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Assessing the Status of E-waste Recycling in Selected Countries in the Asia-pacific Region and Facilitating the Environmentally Sound Management (ESM) of E-waste

Basel Convention Regional Center for Asia and the Pacific/ Stockholm Convention Regional Centre for Capacity-building and the Transfer of Technology in Asia and the Pacific

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1. Introduction

1.1 Background

At the meetings of the Conferences of the Parties to the Basel, Rotterdam and Stockholm conventions in 2011 and later in 2013, the Parties approved cross-cutting and joint activities for inclusion in the program of work of the Secretariat in addition to the convention specific activities through various decisions. Those activities include Activity 19 on regional centers on coordination of and support to the Basel and Stockholm Conventions regional centers and cooperation and coordination between regional centers.

One of the outputs of Activity 19 is Basel and Stockholm convention regional centers serve as an entry point for parties to channel their needs for technical assistance which include development and implemented of joint activities, technical assistance and capacity building activities by regional centers on a bilateral or multilateral basis

In paragraph 6 (c) of decision BC-11/12 adopted by the Conference of the Parties to the Basel Convention at its 11th meeting requests the Secretariat to increase efforts to facilitate financial resource mobilization by the centers, including by linking the centers in their implementation of capacity-building activities and pilot projects with the Global Environment Facility, the World Bank, the regional development banks and bilateral donors;

Government of Norway provided financial resources to the Secretariat for 2013 to implement technical assistance and capacity building activities through Basel Convention Regional Centers also known as Regional Centre Small Grant Program. The Secretariat invited all BCRCs to submit project proposals that are based on their agreed business plans, relevant with their expertise and meeting the technical assistance and capacity building need of the Parties.

1.2 Goals and scope

The objective of this SSFA is to implement a project proposal submitted by the BCRC China entitled “Assessing the Status of E-waste Recycling in Selected Countries in the Asia-Pacific Region and Facilitating the Environmentally Sound

Management of E-waste" which was selected for implementation under the Regional Centre Small Grant Program for 2013 to be implemented in 2014. The specific objective of the project is to identify the status of laws and regulations, standards, technologies and facilities relating to e-waste in selected countries in the Asia-Pacific region, and analyze the gaps/needs in order to propose priority activities/areas to facilitate the environmentally sound management of e-waste in the Asia-Pacific region in the near future.

- Activity 1 – Study on the criteria on ESM of e-waste and compilation of the status of legal frameworks, technologies and facilities in the area of e-waste in project countries

Study on the criteria on ESM of e-waste. Basically a desk study will be undertaken to compile the information from the selected countries from published sources and a survey will be conducted to collect information through the public and private sector on the status of technologies that the countries have and are in use

- Activity 2 - Analysis, stakeholder consultation and synthesis of the information on status and management of e-waste

Consultations with stakeholders will be done in order to receive further inputs on the compilation and survey results.

- Activity 3 - Reporting

A final draft report encompassing the outcome of consultations, analysis and synthesis of compilation and survey data on e-waste from selected countries will be prepared and submitted to the secretariat for its finalization. The report will be finalized by incorporating the comments/concerns raised by the secretariat.

1.3 Outline of the report

The present report consists of four parts: A first part gives a general introduction of the project, includes background, goals and scope and the activity of the project, a second part presents the criteria on ESM of e-waste, a third part gives the national laws, regulations and standards on e-waste management in selected countries, especially on Cambodia，China，India，Mongolia, Pakistan，Sri-Lanka and Vietnam, and a forth part identifies the technologies and facilities in these countries and compare to the guideline of ESM.

1.4 Disclaimer

The project team compiled the report basing on the 7 national reports supplied by the national consultants and part of questionnaires. The conclusion just reflects the status of several Asian countries but not the overall situation of the Asia-Pacific Region.

2. Criteria on ESM of E-waste

Guidelines on Environmentally Sound Management of E-waste, including "Environmentally Sound Management (ESM) Criteria Recommendations", "Revised guideline on environmentally sound testing, refurbishment and repair of used computing equipment", "Revised guideline on environmentally sound material recovery and recycling of end-of-life computing equipment" and "Guidance on Transboundary Movement (TBM) of Used and End-of-Life Computing Equipment", have been studied systematically and carefully, especially the criteria on ESM.

As stipulated in the guidelines, criteria on ESM come down to management of e-wastes in the whole process, also including packaging and data security. The criteria could be the tutorial, as well as the evaluating standers dealing with e-waste management, treatment and disposal.

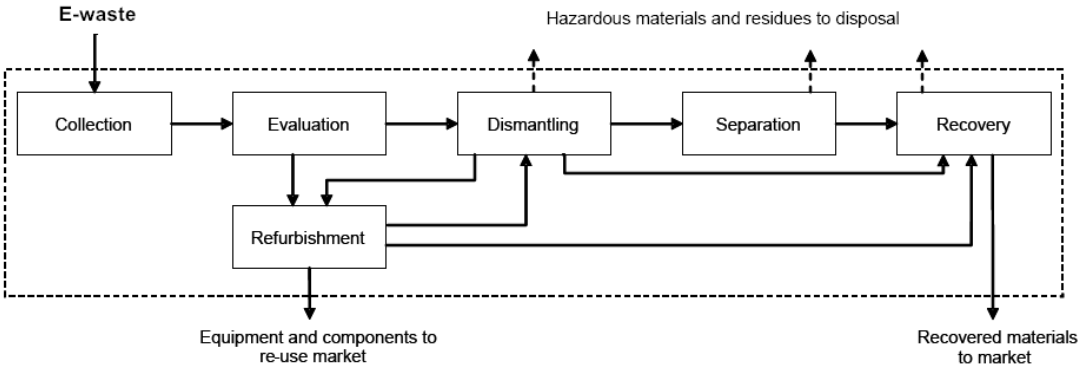

Figure 2-1: Flow of e-waste in the guidelines

Criteria on ESM consist of eight pieces:

- Top Management Commitment to a Systematic Approach

The commitment of top management is considered necessary within any facility to ensure that appropriate policies, programs, resources (i.e. human, financial, etc.) and other facility measures are in place to achieve environmentally sound

management.

- Risk Assessment

The identification of actual and potential risks to public and worker health and safety, and the environment that are associated with facility activities, products and services is an important aspect of ESM.

- Risk Prevention and Minimization

Such provisions enable facilities to identify the types of hazards and risks; assess the scope, magnitude and likelihood of these hazards and risks; and ensure that all reasonable care is taken to prevent, minimize or otherwise address identified hazards and risks.

- Legal Requirements

Compliance with applicable legal requirements that pertain to the jurisdiction in which a facility is located is a prerequisite for bona-fide companies doing business, and therefore an essential requirement for environmentally sound management. Working with legally compliant suppliers and service providers is also an important consideration from the perspective of forging strong business relationships with environmentally sound organizations, and establishing or maintaining a good facility reputation with investors, regulators and the general public.

- Awareness, Competency and Training

Awareness, competency and training is necessary to ensure employees are aware of risks identified within the workplace, and that they are trained and competent to ensure public and worker health and safety, and contribute to the protection of the environment through their activities. This includes the ability to identify, prevent and/or minimize hazards and risks, and effectively respond to emergency situations.

- Record-keeping and Performance Measurement

Record-keeping and performance measurement enables an organization to make informed decisions regarding whether programs, investments, and acquisitions are achieving desired results or if it is necessary to implement corrective actions. In some cases, record-keeping and performance measurement may be identified as a legal obligation and/or used to demonstrate facility compliance with legal requirements.

- Corrective action

Corrective action is necessary to remedy weaknesses that are identified with respect to achieving ESM. It also helps to ensure that facility approaches to ESM undergo continual improvement.

- Transparency and Verification

Transparency and Verification are considered important to provide public assurances that facility operations and activities demonstrate conformity with each of the identified ESM Criteria.

This criteria provide a broad set of skills，a devices-specific expertise and operational controls, which aims at helping governments, environmental groups and academia to tackle the environmentally sound management, taking into account social responsibility and the concept of sustainable development, and promoting the sharing of information on life cycle thinking. All these should be of assistance to the reduction of risks to the environment and public health, the protection of stockholder and stakeholder interests, and the economic benefits from increased plant efficiency, as well as the following implementation of this project.

3. National laws, regulations and standards on e-waste management in selected countries

3.1 Status of national laws, regulations and standards on e-waste management

3.1.1 China

China's Waste Electrical and Electronic Equipment (WEEE) management system consists of laws, regulations and standards components. China has issued numerous WEEE related laws and regulations (Table 3-1). Meanwhile, to support the implementation of laws and regulations, management departments have or are developing a number of WEEE recycling standards and norms (Table 3-2).

Table 3-1 Main Law and Regulations on WEEE in China

Law/Regulation Name	**Hierarchies**	**Issuing Institutions**	**Implementation Date**	**Applicable Scope**
Law of the People's Republic of China on the Promotion of Clean Production	State law	NPC Standing Committee of PRC	2002	Promote cleaner production, increase the efficiency of the utilization rate of resources, reduce and avoid the generation of pollutants, protect and improve environments, ensure the health of human beings and promote the sustainable development of the economy and society.
The Circular on Strengthening Environmental Management of Waste Electrical and Electronic Equipment	Ministerial decree	SEPA, (now MEP)	2003	Encourage eco-design and cleaner production of e-product. Ban on the environmental harmful technology for e-waste disposal
Technical Policy on Pollution Prevention of Waste Batteries	Technical policy	SEPA, (now MEP)	2003	Stipulate guidance of production, collection, transport, storage, recycling and disposal of battery. Prohibit production and sale oxidation mercury batteries. Encourage environmentally friendly technology for battery production
Law of People's Republic of China on Prevention of Environmental Pollution	State law	NPC Standing	1 April 2005	Regulations on pollution prevention and control in WEEE recycling

caused by Solid Waste (2004 revision)		Committee of PRC		and treatment
Technical Policy on Pollution Prevention of Discarded Appliances and Electronic Products	Technical policy	SEPA,(now MEP) MOST, MIIT, MOFCOM	2006	Encourage the establishment of multivariate recycling system of e-waste. Set forth the "3R" principle and "polluter pays" principle. Stipulate general rules of eco-design and information disclosure of toxic substances contained in e-products
Measures for Administration of the Pollution Control of Electronic Information Products	Ministerial decree	MIIT	1 March 2007	Restrict the use of hazardous substance (including POPs) in the design and production of electronic information products (corresponding to the EU RoHS Directive)
Renewable Resources Recycling Management	Ministerial decree	MOFCOM	1 May 2007	Provisions on management and supervision of renewable resources, including waste electrical and electronic products. Encourage environmentally friendly processing of renewable resources recycling and relevant technological innovation. Qualified certification for recycling enterprises. Establish modern renewable resources recycling system
Administrative Measures on the Prevention and Control of Environmental Pollution by Waste Electric and Electronic Products (SEPA, No. 40)	Ministerial decree	MEP	1 February 2008	Provision on the supervision and management responsibilities by relevant parties on the dismantle, use and disposal of waste electric and electronic products

Circular Economy Promotion Law of the PRC	State law	NPC Standing Committee of PRC	1 January 2009	Principle requirements on the development of waste electrical and electronic recovery and recycling industry
Notice on the Formation of the Development Plan of the Treatment and Disposal of Waste Electrical and Electronic Products	Notice	MEP, NDRC, MIIT, MOFCOM	10 September 2010	Guide the provinces and municipalities under the scientific and reasonable planning and development of WEEE treatment industry
The Regulations on the Administration of the Recycling and Treatment and Disposal of Waste Electrical and Electronic Products (No. 551)	Administrative regulation	State Council of PRC	1 January 2011	Provisions targeting the recycling and related activities of waste electrical and electronic products, not to engage in trading of second hand products. Establishment of WEEE treatment catalogue, certification, funds, and development plans
Administrative Measures on Qualification License of the Treatment and disposal of Waste Electrical and Electronic Products	Ministerial decree	MEP	1 January 2011	Standardize the WEEE products processing qualification licensing work
Administrative Measures on Collection and Use for Treatment Fund of Waste Electrical and Electronic Equipment	Ministerial decree	MOF, MEP, NDRC, MIIT	1 July 2012	Standardize and promote the management of WEEE products treatment fund, including collection, use and range.

Table 3-2 WEEE Related National Standards and Specifications

Standards/Specifications Name	Issuing Institution	Effective Date
Second Hand Goods Quality Appraisal Part 2: Appraisal Standard for Second Hand Home Electrical Appliances (GB/T 10398.2-2005)	Ministry of Commerce	1 March 2005
Environmental Protection Technical Specifications for Centralized District undertaking Disassembly, Utilization and Disposal of Waste Mechanical and Electrical Equipment (HJ/T181-2005)	Ministry of Environmental Protection	1 September 2005
Technical Policy on Pollution Prevention and Control of Waste Electrical and Electronic Equipment (SEPA No. 115)	Ministry of Environmental Protection	27 April 2006
Guideline for the Assessment on the Reuse and Recycling System of Waste Electrical and Electronic Equipment (GB/T21474-2008)	Standardization Administration of China	1 August 2008
General Technical Specifications of Recycling for Waste Electrical and Electronic Equipment (GBT23685-2009)	Standardization Administration of China	1 December 2009
Technical Specifications of Pollution Control for Processing Waste Electrical and Electronic Equipment (HJ 527)	Ministry of Environmental Protection	1 April 2010
Code for design of the waste electrical and electronic equipment processing engineering (GB 50678-2011)	Ministry of Industry and Information Technology	September 2011

In 2005 China began implementing “Law on Prevention of Environmental Pollution caused by Solid Waste." Article 18 of the Law stipulates that: "enterprises that produce, sell, import products and packaging materials included in the compulsory recycling list must undertake recycling of the products and packaging materials in accordance with relevant state regulations.” The “Circular Economy Promotion Law” became effective January 1, 2009 and clearly declared that when electrical and electronic products reach their end of technical life, the responsibility for the recycling and treatment of the product rests with the producer.

For controlling pollution during disposal process China began implementing the

"Regulation on the Administration of the Recovery and Disposal of Waste Electrical and Electronic Products" in 2011. The Regulation also prescribes the establishment of a special WEEE Treatment Fund to subsidize the costs of recycling the waste products.

Until 2012, only the “Measures for the Collection, Use and Management of Funds for the Disposal of Waste Electric and Electronic Products” was promulgated and took effect on 1 July 2012 to collect fees from producers towards a WEEE Treatment Fund to subsidize the costs of dismantling and processing of the waste products, in other words, EPR has not been effectively implemented in China.

3.1.2 Cambodia

The number of waste electric and electronic equipment (WEEE) in Cambodia is noticeably increased from year after year, in parallel with the great flow of WEEE importations, many concerns are being raised resulted from unsound management and disposal of E-waste. Then Cambodia promulgated “Announcement on the Ban of importation of old computers and spare-parts for occupation purpose, except, for self-consumption and/or charity in minor amount” in 12/03/02.

On the other hand, unsustainable use and practice is taken into account while Cambodia does not have a capability and sufficient capacity to managing and recycling E-waste residues. EEE repairers usually do their jobs with either less or unaware scope of health risk to their health occurring during the operation of EEE repairing, cracking, dismantling, storage and disposal. But Cambodia does not have special legislation for e-waste management or EEW collection systems, take-back policy on EEW founded by produced countries does not take into account neither.

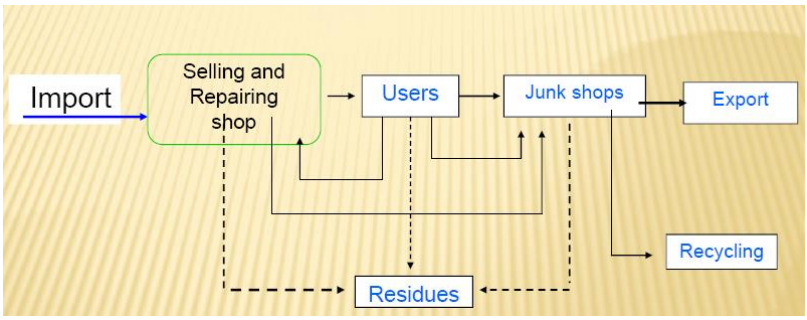

Fig .3-1 Flow chart of electric and electronic equipment in Cambodia

Cambodia has not specific law related to E-waste Management, but some

regulation has concerned to control, monitoring the activities operation, which are impact to human health and environment. The regulation concerning to e-waste management has been described below:

- Law on Environmental Protection and National Resource Management

Laws on Environmental protection and National Resource Management adopted by national assembly on 24 December 1996 stipulated that "the prevention, reduction, control of airspace, water and land pollution, noise and vibration disturbances as well as waste, toxic substances and hazardous substances, shall be determined by sub-decree following a proposal of the ministry of Environment in Article 13, chapter 5 of this law.

- Sub-decree on Solid Waste Management

The Sub-decree No. 36 on Solid Waste Management that issued dated on 27 April 1999 by Royal Government of Cambodia, covered all activities related to disposal, storage, collection, transport, recycling, dumping of garbage and hazardous waste. In article 3 paragraph c of this sub-decree hazardous waste refer to "radioactive substances, explosive substances, toxic substances, inflammable substances, pathogenic substances, irritating substances corrosive substances, oxidizing substances, or other chemical substances which may cause the danger to human health and animal or damage plants, public property and environment.

In this annex of the Sub-decree hazardous waste also includes the following types of WEEE: PCB waste from use of PCB contained in discarded air-conditioners, TV and microwaves, metal waste and their compounds, wastes from used or discarded electricity lamps, and wastes from the production or use of batteries.

This sub-decree cover all activities related to storage, collection, transportation, treatment, recycling, disposal and dumping of solid waste and hazardous waste. For importation and exportation of hazardous waste has stipulated in article 20 and 21 as below:

Article 20: The exportation of the hazardous waste from the Kingdom of Cambodia to abroad could be conducted if there are an agreement from the Ministry of Environment, export license from the Ministry of Trade, and permit from the import country. The exportation of the hazardous waste shall be consistent with the

provisions and principles of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal in 1989 which come into force on May 05, 1992.

Article 21: The importation of the hazardous waste from abroad into the Kingdom of Cambodia is strictly prohibited.

- Sub-decree on Water Pollution Control

This Sub-decree stipulated that "The disposal of solid waste or any garbage or hazardous substances into public water areas or into public drainage system shall be strictly prohibited. The storage or disposal of solid waste or any garbage and hazardous substances that lead to the pollution of water of the public water areas shall be strictly prohibited." This Article strictly prohibits to all activities disposing hazardous wastes and other residues into water sources in order to protect and maintain public health and the environment (Article 8, chapter 2).

- Sub-decree on Air Pollution Control and Noise Disturbance

This Sub-decree will be strictly control/monitor emission from WEEE recycling and/or EEW burning. But this Sub-Decree seems to be unnecessary, because recycling process of WEEE does not existed in Cambodia right now.

- Sub-decree on Ozone Depleting Substances

This Sub-decree applies to import, export, handling, production and the use of ozone depleting substances.

- Sub-decree on Business Facilitation by risk Management 2006

This sub-decree aims to: (i) improve the importation/exportation processes of goods and other facilities in complying with the national laws/regulations and international agreements/protocols; (ii) effective management and monitoring; (iii) lower cost in service compared to other adjacent countries; (iv)authorize functions/duties of line institutions at check-points; and (v) facilitate a rapid and easier way to importers/exporters.

- Directive's Custom and Excise General department

This directive has been announced on the Ban of importation of old computers and spare-parts for occupation purpose, except, for self-consumption and/or charity in

minor amount (12/03/02).

- Guideline on the Environmentally Sound Management of Waste Electrical and Electronic Equipment (WEEE) in Cambodia.

Currently, Cambodia has not specific regulation for management of e-waste yet, although, recently, Ministry of Environment of Cambodia has been developed the guideline on the Environmentally Sound Management of Waste Electrical and Electronic Equipment (WEEE) in Cambodia. This guideline was developed under the project proposal, namely "The Preparation of Guideline to manage on Waste electrical and electronic Equipment in Cambodia" that supported by Ministry of Environment Korea. This guideline aims to maintain and protect the environment and human health which may be harmful by unsound management and disposal of WEEE, as well as to achieve the initiative of resources recovery that is the crucial part of integrated waste management, or sustainable solid waste management.

3.1.3 Vietnam

In Vietnam, an initial inventory result shows that e-waste is becoming one of the biggest problems in terms of management of hazardous waste. The problems come from all processes of collection, dismantlement, recycling, and final treatment of residues. Currently in Vietnam, the residues are usually non-recyclable and hazardous and discarded into the environment or landfill as municipal solid waste. Soil, water and air environmental pollutions in and around recycling entities are the big problems in Vietnam in general and in recycling villages in particular.

Considering of the above-mentioned issues relating to e-waste dismantlement, recycling, and final treatment of residues, it requires an endeavor to control and manage them in a proper way to prevent and reduce the risk to the environment and human health in Vietnam.

Currently, Vietnam does not have any specific regulation on E-waste. Instead, e-waste is managed under the umbrella of hazardous waste management legislation. Most important legal documents regarding e-waste regulation is the Law on Environmental Protection, Circular 12/2011/TT-BTNMT of Ministry of Natural Resources and Environment, and the Decision 50/2013/QD_TTg of the Prime Minister.

- Law on Environmental Protection

The Law on Environmental Protection 2005 contains provisions relating to policies which encourage waste recycling and use recycled products as follows. Article 5 states clearly that one of the State policies on environmental protection is to promoting waste reuse and recycling, including e-waste. Also, the State encourages organizations and individuals to consume products made of recyclable materials from wastes. Regarding the responsibility of waste management, the law requires organizations and individuals engaged in activities that generate wastes, shall have the responsibility to reduce, recycle and reuse wastes so as to minimize the volumes of wastes required to be discharged and disposed.

For waste recycling facilities, it is responsible of them to separate waste into categories according to the purposes of recycling, treatment and disposal. Organizations and individuals have activities in the field of waste recycling and products shall be received to preferential policies in accordance with the provisions of this Law and the other provisions of the relevant laws. Organizations and individuals invest in the construction of waste recycling facilities shall be received to preferential policies of tax, financial support and land use given by the State. In 2014, the law on Environmental Protection was revised and the revised law will take effective in January 2015. However, the major provision regarding the e-waste is kept the same with the The Law on Environmental Protection 2005.

- Circular No 12/2011/TT-BTNMT dated 14/4/2011 of MoNRE

The Circular stipulates all aspect of hazardous waste management, including the lists of hazardous waste. Although there is no clear definition of e-waste under Vietnam regulations, wastes that are listed in the above table are considered as e-waste in the framework of this reports.

Besides, the Circular also stipulates the responsibility of related parties as follow:

1. Generators: E-waste generators must prepare an application to DONRE for a Registration Book before they can transfer their wastes off-site. The regulation prescribes the application form and information required to be submitted with the form. Generators must take measures to reduce pollution, properly classification of waste (not allowed to mix waste), packaging wastes, transport wastes off-site within six months (or report to the DONRE), manage spills, protect against fire and support

worker safety. In addition, they must have a contract with the permitted treatment/ disposal facility. Registration Books remain in force until there are significant changes in the operation of the generating facility that force a new application.

2. Hazardous waste treatment/disposal facilities (including e-waste recycling facilities): could be able to operate only when permitted.

- Decision 50/2013/QD_TTg of the Prime Minister dated August 09 2013 on "The responsibilities of businesses in taking back of the discarded products"

With the legal basis of the Article 67 of the Law on Environmental Protection 2005, which states that owners of production, business and service establishments must have the responsibility to take-back and treatment of expired or discarded products, such as: batteries, accumulators, home and industrial electronic and electric equipment, the Decision 50/2013/QD_TTg of the Prime Minister on "The responsibilities of businesses in taking back of the discarded products" has been developed and submitted to the Prime Minister for issuance. The Decision makes the roadmap for collection and treatment of discarded products, the list of take-back products and take-back modality. Manufacturers/importers must have responsible for taking back and treatment of the products sold in the market. Consumers must have responsible for transfer of discarded products to take-back location or transfer to organizations and individuals which have services of waste collection and transportation.

3.1.4 Mongolia

There are no structures and legislation or regulation for e-waste in Mongolia. "Law on household and industrial solid waste on 2003", draft of which is developed by the Government of Mongolia to improve the management of household and industrial solid waste, creating an economic mechanism for reuse and reduction of waste, and managing solid waste to keep environmental balance. This law has been followed since 2004 and updated 2012 as Low on Waste. This is a basic legal framework for waste management in Mongolia. All the rights and obligations of stakeholders, on waste collection, segregation, treatment and disposal procedure, database, economic regulations and control mechanisms are reflected entirely in the law.

Provisions for the implementation of the Law on waste include the followings: “Rule on hazardous waste certification”, “Methods of waste payment evaluation and norm setting”, “Hazardous waste classification and rate” and “Solid waste disposal construction, sort of dumps and their requirements, responsible persons and organization’s activities”.

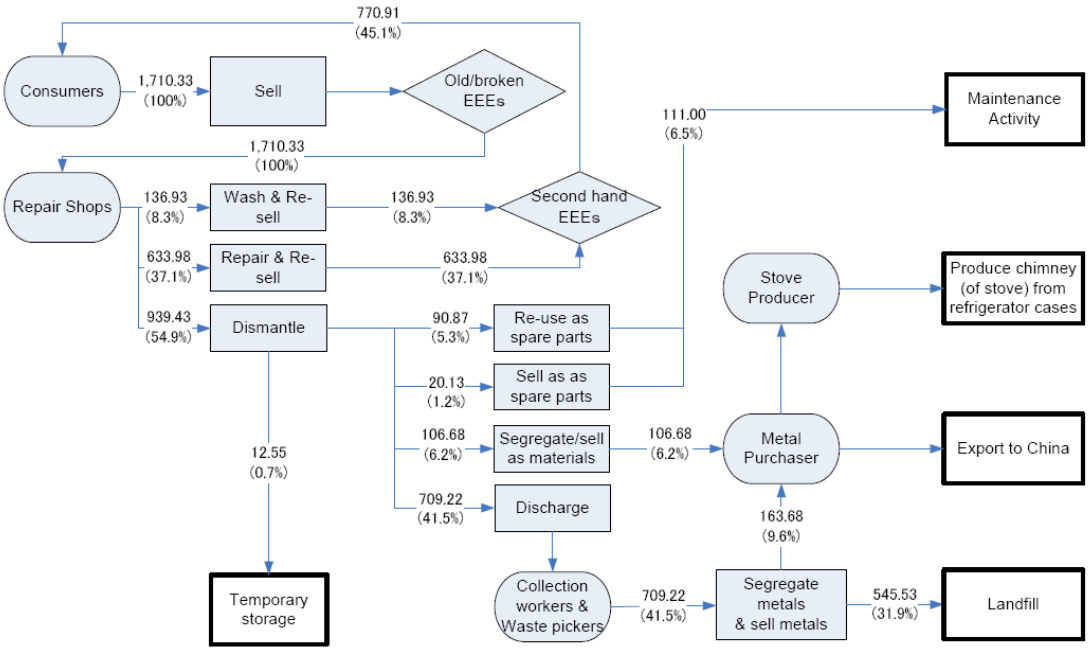

Figure 3-2 Overall E-waste Flow in Mongolia (tons/year)

Policy measures for the prevention and minimization of e-wastes in Mongolia:

- At the international level, Mongolia joined “The Basel Convention on the Control of Transboundary Movement of Hazardous Wastes” in 1996, “Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade” in 2001 and “Stockholm Convention on Persistent Organic Pollutant” in 2004.

- The “Law on prohibition of importing, transit and export of hazardous waste” was approved in 2000 and the “Law on household and industrial waste” in 2003.

- In line with the international conventions on hazardous wastes, the Government of Mongolia approved the “The National Program on Waste Reduction” for 10 years since 2010 and has been implementing the program. It has planned to develop and implement strategy that consider revision of the national program and introduction of 3R principles (reduce, reuse and recycle) starting from 2010.

- With an aim to improve the waste management, Mongolia developed the following regulations: “A rule on classification, collection, temporary storage, transportation, treatment of hazardous wastes” (2002); “Regulation and procedures on disposal and landfill of hazardous waste of business entities, and requirements on waste containers and waste disposal sites” (2006); “Methodology for calculating waste norms” (2006); “Payment calculation methodology for hazardous waste” (2006); “Classification and characteristics and hazard level of waste” with joint order No. 324/318/336 of Ministers for environment, health, and education, culture and science (2006); “Regulation on labeling hazardous waste” (2006); “Regulation on national reporting and inventory of hazardous waste” (2009).

- Since 2004, with the support from the Government of Japan, and JICA “The Solid Waste Master Plan of Ulaanbaatar” was developed, and as a result of the project “Improvement of Ulaanbaatar City Waste Management System” new disposal site was created in an environmentally friendly way and developed new waste management system. And at the next stage, Ulaanbaatar city will focus more on implementing 3R waste management principle at individual, households and business entity levels and promoting reduction of excess consumption by supporting products reuse practices based on certain economic incentives.

- The green development policy was approved by the Mongolian Parliament in June, 2014.

3.1.5 Sri Lanka

In Sri Lanka, importation of electronic and equipment gradually increases, resulting in the generation of a large amount of WEEE. The WEEE is not yet addressed by policy, while this country is now confronted with emerging issue of generation of Electronic waste.

- Organizational Structure of Managing E waste

(a) Ministry of Environmental and Renewable Energy

The Ministry of Environment and Renewable Energy (MOERE) of Sri Lanka is the designated line Ministry for policy making on management of the environment and natural resources in the country. MORE also stands as the National focal point for implementing the obligations of the Basel Convention in Sri Lanka.

Under the MOERE, there are six agencies which are responsible for policy implementation, including the Central Environmental Authority (CEA).

(b) Central Environmental Authority.

The CEA was established in 1981 as the authority with regulatory powers for the environmental management under the National Environment (Amendment) Acts No. 56 of 1988 and No. 53 of 2000.

Upon its powers to control environmental pollution under provisions of the National Environmental Act, Hazardous waste management has been regularized since 1996. Considering the hazardous nature some of the E waste some of electronic waste had been prescribed as hazardous waste under the gazette Extra Ordinary 1534/18 dated 1st February 2008. The controlling powers of this waste stream also vested on the Central Environmental Authority.

- Policies and regulations

(a) National Electrical and Electronic Waste Management Policy in Sri Lanka

Policy on E waste management was drafted and called for public comments in 2008 and has not been finalized. However the Ministry of Environment and Renewable Energy is doing industriously in the process of finalizing the draft.

As stated in the e-waste policy it is a timely action that has to be taken in managing electrical and electronic equipment in a manner which is sustainable throughout its life cycle and it is also necessary to honor and comply with the provisions of the Basel Convention and other related Conventions ratified by the country in managing e-waste.

As per the National Environmental (Protection & Quality) regulation No. 01 of 2008 published by the gazette notification No 1534/18 on 01.02.2008, following types of WEEE has been prescribed as Hazardous waste (scheduled waste; as prescribes in the mentioned gazette) that requires a license for handling. According to this regulation generator, collector, storer, recycler, recover and disposer should obtain a License for Scheduled Waste Management (SWM License) from the Central Environmental Authority.

As this regulation came in to force in 2008 currently the Central Environmental

Authority is in the process of amending the above regulation including all other types of Electronic and electrical waste.

(b) Import Export Control of Electronic Waste

As per a cabinet decision taken in 1998 Sri Lanka banned importation of List A waste of Schedule VIII of the Basel Convention and List B is regulated in case by case basis on importations.

By the Gazette Extraordinary No 1813/14 dated 5th June 2013 stipulated under National Imports and Exports (Control) Act No 01 of 1969 following types of WEEE has been subjected to obtain a license to be imported. The license is issued by the Department of Import and Export Control of Sri Lanka upon a "No objection" obtained from the Central Environmental Authority in case by case basis. Used /reconditioned Portable automatic data processing machines, weighing not more than 10 Kg, consisting of at least a central processing unit, a key board and a display; used/reconditioned other automatic data processing machines comprising in the same housing at least a central processing unit and output unit, whether or not combined; used/reconditioned other data processing machines presented in the form of systems; used /reconditioned processing units other than mentioned above, whether or not containing in the same housing one or two of the following types of unit , storage units, input units, output units; used /reconditioned cellular mobile telephones; used reconditioned Cathode Ray monitors and used or reconditioned other monitors are all included in the item list.

As per a decision made by the National Coordinating Committee for implementation of Basel Convention in Sri Lanka importation of used or refurbished CRT monitors are banned.

At the same time, EIA has also become a mandatory requirement for establishment of development projects in Sri Lanka under the National Environmental Act as well as under a few other legislations.

The National Environmental (Amendment) Act No. 56 of 1988 introduced EIA, as a part of the strategy to achieve sustainable development for the entire country and the Central Environmental Authority was assigned regulatory functions.

Part IV C of the amendment act mandated that all "prescribed" development

projects are required to be subjected to Environmental Impact Assessment. Only large scale development projects that are likely to have significant impacts on environment are listed as prescribed projects. In addition "prescribed projects" if located in "environmental sensitive areas" are required to undergo EIA irrespective of their magnitude.

The prescribed projects are listed in the gazette No 772/22 of 24th June 1993, 859/14 of 23rd February 1995, 1104/22 of 5th November 1999 and 1108/1 of 29th November 1999.

"Construction of waste treatment plants treating toxic or hazardous waste" has been listed as a "prescribed project" in the aforesaid gazette. Hence the Electronic waste treatment facilities must undergo EIA process.

3.1.6 India

In the recent years, there has been increasing use and dependence on electrical and electronic gadgets like mobile phone, personal computers, laptops, server, data storage devices, photo copying machines, TV (CRT/LED/LCD), washing machine, refrigerators and air conditioners, etc. resulting into generation of large quantities of E-waste. The high rates of obsolescence of the above mentioned items coupled with steady rise in the demand have also resulted into substantial growth in e-waste generation. Before promulgation of the special regulation, e-waste management observes "Hazardous Waste Management, Handling and Transboundary Movement Rules, 2008".

The "E-Waste (Management and Handling) Rules 2011" has come into force since 1st May 2012, objective of which is to ensure environmentally sound management of E-waste generated from the end of life electrical and electronic equipment. This regulation is applicable to IT and telecommunication equipment and Consumer electrical and electronic equipment, applies to every producer, consumer or bulk consumer involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components. This document also provides guidance on setting up collection mechanism, dismantling and recycling operations.

EPR is main feature of the "E-waste (Management and Handling) Rules, 2011", wherein the producer of electrical and electronic equipment was given the

responsibility of managing such equipment after its 'end of life', thus the producer is responsible for their products once the consumer discards them. Under this EPR, producer is also entrusted with the responsibility to finance and organize a system to meet the costs involved in complying with EPR.

Apart from the responsibilities, the rules also stipulates the procedures for seeking authorization and registration for handing e-waste, the ways to reduce the use of hazardous substances in manufacture of electrical and electronic equipment, and miscellaneous.

As an important part of the national system, "E-Waste (Management and Handling) Rules 2011" will be of great assistance to management and treatment of e-waste in India.

3.1.7 Pakistan

At present, the e-waste recycling industry is not regulated by any government departments and ministries, both at the federal and provincial level Pakistan. Sections either currently involved in the affairs of e-waste or by virtue of their mandate can have a potential role in the future are listed as follows: Ministry of Climate Change (MoCC), the Pakistan Environment Protection Agency (PEPA), and the Ministry of Industries and Production (MoIP).

The Pakistan Environmental Protection Act of 1997 is the basic environmental law of Pakistan, and the sections applicable to e-waste recycling activities such as: Section 11 prohibits discharge or emission of effluent into air, water or soil in excess of National Environment Quality Standards (NEQS); Section 13 prohibits import of hazardous waste in Pakistan and its territorial waters.

Pakistan is also the party of Basel Convention and is participating on the matter of E-waste at national and international level, and the Ministry of Climate Change is the focal ministry of this multilateral environmental agreement, with the role as an overseer of environmental protection. Main objectives of Basel convention on E-waste are: look at new sustainable business models; need for comprehensive policies encompassing environmental, socio-economic requirements; need for technical guidance and standards; Need for capacity building activities in developing countries; encourage the consideration of e-waste minimization and management in

the design of ICT policy; adopt strategic policies, international standards and regulatory approaches that are sensitive to local context; and encourage concerted cooperation in handling E-waste at the national, regional and international level; Solve challenges related to enforcement of existing regulations.

At present there are no restrictions on import of E-waste for recycling, once Pakistan has approved policy then the act empowers GoP to restrict import of E-waste.

From the E-waste recycling point of view, emphasis on health and safety hazards as well as decent working conditions is important. The Labor Policy 2010 calls for providing decent working conditions for the workers.

3.2 Summary of Law and policy situations

From the above, China has formulated much of laws and regulations pertaining to e-waste management, forming a relative perfect system; India has one special law to guide management of e-waste, which came into force in 2012; while the rest four countries (Sri Lanka, Lao PDR, Mongolia and Cambodia) have no special regulations or policies dealing with this issue, among them Cambodia has formulated and released e-waste list. The summary of laws and policies situation on e-waste management was shown in Table 3-3.

Table 3-3 Summary of Laws and policies situation on e-waste management

Country	Competent authorities	Legislation or policies
Cambodia	Ministry of Environment	E-waste list, with relevant and pending laws, but no special legislation
China	Ministry of Environmental Protection	Lots of special legislation and regulations
Vietnam	Ministry of Environment, Science and Technology	No specific regulation on E-waste
Mongolia	Ministry of Nature, Environment and Tourism	No structures or regulations
Sri Lanka	Central Environmental Authority	No special policies

India	Ministry of Environment, Forests and Climate Change	One special law, came into force in 2012
Pakistan	Not regulated by any government departments and ministries	No special laws or policies

4. Technologies and facilities in selected countries

4.1 China

4.1.1 Collection and transportation

The existing e-waste collection system is a mixed system with the traditional collection and collection under the national policy guidance：Individual collector、Second-hand market、Repair store、“Old for New”、 Production enterprise、Treatment enterprise、Institutions & Enterprises、MOC（Ministry of Commerce） collection network、Pilot Base of Urban Mining.

Fig. 4-1 Collection channels of e-waste

The informal collection system is effective because individual collectors can efficiently reach almost any household, while urban residents (consumers) are doubly incentivized to sell to collectors because they are able to generate cash from obsolete and waste household items while at the same time saving the time and effort that would have been required to dispose of the items themselves. The effectiveness of the informal collection system increases the rates of re-use and material recycling, thus providing an important environmental benefit by keeping these materials out of the general waste stream and reducing the need for resource extraction.

It is estimated that about 20 million migrant workers are currently engaged in the informal collection and recycling of solid waste. Among the various types of solid waste collected by informal collectors, the collection and recycling of e-waste is

particularly labor-intensive. Due to the high labor input it requires, informal e-waste collection provides working opportunities and livelihoods for hundreds of thousands of unskilled and redundant workers from China's rural areas. However, formulating precise estimates of the numbers of informal e-waste collectors has proven challenging due to the difficulty of separating generalist solid waste collectors from collectors who specialize in e-waste. In most cases, informal e-waste collectors also collect other types of valuable solid waste, such as plastic, metal and paper scraps.

To be honest, the boundary between informal and formal collectors is not always clear. In principle, at least, anyone in China can sell or buy e-waste within the country. Nevertheless, formal collectors are generally defined as those collectors who work in a formal, tax-paying business entity and who deliver the collected e-waste to legitimate recyclers for environmentally-sound treatment.

From June 2009 to December 2011, the Chinese government implemented a national "Home Appliance Old for New Rebate Program" (hereafter referred to as the "Old for New Program") in order to stimulate both the buying of new home appliances and the proper recycling of old appliances. This program first launched as a pilot in nine cities and provinces deemed to be more economically developed than other regions. Only authorized collectors – including home appliance retailers, chain stores, supermarkets, waste collection companies and logistics companies – were allowed to participate in this rebate program, through which they received collection subsidies from the government. These authorized collectors were eligible to take back old appliances from consumers and to issue discount coupons to these consumers in order to reward their participation in the project.

According to an industrial report, formal collectors collected 61.29 million home appliances for recycling in 2011, including 51.49 million TVs, 2.23 million refrigerators, 4.72 million washing machines, 0.22 million air conditioners and 2.62 million computers. When the total volume of e-waste collected by the formal sector in 2011 is divided by the total volume of e-waste generated in 2011 (3.62 million tonnes; see Figure 8), the annual collection rate for the formal sector is 64 per cent. Factoring in only the e-waste generated and collected in urban areas, the collection rate for the formal sector rises to nearly 88 percent.

The "Old for New Program" achieved impressive collection rates for home

appliances and set an important precedent for future e-waste management plans. However, when the program and its subsidies to formal collectors ended in December 2011, the formal sector's competitive advantage over the informal sector also vanished. The peddlers take care of collection and transportation as part of a self-organizing, demand-driven system that continuously establishes market values for e-waste. They do not see a prohibition of the informal sector as practical. Government and private sector investment for formal processing systems is growing, it will not match the efficiency of the pervasive and cheap informal sector. Therefore, to ameliorate the polluting aspects of informal e-waste processing, investment should also be directed to workable technical solutions that could be adapted for small, cheaply-operated shops.

4.1.2 Dismantling and treatment

Formal and informal recyclers co-exist within China's current e-waste treatment system, and informal recycling of e-waste is prevalent in China, particularly in some coastal regions. Informal part involves labor-intensive and sometimes hazardous manual dismantling of equipment using simple tools like hammers, chisels and screwdrivers to achieve swift separation of the various materials. Waste appliances are manually disassembled and the various components are sorted out. The re-usable parts are directly reapplied and the non-re-usable ones are recycled. Revenue is created from both the component re-use and material recycling.

Informal dismantlers target components and materials positive market values. Reusable components like Li-ion and Ni-MH batteries, toner cartridges, motors, compressors, power supplies, cables, circuit boards and chips (such as memories, smart cards, mother boards) and accessories are given priority for recovery during the dismantling. These parts are then sold for repair and re-assembly. Secondary materials with market value are also singled out during the dismantling processes and then upgraded through various refining processes.

Substandard informal recycling practices include open burning or direct melting of plastics, toner sweeping, dumping of lead-containing CRTs, acid stripping of printed wiring boards (PWB) and de-soldering of chips, as well as dumping unwanted residuals such as CRT glass, polychlorinated biphenyl (PCB) liquid, and chlorofluorocarbon (CFC) liquid, among others, directly onto the soil or into water sources. These common practices pose direct risks to the health of workers and to the local environment. Although these informal e-waste recycling practices have been banned by the government, the environmental damage they cause will persist for

many years and require substantial effort and resources to mitigate. Table 4-1 provides a snapshot of the hazards associated with various informal treatment practices.

As for the formal part, the "Administrative Measures on the Prevention and Control of Environmental Pollution by Electronic Waste" (SEPA, No. 40, effective since February 2008) prohibits any individuals or enterprises not listed in the e-waste dismantling enterprise list to engage in the dismantling, recycling and/or disposal of e-waste. Furthermore, according to "Regulations on the Administration of Recycling and Treatment of Waste Electric and Electronic Equipment" (Decree of the State Council, No. 551, effective since January 2011), enterprises that handle any or all of the five primary types of e-waste – televisions, refrigerators, washing machines, air conditioners and computers – must first receive a treatment license signifying that they have received qualification permission. Currently, more than 130 e-waste recycling enterprises are registered on the e-waste Dismantling Enterprise List.

The treatment of e-waste by designated recyclers varies depending on the type of e-waste to be processed. The recycling of CRT televisions entails cutting through the monitor with heated wire in order to separate the cone from the funnel glass, which is usually then resold. The prevailing method for treating printed circuit boards is a combination of mechanical shredding and hydrometallurgical recovery of the precious metals, copper and other nonferrous metals. For cooling and freezing equipment, automatic and hermetic treatment systems have been installed in some facilities in order to capture the coolants. However, the recovery rate for CRT glass, mixed non-metallic materials from equipment such as polyurethane foam plastics found in refrigerators, and other potentially recoverable materials, is still low in practice. The same is true of the recovery and treatment of waste circuit board components and lithium batteries. Fig. 4-2-12 showed procedures and site conditions of formal treatment of several typical e-wastes.

At present, many e-waste recycling processes lack emissions controls. Many formal recycling facilities lack ventilation systems, thus endangering the health of workers. While the dismantling techniques, knowledge and equipment for advanced treatment process and technology, emission control and comprehensive utilization of resources have improved in recent years, much room remains for further improvement.

Table 4-1 Snapshot of the hazards associated with various informal treatment practices

E-waste components	Processes witnessed in China	Potential occupational hazards	Potential environmental hazards
Cathode ray tubes (CRTs)	Breaking, removal of copper yoke, and dumping	- Silicosis - Cuts from CRT glass in case of implosion - Inhalation or contact with phosphor containing cadmium or other metals	Lead, barium and other heavy metals leaching into groundwater, release of toxic phosphor
Printed circuit board	Open burning of waste boards that have had chips removed to remove final metals	- Toxicity to workers and nearby residents from tin, lead, brominated dioxin, beryllium, cadmium, and mercury inhalation - Respiratory irritation	- Tin and lead contamination of immediate environment including surface and ground-water - Brominated dioxins, beryllium, cadmium, and mercury emissions
Gold from printed circuit boards	De-soldering and removing computer chips	- Tin and lead inhalation - Possible brominated dioxin, beryllium, cadmium, mercury inhalation	Air emission of same substances
Chips and other gold-plated components	Chemical stripping using nitric and hydrochloric acid along riverbanks	- Acid contact with eyes and skin may result in permanent injury - Inhalation of mists and fumes of acids, chlorine and sulphur dioxide gases can cause respiratory irritation, pulmonary edema, circulatory failure, and even death	- Hydrocarbons, heavy metals, brominated substances etc. discharged directly into river and banks - Acidifies the river, destroying fish and flora
Plastics	Shredding and low temperature	Probable hydrocarbon, brominated dioxin, and	Emissions of hydrocarbons, brominated

	melting to be re-utilized in low-grade plastics	heavy metal exposures	dioxins and heavy metals
Computer wires	Open burning tore cover copper	Brominated and chlorinated dioxin, polycyclic aromatic hydrocarbons (PAH) (carcinogenic) exposure to people living and working in the burning areas	Hydrocarbon ashes(including PAH) discharged into air, water and soil
Miscellaneous computer parts encased in rubber or plastic(e.g. steel rollers)	Open burning tore cover steel and other metals	Hydrocarbon (including PAH) and potential dioxin exposure	Hydrocarbon ashes(including PAH) discharged into air, water and soil
Toner cartridges	Use of paintbrushes to recover toner with no protective gear	- Respiratory tract irritation - Carbon black is a possible human carcinogen - Cyan, yellow, and magenta toners contain unknown toxicity	Cyan, yellow, and magenta toners contain unknown toxicity
Secondary steel, copper and precious metal smelting	Furnace recovers steel or copper from waste, including organics	Furnace recovers steel or copper from waste, including organics	Emissions of dioxins and heavy metals

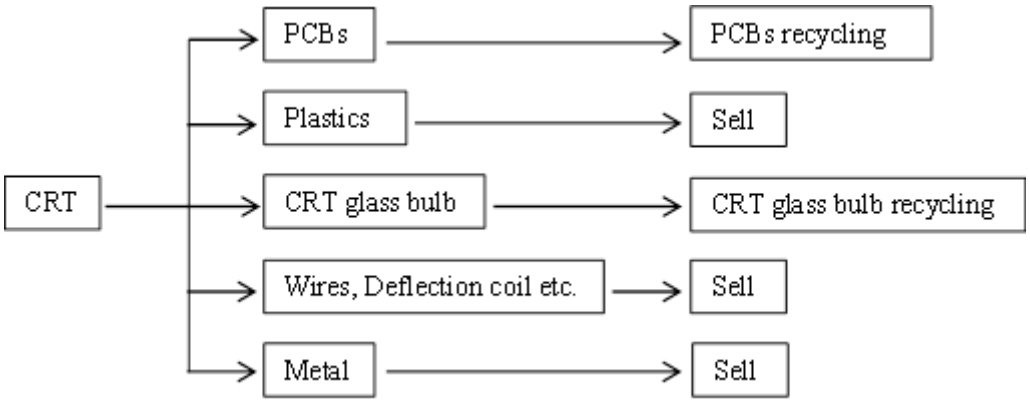

Fig. 4-2 Treatment scheme of CRTs

Fig. 4-3 Formal CRT disassembly line

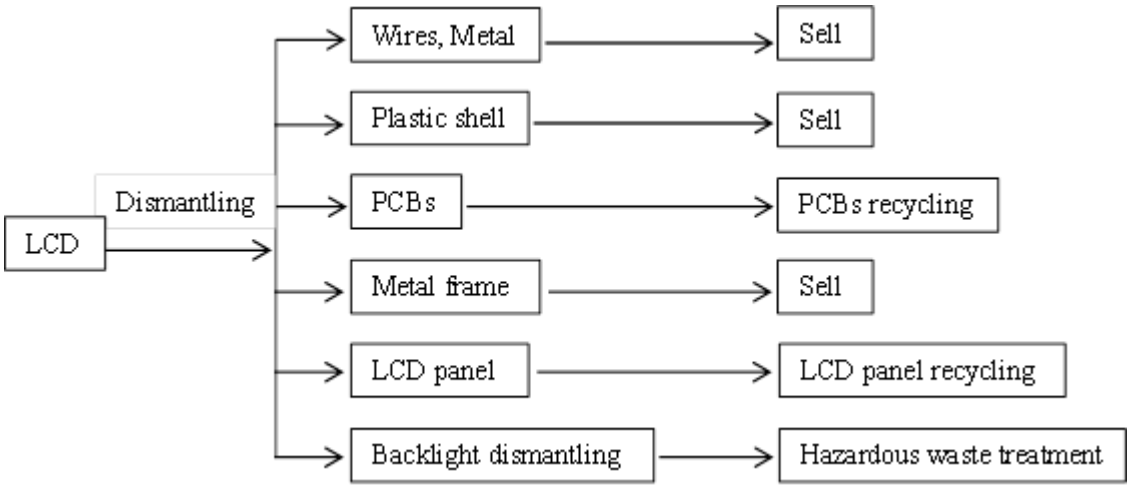

Fig. 4-4 Treatment scheme of LCD

Fig. 4-5 Sealed vacuum LCD dismantling platform

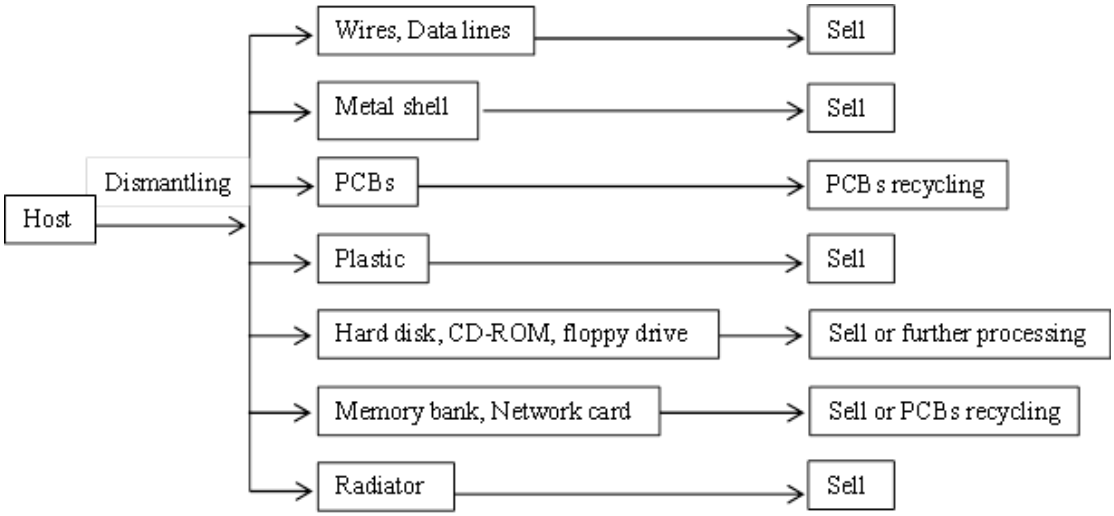

Fig. 4-6 Treatment scheme of computer host

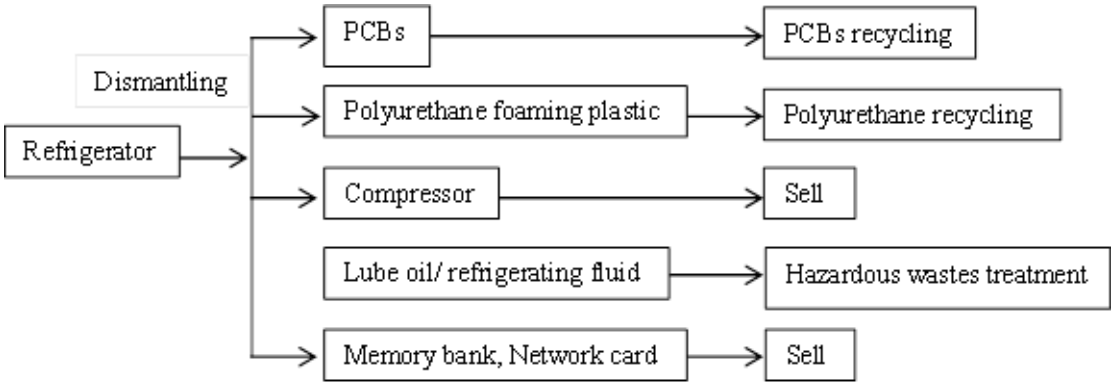

Fig. 4-7 Treatment scheme of manual dismantling of refrigeration equipment

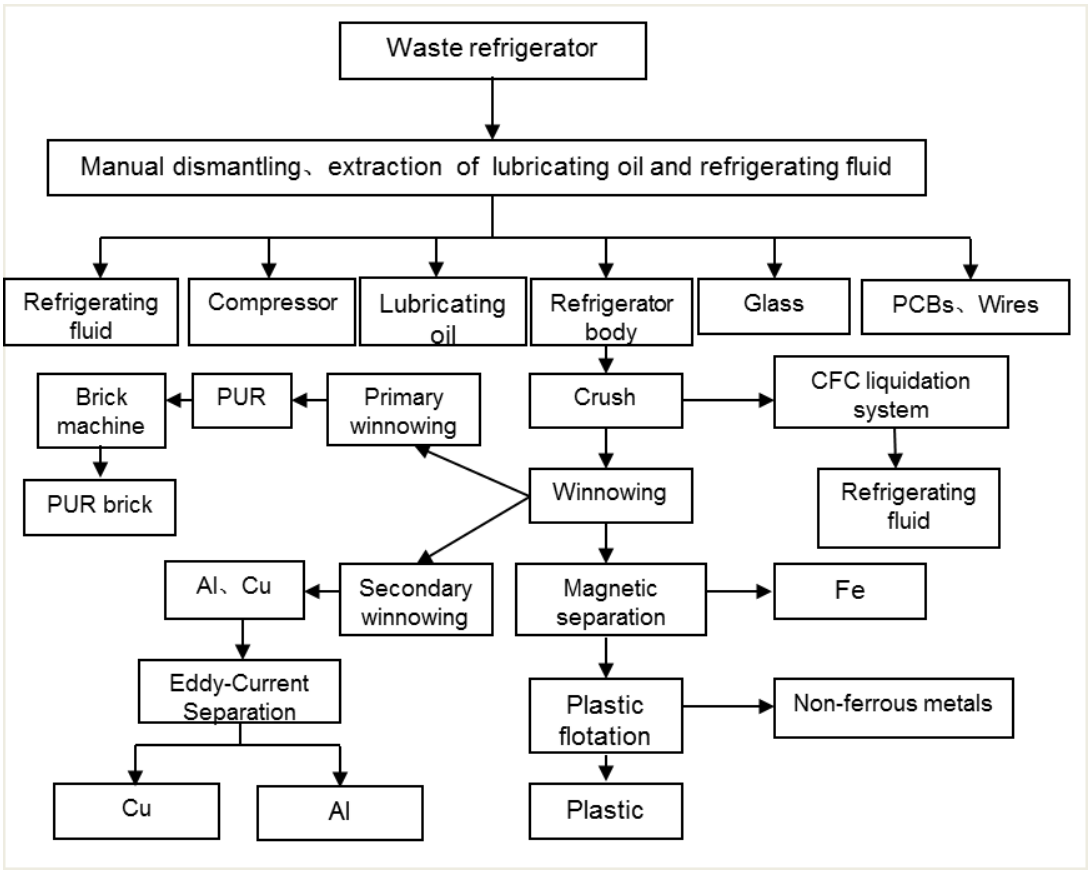

Fig. 4-8 Treatment scheme of manual/mechanical dismantling of refrigeration equipment

Fig. 4-9 Refrigerator crush and separation equipment

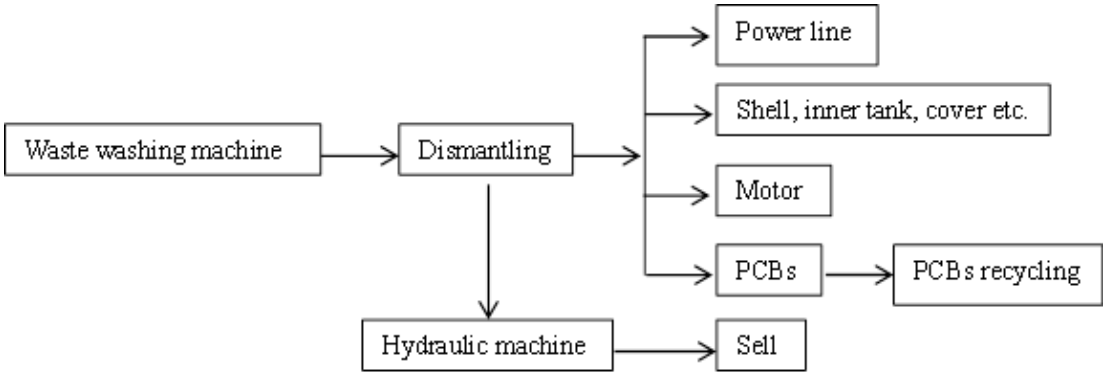

Fig. 4-10 Treatment scheme of washing machine

Fig. 4-11 Separating equipment for CRT glass using heating wire method

The mainstream technology for CRT glass separation in China is heating wire. Currently the most used under negative pressure environment is confined dry grinding method. Wet friction cleaning method developed by Tsinghua University has applied in a number of demonstration projects.

Fig. 4-12 Fluorescent Powder collecting

China use mainly Vacuum aspiration method for collection of Fluorescent Powder in the CRT, because the process is simple, easy to operate, low cost, no secondary pollution.

The current main disposal ways is hazardous waste landfill disposal, while with the decreasing of rare earth metal storage in the future, it will be developed in the

resource recycling of rare earth metals.

4.1.3 Recycling

The most sought-after secondary materials include precious metals, ferrous and non-ferrous metals (copper, aluminum, magnet, various alloys etc.) and plastics. Among these materials, fractions containing precious metal (e.g. circuit boards and contacts) possess the highest market values and provide major revenues for informal recyclers.

Like formal recyclers, informal recyclers seek to extract maximum value from e-waste by separating and upgrading secondary materials. However, unlike formal recyclers, informal recyclers lack the appropriate technology, equipment and training to undertake such operations in a safe and environmentally-responsible manner.

As for CRT glass recycling, the method most used is glass tube remanufacture, while with the shrinking CRT monitor market，the future tends to lead smelting or other using. Recycling of base board includes separation of copper metal and nonmetal materials through crushing and sorting-Mainstream technology.

Fig. 4-13 Solder heating device and physical cutting device

Fig. 4-14 Primary crusher and fine-crushing, winnowing, static electric separation machine

Components

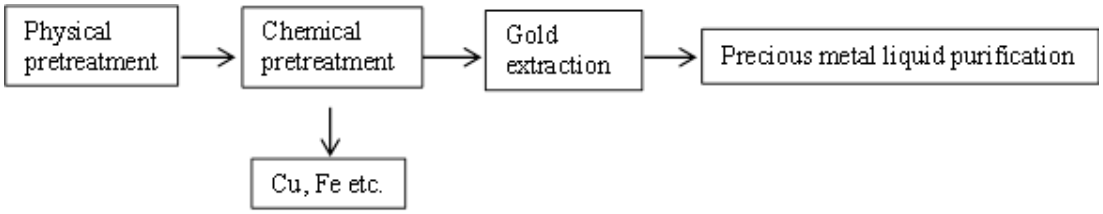

Fig. 4-15 Treatment scheme of precious metals

Table 4-2 demonstrates a brief description of components recycling methods.

Table 4-2 Components Recycling

Type	Main substance	Treatment method
Surface mount device	Precious metal	Crushing, mechanical, metallurgy
Plug in components	Plastic, Cu, Fe	Mechanical separation
Dangerous components	Toxic substance	Centralized disposal

4.1.4 Final disposal

At present, the main treatment of polyurethane plastic is given priority to burning, physical is the focus of current research. Due to the low density of polyurethane plastic, direct transport needs larger costs, so need to be compressed before transportation, compression ratio of 1:20 in general.

Flame Retardant Plastics recycling mainly goes to preparation of degraded plastic in China, with the flow of “Classification - Cleaning – Melt to re-granulation – Forming”.

4.1.5 Labor protection

Typically, the workers labor without goggles, gloves or proper ventilation, indeed without basic personal safeguards; many are minors. Common chores, such as grilling circuit boards over an open fire to melt the lead and plastic (allowing extraction of embedded IC chips), expose workers to PBDE and other toxic fumes, as well as high concentrations (43–389 times the action value) of fine particulate lead.

4.2 India

In India, e-waste is a major issue and an important waste stream in terms of both quantity and toxicity owing to the generation of domestic e-waste, as well as imports from developed countries.

India's electronic industry is one of the fastest growing industries in the world. The sale of personal computers (PCs), cellular, microwave ovens, air conditioners, refrigerator, washing machines, color televisions (CTVs) is increased sharply year by year.

Since 1990, the first phase of economic liberalization, the problems associated with E-waste in India have started manifesting. The preliminary estimates carried out by National WEEE task force in 2005 suggest that total WEEE generation in India is approximately 146,000 tons per year. The top states in order of highest contribution to WEEE include Maharashtra, Andhra Pradesh, Tamil Nadu, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab. The ranked list of cities as WEEE generators are Mumbai, Delhi, Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur in the order .

India continues to be a growing economy and is set to generate even larger quantities of e-waste in years to come, as shown in Figure 4-16. The annual e-waste generation in India, as per the official figure of the MoEF mentioned earlier, is estimated to reach 800,000 tons in 2012, and the annual growth rates may range from 7% to 10%.

It estimated that around 41-152 million computers will become obsolete in India in 2020. A report released by the UN predicts that by 2020 e-waste from old computers in India will have jumped by 500% compared with 2007 levels. It also states that by 2020 e-waste from discarded mobile phones will be about 18 times higher in India.

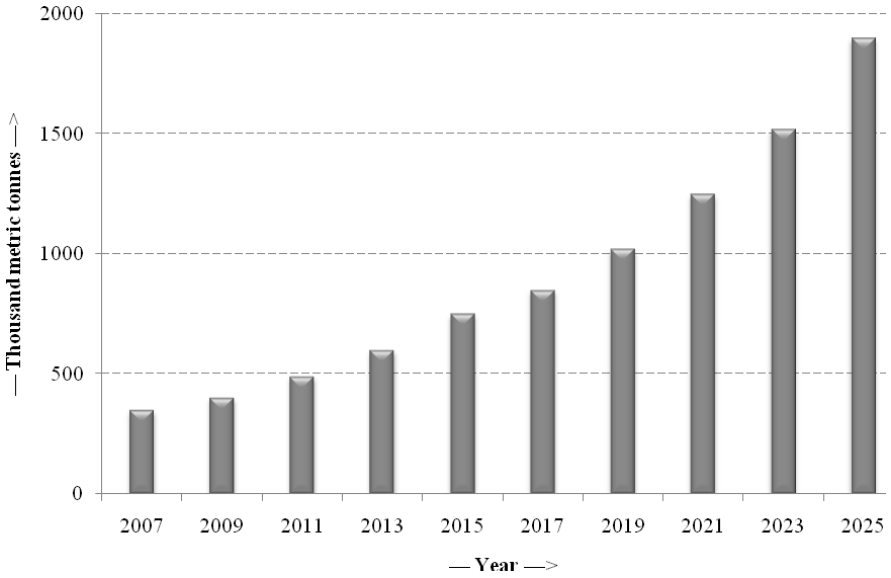

Figure 4-16 E-waste generation in India: past figures and forecasts for the future (DIT-GoI, 2012)

4.2.1 Collecting

The India's E-waste management system is not formally developed. Based on the study and analysis, of the Indian E-waste scenario, the life cycle of the EEE in India can broadly be divided in to three levels (EEE generation/ WEEE generation/ WEEE re-processing).

This level can be further divided as pre-reprocessing stage and reprocessing stage, the actors involved are mostly unorganized. In pre-reprocessing stages collection of the E-waste is mostly done by the un-organized sector of scrap dealers/traders, who purchases E-waste along with the other recyclable waste or scrap like old newspapers, books, cardboards, plastics, ferrous-tin material items, glass bottles, etc., from the consumer, and sell it through small traders to the wholesaler/bigger trader who segregates and sort out different types of waste material components, and ultimately sells it to the recycler/dismantler and disposers for reprocessing.

4.2.2 Dismantling and Recycling

India has a lucrative market for reusable products through repair, reconditioning and component reuse, and refurbishing shops are common. Only primary products of the Indian market are actually repaired or re-used in appreciable quantities; non-functional imports serve only for recycling (Oliveira et al., 2012). The institutions

authorized to recycle e-waste in India collect only 3% of the e-waste produced. The remaining portion is processed through informal recycling processes in large cities such as Delhi, Mumbai and Bangalore. Except for recovering precious metals from circuit boards, there are also cases in which pre-treatment is conducted in India prior to export of the material to another Asian country. There are only three licensed hazardous waste sites in the entire country, and a large amount of solid waste containing heavy metals and hazardous substances is landfilled.

With only three facilities currently existing in India to properly handle e-waste, the overwhelming majority goes into the informal sector.

The recycler/dismantler dismantles the E-waste and the readily reusable/recyclable materials like plastic, glass, cable-wires, components, etc. are resale back to raw material supplier for reuse. While the remaining E-waste is reprocess to recover the valuable materials like copper, gold, silver, aluminum, etc. from it and then dispose-off the residual waste either in an incinerator or in a landfill, open dumping of the residual or un-recoverable E-waste, along with acids used in extraction, on the open land and water bodies was also reported

The process followed by these recyclers is product reuse, refurbish, conventional disposal in landfills, open burning and backyard recycling. While bulk recycling in developed nations have reached a certain level of automation to fulfill and sustain mandatory recycling targets, manual disassembly and segregation remains the preferred method for developing nations like India. There is a huge potential for organized recycling industry in India given the fact that about 95 per cent of e-waste is processed by the informal sector.

4.2.3 Import and Export

India is the second largest recipient of e-waste, nearly 22% of all e-waste exported from the EU countries. The country has been one of the main destinations for WEEE and WEEE from OECD (Organization for Economic Co-operation and Development) countries, with an estimated 50,000 tons of e-waste imported every year. 70% of the e-waste processed or disposed of in India is believed to originate abroad, with Delhi as its primary destination.

Domestic e-waste is significant in addition to illegal imports. Bangalore handles

more that is domestically produced; India by itself produces 400,000 t of e-waste annually.

4.2.4 Labor protection and Monitor

The total E-waste management system is labor intensive and most of the recycling and recovery operations are carried out using outdated technologies and processes.

Most of the laborer working in this sector is poor literate and un-educated, they are little or completely not aware about the harmful effects of E-waste recycling on their health and environment. As collection, dismantling, sorting-segregation and recovery of E-waste are mostly done manually; in India this business has significant employment potential.

Informal e-waste recycling exists on a large scale but exposure assessment is scarce in India, therefor, comprehensive exposure assessment is urgently needed to characterize the profiles of chemicals and their concentrations. Primitive tools and methods often involve the open burning of plastic waste, exposure to toxic solders, acid baths to recover saleable materials and components from WEEE with little or no safeguards to human health and the environment which results in polluting the land, air and water due to river dumping of acids and widespread general dumping.

The biggest drawback of the current E-waste system in India is the uncontrolled emission of pollutants that are going into the air, water and soil, which are neither quantified nor monitored. The health hazards from fumes, ashes and harmful chemicals affect not only the workers who come into contact with the E-waste, but also others who are exposed to the E-waste environment.

4.2.5 Hubs of e-waste management

The two main hubs where e-waste is re-cycled in the country are Delhi and Mumbai. The other two major hubs are Hyderabad and Bangalore which have been the centers of the electronics and information technology industry. They are among the top ten cities in India which have been generating e-waste. Their status as primary centers of the e-waste recycling process - whether it concerns storage, dismantling, recycling, refurbishing, and distribution-has been a predictable fall-out of the

electronic industrial growth and development in these cities.

- Delhi, India

Delhi is the leading processing center of e-waste in the country, and acts as the center of e-waste recycling in the country. A report by the Toxics Link in 2004 found that 70% of e-waste collected at recycling units in New Delhi was actually exported or dumped by the developed countries. According to the study conducted by the GTZ in 2007, there were about 25,000 workers refurbishing 10,000-20,000 tonnes of e-waste annually. The work takes place in small illegal units where neither regulations nor environment or health safeguards are in place. The material recovery of the e-waste recycling system is mainly driven by the precious metal content of personal computers.

Recently, huge numbers of secondhand motherboards have been illegally imported from China. Some of these are sold in used goods markets, and the others are recycled in the Mandoli Industrial Area in Delhi. Apart from e-waste imports and supply from the neighbouring regions, another source of domestic supply of e-waste is the kabadiwalas (waste pickers) who buy scrapped electronics from households.

In New Delhi, workshops are mainly in the East Delhi area. Shastri Park, Seelampur and Mustafabad in New Delhi are the prime areas for computer scrap trading and pre-processing, as shown in Figure 4-17. In the Mandoli Industrial Area in Delhi, Muslim residents engage in illegal recycling of printed circuit boards using acid bath processes to recover copper and gold. The recovery rate for precious metals from circuit boards is approximately 20%, which is sufficient to make informal recovery of these metals profitable.

Figure 4-17 Plastic Recycling hotspots in Delhi

PBDEs identified in dust associated with manual separation of circuit boards and solder recovery in New Delhi were detected at trace levels. Ashes and soils from the New Delhi burning sites had PBDE concentrations of 23,000 ng/g dw, that were 230 times higher than PBDEs in urban soils of the UK.

Wastewater containing residues from cyanide and acid leaching processes as well as from e-waste dismantling activities in New Delhi was 20.4 mg/l. Concentration of lead, which ranged 3560-6450 mg/kg in the bottom ashes of e-waste recycling facilities in New Delhi as reported by Brigden et al. (2005), are 254-461 times higher than the average content of Pb in bottom ash from three major power plants in and around New Delhi. These concentrations are also 7.12-12.9 and 102-184 times higher than the Pb value for industrial soils and the background level for soil (from non-anthropogenic sources) as specified by the State Environmental Protection Administration (SEPA) of China (SEPA, 1995), and about 6.72–12.2 times higher than the action value for Pb as stipulated by the Ministry for Social Building, Regional Planning, and Environment Administration of the Netherlands.

The Pb content in the dust from streets near the e-waste facilities in New Delhi was high when compared to the background and industrial levels of this metal for soils according to SEPA and the action value set by VROM.

Lead dust concentrations in circuit boards from e-waste dismantling and shredding workshops of New Delhi were higher by factors of 16.6 to 17.6 when compared with the Pb action value set by VROM and the Pb value for industrial soils specified by SEPA.

- Mumbai, India

Mumbai is not only the port of import for new and used electronics; it is also home to a large user and manufacturer base, both generating large volumes of e-waste.

The e-waste recycling market exists in a major way in Mumbai. The market of e-waste in Mumbai is not concentrated in a single place, but spread over different areas, each handling a different aspect of recycling. The city has a large network of scrap traders, with the main centers in Kurla, Saki Naka, Kamthipura- Grant Road, Jogeshwari and Malad. The general practices of recycling of the most complex parts of PCs, for instance, circuit boards and PVC wires by open roasting and acid bath to recover different metals, has not been observed in Mumbai. Most of the e-waste generated in the Pune and Pimpri Chinchwad Region is transported to the Mumbai Metropolitan Region (MMR) for further treatment and distribution.

The items, which require extraction through wet processes are sold to traders from Delhi. Though it is claimed nothing is dumped in open fields, the report prepared by the IRG Systems South Asia under the aegis of the Maharashtra Pollution Control Board (MPCB) acknowledges that the hazards involved in product recycling can cause environmental damage.

As per country level e-waste assessment study, Mumbai generates maximum wastes among all the cities in India. Total electrical and electronic waste generation in Maharashtra is 20,270.6 tonnes, out of which Navi Mumbai contributes 646.48 tonnes, Greater Mumbai 11,017.06 tonnes, Pune 2,584.21 tonnes and Pimpri-Chinchwad 1,032.37 tons.

Jain and Hu (2006) assessed potential correlates of BLLs in 1,081 children who were < 3 years of age and living in Mumbai or Delhi, India, and found that most children (76%) had BLLs between 5 and 20 μg/dL. The correlation between greater than the 95th percentile weight/height and higher BLL may reflect an impact of lead exposure on body habitus.

- Bangalore, India

Bangalore is known as the Silicon Valley of India because of its preeminent position as the nation's leading IT employer and exporter, and also one of the eight biggest generators of e-waste in India (BIRD, 2005; EPTRI, 2010). E-waste recycling including licensed and some unlicensed operations are also active in Bangalore and thus environmental and human contamination at the e-waste recycling areas is of great concern.

In Bengaluru, e-waste recycling is a multi-crore market where e-waste is received in Gowripalya and Nayandahalli. The e-waste scrap dealers often employ women and children to deal with the scrap and remove usable metal, and send the segregated and dismantled e-waste parts to Delhi and Mumbai every alternative day. It is estimated that around 25,000 people work in the informal e-waste sector and earn wholly or partly their living out of it, as per an e-waste case study Bangalore city. The e-waste recyclers earn around Rs. 2-3 lakhs a month from selling the dismantled e-waste to Delhi.

Improper disposal or contact with these materials can lead to contamination of the surrounding ecosystem and can be a major health hazard. As many as 1,000 tons of plastic, 300 tons of lead, 0.23 tons of mercury, 43 tons of nickel and 350 tons of copper are annually generated in Bangalore from e-waste, particularly as computers are broken down during the recycling and disposal processes (Guptha and Shekar, 2009).

Gold recovery is the most important division of the precious metal recovery in Bangalore and printed wiring boards are considered as one of the most important fraction in e-waste for the gold recovery. But some of the precious metal recovery processes are identified problematic. For example to recover gold from e-waste wet chemical leaching processes, which use several hazardous substances and materials (e.g. cyanide and nitric acid) are conducted. Waste water containing residues from cyanide and acid leaching processes as well as from e-waste dismantling activities in Bangalore was 4 mg/l.

Air at an e-waste recycling slum in Bangalore contained Cd, In, Sn, Sb, Pb and Bi at concentrations of 1.5, 1.3, 91, 13, 89 and 1.0 ng/m^3 respectively. And soils contained up to 39 mg/kg Cd, 4.6 mg/kg, 957 mg/kg Sn, 180 mg/kg Sb 49 mg/kg Hg,

2850 mg/kg Pb, and 2.7 mg/kg Bi. These concentrations are some one-hundredfold higher than those found at a nearby control site in the same city (Ha et al., 2009).

- Hyderabad, India

For sometimes, Hyderabad has been known as the emerging Silicon capital of India. The annual e-waste generation has been estimated for Hyderabad at 3,263,994 MT from computers, printers, television and mobile phones (EPTRI, 2010).

Most of the e-waste collectors and recyclers only do size reduction (shredding) and segregation. There are two formal recycling units in Andhra Pradesh. Although the formal recyclers exist, most of the e-waste finds its way into unauthorized recycling centers or to scrap dealers for quick money. In most of these units, workers are mainly women and children. The report prepared by the Environment Protection Training & Research Institute (EPTRI), Hyderabad under the aegis of the WHO, New Delhi revealed that on an enquiry, the workers stated that there was no health problem but a study needed to be taken up to find the actual pollution load generated and health problems among the workers.

With the fast rate of technological changes and growing dependency on information technology and other modern electronic household items, the quantum of e-waste is set to rise in every electronic item. Since most of the e-waste finds its way to the unorganized sector with profit as the prime motivating factor, e-waste recycling undeniably requires better management and improved working environment guided by strict regulations.

- Other cities in India

The lack of control and regulation of the e-waste recycling industry has led the poorest members of the population to find an economic benefit in recovering valuable parts from e-waste while discarding the unwanted components. These activities are performed in an unprofessional manner with very high health and environmental risks. E-waste is also recycled in Chennai, Pune and Kolkata.

Presumably, what has not been factored in this international trade concept is the exponential spurt in domestic WEEE generation, the increasing numbers of formal recycling entrepreneurs and the growing awareness of the environmental impact of such products in India.

4.3 Mongolia

In Ulaanbaatar city, 45.1% of total electrical and electronic waste is being reused, 23.0% is being recycled and 31.9% is disposed.

4.3.1 Responsible department

Ministry of Environment and Green Development is responsible for assessing the environmental impacts of SW, and if appropriate closing a disposal site, for example, maintaining statistical records on hazardous waste; and responsible under the recent Government changes for advising Government on the policy framework for environmental pollution including SWM; and for ensuring implementation of State policy and national programs on waste management. The MEGD with national responsibility for implementing SWM policy, including setting national standards and improving management in the sector.

4.3.2 Transportation

Nearly 75% of total generated waste is collected by waste transportation companies and 15% is transported by the organizations and people witch their own trucks and 5-10% of waste is left without being transported.

4.3.3 Dismantling and treatment

Repair shops usually buy WEEE from household users at a relative low price, but they do not have professional disposal facilities; thus, environmental pollutions are mainly caused by this channel of e-waste disposal. Fig. 4-18 and Fig, 4-19 provide several photos on e-waste dismantling in Mongolia.

Fig. 4-18 Photos on e-waste dismantling in Mongolia.

Fig. 4-19 Photos on e-waste store in Mongolia.

Repair shops repair most of the purchased EEEs, resell them to residents and dismantle other EEEs that are impossible to repair. Repair shops playing the important roles are usually small and medium in size consisting of 1 to 3 persons; especially in TV and PC recycling, repair shops are usually operated by individual repairmen not by companies. The useless parts of dismantled WEEEs are discharged by repair shops discharge points as a municipal waste and waste pickers working in the city and collection workers pick metal containing parts among the discharged items to segregate metals before transporting them to the landfill site.

Recyclables and non–recyclables

The WEEE recyclers in Mongolia are repair shops or individual repairmen, collection workers, waste pickers and metal purchasers.

The majority of the most common recyclables are metal-containing parts. Generally, metal containing parts are recycled regardless of their functionality as non-functional ones can be sold as metal after segregation. Among the non-metal or mixed small parts, any of the functional ones can be used in maintenance as spare parts.

Table 4-3 Recyclables and non-recyclables of e-waste in Mongolia

	TV sets	Refrigerator	Washing machine	PC
Recyclables:	PCB	Compressor	Compressor	Main board items
	Choke coil	Iron cases	Iron cases	Some functional parts
	Wres	Wires	Wires	Power supply unit
				Processor case
				Wires
Non-recyclables:	CRT	Rubber items	Plastic items	CRT monitor
	Plastic cases	Glass		Optical drives
		Plastic		Floppy drive
				Plastics & mixed items

4.3.4 E-waste import

In Mongolia, there are no operations of WEEE collection, separation and recycling and no import is made for recycling purposes, too.

4.3.5 Landfill

Ulaanbaatar city have three landfill sites，Narangiin Enger, Moringiin Davaa and Tsagaan Davaa. Nearly 2,500-2,800 tons of wastes dumped a day, which makes 1,120,600 tons a year. Compared to 2012, waste generation was increased by 15%. Provinces are generating 1,905,611 tons waste annually. There is no specific data for e-waste and e waste is included as plastic waste.

4.4 Sri Lanka

According to the past evidences the Electronic waste management enterprises had started their operations nearly a decade before informally. This was done through scrap collectors and collecting end of life e- items obtained from corporate sector in bulk when they remove the stock piled e waste. At the beginning only a two or three e waste collectors were operated and localized to the capital city.

After March in 2008 certain types of e waste had been subjected to regularize under the National Environmental act by mandating the Scheduled Waste Management license for all e waste management activities carry out in industrial scale. In parallel to the internal legal framework, government has adopted Basel

Conventions notification procedure for exportation of e waste. Currently it is being strictly implemented and importing country's consent, exportations are not allowed. Through these procedures informally operated e waste management facilities were gradually formalized and general public and public and private sector organizations tend to hand over their e waste to the license holders.

After 2010 the formal sector collectors expanded their operations in a more organized way with business agreements with cooperate sector and also they started expanding the collection mechanism throughout the country with their own door to door collection.

In 2010 Central Environmental Authority (CEA) came in to a Memorandum of Understanding with a Telecommunication service provider to establish an island wide collection mechanism for M-waste (Waste mobile phone). Through this programme all their franchise shops and sales arcades had been converted as collection centers.

In 2011 CEA launched "National Cooperate E waste management programme" under a common logo and theme "Ensuring an E waste free environment. Through this 14 private and public sector partner organizations signed a Memorandum of Understanding with the CEA. Telecommunication service providers, Electronic venders, E waste management companies, Software companies were take part as stakeholders in this national level programme and they extended their contribution by establishing an island wide collection mechanism, organizing drop off events and raising awareness among general public.

This programme is still in progress and in 2014 partner organizations have been increased up to 19. Awareness created through this programme has boosted the people to enter in to the e waste business. General public tend to handover their e waste to collectors rather than give away with municipal solid waste.

It was clearly noted that the formal sector collection and storages had been expanded nearly two fold within past four years and they do their collection, storage and dismantling practices in more organized way. However there are only five formal sector collectors are in operation.

There is a significant tendency for mandating the Scheduled Waste Management License as a primary requirement in many public sector and business establishments when they calling tenders to hand over their obsolete e-items. This has induced the

informal sector to obtain the license and operate in a formal way. There are number of such informal sector collectors in the process of streamlining their operations.

At present Sri Lanka does not have a comprehensive recycling facility for electronic waste. Only the plastic and metallic components are sold to downstream vendors and recycled internally while all the Printed Circuit boards are exported. Even though these facilities have been identified as formal sector

However with the formal sector development it was also observed that there is a significant expansion of informal sector operations all over the country starting from door to door collection and ending up with rudimentary dismantling and metal recovery practices. Mainly the scrap collectors engaged in this business and operated in domestic level in some localities it has become a community based operation.

At present some private sector companies are in the process of establishing recycling facilities having the processes of metal refining in order to cater the entire downstream management of e waste.

4.4.1 Collection

- Formal sector e-waste management facilities

There are five formal sector collectors bearing Scheduled Waste Management license to collect e waste are currently do their collection operations. Out of these five formal sector collectors four collectors are stationed in the Western province and one in Sabaragamuwa Province.

These collectors have extended their services throughout the country depending on the intensity of generation. Their collection network is well organized and mainly focused on commercial / industrial sectors which are considered as mass scale generators. Generally many of these collectors having agreements with commercial and industrial establishments to undertake their e waste. However some of these formal sector collectors practicing door to door collections and also organized drop off events. Generally these drop off events are being held under the supervision of the Central Environmental Authority.

Formal sector extended their collect all most all types of waste electronic items. They possess modified vehicles with attractive displays.

Electronic item venders and Telecommunication service providers who have entered in to a Memorandum of Understanding with the Central Environmental Authority had established e waste collection points in their island wide sales outlets. This mechanism started in 2009 by a telecommunication service provider for the first time and in 2010 and 2014 some other telecommunication service providers and some e venders joined to the island wide collection network. There are collection centers operate island wide through this mechanism.

Normally E venders collect all most all waste e devices and telecommunication service providers collect only mobile phones and batteries. In these sales outlets a drop off box had been kept to drop the waste mobile phones. These collectors hearing agreements with Formal sector E waste management establishments mentioned in 3.2 (a). Central Environmental Authority monitors the mechanism.

- E venders implementing EPR

E venders practicing EPR policy also contribute in collection mechanism. Through these mechanisms consumers can take back waste electronic devices to retail stores that distribute similar electronic items they could get back the electronic item at the retail store in reduced price for purchase of a new product.

Mainly the Refrigerator, TV sets, and Air conditioner vendors are engaged in these EPR based collection mechanism. Some of the electronic item vendors implement EPR collection mechanisms aiming the brand protection. Mainly the computers and accessories and mobile phones practicing this mechanism

- Non profitable Agencies/ Non Government Organizations.

Some Non profitable agencies and NGOs implement collection programmes with some awareness one waste. Such establishments are very rear and these organizations also maintain their own storages.

- Informal sector collectors

Informal sector collectors operate their collection activities mainly as door to door collection. Generally the metal scrap collectors are the key players in this sector. Informal sector collection distributed throughout the country covering all 25 districts. Unlike the formal sector, informal sector collection operations are distributed to the rural areas as well and when comparing with the formal sector, informal sector

dominating in the rural areas. The collection network of the informal sector may consist of several modes of linkages such as buyers, intermediates, transporters etc.

Basically the scrap collectors dominating the informal sector collection and dismantling, apart from that some small scale electronic item repair shops also engaged in dismantling operations. Scrap collectors distributed throughout the country and mainly perform door to door collection.

The informal sector is very active in activities related to the e-waste recycling chain and they are motivated by the precious materials contained in the e-waste stream and its market value. When comparing with the formal collectors, informal collectors also achieve high collection efficiencies. Mainly the collection done by small tractors, bicycles, small Lorries and carts and they collect almost all types of electronic waste ranging from small household appliances to larger electronic items such as refrigerators.

This network is widespread, and it is linked by different strata of collectors, intermediates and buyers, and linking with the formal sector as well. Hence the informal sector is likely to be more organized and vigorous than expected.

In fact informal collection of e-waste does not have any major adverse impacts on the environment. Instead they lead to high collection rates and many economic and social benefits to the unskilled lower income generators of the community. The informal sector is also involved in the second stage of the e-waste recycling chain - dismantling pre-processing. Even here there are no major impacts on the environment but gain more economic and social benefits to the poor community.

4.4.2 Dismantling

Formal sector dismantling is also carried out by the formal sector collectors which is also an activity covered under the Scheduled Waste Management License (Hazardous Waste Management License). General practice in all these formal sector is manual dismantling to separate Printed circuit boards, plastics, and other metal components

Normally 2-10 workers engaged in dismantling operations in these establishments and some had been provided with adequate trainings. Formal sector dismantlers are mainly localized to Colombo and suburbs.

Some electronic item repair shops also engaged in dismantling operations. Items that cannot be repaired further are dismantled and components are segregated to be sold out.

Generally the urban poor has engaged in the dismantling of e waste. Informal sector dismantlers spread all over the country and in most cases operations are going on in domestic level. Mainly in Colombo districts informal sector operations are widely found in unauthorized settlements in water body reservations and slums Generally the scrap collectors are engaged in dismantling e waste and also there are some cottage level establishments dedicated only for dismantling is also found. Informal sector collectors sell their e-waste to these establishments as a common practice.

4.4.3 Treatment and disposal

Presently there is no any kind of a facility to cater treatment or recovery of Printed Circuit Boards within the country. Only the plastic components and the metallic parts recovered out of electronic waste are being recycled locally.

Plastic components recovered from the e waste are crushed in recycling facilities. These recycling facilities are mostly operated as small and medium scale enterprises. Recycled plastics are being generally used to manufacture electric switches, plugs, shoe sole and heals. Out of these recycling/treatment facilities only few recycling establishments are operated as formal sector. recovered metal parts are sold to smelters.

In Sri Lanka no secure land fill facility available to dispose the hazardous waste. Only disposal activity that could be observed in relation to electronic waste is open dumping by the informal sector. They recover the parts which are having economical value and rest are dumping hap hazard manner creating several environmental issues.

The last stage of the e-waste recycling chain where processes/techniques are necessary to extract the valuable components such as metals is where the current environmental impacts are. Basically the primitive technologies utilized by informal recyclers to extract raw materials from printed wire boards, wires and other metal bearing components have very low material recovery rates and also result in major environmental impacts.

In the informal sector operations e-waste is managed by using various improper methods such as backyard recycling, open dumps, and disposal into surface water bodies. It is common to see open burning of plastics to reduce the e-waste volumes, copper wires to salvage valuable metals such as copper. Such operations have resulted in severe environmental pollution and mainly these practices are going on in the unauthorized settlements and the slums.

Fortunately children are not engaged in collection of e waste in Sri Lanka as the Child labor is prohibited and education is mandatory for the children below 16 years.

4.5 Vietnam

4.5.1 Collection and transportation

There are some facilities owned by former state waste recovery and treatment enterprises, etc. in Vietnam, which conduct the collection, manual dismantling and separation of e-waste.

4.5.2 Dismantling and treatment

In Vietnam, the typical treatment methods for e-waste in Vietnam are as follow:

- Lead battery reclamation:

At the moment, the most common technology for lead battery recycling is as follow:

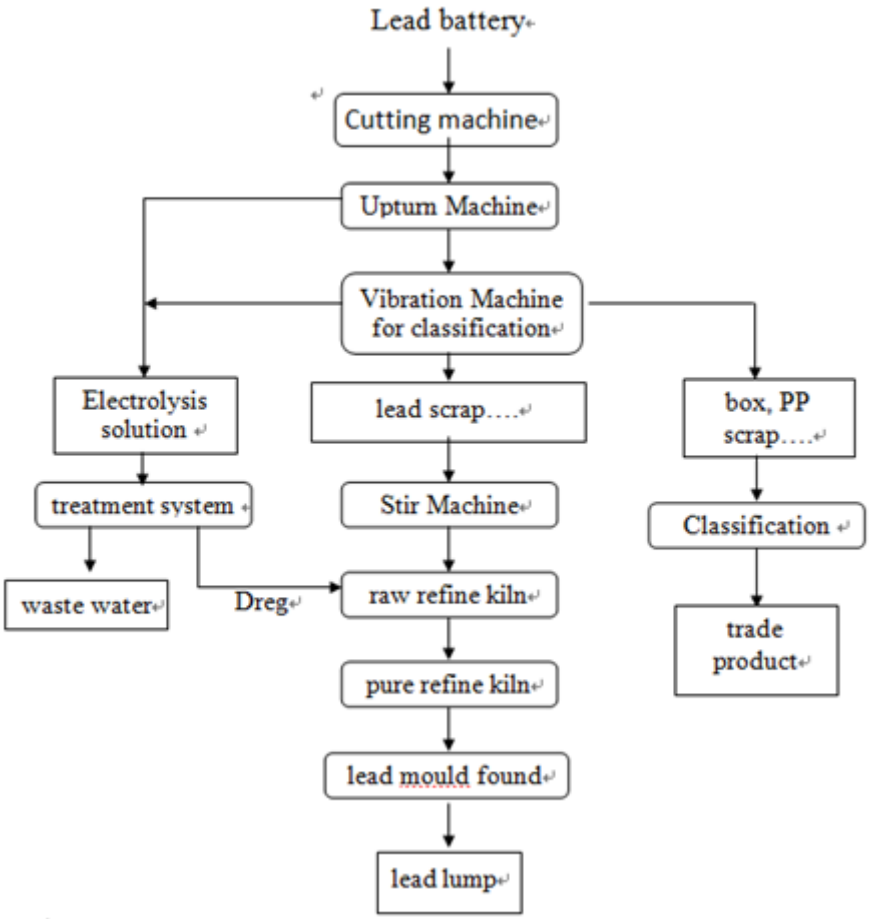

Fig. 4-20 Diagram of lead battery reclamation

The stages of process include:

During the cut period, waste batteries is loaded on conveyer belt to cut machines for cutting cap and bottom of cover, separate to parts of cover and electrolysis solution.

Parts of battery: continue being classified

Electrolysis solution: be collected and treated at electrolysis solution treatment system.

In the period of classification, parts of battery after be cut move to upturn machine and vibration machine for separating PP cover and lead-contained parts

PP cover: classification on size and type and sell to market

Lead-contained parts: be moved to lead refine system

- Process of lead refinement:

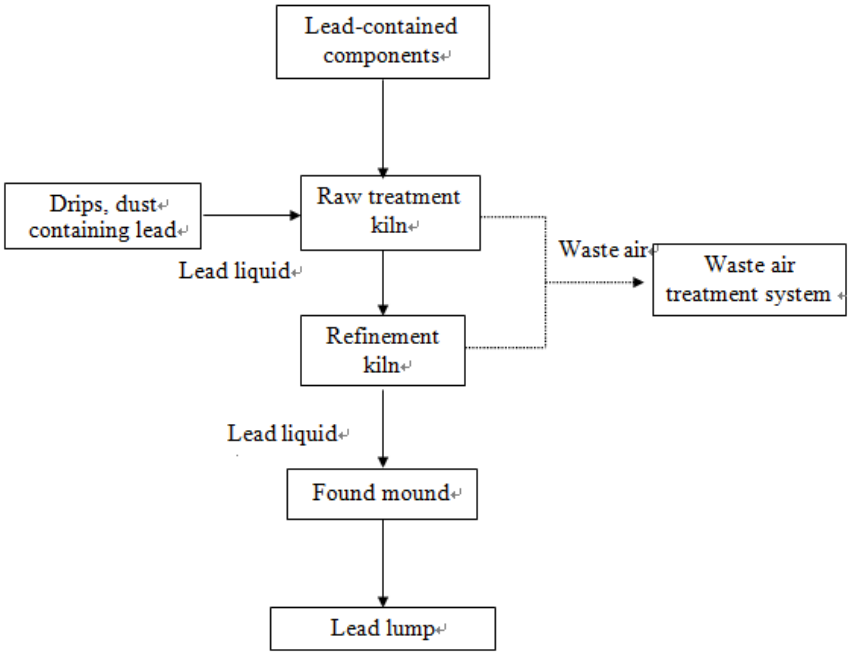

Fig. 4-21 Diagram of lead refinement

Raw for treatment is component containing lead. At high temperature, lead changes to liquid status and move to refine kiln. Heat is made from burning LPG air. Liquid lead is poured to gutter and link to found machine and found to lump. Lead lump is dismantled from mould and store.

Waste dust and air is collected, run on small pipe to collection pipe. That pipe is arranged zigzag. Sediment is collected in bottom of pipe regularly.

Air after dust filter system is moved to absorbent tower for treating acid steam in waste air. Dust from filter bag is collected regularly and transfer to cast kiln. Air in absorbent tower go up, base solution go down. Period of reaction occur along the length of tower. Base solution is used periodically and regularly transferred to acid pool.

- Printed Circuit Board

Currently, there is only one facility that has technology to recycle metal components in printed circuit board. Other facilities just incinerate in incinerator. The technology for recycling printed circuit board is transferred to raw crush machine for exploding and then transferred by conveyor belt to pure crush machine. Pound is mixed with water in special machine, product is sludge status. Sludge pump is used to pump sludge up to drum-shaped overflow pool and then to Vibration table machine.

Here, metal and no-metal is separated by water-chosen principal.

This is advance method, not use chemical, reuse washing water, do not pollute as chemical method or burn method.

Metal is recycled, no-metal is used as construction materials or composite.

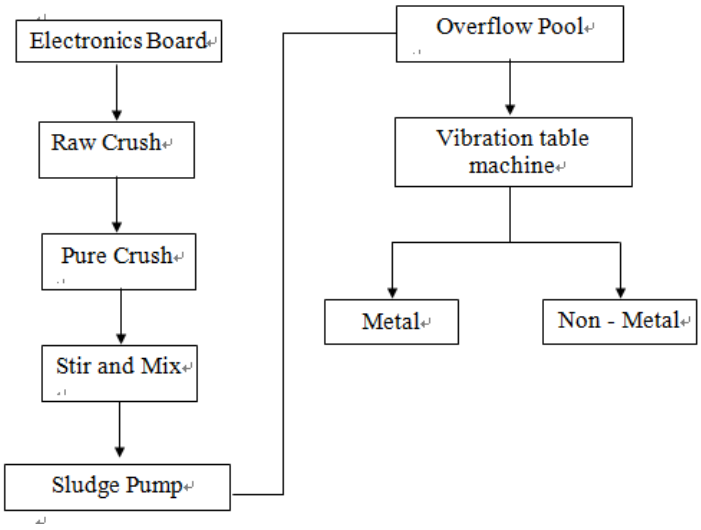

Fig. 4-22 Diagram of printed circuit board treatment

- Treatment technology of fluorescent lamp:

This technology is currently used by most of treatment facilities due to the need of generators. However, the complexity of technology varies from one facilities to another. The general information could be summarized as follow:

Steps of treatment process:

Waste lamp is transferred to crush equipment

Vacuum pump system creates low pressure in whole system and supply water to wash fluorescent powder.

Crush machine beats lamp and crush glass into small pieces size 3-4 mm and go into filter net to glass container. Metal part is remained and moved outside.

In glass scrap container, glass scrap is washed cleanly the fluorescent and go outside for recycling and used for other purpose. Fluorescent goes into fluorescent container.

In fluorescent container, the wash water goes into water pool. Fluorescent is

remained and supply heat to 250℃ at low pressure, Hg from fluorescent powder is collected completely goes into Hg steam collection system. Remained powder is not harmful and can be burned or buried.

In the wash process of glass, little Hg goes into wash water, so wash water have to goes into absorbent equipment that contains full of active carbon. Here, Hg is absorbed completely, wash water is pumped again treatment system making a closed cycle, so save water.

Hg steam collected from treatment process goes into active carbon collection system (active carbon is soaked in H_2SO_4). At here, Hg is collected completely with air going outside respond the standard.

When Hg collection system is saturate, Hg steam occurs in show column. Absorbent in column changes color. System for recycle absorbent equipment has to be stopped.

Active carbon column after is saturate with Hg steam is washed by solution HNO_3 and HCl and reuse. Hg salt solution is refined to trade product

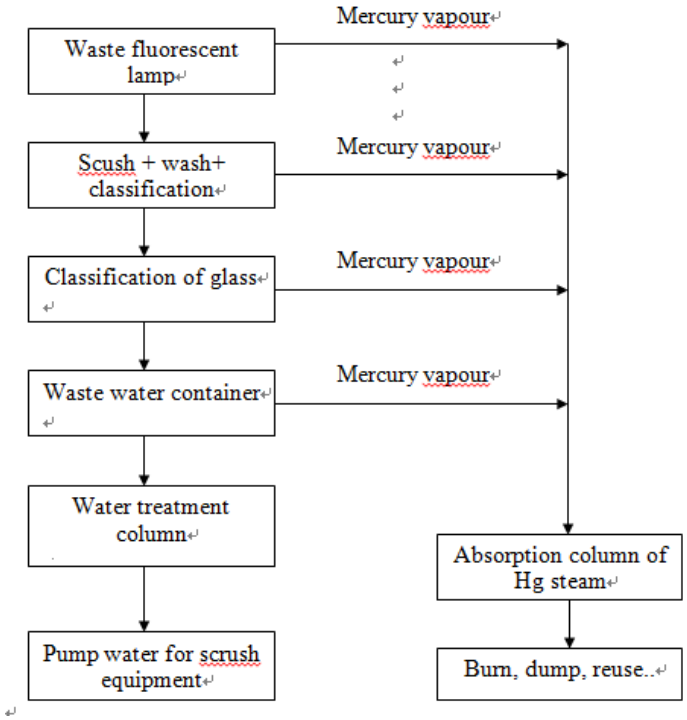

Fig. 4-23 Diagram of fluorescent lamp treatment

Advantages: reasonable investment cost, easy to operate. Fluorescent powder, glass obtained can be used as raw material in cement production or re-use glass

cleaner.

Disadvantages: absorption of mercury vapor discharge lamps will create new waste to be treated as mercury salts.

4.6 Pakistan

4.6.1 Background

Hazardous E-waste has become one of the biggest health risks in Pakistan, with rising trend of bulk import of used and obsolete computers and other electronic equipment from the West. The people, especially the youth, are buying E-waste of the West as branded computers due to lack of awareness about the grave risks it is posing to the human life and environment.

In Pakistan, the scale of urban consumption and waste generation and the negative impacts associated with them varies dramatically from area to area, depending in a large part on a city's wealth and size. According to environmentalists, the toxic materials found in computer equipment include lead, cadmium, chromium, mercury, barium etc, warning that older the computer, the higher the level of toxic elements. Used computer market has been popular with masses due to price differences. According to a report, a person using an old computer is wasting 60 per cent more energy.

No statistical data related to import of electronic devices such as used computers and mobile phones are available at federal bureau statistics site. According to All Pakistan Electronics Manufacturer Association, all major components in electronics industry are imported. This situation indicates that even large multinational companies are as a matter of fact engaged in import business, as they are actually selling the imported parts just after giving them the shape of an assembled product.

At present E-waste in Islamabad do not meet NEQS and the requirements of Basel Convention, and maybe it is the same condition with the whole country.

4.6.2 Collection and dismantling

In Pakistan, the accrued electronic and electric wastes are bought by scrappers at different prices.

Fig. 4-24 Discarded Hard Disks

In Pakistan, the collected electronic and electric wastes are dismantled and sorted manually to fractions such as printed wiring boards, cathode ray tubes (CRT), cables, plastic, metals and batteries. Circuit boards in Pakistan are often taken apart indoors with blowtorches and with very little ventilation.

Working in poorly ventilated enclosed areas without masks and technical expertise results in exposure to dangerous and slow poisoning chemicals. Printed circuit boards, plastic casings, cables and polyvinyl chloride (PVC) cables containing brominated flame retardants are burned to retrieve copper which releases highly toxic dioxins and furans placing unsuspecting humans and other life forms at risk.

Fig. 4-25 Dismantling of Electronic Items

Fig. 4-26 Picture from mobile workshop

4.6.3 Treatment and disposal

At present, open burning of waste or open disposal is a general practice.

Waste components which do not have any resale or reuse are openly burnt or disposed of in open dumps. Backyard smelting using crude processes is done which result in fugitive emissions and slag containing heavy metals. Strong acid is used for the removal of heavy metals which results in respiratory problems.

Pollution problems associated with such backyard smelting using crude processes are resulting in fugitive emissions and slag containing heavy metals of health concern. CRT breaking operations result in injuries from cuts and acids used for removal of heavy metals and respiratory problems due to shredding, burning etc. They use strong acids to retrieve precious metals such as gold. Working in poorly ventilated enclosed areas without masks and technical expertise results in exposure to dangerous and slow poisoning chemicals. Brominated flame retardants on printed circuit boards, plastic casings, cables and polyvinylchloride (PVC) cable insulation can release highly toxic dioxins and furans when burned to retrieve copper from the wires.

Fig. 4-27 Second hand laptops for sale in a shop

4.6.4 Ruse and recycling

The valuable fractions are processed to directly reusable components and to secondary raw materials in a variety of refining and conditioning processes.

In practice, after removing the working machines and usable parts, the bulk of the consignment is sent to the recycling industry

Hundreds of workers, including teenage children, earn their livelihoods by

dismantling the electronic scrap and extracting valuable components such as copper.

4.6.5 Import and export

The Pakistan Environmental Protection Act of 1997 is the basic environmental law of Pakistan, and Section 13 of which prohibits import of hazardous waste in Pakistan and its territorial waters.

This Act regulates imports and exports of the country and allows the Government to prohibit or restrict import and export by air, sea, and land. The Act allows the Government to restrict or ban import of goods or any class of goods.

At present there are no restrictions on import of E-waste for recycling. Once Pakistan has approved policy then the act empowers GoP to restrict import of E-waste.

4.6.6 Labor protection and Monitor

Due to lack of awareness, these unorganized recyclers are not only risking their health but also affecting the environment. After this, the valuable fractions are processed to directly reusable components. No sophisticated machinery or personal protective equipment is used for the extraction of different materials. All work is done by bare hands and only with the help of hammers and screw drivers. Children and women are routinely involved in the operations.

No training mechanism for workers. Working in poorly ventilated enclosed areas without masks and technical expertise results in exposure to dangerous and slow poisoning chemicals.

4.7 Cambodia

Now in Cambodia, the increasing e-waste generated every year and implementation of the informal sector of the activities of collection, transportation, repairing, reassemble and dismantling, which is unsound management during practicing; it will cause effect to human health and environment.

4.7.1 Collection and Transportation

At the moment, no data of e-waste in the recyclable wastes collecting site and no e-waste audit system has ever been introduced in Cambodia. There is no formal take

back system or transportation system existent in through country, while dismantler s' in informal sector have their own collection and transportation system.

Vehicles from municipal solid waste transportation company pick E-waste residues from the bins for disposal at waste dump site, while waste pickers use hand carts for transportation of E-waste.

Fig. 4-28 Collection of e-waste in Cambodia

Fig. 4-29 Transportation of e-waste in Cambodia

4.7.2 Repairing and dismantling

Repairing and dismantling process to few items of WEEE is simply done, due to insufficiency of modern technology, and sectoral awareness, the treating steps are listed below:.

First testing to identify problems as well as other useable parts;

Connecting or replacing a spare-part from dismantled items to get a new one with appropriate functioning, although it has lower quality;

Retesting will be done in order to emphasize the function of repaired EEE.

If this repaired EEE does not function and/or improperly function, the repairing will be done once more.

Beside the use of simple method of repairing, some broken/un-functioning EEE,

e.g. laptop computer was sent to overseas for repairing in according to the negotiation between shop owner/manager and customer.

Same as a repairing process, there is no technology has been presented and used for dismantling and recycling of the six selected items of WEEE although in Phnom Penh Municipality.

The dismantling site and activities practice are in the simple manual, meanwhile, they did not use equipment and high technology for dismantle, shredding, and sort by item, in particular, did not use protection equipment during working.

Fig. 4-30 E-waste treatment in Cambodia

4.7.3 E-waste Disposal

The residue of E-waste focus on the kinds of waste/WEEE could not reusable and recyclable, which are generated from various sources such as household, commercial sector, repairing shop, junk shop, reassemble shop and dismantling site. These residue wastes are being disposed with household dustbin and/or illegal disposal at public road, land- lot/free land and forest. For the e-waste disposed in household dustbin, it was mixed with household waste without separation and then collected and transported directly to dumping site of the cities.

4.7.4 E-waste Impact to human health and Environment

According to the interim report of the project on the preparation of guideline to manage on waste electrical and electronic equipment in Cambodia, it has identified

the E-waste directly and indirectly impact to the human health and environment as detail below:

a) Occupational health impact resulting from E-wastes

It may occur in the different stages of e-waste flow of: repairing and dismantling shops, junkshops, recycling and reassemble shops as well. The accidents at the repairing process are caused by acid emission, and other chemical substances, including electric shocking. Additional negative aspects of smelling, noise pollution, particles release, smoke and toxic substances are recognized from repairing and dismantling shops too.

As an observation, workers ignore to wear the protective equipment. Most of these people do not realize the chemical substances contain in EEE or WEEE, or they do not know the negative impacts on their health.

b) Environmental impacts.

Most WEEEs are being generated by repairing and dismantling shops, and junkshops. Remarkably, some small amounts are generated by consuming sources (e.g. households, public entities, business centers, etc.). In a short, these wastes are collected, transported and disposed at dumpsite same as household waste without separation for different hazardous waste disposal.

The way of unsound disposal of WEEE is recognized to cause serious impacts and hazards to waste pickers, as well as to pollute surface/ground water quality and ecosystem through the release or leakage of hazardous substances into water sources. Another serious concern from unsound management of WEEE–that is the atmospheric pollution due to burning or self-firing hazardous wastes and household wastes at dumpsites, which emit toxic fume/smoke into the atmosphere, and it is considered to contribute the cause of acid deposition and climate change.



Fig. 4-31 Impacts of abnormal e-waste treatment

c) Public Health Impacts

Unsound management of WEEE and related residues is not only caused serious impacts the environment and biological diversities, but it also impacts the public health indirectly by different route of pollution, e.g. drinking or consuming of polluted water or fishes, breathing toxic air, opened burning WEEE and related residues.

Waste pickers or scavengers absolutely confront to potential health risks and hazards due to directly contacting and absorbing harmful/hazardous wastes and other pollutants through their daily tasks of picking recyclable wastes/items at dumpsite and waste disposal areas, unless, they have strictly paid attention to health precaution. Waste pickers commonly do their jobs without wearing safe-facilities, e.g. glove, mask glasses, etc. As observing, they concernedly use both dirty hands for either eating or smoking.

Fig. 4-32 Working-circumstance without protection from e-waste damage

5. Potential analysis for ESM of e-waste

The Environmentally Sound Management (ESM) goal is protection of public health and the environment. It is one of the underlying principles of waste management policies and has been referred to in most legislation regarding the transboundary movements of wastes and in other international, regional and/or national regulations. A basic condition to allow or prohibit an export or import was whether, or not, the waste in the receiving facility would be "environmentally soundly managed". It is also a good method of encouraging continuous improvement of ESM by developing countries. However implementation of ESM is an evolutionary process that takes time to achieve and that existing provisions can vary greatly from country to country and from facility to facility.

The criteria of ESM includes 8 aspects, (1) top management commitment to a systemic approach, (2) risk assessment, (3) risk prevention and minimization, (4) legal requirements, (5) awareness, competency and training, (6) record-keeping and performance measurement, (7) corrective action and (8) transparency and verification. This criteria provide a broad set of skills，a devices-specific expertise and operational controls, which aims at helping to tackle the environmentally sound management. All these should be of great assistance to the reduction of risks to the environment and public health, the protection of stockholder and stakeholder interests, and the economic benefits from increased plant efficiency, as well as the following implementation of this project. Basing on the national reports and questionnaires returned and consultation from experts, officers and industries, the gaps to facilitate the implementation of ESM of e-waste in different countries are analyzed as below.

5.1 China

China plays a key role in the global electrical and electronic products industry, including manufacturing, the refurbishment and reuse of EEE and recycling of e-waste. Due to the global nature of the electronics market and industry, e-waste management and legislative developments in China have significant influence on the environmentally-sound management of used electronics at the international level. China is now facing increasing e-waste problems due to the growing domestic consumption of electronics.

Under the progressive development of pilot projects and domestic e-waste

legislation over the years, the formal e-waste recycling industry in China has shown considerable growth in both treatment capacity and quality. With the construction of formal collection channels and recycling infrastructure by the government and treatment subsidies from producers, the formal e-waste treatment industry can expect further technological and economic improvement. The growth of the formal sector is important for lessening the environmental and health impacts of e-waste treatment. However, due to a range of social and economic factors discussed in this report, informal collectors continue to play a major role in the collection and recycling of e-waste, and informal processing often leads to detrimental effects on the environment and the health and safety of workers and local communities. In the coming years, the formal and informal sectors will both continue to operate.

The Chinese government plays a central role in the planning, administration and monitoring of the e-waste system in China. Other actors, including universities and research institutions, companies, industry associations, NGOs and foreign governments and agencies also play important roles. Improvements in the e-waste management system can thus be achieved through a combination of legislative development and implementation evaluation, technology transfer and innovation, research, knowledge exchange and international cooperation.

According to the criteria on ESM of e-waste, China plays an important role to implement the ESM criteria. In China most facilities follow the ESM criteria, such as the dismantling, sorting and crush, recovery of material and energy and pollutant treatment choosing the different methods in treatment and disposal technology. However in Environmental Management and Risk Assessment should strengthen the facility closure plan, such as site decommissioning plan and site remediation plan. In the criteria on ESM the Competency Training, Corrective Action Transparency, the company social reports are made available to shareholders and society, which include information pertaining to its performance with respect to environmental, health and safety issues are neglected.

This project will facilitate better understanding of the whole e-waste policies, technology and facilities and provide key information and insights that will contribute to the achievement of the goal of ESM, and reducing the negative environmental impacts from e-waste treatment while improving resource efficiency and the benefits to society.

5.2 India

Relevance and need for an appropriate legislative framework, economic incentives to adopt environmentally sound practices and technologies, scope for extending the life of products through reuse, refurbishment and repair and awareness creation have been assessed to determine the potential for promoting ESM of e-waste in India.

E-Waste generated by discarded computers, mobile phones, batteries, and other electronic goods is a growing concern in India. Despite being signatory to the Basel Convention, there is no legal framework to deal with the issues of e-waste management in the country.

The major problem related to e-waste management in the country is that of disposal and recycling. Illegal e-waste processing continues undeterred because disposal of obsolete electronic equipment has become a lucrative business in India. Unlike the developed countries, there are no set norms for handling of electronic waste, and secondly cheap labor makes disposal cost-effective and profitable for local traders. The lack of national regulation and/or lax enforcement of existing laws are promoting the growth of an informal economy in India. While it is a source of livelihood for the urban and rural poor, it often causes severe risks to humans and the local environment.

There are no standard practices for collection and recycling of e-waste at present in the country. Until recently management of e-waste was synonymous with selling e-waste to a scrap dealer from where it reached informal sector recyclers. The e-waste finds its way to the informal sector through dismantlers and scrap dealers involved in segregation of the e-waste into various components like PCB's, plastic, CRT etc. who buy the waste through auctions, from waste collectors and/import waste. Some of this segregated e-waste is used as secondhand products, while some are dismantled for the recovery of precious/valuable metals.

The rest of the e-waste, which are not recycled and reused, is thrown in open dump sites or burnt. The informal recyclers buy items for extraction of various valuable metals. E-Waste recycling is mainly motivated by the recovery of value contained in the PWBs (printed wiring boards), which is retrieved by extracting precious metals (mainly Gold, Silver, Palladium) with wet chemical processes, involving highly toxic substances such as nitric acid , Mercury and Cyanide. Untrained people, resulting in a

high impact on their health and the environment, do these activities. It is essential that India take note of this menace or it will have to pay a heavy price for environmental degradation. There is an urgent need for promotion of the environmentally sound management principles in managing e-waste in the country.

Efforts to adopt the ESM principles for e-waste management in India have been sporadic. While there is no legislation in place as yet, a few corporate organizations are making an effort for practicing ESM of e-waste by initiating good practices for segregation, collection and recycling of e-waste as well as R&D of green products. NGOs are also promoting informal sector inclusive recycling models in association with industry associations and donors.

Consultations with various companies, organizations and stakeholders have identified several bottlenecks which is preventing the implementation of better e-waste management in the country including:

1) Lack of motivation of the top management - the interest with respect to e-waste is not an issue when taken up by top management

2) Lack of authorized recycling facilities in the country - There is an urgent need for the government to promote more e-waste recycling facilities to encourage competition and better prices for e-waste.

3) Participation in Tender Process - The authorized e-waste recycling facilities must take part in the tender process, which is a requirement for government facilities and public sector units for managing e-waste.

4) Lack of trained personnel – Most companies especially public sector and service industries lack qualified and trained staff looking after e-waste management leading to poor understanding of the issues at hand.

5) Lack of collection centres – only a few cities in India have recycling facilities and the collection systems for these facilities are restricted due to logistical and geographical problems.

5.3 Mongolia

Mongolia does not have special electronic waste legislation or regulations and management system/collection, transportation, recycling, disposal e-waste is just treated as municipal solid waste.

1) It is needed to develop a top management commitment to a systemic approach, such as ensure compatibility with requirements of e-waste treatment planning, top management commitment to health and safety and stable recycling channels of e-waste.

2) It is important to develop the treating and disposal technology of e-waste.

5.4 Sri-Lanka

The following recommendations cover Policy, Import control and Customs, Tracking System, Integrating with solid waste management practices, Pilot projects and recycling infrastructure.

1) Policy and Awareness: The state policy should be clearly documented and published. It is recommended to expedite the development of an e-waste set of guidelines and regulations. To sensitize the policy makers and the public alike it is also recommended having a national stakeholder workshop along with a series of publications to the general public through media subsequent to the development of the guidelines.

2) Integrating with Solid Waste Management Strategy: e-waste management should be part of integrated waste management program of the country. At present one company has moved on with a system for collecting used mobile phones. This needs encouragement as well as developmental support. Regulations and guidelines coming into action will enable development of this type of initiative. All responsible parties joining hands to move forward Endeavour’s of this nature should be looked into and state should explore means of program support.

3) Data Base Management and Tracking: Further statistical analysis of data collected is recommended along with the use of earlier data.

4) Treatment Equipment and Disposal Technology: dismantling, sorting, crushing equipment and disposal technology of e-waste are neglected.

5) E-waste specific Recycling Infrastructure: Development of recycling infrastructure is recommended. Environmental improvement schemes could be provided including ISO 14000 systems to recyclers and waste management groups. Small scale practitioners should be encouraged to form recycling cooperatives to bring-in economies of scale.

5.5 Vietnam

At the current practices, the industrial e-waste is collected mostly by permitted hazardous waste management facilities and complied with regulations. Meanwhile, household e-waste is collected both by permitted hazardous waste management facilities and non-permitted hazardous waste management facilities. Especially, when e-waste is transferred to craft village, it is recycled in a way that produce serious pollution. Therefore, there should be a better collection system established in order to make the e-waste transferred to permitted facilities instead of un-permitted ones. In Vietnam the treatment and technology could meet the criteria of ESM, but dismantling of LCDs and CRT monitors need improved. For treatment of CRTs, LCDs and lubricating oil, refrigerant, and polyurethane foam are neglected. Record-keeping, surveillance and performance measurement and competency training, corrective action and transparency should be enhanced.

5.6 Pakistan

Solid waste management, which is already a mammoth task in Pakistan, is becoming more complicated by the invasion of E-waste, particularly computer waste. There exists an urgent need for a detailed assessment of the current and future scenario including quantification, characteristics, existing disposal practices, environmental impacts etc. Institutional infrastructures, including E-waste collection, transportation, treatment, storage, recovery and disposal, need to be established, at national and/or regional levels for the environmentally sound management of e-wastes.

1) Establishment of E-waste collection, exchange and recycling centers should be encouraged in partnership with private entrepreneurs and manufacturers.

2) Policy level interventions should include development of E-waste regulation, control of import and export of e-wastes and facilitation in development of infrastructure.

3) An effective take-back program providing incentives for producers to design products that are less wasteful, contain fewer toxic components, and are easier to disassemble, reuse, and recycle may help in reducing the wastes. It should set targets for collection and reuse/recycling, impose reporting requirements and include enforcement mechanisms and deposit/refund schemes to encourage consumers to return electronic devices for collection and reuse/recycling. End-of life management

should be made a priority in the design of new electronic products.

5.7 Cambodia

The pilot project clearly identified that the main problem areas associated with the environmentally sound management of e-wastes are dismantling, sorting, collecting and legitimate transport to the recycling plants. An isolated example of plastic milling operation could indicate that there may be others, but that is probably unlikely as the export trade in e-wastes is a thriving operation.

These problems are exacerbated because of the inadequate knowledge and understanding of the people working in the sector of the potential health risks to themselves and the environment damage caused by the e-wastes. The workers lack of understanding means that they have adopted poor safety operating practices when handling the e-wastes.

In order to protect and prevent risks to human health and damage to the environment caused by e-wastes at the recyclable wastes collecting site. The recommendations are:

1) The sub decree on the ESM of E-wastes including occupational health and environmental standards for dismantling, collecting, transporting and e-wastes recycling operations should be developed in collaboration with all stakeholders in order to protect the health and safety of workers as well as the general public.

2) Awareness raising through mass media and televised debate program, and Training Courses on the Environmentally Sound Management of E-wastes to be conducted in all recyclable wastes collecting sites throughout the country. These courses must include information about the potentially harmful effects of e-wastes to human health and the environment. There must also be an explanation of the proper handling procedures and recycling practices for e-wastes. The prioritized participants are all those people who work in the e-wastes collecting sites.

3) The introduction of the technical guideline on e-waste management prepared under the Basel Convention and other international bodies, including collection, storage, transportation, recycling and final disposal procedures. These should be undertaken by the Ministry of the Environment in consultation with other concerned Ministries,

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

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

6) Due to the increasing volume of soil and water contaminated accumulated from year to year and caused by e-wastes collection sites, some measures should be taken to introduce an e-wastes collection system in order to stop or at least minimize the risks and hazards to human health and environment,

6. Conclusions

The basic components of ESM that have been identified through reviewing existing guidelines and relevant documents are incorporated in requirement on waste management facility and technology in selected Asian countries. ESM standards includes criteria on operation of facility (pollution prevention measures that comply with laws/regulations in the country; Monitoring, recording and reporting; Occupational health and safety; Identification of existing hazards and risks) ,criteria on competency of staffs in facility (Awareness raising and capacity building of workers; Recruiting of experts), criteria on management of facility (Obtainment of approvals and licenses; Introduction of environmental management system; Emergency response plans; Financing instruments; Downstream recycling chain management)。This project reviewed existing laws，regulations, technologies and facilities and actual ESM policies basing on the national reports from the selected seven Asian countries in order to provide information necessary to facilitate the discussions with regard to ESM standards.

In Asia, many countries have been achieving rapid economic development but their economic and technical levels still considerably vary from one country to another.

E-waste legislation is very important to bring in a systems approach to e-waste management. The legislation must clearly define e-waste and the limitations in terms of quantities of e-waste generated for better management of e-waste. However some countries lack of legislation of e-waste management, such as Mongolia, Sri-Lanka and Cambodia. Some countries lack of motivation of the top management. There is an urgent need for the government to promote more e-waste recycling facilities to encourage competition and better prices for e-waste. Some Asian countries should enhance the dismantling, sorting and crushing treatment and disposal technology. Therefore it is important for each country to be able to ensure ESM at the highest level in the long-term, it is not achievable for many countries at present.

What is more important in the short-term is that wastes subject to treatment and recycling properly flow to facilities which are capable of conducting the ESM of the said facilities at a suitable level and are properly treated there. It is more desirable to ensure appropriate treatment and recycling of wastes under the regime of an international specialization rather than establishment of the uniform international standards. For this reason, ESM standards should be flexible enough not to cause negative impact on recycling market, particularly in developing countries.

The development of certified facilities in Asia capable of meeting the ESM standards means increased opportunities to ensure ESM in the region. Meanwhile, some countries have established treatment standards and guidelines at comparable levels to those of developed countries even though the development of treatment facilities has not made much progress. Such examples suggest that national ESM levels cannot be simply compared based on the state of institutional development. What is essential is to determine which approaches are likely to be the most effective based on an accurate understanding of the situation of individual countries.

For facilities to achieve ESM, it is not enough to construct and improve facilities. Certain social conditions must be met. These are, for example, the availability of a national system (regarding criteria, facility requirements and other relevant matters) and the capacity building of human resources to ensure proper enforcement of the system. Accordingly, the development of ESM facilities practically means not only the transfer of technology to facilities but also institutional development and human resources development through the transfer of technology and training. What is really required is to ensure the progress of all aspects of ESM as a package through efforts

to level up ESM in individual countries to the level of the ESM standards utilizing the framework for partnership under the Basel Convention and other international cooperation schemes.

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Annex 1: Questionnaire of Assessment Elements List on the environmentally sound management status for e-waste treatment facility---China

Part 1: Top Management Commitment To A Systematic Approach	
Basic Conditions	√Ensure compatibility with requirements of e-waste treatment planning √Permit for e-waste treatment √In the enterprise list of e-waste utilization and disposal √The Business License for general taxpayers □Able to receive fund subsidy from the state √Stable recycling channels of e-waste □Definite list for reception
Facility Environment, Health & Safety (EHS) Policy	√Top management commitment to health & safety √Top management commitment to comply with applicable legal requirements √Policy is documented and implemented □Policy is reviewed periodically for relevancy to organization
Allocate Resources	√Adequate financial resources, human resources, specialized skills, organizational infrastructures, and technologies are made available to design, implement, maintain and improve the ESM system
Management representative	√Specific management representatives appointed to oversee the design, implementation and maintenance of the ESM system, including the EHS programs, and report on ESM performance to top management for review
Part 2: Site Arrangement	
Centralized and independent plant	√Lawful land use right or Lease contract of the land □Site location is far away from resource reserves, and downstream

	the business districts and residential areas □Distance from business and residential areas is above 300m Handling capacity per year: Total area of the plant: Area of operation and storage sector:
Storage site	√Dedicated storage site for the pendings and residues □Storage capacity is no less than 10 times the daily processing capacity Storage site: √indoor □outdoor with ceiling and rails □open air without rails √The ground with anti-seepage treatment □Drainage and sewerage for the plot √Storage space is partitioned into several regions, with warning signs attached respectively √Keep open flame or heat source, such as destructor, steam pipeline, and heating coil, clear of the storage site □Retention history is one year at most
Treatment site	√Dedicated site for e-waste treatment Treatment site: √indoor □outdoor √Hardened cement floor in the treatment space √Waste oil collection and oil-water separation facilities are here in the treatment space √Treatment space is partitioned into several regions, and warning signs are set up √Dismantling of small product and electronic components is conducted on negative pressure workbench
Part 3: Treatment And Disposal Technology	

Dismantling	
□Classification of e-wastes while dismantling	
√Isolate components which contain substances toxic and hazardous firstly, such as refrigerants, batteries, lamps, mercury switches, and PCB capacitors	
□Recover refrigerant and compressor oil in the first place, when handle with air-conditions	
□Make sure dismantling of circuit board conducted on workbench with a ventilation system	
√□Classify the dismantled products according to subsequent process	
Dismantling of LCDs	√Manual dismantling □Semi-automatic thermal dismantling □Mechanical crushing at large
Dismantling of CRT monitors	√Assembly line work with manual dismantling □Single station manual dismantling √Dismantling by heat and open-soldering □Dismantling by machines
Sorting and crush	
Sorting of screen (panel)glass and cone (funnel) glass in CRTs	□Diamond cutting □Full automatic heating wire √Semi-automatic heating wire □Frit glass dissolution with hot acid □Mixed glass sorting after direct crush □No sorting after direct crush
Cutting of compressor casing	√By grinding saw □By acetylene burner □By plasma torch

Crush of circuit board	√Impact grinding □Shear broken □Attrition crushing □Low-temperature comminution
√Make sure the crush of LCDs is conducted in a closed system	
√Ensure that crushing and sorting equipment provide closed conditions	
√Carry out the cutting process in a confined space or on an operation desk with gas collection system	
□Sorting of thermoplastics and thermosetting plastics before treatment	
Recovery of material and energy	
Circuit board	□Hydrometallurgy □Heat treating √Mechanical disruption and sorting □Strong acid leaching while discharging the pickle liquor without treatment □Open burning
Refrigerant recovery	□Gas cooling √Gas compression □Liquid recycling □Composite recycling
Refrigerant regeneration	□Simple distillation □Distillation refining
Liquid crystal display (LCD)	√Washing and detach □Smelting burning □Open burning

	□Vitriol immersion
Cables	√Skin-core stripping □Debromination and pyrolysis □Burn down the skin directly to get copper □Simple reverberatory furnace burning
Plastics	□Furnace incineration to recover heat √Direct regeneration to get low-grade plastic □Reuse after modification □Open burning □Cupola burning
Funnel glass	□Deliver to deep-processing enterprises for glass shell production √Deliver to qualified enterprises for final disposal □Discard □Landfill on the spot
Panel glass	√Deliver to deep-processing enterprises for glass shell production □Landfill
Toner cartridges	□Dismantling followed with recovery of chips and the covers □Refurbishment by cleaning and inking √Deliver to deep-processing enterprises
Pollutant treatment	
√Establish a sample chamber, to store samples of e-waste dismantling products which are applied for treatment in other enterprises	
Polyurethane foam	√Incineration □Discard □Regeneration after mixture □Landfill

	√Deliver to deep-processing enterprises for further treatment
Acid pickle	□Direct roasting in roaster □Crystallization after evaporation √Condensation after evaporation □Recover acid by extraction □Direct discharge
Mixed or otiose refrigerant	□Burning in incinerators □Splitting decomposition in reacting furnace □Gaseous cyaniding □Burning in cement kiln □Burning in rotary kiln □Discard on the spot √Deliver to deep-processing enterprises
Product and residue generated in circuit board treatment	√Hydrometallurgy □Heat treating □Mechanical process □Open burning □Open discard □Landfill √Deliver to deep-processing enterprises for further treatment
Liquid crystal	√Precipitation by heating □Decomposition with catalysis
Waste rubber and plastics	□Burning □Discard □Landfill √Deliver to deep-processing enterprises

Toner	□Discard □Landfill √Deliver to deep-processing enterprises
Phosphors	□Rare earth extraction □High-temperature incineration □Storage □Landfill □Discard √Deliver to deep-processing enterprises for further treatment
Part 4: Treatment Equipment	
For treatment of CRTs	√Equipment or device for separation and sorting of screen glass and cone glass √Measures to prevent leaded glass from scattering √Install cofferdam around the work area √Flat ground in the work area in favour of leaded glass collection √Equipment for collection of phosphors √Dust extraction and filtration devices compatible with dry process of phosphor coating Cleaning √Devices for sewage treating, sludge disposal and wastewater recycling compatible with wet process of phosphor coating Cleaning □Possess lead extraction equipment or devices □Equipment for joint smelting
For treatment of LCDs and backlights	√Negative pressure workbench with ventilation and emission control system, for backlight dismantlement □Equipment or devices for Liquid crystal separation □Equipment or devices for separation of glass and organic thin-film

For treatment of lubricating oil, refrigerant, and polyurethane foam	√Devices for extraction of refrigerant and lubricating oil √Devices for refrigerant storage, such as sealed cylinder √Sealed devices for lubricating oil storage √Dedicated negative pressure sealing equipment for insulating layer crush, equipment for volume reduction of polyurethane foam
For treatment of circuit boards	□Facility for heat-treating of circuit board √Equipment for hydrometallurgy √Equipment for PCB crush, components sorting, and metal recovery, compatible with mechanical methods □Program and equipment for sludge treatment, compatible with hydrometallurgy □Cofferdam and anti-seepage process to prevent chemicals from leakage, compatible with hydrometallurgy √Equipment for treatment and disposal of non-metallic materials generated during PCB separation, such as epoxy resin, compatible with mechanical methods □Documents to demonstrate the delivery to deep-processing enterprises □Set up ventilation system while components dismantling by melting process
Part 5: Transporting, Packaging And Other Equipment Adapt To E-waste Treatment	
Transportation equipment	√Provided with transport vehicles or entrust transportation to units with relevant qualifications √Measures such as setting baffles and covering tarpaulins are made on transport vehicles
Haulage and packing equipment	√Equipment for carrying weights, such as forklifts √Compressing, packaging and other equipment, such as balers

Dedicated containers	√Dedicated containers for batteries, capacitors and acid pickle √Lables attached to the containers to demonstrate the information of inner mass, such as type, quantity and weight √Configure strong hierarchical storage rack when multilayer storage is necessary
Metering equipment	√Equipped with electronic loadometers that can automatically record and print out the amount of each batch √Loadometers set at the entrances of the plant or storage area √Metering equipment are certified to be eligible by inspection department, with documents provided Time difference between weighing time and recording time: □no difference√within three minutes□more than three minutes
Ammeter	□Dedicated meters are allocated in dismantling lines √No dedicatedmeter, but the meter commonly used is accurate in processing workshop
short-circuit protection device	√Accessorize short-circuit protection device while e-waste cleaning and assembling
Database destruction	√Database destruction procedure and its documentary evidence
labor protection	√Provide dust masks, helmets, goggles and other protective equipment to the operators
Part 6: Environmental Management And Risk Assessment	
Procedures and equipment for depollution	√Environmental acceptance of equipment and facilities for depollution √Dust collecting and purifying device √Noise-reducing devices should be installed compatible with mechanical methods

	√Pretreatment before discharge of the rinse-wastewater
Environmental monitoring	√Establish routine environmental monitoring system □Possess corresponding facilities for environmental monitoring √Sign precatory monitoring contract with qualified companies □Retention history of monitoring report reaches three years or more √Reactive measures of performance to monitor accidents, ill health, incidents, near misses, and other historical evidence of deficient EHS performance □Calibration of monitoring and measurement equipment √Recording of data and results of monitoring and measurement to facilitate corrective and preventive action analysis
Assess hazards to environment, health & safety (EHS)	□Procedure to identify and prioritize EHS hazards associated with new, existing and planned activities, products & services √EHS hazard information is documented and kept current
Emergency preparedness & response	√Procedure to identify potential emergency situations and accidents and how to respond to them √Equipment for incident response, such as fire extinguishers □Review emergency preparedness and response procedures, especially after the occurrence of accidents or emergency situations √Periodically test procedures and equipment where practicable，and exercise the contingency plan
Risk prevention	√Establish and maintain documented procedures for operations and activities associated with significant EHS hazards where their absence could lead to deviation from the ESM policy, objectives and targets
Facility closure plan	□Site decommissioning plan □Site remediation plan
Part 7: Record-Keeping、Surveillance And Performance Measurement	

Information system	√Establish data information management system
Records	√Maintain track record, such as basic form and daily statement √Establish random inspection system and keep record □Procedures to identify, protect, retrieve, retain, store, and dispose of records √EHS records are easily retrievable and protected from damage, loss and deterioration √Records are legible, identifiable, and traceable to the activity, product or service involved √Retention history of records is three years or more
Video surveillance	√Establish closed-circuit surveillance system and control room √Entire process surveillance √Videos are identifiable, unambiguous and uninterrupted √Recording date and time showed on the vedios □Supply additional illuminant at night to ensure definition □Save the recordings in hard disks √Retention history of recordings is one year or more
Internal audit	□ESM system undergoes periodic audits √Audits are conducted by personnel independent of those having direct responsibility for the activity being examined to ensure objectivity and impartiality of the audit process
Part 8: Competency Training, Corrective Action And Transparency	
Personnel and Competency Training	√Develop operating administrative manual, and keep regular guidance and training for employees √Raise awareness amongst employees concerning the actual and/or potential EHS hazards linked to job tasks, and provide employees with appropriate training on how to mitigate risks associated with

	these hazards √Ensure job tasks that are or may be associated with significant EHS hazards are undertaken by employees that are competent to perform these duties on the basis of education, training and/or experience √Make employees aware of the importance of adhering to operating procedures and the consequences of failing to do so √Maintain up-to-date training records for employees
Corrective Action	√Investigate nonconformities and causes, and take action to avoid recurrence √Record results of corrective actions and preventative actions
Transparency	√Facility Environment, Health & Safety (EHS) policy is available to public □Company social reports are made available to shareholders and society, which include information pertaining to its performance with respect to environmental, health and safety issues

Annex 2: Questionnaire of Assessment Elements List on the environmentally sound management status for e-waste treatment facility---Vietnam

Assessment Elements List on the environmentally sound management status for e-waste treatment facility

The objective of this list is to gather valuable and updated status information on e-waste treatment, which may contribute greatly to the actions of assessing the technologies and facilities, as well as the environmentally sound management status.

Part 1: Top Management Commitment To A Systematic Approach	
Basic Conditions	☑Ensure compatibility with requirements of e-waste treatment planning ☑Permit for e-waste treatment ☐In the enterprise list of e-waste utilization and disposal ☑The Business License for general taxpayers ☐Able to receive fund subsidy from the state ☐Stable recycling channels of e-waste ☐Definite list for reception
Facility Environment, Health & Safety (EHS) Policy	☑Top management commitment to health & safety ☑Top management commitment to comply with applicable legal requirements ☑Policy is documented and implemented ☐Policy is reviewed periodically for relevancy to organization
Allocate Resources	☑Adequate financial resources, human resources, specialized skills, organizational infrastructures, and technologies are made available to design, implement, maintain and improve the ESM system
Management representative	☐ Specific management representatives appointed to oversee the design, implementation and maintenance of the ESM system, including the EHS programs, and report on ESM performance to top management for review
Part 2: Site Arrangement	
Centralized and independent plant	☑Lawful land use right or Lease contract of the land ☐Site location is far away from resource reserves, and downstream the business districts and residential areas ☐Distance from business and residential areas is above 300m Handling capacity per year: Total area of the plant: Area of operation and storage sector:
Storage site	☑Dedicated storage site for the pendings and residues ☐Storage capacity is no less than 10 times the daily processing capacity Storage site: ☐indoor ☐outdoor with ceiling and rails ☐open air without rails ☐The ground with anti-seepage treatment ☐Drainage and sewerage for the plot ☐Storage space is partitioned into several regions, with warning signs attached

1

	respectively □Keep open flame or heat source, such as destructor, steam pipeline, and heating coil, clear of the storage site □Retention history is one year at most
Treatment site	√Dedicated site for e-waste treatment Treatment site:□indoor □outdoor □Hardened cement floor in the treatment space □Waste oil collection and oil-water separation facilities are here in the treatment space □Treatment space is partitioned into several regions, and warning signs are set up □Dismantling of small product and electronic components is conducted on negative pressure workbench

Part 3: Treatment And Disposal Technology	
Dismantling	
□Classification of e-wastes while dismantling	
√Isolate components which contain substances toxic and hazardous firstly, such as refrigerants, batteries, lamps, mercury switches, and PCB capacitors	
□Recover refrigerant and compressor oil in the first place, when handle with air-conditions	
□Make sure dismantling of circuit board conducted on workbench with a ventilation system	
√Classify the dismantled products according to subsequent process	
Dismantling of LCDs	□Manual dismantling □Semi-automatic thermal dismantling □Mechanical crushing at large
Dismantling of CRT monitors	□Assembly line work with manual dismantling □Single station manual dismantling □Dismantling by heat and open-soldering □Dismantling by machines
Sorting and crush	
Sorting of screen (panel)glass and cone (funnel) glass in CRTs	□Diamond cutting □Full automatic heating wire □Semi-automatic heating wire □Frit glass dissolution with hot acid □Mixed glass sorting after direct crush √No sorting after direct crush
Cutting of compressor casing	√By grinding saw □By acetylene burner □By plasma torch
Crush of circuit board	√Impact grinding □Shear broken □Attrition crushing □Low-temperature comminution
√Make sure the crush of LCDs is conducted in a closed system	
□Ensure that crushing and sorting equipments provide closed conditions	

☐Carry out the cutting process in a confined space or on an operation desk with gas collection system	
☐Sorting of thermoplastics and thermosetting plastics before treatment	
Recovery of material and energy	
Circuit board	☑Hydrometallurgy ☑Heat treating ☑Mechanical disruption and sorting ☑Strong acid leaching while discharging the pickle liquor without treatment ☐Open burning
Refrigerant recovery	☐Gas cooling ☐Gas compression ☐Liquid recycling ☐Composite recycling
Refrigerant regeneration	☐Simple distillation ☐Distillation refining
Liquid crystal display (LCD)	☑Washing and detach ☐Smelting burning ☐Open burning ☐Vitriol immersion
Cables	☑Skin-core stripping ☐Debromination and pyrolysis ☑Burn down the skin directly to get copper ☐Simple reverberatory furnace burning
Plastics	☑Furnace incineration to recover heat ☐Direct regeneration to get low-grade plastic ☐Reuse after modification ☐Open burning ☐Cupola burning
Funnel glass	☐Deliver to deep-processing enterprises for glass shell production ☐Deliver to qualified enterprises for final disposal ☑Discard ☑Landfill on the spot / Solidification
Panel glass	☐Deliver to deep-processing enterprises for glass shell production ☑Landfill / Solidification
Toner cartridges	☐Dismantling followed with recovery of chips and the covers ☑Refurbishment by cleaning and inking ☐Deliver to deep-processing enterprises
Pollutant treatment	
☐Establish a sample chamber, to store samples of e-waste dismantling products which are applied for treatment in other enterprises	
Polyurethane foam	☐Incineration ☐Discard ☐Regeneration after mixture ☐Landfill ☐Deliver to deep-processing enterprises for further treatment

Acid pickle	☐Direct roasting in roaster ☐Crystallization after evaporation ☐Condensation after evaporation ☐Recover acid by extraction ☐Direct discharge Neutralization
Mixed or otiose refrigerant	☑Burning in incinerators ☐Splitting decomposition in reacting furnace ☐Gaseous cyaniding ☑Burning in cement kiln ☑Burning in rotary kiln ☐Discard on the spot ☐Deliver to deep-processing enterprises
Product and residue generated in circuit board treatment	☑Hydrometallurgy ☑Heat treating ☑Mechanical process ☐Open burning ☐Open discard ☑Landfill ☐Deliver to deep-processing enterprises for further treatment
Liquid crystal	☑Precipitation by heating ☐Decomposition with catalysis
Waste rubber and plastics	☑Burning ☐Discard ☑Landfill ☐Deliver to deep-processing enterprises
Toner	☐Discard ☑Landfill ☑Deliver to deep-processing enterprises
Phosphors	☐Rare earth extraction ☑High-temperature incineration ☐Storage ☑Landfill ☐Discard ☐Deliver to deep-processing enterprises for further treatment
Part 4: Treatment Equipment	
For treatment of CRTs	☐Equipment or device for separation and sorting of screen glass and cone glass ☐Measures to prevent leaded glass from scattering ☐Install cofferdam around the work area ☐Flat ground in the work area in favour of leaded glass collection ☐Equipment for collection of phosphors ☐Dust extraction and filtration devices compatible with dry process of phosphor coating Cleaning ☐Devices for sewage treating, sludge disposal and wastewater recycling compatible

	with wet process of phosphor coating Cleaning □Possess lead extraction equipment or devices □Equipment for joint smelting
For treatment of LCDs and backlights	□Negative pressure workbench with ventilation and emission control system, for backlight dismantlement □Equipment or devices for Liquid crystal separation □Equipment or devices for separation of glass and organic thin-film
For treatment of lubricating oil, refrigerant, and polyurethane foam	☑Devices for extraction of refrigerant and lubricating oil □Devices for refrigerant storage, such as sealed cylinder □Sealed devices for lubricating oil storage □Dedicated negative pressure sealing equipment for insulating layer crush, equipment for volume reduction of polyurethane foam
For treatment of circuit boards	☑Facility for heat-treating of circuit board ☑Equipment for hydrometallurgy ☑Equipment for PCB crush, components sorting, and metal recovery, compatible with mechanical methods ☑Program and equipment for sludge treatment, compatible with hydrometallurgy □Cofferdam and anti-seepage process to prevent chemicals from leakage, compatible with hydrometallurgy ☑Equipment for treatment and disposal of non-metallic materials generated during PCB separation, such as epoxy resin, compatible with mechanical methods □Documents to demonstrate the delivery to deep-processing enterprises □Set up ventilation system while components dismantling by melting process
Part 5: Transporting, Packaging And Other Equipments Adapt To E-waste Treatment	
Transportation equipment	☑Provided with transport vehicles or entrust transportation to units with relevant qualifications □Measures such as setting baffles and covering tarpaulins are made on transport vehicles
Haulage and packing equipment	□Equipments for carrying weights, such as forklifts ☑Compressing, packaging and other equipments, such as balers
Dedicated containers	☑Dedicated containers for batteries, capacitors and acid pickle ☑Lables attached to the containers to demonstrate the information of inner mass, such as type, quantity and weight □Configure strong hierarchical storage rack when multilayer storage is necessary
Metering equipment	□Equipped with electronic loadometers that can automatically record and print out the amount of each batch □Loadometers set at the entrances of the plant or storage area □Metering equipments are certified to be eligible by inspection department, with documents provided Time difference between weighing time and recording time: □no difference□within three minutes□more than three minutes
Ammeter	□Dedicated meters are allocated in dismantling lines

	☑No dedicatedmeter, but the meter commonly used is accurate in processing workshop
short-circuit protection device	☐Accessorize short-circuit protection device while e-waste cleaning and assembling
Database destruction	☐Database destruction procedure and its documentary evidence
labor protection	☑Provide dust masks, helmets, goggles and other protective equipment to the operators
Part 6: Environmental Management And Risk Assessment	
Procedures and equipments for depollution	☑Environmental acceptance of equipments and facilities for depollution ☑Dust collecting and purifying device ☐Noise-reducing devices should be installed compatible with mechanical methods ☑Pretreatment before discharge of the rinse-wastewater
Environmental monitoring	☑Establish routine environmental monitoring system ☑Possess corresponding facilities for environmental monitoring ☑Sign precatory monitoring contract with qualified companies ☐Retention history of monitoring report reaches three years or more ☑Reactive measures of performance to monitor accidents, ill health, incidents, near misses, and other historical evidence of deficient EHS performance ☐Calibration of monitoring and measurement equipment ☑Recording of data and results of monitoring and measurement to facilitate corrective and preventive action analysis
Assess hazards to environment, health & safety (EHS)	☑Procedure to identify and prioritize EHS hazards associated with new, existing and planned activities, products & services ☐EHS hazard information is documented and kept current
Emergency preparedness & response	☑Procedure to identify potential emergency situations and accidents and how to respond to them ☑Equipment for incident response, such as fire extinguishers ☑Review emergency preparedness and response procedures, especially after the occurrence of accidents or emergency situations ☑Periodically test procedures and equipment where practicable, and exercise the contingency plan
Risk prevention	☑Establish and maintain documented procedures for operations and activities associated with significant EHS hazards where their absence could lead to deviation from the ESM policy, objectives and targets
Facility closure plan	☐Site decommissioning plan ☑Site remediation plan
Part 7: Record-Keeping、Surveillance And Performance Measurement	
Information system	☐Establish data information management system
Records	☐Maintain track record, such as basic form and daily statement

	☐Establish random inspection system and keep record ☑Procedures to identify, protect, retrieve, retain, store, and dispose of records ☑EHS records are easily retrievable and protected from damage, loss and deterioration ☐Records are legible, identifiable, and traceable to the activity, product or service involved ☑Retention history of records is three years or more
Video surveillance	☐Establish closed-circuit surveillance system and control room ☐Entire process surveillance ☐Videos are identifiable, unambiguous and uninterrupted ☐Recording date and time showed on the vedios ☐Supply additional illuminant at night to ensure definition ☐Save the recordings in hard disks ☐Retention history of recordings is one year or more
Internal audit	☐ESM system undergoes periodic audits ☐Audits are conducted by personnel independent of those having direct responsibility for the activity being examined to ensure objectivity and impartiality of the audit process
Part 8: Competency Training, Corrective Action And Transparency	
Personnel and Competency Training	☑Develop operating administrative manual, and keep regular guidance and training for employees ☐Raise awareness amongst employees concerning the actual and/or potential EHS hazards linked to job tasks, and provide employees with appropriate training on how to mitigate risks associated with these hazards ☐Ensure job tasks that are or may be associated with significant EHS hazards are undertaken by employees that are competent to perform these duties on the basis of education, training and/or experience ☑Make employees aware of the importance of adhering to operating procedures and the consequences of failing to do so ☐Maintain up-to-date training records for employees
Corrective Action	☐Investigate nonconformities and causes, and take action to avoid recurrence ☐Record results of corrective actions and preventative actions
Transparency	☐Facility Environment, Health & Safety (EHS) policy is available to public ☐Company social reports are made available to shareholders and society, which include information pertaining to its performance with respect to environmental, health and safety issues

Annex 3: Questionnaire of Assessment Elements List on the environmentally sound management status for e-waste treatment facility---Pakistan

Part 1: Top Management Commitment To A Systematic Approach	
Basic Conditions	✓ Ensure compatibility with requirements of e-waste treatment planning □Permit for e-waste treatment □In the enterprise list of e-waste utilization and disposal □The Business License for general taxpayers □Able to receive fund subsidy from the state □Stable recycling channels of e-waste □Definite list for reception
Facility Environment, Health & Safety (EHS) Policy	✓ Top management commitment to health & safety □Top management commitment to comply with applicable legal requirements □Policy is documented and implemented □Policy is reviewed periodically for relevancy to organization
Allocate Resources	□Adequate financial resources, human resources, specialized skills, organizational infrastructures, and technologies are made available to design, implement, maintain and improve the ESM system
Management representative	□Specific management representatives appointed to oversee the design, implementation and maintenance of the ESM system, including the EHS programs, and report on ESM performance to top management for review
Part 2: Site Arrangement	
Centralized and independent plant	□Lawful land use right or Lease contract of the land □Site location is far away from resource reserves, and downstream the

	business districts and residential areas □Distance from business and residential areas is above 300m Handling capacity per year: Total area of the plant: Area of operation and storage sector:
Storage site	□Dedicated storage site for the pendings and residues □Storage capacity is no less than 10 times the daily processing capacity Storage site: □indoor □outdoor with ceiling and rails □open air without rails □The ground with anti-seepage treatment □Drainage and sewerage for the plot □Storage space is partitioned into several regions, with warning signs attached respectively □Keep open flame or heat source, such as destructor, steam pipeline, and heating coil, clear of the storage site □Retention history is one year at most
Treatment site	□Dedicated site for e-waste treatment Treatment site:□indoor □outdoor □Hardened cement floor in the treatment space □Waste oil collection and oil-water separation facilities are here in the treatment space □Treatment space is partitioned into several regions, and warning signs are set up □Dismantling of small product and electronic components is conducted on negative pressure workbench
Part 3: Treatment And Disposal Technology	
Dismantling	

□Classification of e-wastes while dismantling	
□Isolate components which contain substances toxic and hazardous firstly, such as refrigerants, batteries, lamps, mercury switches, and PCB capacitors	
□Recover refrigerant and compressor oil in the first place, when handle with air-conditions	
□Make sure dismantling of circuit board conducted on workbench with a ventilation system	
□Classify the dismantled products according to subsequent process	
Dismantling of LCDs	□Manual dismantling □Semi-automatic thermal dismantling □Mechanical crushing at large
Dismantling of CRT monitors	□Assembly line work with manual dismantling □Single station manual dismantling □Dismantling by heat and open-soldering □Dismantling by machines
Sorting and crush	
Sorting of screen(panel)glass and cone(funnel) glass in CRTs	□Diamond cutting □Full automatic heating wire □Semi-automatic heating wire □Frit glass dissolution with hot acid □Mixed glass sorting after direct crush □No sorting after direct crush
Cutting of compressor casing	□By grinding saw □By acetylene burner □By plasma torch
Crush of circuit board	□Impact grinding

	□Shear broken □Attrition crushing □Low-temperature comminution
□Make sure the crush of LCDs is conducted in a closed system	
□Ensure that crushing and sorting equipment provide closed conditions	
□Carry out the cutting process in a confined space or on an operation desk with gas collection system	
□Sorting of thermoplastics and thermosetting plastics before treatment	
Recovery of material and energy	
Circuit board	□Hydrometallurgy □Heat treating □Mechanical disruption and sorting □Strong acid leaching while discharging the pickle liquor without treatment □Open burning
Refrigerant recovery	□Gas cooling □Gas compression □Liquid recycling □Composite recycling
Refrigerant regeneration	□Simple distillation □Distillation refining
Liquid crystal display(LCD)	□Washing and detach □Smelting burning □Open burning □Vitriol immersion

Cables	□Skin-core stripping □Debromination and pyrolysis □Burn down the skin directly to get copper □Simple reverberatory furnace burning
Plastics	□Furnace incineration to recover heat □Direct regeneration to get low-grade plastic □Reuse after modification □Open burning □Cupola burning
Funnel glass	□Deliver to deep-processing enterprises for glass shell production □Deliver to qualified enterprises for final disposal □Discard □Landfill on the spot
Panel glass	□Deliver to deep-processing enterprises for glass shell production □Landfill
Toner cartridges	□Dismantling followed with recovery of chips and the covers □Refurbishment by cleaning and inking □Deliver to deep-processing enterprises
Pollutant treatment	
□Establish a sample chamber, to store samples of e-waste dismantling products which are applied for treatment in other enterprises	
Polyurethane foam	□Incineration □Discard □Regeneration after mixture □Landfill □Deliver to deep-processing enterprises for further treatment

Acid pickle	□Direct roasting in roaster □Crystallization after evaporation □Condensation after evaporation □Recover acid by extraction □Direct discharge
Mixed or otiose refrigerant	□Burning in incinerators □Splitting decomposition in reacting furnace □Gaseous cyaniding □Burning in cement kiln □Burning in rotary kiln □Discard on the spot □Deliver to deep-processing enterprises
Product and residue generated in circuit board treatment	□Hydrometallurgy □Heat treating □Mechanical process □Open burning □Open discard □Landfill □Deliver to deep-processing enterprises for further treatment
Liquid crystal	□Precipitation by heating □Decomposition with catalysis
Waste rubber and plastics	□Burning □Discard □Landfill □Deliver to deep-processing enterprises
Toner	□Discard

	□Landfill □Deliver to deep-processing enterprises
Phosphors	□Rare earth extraction □High-temperature incineration □Storage □Landfill □Discard □Deliver to deep-processing enterprises for further treatment
Part 4: Treatment Equipment	
For treatment of CRTs	□Equipment or device for separation and sorting of screen glass and cone glass □Measures to prevent leaded glass from scattering □Install cofferdam around the work area □Flat ground in the work area in favour of leaded glass collection □Equipment for collection of phosphors □Dust extraction and filtration devices compatible with dry processof phosphor coatingCleaning □Devices for sewage treating, sludge disposal and wastewater recyclingcompatible with wet process of phosphor coating Cleaning □Possess lead extraction equipment or devices □Equipment for joint smelting
For treatment of LCDs and backlights	□Negative pressure workbench with ventilation and emission control system, for backlight dismantlement □Equipment or devices for Liquid crystal separation □Equipment or devices for separation of glass and organic thin-film
For treatment of lubricating oil,	□Devices for extraction of refrigerant and lubricating oil

refrigerant, and polyurethane foam	□Devices for refrigerant storage, such as sealed cylinder □Sealed devices for lubricating oil storage □Dedicated negative pressure sealing equipment for insulating layer crush, equipment for volume reduction of polyurethane foam
For treatment of circuit boards	□Facility for heat-treating of circuit board □Equipment for hydrometallurgy □Equipment for PCB crush, components sorting, and metal recovery, compatible with mechanical methods □Program and equipment for sludge treatment, compatible with hydrometallurgy □Cofferdam and anti-seepage process to prevent chemicals from leakage, compatible with hydrometallurgy □Equipment for treatment and disposal of non-metallic materials generated during PCB separation, such as epoxy resin, compatible with mechanical methods □Documents to demonstrate the delivery to deep-processing enterprises □Set up ventilation system while components dismantling by melting process
Part 5: Transporting, Packaging And Other Equipment Adapt To E-waste Treatment	
Transportation equipment	□Provided with transport vehicles or entrust transportation to units with relevant qualifications □Measures such as setting baffles and covering tarpaulins are made on transport vehicles
Haulage and packing equipment	□Equipment for carrying weights, such as forklifts □Compressing, packaging and other equipment, such as balers
Dedicated containers	□Dedicated containers for batteries, capacitors and acid pickle □Lables attached to the containers to demonstrate the information of

	inner mass, such as type, quantity and weight □Configure strong hierarchical storage rack when multilayer storage is necessary
Metering equipment	□Equipped with electronic loadometers that can automatically record and print out the amount of each batch □Loadometers set at the entrances of the plant or storage area □Metering equipment are certified to be eligible by inspection department, with documents provided Time difference between weighing time and recording time: □no difference□within three minutes□more than three minutes
Ammeter	□Dedicated meters are allocated in dismantling lines □No dedicatedmeter, but the meter commonly used is accurate in processing workshop
short-circuit protection device	□Accessorize short-circuit protection device while e-waste cleaning and assembling
Database destruction	□Database destruction procedure and its documentary evidence
labor protection	□Provide dust masks, helmets, goggles and other protective equipment to the operators
Part 6: Environmental Management And Risk Assessment	
Procedures and equipment for depollution	□Environmental acceptance of equipment and facilities for depollution □Dust collecting and purifying device □Noise-reducing devices should be installed compatible with mechanical methods □Pretreatment before discharge of the rinse-wastewater
Environmental monitoring	□Establish routine environmental monitoring system

	□Possess corresponding facilities for environmental monitoring □Sign precatory monitoring contract with qualified companies □Retention history of monitoring report reaches three years or more □Reactive measures of performance to monitor accidents, ill health, incidents, near misses, and other historical evidence of deficient EHS performance □Calibration of monitoring and measurement equipment □Recording of data and results of monitoring and measurement to facilitate corrective and preventive action analysis
Assess hazards to environment, health & safety (EHS)	□Procedure to identify and prioritize EHS hazards associated with new, existing and planned activities, products & services □EHS hazard information is documented and kept current
Emergency preparedness & response	□Procedure to identify potential emergency situations and accidents and how to respond to them □Equipment for incident response, such as fire extinguishers □Review emergency preparedness and response procedures, especially after the occurrence of accidents or emergency situations □Periodically test procedures and equipment where practicable， and exercise the contingency plan
Risk prevention	□Establish and maintain documented procedures for operations and activities associated with significant EHS hazards where their absence could lead to deviation from the ESM policy, objectives and targets
Facility closure plan	□Site decommissioning plan □Site remediation plan
Part 7: Record-Keeping、Surveillance And Performance Measurement	
Informationsystem	□Establish data information management system

Records	□Maintain track record, such as basic form and daily statement □Establish random inspection system and keep record □Procedures to identify, protect, retrieve, retain, store, and dispose of records □EHS records are easily retrievable and protected from damage, loss and deterioration □Records are legible, identifiable, and traceable to the activity, product or service involved □Retention history of records is three years or more
Video surveillance	□Establish closed-circuit surveillance system and control room □Entire process surveillance □Videos are identifiable, unambiguous and uninterrupted □Recording date and time showed on the vedios □Supply additional illuminant at night to ensure definition □Save the recordings in hard disks □Retention history of recordings is one year or more
Internal audit	□ESM system undergoes periodic audits □Audits are conducted by personnel independent of those having direct responsibility for the activity being examined to ensure objectivity and impartiality of the audit process
Part 8: Competency Training, Corrective Action And Transparency	
Personnel and Competency Training	□Develop operating administrative manual, and keep regular guidance and training for employees □Raise awareness amongst employees concerning the actual and/or potential EHS hazards linked to job tasks, and provide employees with appropriate training on how to mitigate risks associated with these hazards □Ensure job tasks that are or may be associated with significant EHS hazards are undertaken by employees that are competent to perform

	these duties on the basis of education, training and/or experience □Make employees aware of the importance of adhering to operating procedures and the consequences of failing to do so □Maintain up-to-date training records for employees
Corrective Action	□Investigate nonconformities and causes, and take action to avoid recurrence □Record results of corrective actions and preventative actions
Transparency	□Facility Environment, Health & Safety (EHS) policy is available to public □Company social reports are made available to shareholders and society, which include information pertaining to its performance with respect to environmental, health and safety issues

Annex 4: Questionnaire of Assessment Elements List on the environmentally sound management status for e-waste treatment facility---Sri Lanka

No.1

CORPORATE NAME: Z Max Enterprises (Pvt) Ltd DATE: 13.10.2014

THEME / CATEGORY	EXAMPLES OF MEASURES
Part 1: Top Management Commitment To A Systematic Approach	
Basic Conditions	x□Ensure compatibility with requirements of e-waste treatment planning x□Permit for e-waste treatment x□In the enterprise list of e-waste utilization and disposal x□The Business License for general taxpayers □Able to receive fund subsidy from the state □Stable recycling channels of e-waste x□Definite list for reception
Facility Environment, Health & Safety (EHS) Policy	x□Top management commitment to health & safety x□Top management commitment to comply with applicable legal requirements □Policy is documented and implemented □Policy is reviewed periodically for relevancy to organization
Allocate Resources	x□Adequate financial resources, human resources, specialized skills, organizational infrastructures, and technologies are made available to design, implement, maintain and improve the ESM system
Management representative	□Specific management representatives appointed to oversee the design, implementation and maintenance of the ESM system, including the EHS programs, and report on ESM performance to top management for review
Part 2: Site Arrangement	
Centralized and independent plant	x□Lawful land use right or Lease contract of the land □Site location is far away from resource reserves, and downstream the business districts and residential areas □Distance from business and residential areas is above 300m Handling capacity per year: 70,000 tons Total area of the plant: 12 000 Sq ft Area of operation and storage sector: 10 000 Sq ft
Storage site	x□Dedicated storage site for the pendings and residues □Storage capacity is no less than 10 times the daily processing capacity Storage site: x□indoor □outdoor with ceiling and rails x□open air without rails

	x□The ground with anti-seepage treatment □Drainage and sewerage for the plot x□Storage space is partitioned into several regions, with warning signs attached respectively □Keep open flame or heat source, such as destructor, steam pipeline, and heating coil, clear of the storage site x□Retention history is one year at most
Treatment site	x□Dedicated site for e-waste treatment Treatment site: x□indoor □outdoor x□Hardened cement floor in the treatment space □Waste oil collection and oil-water separation facilities are here in the treatment space x□Treatment space is partitioned into several regions, and warning signs are set up □Dismantling of small product and electronic components is conducted on negative pressure workbench
Part 3: Treatment And Disposal Technology	
Dismantling	
x□Classification of e-wastes while dismantling	
□Isolate components which contain substances toxic and hazardous firstly, such as refrigerants, batteries, lamps, mercury switches, and PCB capacitors	
□Recover refrigerant and compressor oil in the first place, when handle with air-conditions	
x□Make sure dismantling of circuit board conducted on workbench with a ventilation system	
□Classify the dismantled products according to subsequent process	
Dismantling of LCDs	□Manual dismantling □Semi-automatic thermal dismantling □Mechanical crushing at large
Dismantling of CRT monitors	□Assembly line work with manual dismantling □Single station manual dismantling □Dismantling by heat and open-soldering □Dismantling by machines
Sorting and crush	
Sorting of screen glass and cone glass in CRTs	□Diamond cutting □Full automatic heating wire □Semi-automatic heating wire □Frit glass dissolution with hot acid □Mixed glass sorting after direct crush □No sorting after direct crush
Cutting of compressor casing	□By grinding saw □By acetylene burner □By plasma torch

Crush of circuit board	□Impact grinding □Shear broken □Attrition crushing □Low-temperature comminution
□Make sure the crush of LCDs is conducted in a closed system	
□Ensure that crushing and sorting equipment provide closed conditions	
□Carry out the cutting process in a confined space or on an operation desk with gas collection system	
□Sorting of thermoplastics and thermosetting plastics before treatment	
Recovery of material and energy	
Circuit board	□Hydrometallurgy □Heat treating □Mechanical disruption and sorting □Strong acid leaching while discharging the pickle liquor without treatment □Open burning
Refrigerant recovery	□Gas cooling □Gas compression □Liquid recycling □Composite recycling
Refrigerant regeneration	□Simple distillation □Distillation refining
Liquid crystal display	□Washing and detach □Smelting burning □Open burning □Vitriol immersion
Cables	x□Skin-core stripping □Debromination and pyrolysis □Burn down the skin directly to get copper □Simple reverberatory furnace burning
Plastics	□Furnace incineration to recover heat x□Direct regeneration to get low-grade plastic □Reuse after modification □Open burning □Cupola burning
Cone glass	□Deliver to deep-processing enterprises for glass shell production □Deliver to qualified enterprises for final disposal □Discard □Landfill on the spot
Screen glass	□Deliver to deep-processing enterprises for glass shell production □Landfill
Toner cartridges	x□Dismantling followed with recovery of chips and the covers □Refurbishment by cleaning and inking

	□Deliver to deep-processing enterprises
Pollutant treatment	
□Establish a sample chamber, to store samples of e-waste dismantling products which are applied for treatment in other enterprises	
Polyurethane foam	□Incineration □Discard □Regeneration after mixture □Landfill □Deliver to deep-processing enterprises for further treatment
Acid pickle	□Direct roasting in roaster □Crystallization after evaporation □Condensation after evaporation □Recover acid by extraction □Direct discharge
Mixed or otiose refrigerant	□Burning in incinerators □Splitting decomposition in reacting furnace □Gaseous cyaniding □Burning in cement kiln □Burning in rotary kiln □Discard on the spot □Deliver to deep-processing enterprises
Product and residue generated in circuit board treatment	□Hydrometallurgy □Heat treating □Mechanical process □Open burning □Open discard □Landfill x□Deliver to deep-processing enterprises for further treatment
Liquid crystal	□Precipitation by heating □Decomposition with catalysis
Waste rubber and plastics	□Burning □Discard □Landfill x□Deliver to deep-processing enterprises
Toner	□Discard □Landfill x□Deliver to deep-processing enterprises
Phosphors	□Rare earth extraction □High-temperature incineration □Storage □Landfill □Discard

	□Deliver to deep-processing enterprises for further treatment
Part 4: Treatment Equipment	
For treatment of CRTs	□Equipment or device for separation and sorting of screen glass and cone glass □Measures to prevent leaded glass from scattering □Install cofferdam around the work area □Flat ground in the work area in favour of leaded glass collection □Equipment for collection of phosphors □Dust extraction and filtration devices compatible with dry process of phosphor coating Cleaning □Devices for sewage treating, sludge disposal and wastewater recycling compatible with wet process of phosphor coating Cleaning □Possess lead extraction equipment or devices □Equipment for joint smelting
For treatment of LCDs and backlights	□Negative pressure workbench with ventilation and emission control system, for backlight dismantlement □Equipment or devices for Liquid crystal separation □Equipment or devices for separation of glass and organic thin-film
For treatment of lubricating oil, refrigerant, and polyurethane foam	□Devices for extraction of refrigerant and lubricating oil □Devices for refrigerant storage, such as sealed cylinder □Sealed devices for lubricating oil storage □Dedicated negative pressure sealing equipment for insulating layer crush, equipment for volume reduction of polyurethane foam
For treatment of circuit boards	□Facility for heat-treating of circuit board □Equipment for hydrometallurgy □Equipment for PCB crush, components sorting, and metal recovery, compatible with mechanical methods □Program and equipment for sludge treatment, compatible with hydrometallurgy □Cofferdam and anti-seepage process to prevent chemicals from leakage, compatible with hydrometallurgy □Equipment for treatment and disposal of non-metallic materials generated during PCB separation, such as epoxy resin, compatible with mechanical methods x□Documents to demonstrate the delivery to deep-processing enterprises □Set up ventilation system while components dismantling by melting process
Part 5: Transporting, Packaging And Other Equipment Adapt To E-waste	

Treatment	
Transportation equipment	x□Provided with transport vehicles or entrust transportation to units with relevant qualifications x□Measures such as setting baffles and covering tarpaulins are made on transport vehicles
Haulage and packing equipment	x□Equipment for carrying weights, such as forklifts □Compressing, packaging and other equipment, such as balers
Dedicated containers	x□Dedicated containers for batteries, capacitors and acid pickle x□Lables attached to the containers to demonstrate the information of inner mass, such as type, quantity and weight □Configure strong hierarchical storage rack when multilayer storage is necessary
Metering equipment	□Equipped with electronic loadometers that can automatically record and print out the amount of each batch □Loadometers set at the entrances of the plant or storage area □Metering equipment are certified to be eligible by inspection department, with documents provided Time difference between weighing time and recording time: □no difference □within three minutes □more than three minutes
Ammeter	□Dedicated meters are allocated in dismantling lines □No dedicated meter, but the meter commonly used is accurate in processing workshop
short-circuit protection device	□Accessorize short-circuit protection device while e-waste cleaning and assembling
Database destruction	x□Database destruction procedure and its documentary evidence
labor protection	x□Provide dust masks, helmets, goggles and other protective equipment to the operators
Part 6: Environmental Management And Risk Assessment	
Procedures and equipment for depollution	x□Environmental acceptance of equipment and facilities for depollution □Dust collecting and purifying device □Noise-reducing devices should be installed compatible with mechanical methods □Pretreatment before discharge of the rinse- wastewater
Environmental monitoring	□Establish routine environmental monitoring system □Possess corresponding facilities for environmental monitoring □Sign precatory monitoring contract with qualified companies □Retention history of monitoring report reaches three years or more □Reactive measures of performance to monitor accidents, ill health,

	incidents, near misses, and other historical evidence of deficient EHS performance □Calibration of monitoring and measurement equipment □Recording of data and results of monitoring and measurement to facilitate corrective and preventive action analysis
Assess hazards to environment, health & safety (EHS)	□Procedure to identify and prioritize EHS hazards associated with new, existing and planned activities, products & services □EHS hazard information is documented and kept current
Emergency preparedness & response	x□Procedure to identify potential emergency situations and accidents and how to respond to them □Equipment for incident response, such as fire extinguishers □Review emergency preparedness and response procedures, especially after the occurrence of accidents or emergency situations □Periodically test procedures and equipment where practicable， and exercise the contingency plan
Risk prevention	□Establish and maintain documented procedures for operations and activities associated with significant EHS hazards where their absence could lead to deviation from the ESM policy, objectives and targets
Facility closure plan	□Site decommissioning plan □Site remediation plan
Part 7: Record-Keeping、Surveillance And Performance Measurement	
Information system	x□Establish data information management system
Records	x□Maintain track record, such as basic form and daily statement □Establish random inspection system and keep record □Procedures to identify, protect, retrieve, retain, store, and dispose of records □EHS records are easily retrievable and protected from damage, loss and deterioration □Records are legible, identifiable, and traceable to the activity, product or service involved □Retention history of records is three years or more
Video surveillance	x□Establish closed-circuit surveillance system and control room x□Entire process surveillance x□Videos are identifiable, unambiguous and uninterrupted x□Recording date and time showed on the vedios x□Supply additional illuminant at night to ensure definition x□Save the recordings in hard disks □Retention history of recordings is one year or more

Internal audit	□ESM system undergoes periodic audits □Audits are conducted by personnel independent of those having direct responsibility for the activity being examined to ensure objectivity and impartiality of the audit process
Part 8: Competency Training, Corrective Action And Transparency	
Personnel and Competency Training	□Develop operating administrative manual, and keep regular guidance and training for employees x□Raise awareness amongst employees concerning the actual and/or potential EHS hazards linked to job tasks, and provide employees with appropriate training on how to mitigate risks associated with these hazards x□Ensure job tasks that are or may be associated with significant EHS hazards are undertaken by employees that are competent to perform these duties on the basis of education, training and/or experience x□Make employees aware of the importance of adhering to operating procedures and the consequences of failing to do so □Maintain up-to-date training records for employees
Corrective Action	□Investigate nonconformities and causes, and take action to avoid recurrence □Record results of corrective actions and preventative actions
Transparency	□Facility Environment, Health & Safety (EHS) policy is available to public □Company social reports are made available to shareholders and society, which include information pertaining to its performance with respect to environmental, health and safety issues

No.1

CORPORATE NAME: Ceylon Waste Management (Pvt) Ltd DATE: 29.01.2015

THEME / CATEGORY	EXAMPLES OF MEASURES
Part 1: Top Management Commitment To A Systematic Approach	
Basic Conditions	x□Ensure compatibility with requirements of e-waste treatment planning x□Permit for e-waste treatment x□In the enterprise list of e-waste utilization and disposal x□The Business License for general taxpayers □Able to receive fund subsidy from the state □Stable recycling channels of e-waste x□Definite list for reception
Facility Environment, Health &	x□Top management commitment to health & safety x□Top management commitment to comply with applicable legal requirements

Safety (EHS) Policy	x□Policy is documented and implemented □Policy is reviewed periodically for relevancy to organization
Allocate Resources	x□Adequate financial resources, human resources, specialized skills, organizational infrastructures, and technologies are made available to design, implement, maintain and improve the ESM system
Management representative	x□Specific management representatives appointed to oversee the design, implementation and maintenance of the ESM system, including the EHS programs, and report on ESM performance to top management for review
Part 2: Site Arrangement	
Centralized and independent plant	x□Lawful land use right or Lease contract of the land □Site location is far away from resource reserves, and downstream the business districts and residential areas □Distance from business and residential areas is above 300m Handling capacity per year: 13 500 Tons Total area of the plant: 12 500 Sq ft Area of operation and storage sector: 8000 Sq ft
Storage site	x□Dedicated storage site for the pendings and residues □Storage capacity is no less than 10 times the daily processing capacity Storage site: x□indoor □outdoor with ceiling and rails x□open air without rails x□The ground with anti-seepage treatment □Drainage and sewerage for the plot x□Storage space is partitioned into several regions, with warning signs attached respectively □Keep open flame or heat source, such as destructor, steam pipeline, and heating coil, clear of the storage site x□Retention history is one year at most
Treatment site	x□Dedicated site for e-waste treatment Treatment site: □indoor □outdoor x□Hardened cement floor in the treatment space □Waste oil collection and oil-water separation facilities are here in the treatment space x□Treatment space is partitioned into several regions, and warning signs are set up □Dismantling of small product and electronic components is conducted on negative pressure workbench
Part 3: Treatment And Disposal Technology	
Dismantling	
x□Classification of e-wastes while dismantling	

□Isolate components which contain substances toxic and hazardous firstly, such as refrigerants, batteries, lamps, mercury switches, and PCB capacitors	
□Recover refrigerant and compressor oil in the first place, when handle with air-conditions	
x□Make sure dismantling of circuit board conducted on workbench with a ventilation system	
□Classify the dismantled products according to subsequent process	
Dismantling of LCDs	□Manual dismantling □Semi-automatic thermal dismantling □Mechanical crushing at large
Dismantling of CRT monitors	□Assembly line work with manual dismantling □Single station manual dismantling □Dismantling by heat and open-soldering □Dismantling by machines
Sorting and crush	
Sorting of screen glass and cone glass in CRTs	□Diamond cutting □Full automatic heating wire □Semi-automatic heating wire □Frit glass dissolution with hot acid □Mixed glass sorting after direct crush □No sorting after direct crush
Cutting of compressor casing	□By grinding saw □By acetylene burner □By plasma torch
Crush of circuit board	□Impact grinding □Shear broken □Attrition crushing □Low-temperature comminution
□Make sure the crush of LCDs is conducted in a closed system	
□Ensure that crushing and sorting equipment provide closed conditions	
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Refrigerant	□Simple distillation

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