
* 雪櫃

德國 -處理CRT電視/屏幕

* 拆解時有噴水裝置在最多有害物質的位置噴水
* 於拆解流水線的下方設有抽氣系統，確保員工不會吸入有害物質

德國 -處理LCD電視/屏幕

* 有自動切割線把水銀細光管從LCD顯示屏切割出來
* 安裝一個風閘，當有水銀燈管出現損毀，揮發出來的水銀會被抽走，不會揮散開去
* 當工人處理完水銀細光管，將完整沒有損壞的細光管和有損壞的光管放到不同的密封桶中

德國 -處理雪櫃

* 雪櫃進入公司，先把插頭分開，含有水銀的零部件先拆走
* 有裝置讓工人知道有什麼種類的雪櫃進入工廠，對應的處理方法是什麼，有圖畫說明如何處理不同種類的雪種
* 裝置對準壓縮機(入口位)把雪種，油等從喉管吸走
* 把油及雪種儲存在不同的地方，並送到下游公司處理

德國 –(3) 保護員工的措施

* 提供適當的個人防護裝備予員工,如安全帽、保護衣、眼罩、手套、口罩、安全鞋及耳罩等
* 確保工作場所保持清潔
  * 員工可以使用強力吸塵裝置將身上面塵埃吸走
  * 有水車開入工場噴出水霧，避免工人將塵埃入到體內

德國 –(4) 緊急情況的對應措施

* 回收場設有清楚的緊急逃生路線圖,集合地點
* 適當的緊急情況的對應設備
  * 心臟起搏器
  * 吸油設備
  * 救火用的水池

德國 – (5) 環安健訓練

* 德國政府制定和設計3年的訓練課程，經考核後獲得證書內容包括
  * 環安健訓練
  * 不同四電一腦拆解技術和方法
* 在拆解工場張貼單張和圖畫，清楚解釋處理工序和環安健所要注意的事項
* 每個訪客探訪廠前，都有一張單張，上面表明了緊急突發事件的集合點，或身體不適時應該去什麼地方尋找急救設備

(四)香港,韓國及德國環安健措施的比較

	香港	韓國	德國
貯存	• 有些貯存地方不是全天候覆蓋 • 暫時未有貯存高度限制 • 有些回收公司未有在廢電器電子產品使用條碼	• 貯存地方:全天候覆蓋，使用防滲漏地面 • 貯存高度限制:不超過兩層卡板的廢電器電子產品 • 把條碼貼在每一件廢電器電子產品及卡板上，以作識別方便追蹤	• 貯存地方:全天候覆蓋，使用防滲漏地面 • 擺放廢電器電子產品（如雪櫃）的方向和排列，有嚴格規定 • 把條碼貼在廢電器電子產品以作識別，方便追蹤
分類	• 有些公司某些廢電器電子產品有一定程度的分類 • 有些公司可實行更好的分類	• 一個卡板/ 籠只貯存一種廢電器電子產品 • 不同類型的廢電器電子產品有不同的貯存方法	• 一個卡板/ 籠只貯存一種廢電器電子產品 • 不同類型的廢電器電子產品有不同的貯存方法
處理(包括拆解及除毒)	• 有些公司在某些廢電器電子產品未有使用符合環安健規定的處理方法	• 使用符合環安健規定的處理方法	• 使用符合環安健規定的處理方法 • 在拆解工場張貼單張和圖畫清楚解釋處理工序和環安健所要注意的事項

(四)香港,韓國及德國環安健措施的比較

	香港	韓國	德國
保護員工的措施	• 大部分公司提供適當的個人防護裝備予員工，但有時員工未有配戴 • 很多公司未有提供身體檢查予員工	• 提供適當的個人防護裝備予員工 • 在員工入職前/入職後提供身體檢查	• 提供適當的個人防護裝備予員工 • 確保工作場所保持清潔
緊急情況的預防及對應措施	• 有些公司未有提供足夠的措施	• 適當的預防措施,如防火訓練 • 火警發生時的對應方法，減火筒及消防喉的使用方法等	• 適當的措施，如回收場設有清楚的緊急逃生路線圖 • 適當的緊急情況的對應設備
環安健訓練	• 有些公司提供環安健訓練及廢電器電子的拆解訓練未足夠	• 員工入職時公司會提供環安健訓練及廢電器電子的拆解訓練	• 德國政府制定和設計3年的訓練課程，經考核後獲得證書內容，包括環安健訓練和不同四電一腦拆解技術和方法 • 對訪客也有環安健措施的提醒

(五) 香港廢電器電子回收業實行環安健典範的困難

(1) 香港缺少正式的環安健指引及訓練

a) 除了一些認證，如ISO14001、OHSAS18001及R2外，一些回收中小企業未必有足夠環安健指引，不知如何提升環安健水平

b)一些回收中小企業缺少有系統的環安健訓練

(2) 財政負擔

a) 提升環安健水平所需的儀器如空氣監測

b) 提供身體檢查予員工

c) 自動化設備如水銀細光管自動切割系統

(六)提升香港廢電器電子回收業的可行方案

	建議的可行方案
貯存	• 全天候覆蓋(若可行) • 使用防滲漏地面 • 設置貯存高度限制 • 以編碼或條碼貼在廢電器電子產品及容器上，以作識別
分類	• 一個卡板/容器只貯存一種廢電器電子產品 • 不同類型的廢電器電子產品有不同的貯存方法
處理 (包括拆解及除毒)	• 使用符合環安健規定的處理方法 • 在拆解工場張貼單張和圖畫，清楚解釋處理工序和環安健所要注意的事項 • 適當地安裝自動化設備

(六)提升香港廢電器電子回收業的可行方案

	建議的可行方案
保護員工的措施	• 提供適當的個人防護裝備,並提醒員工使用 • 為員工提供身體檢查 • 確保工作場所保持清潔
緊急情況的預防及對應措施	• 適當的預防措施,如 防火訓練 • 火警發生時的對應方法，滅火筒及消防喉的使用方法等 • 適當的緊急情況的對應方法，如回收場設有清楚的緊急逃生路線圖
環安健訓練	• 員工入職時公司提供環安健訓練及廢電器電子的拆解訓練 • 對訪客也有環安健措施的提醒

總結

(1) 雖然與韓國和德國比較,香港廢電器電子回收中小企在一些環安健範疇上有需要改善的地方，但通過提升**環安健意識、指引/法規及訓練**，相信未來香港廢電器電子回收業的環安健水平可大大提升

(2) 以下是一些提升環安健水平的建議

a) 建立適合香港的環安健指引

b) 採取一些較低成本而有效的環安健措施

c) 回收中小企業添置提升環安健的儀器和設備

「提升本港廢電器電子回收業環保、職業健康及安全(環安健)的意識」項目

* 由工貿署「中小企業發展支援基金」撥款資助，**香港電子業商會**主辦，**香港理工大學綠色生產及環保設計研究小組**執行
* 項目由11/2014 – 5/2016, 為期1年半
* 項目目的:
  * 提升及加強本港廢電器電子回收業對環安健的意識
  * 學習海外(韓國、德國)廢電器電子回收業的環安健的典範
  * 建立本地化的環安健典範指引及提升回收中小型企業的相關技術水平，增加他們的競爭力

「提升本港廢電器電子回收業環安健的意識」項目
已舉行的活動



簡單調查

關於本地廢電器電子回收業的現況

海外研究

學習海外(韓國、德國)廢電器電子回收業的環安健的典範

2套短片

拍攝韓國、德國廢電器電子回收業的環安健的典範

「提升本港廢電器電子回收業環安健的意識」項目
已舉行的活動







3/2015

4次研討會

學習海外(德國、韓國)廢電器電子回收業的環安健的典範

7/2015

「提升本港廢電器電子回收業環安健的意識」項目
已舉行的活動





9/2015

4次研討會

學習海外(德國、韓國)廢電器電子回收業的環安健的典範

10/2015

電子書(環安健典範指引)– 即將推出

* 由香港電子業商會主辦，香港理工大學綠色生產及環保設計研究小組執行的「提升本港廢電器電子回收業環保、職業健康及安全的意識」項目將於今年5月推出為香港廢電器電子回收業而設的環安健典範指引,內容包括
  * 收集
  * 運輸
  * 貯存
  * 基本處理

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Department of Industrial and Systems Engineering
工業及系統工程學系
Green Manufacturing and Eco-Design Research Group
The Hong Kong Polytechnic University
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謝謝!

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APPENDIX B

Guidelines on storage and treatment of e-wastes (in Chinese)

1. 有關受管制電器廢物的貯存及相關貯存設施的建議指引

1.1 貯存設施

1) 適用於在處理受管制電器廢物之前及處理受管制電器廢物時貯存場地 (包括臨時貯存): 在適當地方使用全天候覆蓋。

2) 適用於在處理受管制電器廢物之前及處理受管制電器廢物時貯存場地 (包括臨時貯存): 使用不可滲透的地面。

3) 設置貯存專區，並標示區域。

4) 應設有溢出液收集及污染物截流設施。

5) 應設有排水設施。

6) 只准獲准許人士進入貯存設施。

7) 應設有適當的附合消防條例的緊急應變之設備，如手提滅火筒、緊急照明系統、緊急出口指示和警鐘系統等。

8) 應設有適當的個人防護裝備。

1.2 受管制電器廢物的一般貯存運作

1) 應設有高度限制。

2) 應分類分區貯存，並於明顯處標示其種類及名稱等。

3) 把條碼貼在每一件受管制電器廢物、卡板或容器上，可以建立相關資訊系統以追蹤受管制電器廢物。

4) 貯存方法應防止任何物質洩漏以危害員工安全及/或環境。

5) 適當的措施防止受管制電器廢物掉落、倒塌或崩塌等情況，如採取繩索捆綁、護網、擋樁、堵牆或其他必要措施。

6) 貯存地點、容器、設施應經常保持清潔完整。

7) 適當地貯存已拆解的零件。

8) 應設有有關受管制電器廢物的貯存運作的適當環安健培訓和再培訓。

9) 於貯存場地設有適當的安全訊息提供予員工。

10) 應設有緊急應變的計劃。

11) 應設有適當及足夠的資源去應付緊急情況。

12) 如發生緊急事故，應有緊急事故及其相應行動的報告。

13) 定期舉行緊急事故演習，以訓練員工。

14) 應設有有關貯存設施的文件紀錄安排

2. 有關受管制電器廢物的處理、再加工和循環再造、及其相關設施的建議指引

2.1 處理、再加工和循環再造的設施

1) 在適當地方使用全天候覆蓋。
2) 使用不可滲透的地面。
3) 設置處理、再加工和循環再造的專區，並標示區域。
4) 應設有溢出液收集及污染物截流設施。
5) 應設有排水設施。
6) 應設有適當的個人防護裝備。
7) 作業區應有良好之光線或設置有足夠之照明設備。
8) 應設有適當的附合消防條例的緊急應變之設備及污染控制設備。
9) 只准獲准許人士進入貯存設施。

2.2 有關一般處理、再加工和循環再造的運作

1) 應經常保持清潔。
2) 應設有相關運作的適當環安健培訓和再培訓。
3) 應設有相關的適當運作程序的培訓予有關員工。
4) 於貯存場地設有適當的安全訊息提供予員工。
5) 如可以，每年提供身體檢查予員工。
6) 應設有緊急應變的計劃。
7) 應設有有關受管制電器廢物的貯存運作的適當環安健培訓和再培訓。
8) 如發生緊急事故，應有緊急事故及其相應行動的報告。
9) 定期舉行緊急事故演習，以訓練員工。
10) 除毒

應從受管制電器廢物中移除以下物質:

~含有多氯聯苯的電容器

~含有礦物油或人造油的電容器

~高度或直徑大於 25 mm 的電解電容器

~含有汞的開關掣

~電池

~大於 10 平方厘米的線路板

~含有溴化阻燃劑的塑膠

~氯氟烴(CFC), 氫氯氟烴(HCFC) , 氫氟烴(HFC), 碳氫化合物(HC)

~墨盒, 彩色碳粉

~陰極射線管(CRT)

~面積大於 100 平方厘米的液晶顯示屏

~外部電線

2.3 有關特定的受管制電器廢物

(a1) 空調機 [含有 CFC, HCFC or HFC]

i) 收集，貯存，處理及運輸
   1) 應在處理工場把雪種類型分類。
   2) 應小心處理空調機，避免破損及雪種洩漏。
   3) 處理設施應有減噪及集塵系統。
   4) 取出的 CFC, HCFC or HFC 應當小心貯存，處理及運輸，避免洩漏。

ii) 把 CFC, HCFC 或 HFC 和油從冷凝管取出

1) 所有會污染其他部件的液體應當取出。
2) 把雪種和油分離。

iii) 場地安全
1) 應量度場地中的 CFC, HCFC 或 HFC 濃度，如濃度超標，應響警報及停止運作。

(a2) 空調機 [含有碳氫化合物 (HC)]

i) 收集，貯存，處理及運輸
1) 應在處理工場把雪種類型分類。
2) 應小心處理空調機，避免破損及雪種洩漏。
3) 由於碳氫化合物是易燃的，處理此類空調機時應採取相關防護措施。

ii) 處理

移除所有液體

1) 移除所有會污染其他部件的液體。
2) 把雪種和油分離。
3) HC 排放應附合香港法例。
4) 應採取相關防護措施，防止火災及爆炸。

進一步處理箱體

5) 應採取相關防護措施，保障員工安全.
6) HC 排放應附合香港法例。
7) 如發泡棉中 HC 沒有取出，應確保釋放附合安全和健康規例。

iii) 防止爆炸措施
1) 場地應採取相關防護措施，避免爆炸。

(b1) 雪櫃 [含有 CFC, HCFC 或 HFC]

i) 收集，貯存，處理及運輸
1) 應在處理工場把雪種類型分類。
2) 應小心處理雪櫃，避免破損及雪種洩漏。
3) 處理設施應有減噪及集塵系統。
4) 取出的 CFC, HCFC or HFC 應當小心貯存，處理及運輸，避免洩漏。

ii) 把 CFC, HCFC 或 HFC 和油從冷凝管取出
1) 所有會污染其他部件的液體應當取出。
2) 把雪種和油分離。

iii) 把 CFC, HCFC 或 HFC 從發泡棉中取出
1) 應把多於 90%的 CFC, HCFC 或 HFC 從發泡棉中取出。

iv) 場地安全
1) 應量度場地中的 CFC, HCFC 或 HFC 濃度，如濃度超標，應響警報及停止運作。

(b2) 雪櫃 [含有碳氫化合物 (HC)]

i) 收集，貯存，處理及運輸
1) 應在處理工場把雪種類型分類。
2) 應小心處理雪櫃，避免破損及雪種洩漏。
3) 由於碳氫化合物是易燃的，處理此類空調機/ 雪櫃時應採取相關防護措施。

ii) 處理

移除所有液體

1) 移除所有會污染其他部件的液體。
2) 把雪種和油分離。
3) HC 排放應附合香港法例。
4) 應採取相關防護措施，防止火災及爆炸。

進一步處理箱體

5) 應採取相關防護措施，保障員工安全.
6) HC 排放應附合香港法例。
7) 如發泡棉中 HC 沒有取出，應確保釋放附合安全和健康規例。

(c) 洗衣機

i) 移除雪種
1) 有些設有乾衣功能的洗衣機會使用 CFC 雪種; 應當如雪櫃/空調機的處理方法。

ii) 移除鹽水
1) 從洗衣機移除高濃度鹽水。
2) 取出的鹽水應當在污水處理設施進行稀釋。

(d) CRT 電視/ 顯示器

i) 環安健要求

1) 特別措施防止螢光粉、其他塗層和玻璃塵不受控制逸散於空氣中。
2) 螢光粉、其他塗層和玻璃塵不可污染可吸入區域。
3) 如使用乾法處理，應設有空氣過濾系統連接於排氣口。
4) 如使用濕法處理，當中使用的水應設有閉環設計。
5) 應定期監控空氣過濾系統。
6) 應定期監控室內空氣質素。
7) 應定期把處理程序的職業安全及健康的風險告知操作員工。

ii) 技術要求- 分離程序

1) CRT 或 CRT 玻璃應從其餘 CRT 顯示屏中分離。
2) 應把 CRT or 未清潔的 CRT 玻璃視作危險廢棄物的要求處理。
3) 除毒後，其餘部件不得含有 CRT 玻璃。

iii) 技術要求- 清洗程序

1) 從 CRT 玻璃中移除螢光粉。
2) 應把移除的螢光粉視作危險廢棄物的要求處理。
3) 除毒後，其餘部件不得含有螢光粉。

iv) 技術要求-循環再造和回收程序

1) 循環再造和回收 CRT 玻璃是較理想方法。堆填只可視作後備方法。
2) 只有清潔的 CRT 玻璃可用作循環再造和回收。

(e) LCD 電視/ 顯示器

i) 移除汞

1) 破損的冷陰極管應當貯存及運送於密封容器內。
2) 汞蒸氣不得洩漏，汞應當貯存於密封容器內。
3) 具有冷陰極管 CCFL 的 LCD 電視/ 顯示器，應當於抽氣櫃內處理。
4) 應設置專區妥善貯存取出後之冷陰極燈管。

ii) 液晶

1) 拆解過程中液晶不得洩漏。

iii) 螢光粉回收或棄置

1) 確保適當的螢光粉回收或棄置。

iv) 監控

1) 平面顯示器的處理應當在受控制的環境下進行。
2) 處理含有 CCFL 的 LCD 電視/ 顯示器的場所，應設有汞監控。
3) 應量當員工吸入汞的量。

(f) 個人電腦

1) 首先進行預處理移除外殼及電線。
2) 然後以人手移除線路板，金屬及塑膠。

(g) 列印機

1) 首先從列印機移除碳粉盒或墨盒。
2) 然後把碳粉盒或墨盒送至其他合資格公司作進一步處理。