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Electrical and electronic waste — Treatment and disposal — Requirement

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Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

RS 276-2 was prepared by Technical Committee RSB/TC 013, *Water and Sanitation*.

In the preparation of this standard, reference was made to the following standards:

1) ISO 14001:2015, Environmental management systems — Requirements with guidance for use

2) RS ISO 45001, Occupational health and safety Management systems — Requirements with guidance for use

3) RS 276-1:2016, Electrical and electronic waste — Handling, collection, transportation and storage — Code of practice

The assistance derived from the above source is hereby acknowledged with thanks.

This second edition cancels and replaces the first edition (RS 276-2: 2016) which has been technically revised.

RS 276 consists of the following parts, under the general title *Electrical and electronic waste*:

— Part 1: Handling, collection, transportation and storage — Code of practice

— Part 2: Treatment and disposal — Code of practice

Committee membership

The following organizations were represented on the Technical Committee on Water and Sanitation (RSB/TC 013) in the preparation of this standard.

Enviroserve Rwanda

Ministry of Trade and Industry (MINICOM)Paragraph of participants

Ruliba Clays

Rwanda Environmental Management Authority (REMA)

Rwanda Mines, Petroleum and Gas Board (RMB)

Rwanda Polytechnic (RP)

Rwanda Utility Regulatory Authority (RURA)

Shine Engineers Multisectoral Company Ltd (SEMC)

Standards for Sustainability (SFS)

SULFO Rwanda

University of Rwanda- College of Science and Technology (UR-CST)

Water and Sanitation Corporation (WASAC)

Rwanda Standards Board (RSB) – Secretariat

Electrical and electronic waste — Treatment and disposal — Requirements

1 Scope

This Committee Draft prescribes the treatment and disposal of various categories of Electrical and Electronic waste (e-waste) listed in Annex A to ensure the environment and human health is protected against the potential adverse impacts of e-waste in Rwanda.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14001:2015, *Environmental management systems — Requirements with guidance for use*

RS ISO 45001, *Occupational health and safety management systems — Requirements with guidance for use*

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply

3.1

Environmental Impact Assessment (EIA)

systematic examination conducted to determine whether or not an activity or project will have any significant impact on the environment, provide mitigation for the adverse impacts and optimize the positive impact

3.2

Extended Producer Responsibility (EPR)

environment protection strategy that makes the producer responsible for the entire life cycle of the Electrical and Electronic equipment, especially for take back, recycle and final disposal of the equipment

3.3

chlorofluorocarbon (CFC)

compound consisting of chlorine, fluorine, and carbon. CFCs are commonly used as refrigerants, solvents, and foam blowing agents

3.4

hydrochlorofluorocarbon (HCFC)

compound consisting of hydrogen, chlorine, fluorine, and carbon. The HCFCs are one class of chemicals being used to replace the CFCs

3.5

polychlorinated biphenyls (PCBs)

class of organic compounds with 1 to 10 chlorine atoms attached to a molecule composed of two benzene rings. They are widely used for many applications, especially as dielectric fluids in transformers, capacitors, and coolants. They are toxic and are classified as Persistent Organic Pollutants (POPs)

3.6

recycler

person who engages in treating or processing of used or e-waste materials to make them suitable for reuse

3.8

refurbishing

action of repair, dismantling, improvement of e-waste for the purposes of extending the working life of the Electrical and Electronic equipment

3.9

problematic fractions

components or parts of e-waste where the collection and treatment cost far outweighs the material recovery value

3.10

recovery

process of separating, extracting of materials from used Electrical and Electronic equipment with the aim of retrieving valuable materials and turn into useable materials

3.11

recycling

Any operation by which wastes Electrical and Electronic materials are reprocessed into products, materials or substances weather for original use or other purposes

3.12

re-use

operation by which a product, or a part thereof, having reached the end of one use -stage is used again for the same purpose for which it was conceived

3.13

treatment

processing e-waste through modern and eco-friendly technologies to ensure compliance with environmental protection and human safety

3.14

disposal

any operation which is not recovery, consisting of putting an end to the life of the EE equipment in an environmental friendly manner

3.15

component

element of an appliance with a distinct function which has been removed from the device as a unit

NOTE typical components of Electrical and Electronic equipment include batteries, capacitors, printed circuit boards, cathode-ray tubes (CRTs), hard disk drivers, transformers, power supplies and sub-assemblies, among others

3.16

hazardous material

substance with potential to cause harm to persons, property or the environment because of the chemical, physical and biological properties of the substance

3.17

regulatory authority

competent authority with the responsibilities to regulate e-waste management

4 Requirements

4.1 E-waste treatment

An e-waste treatment process shall include the following main parts:

a) testing of e-waste product in order to sort reusable and non-reusable e-waste separately;

b) refurbishment for further reuse;

c) disassembling/dismantling non-reusable e-waste and sorting e-waste fractions into reusable and non-reusable parts; and

d) size reduction, separation and recovery of different materials from non-reusable e-waste.

4.2 Setting up and management of an e-waste treatment facility

Setting up and managing an e-waste treatment facility shall include the following:

a) the treatment facility shall be licensed by competent regulatory authorities;

b) an Environment Impact Assessment (EIA) shall be undertaken before establishing e-waste treatment facility while the existing one shall undertake an Environmental Audit (EA);

c) the treatment facility shall take sufficient measures to safeguard environment and occupational health and safety in accordance with RS ISO 45001 and ISO 14001; and

d) the treatment facility shall have a regularly-implemented and documented monitoring and record keeping program that tracks key process parameters, compliance with relevant safety procedures, effluents, emissions, stored incoming and outgoing materials and waste.

4.3 E-waste testing

Testing of e-waste shall be done with the purpose to identify:

a) items in good condition that can be reused;

b) items that can be repaired/refurbished; and

c) items for dismantling for recovery of materials or disposal.

NOTE 1 Sorting of waste is encouraged at source to enable easier identification and access to particular waste streams.

NOTE 2 Refurbishment and dismantling shall be carried out after verification that items are no longer reusable.

4.4 E-waste refurbishment

Refurbishment and reuse of e-waste has potential for those used electrical and electronic equipments which can be easily refurbished to put to its original use.

4.5 E-waste dismantling

4.5.1 Dismantling and segregation are the first steps towards recycling of the e-waste. E-waste segregation involves separation of equipment according to its level of difficulty to dismantle and its hazardousness nature. Segregation shall be done before the equipment is dismantled.

4.5.2 Dismantling of e-waste shall be carried out manually or mechanically by authorized entity depending upon the scale of operations and the e-waste being handled.

4.5.3 An integrated facility shall provide a mechanical dismantling facility to dismantle e-waste containing hazardous substances.

4.5.4 The e-waste components shall be classified after dismantling (e.g. parts containing dangerous substances; parts containing valuable substances such as cables containing copper, steel, iron, precious metal containing parts such as contacts, plastics.

4.5.5 Occupational health and safety concerns of facilities for storage and dismantling of the equipment shall be in accordance with RS ISO 45001.

4.5.6 The Authority in charge of Environment Protection and other relevant authorities shall monitor the facilities through controlled environmental and safety audits to determine the handling facilities in terms of physical status and mitigation measures in place to ensure safety of workers as well as protection of the environment.

4.5.7 Collection and transport of separated e-waste shall be done in such a way that enables reuse and recycling of those components or whole appliances.

4.5.8 An appropriate storage site shall be provided for disassembled spare parts (e.g. motors and compressors) that contain oil or other types of fluids. They shall be stored in containers that are secured that will not allow oil and other fluids to escape with an impermeable surface and a sealed drainage system.

4.6 E-waste size reduction

The main units of operation may include:

a) hammering;

b) shredding;

c) special treatment processes which comprise:

1) cathode Ray Tube (CRT) treatment consisting of separation of funnels and screen glass in accordance with Annex C;

2) electromagnetic separation in accordance with Annex D; and

3) eddy current separation in accordance with Annex D.

4.7 Recycling and recovery of valuable materials

Recycling and recovery of valuable materials shall fulfil the following:

a) the recycling facility shall be registered and licensed by competent authorities;

b) recycling of e-waste covers various stages with options of technologies available for recycling the various components of e-waste which may be referred to in Annex B; and

c) the integrated e-waste recycling facility shall opt for the Best Available Technologies (BAT) and provide the state of the art facility complying with all the environmental standards in terms of emissions, effluents, noise waste treatment and disposal, among others.

4.7.1 Plastic recycling

4.7.1.1 There are three different types of plastic recycling options i.e. mechanical recycling, chemical recycling, and thermal recycling:

a) in mechanical recycling process, shredding and identification process is used to make new plastic products;

b) in chemical recycling process, waste plastics are used as raw materials for petrochemical processes or as reductant in a metal smelter; and

c) in thermal recycling process, plastics are used as alternative fuel.

4.7.1.2 All the recycling options shall be done in a manner that minimises the adverse environmental impact and shall secure access to viable systems for collection and quality control.

4.7.1.3 Contamination levels shall be minimised by the following means:

a) clear identification and efficient sorting of materials and products;

b) careful handling in the collection, separation and sorting phases;

c) effective separation and washing processes; and

d) the use of melt filtering or other filtering systems, where appropriate.

NOTE In some cases, contaminants, if present in airborne dust for example, may necessitate special treatment during recovery operations in order to ensure observance of industrial health and safety requirements

4.7.1.3 The two major types of plastic resins, which are used in electronics, are “thermosets” and “thermoplastics”. Thermosets are shredded and recycled because they cannot be re-melted and formed into new products, while thermoplastics can be re-melted and formed into new products.

4.7.1.4 Mechanical recycling process shall include:

a) the first step is the sorting process, where contaminated plastics such as laminated or painted plastics are removed;

b) the first step is the sorting process, where contaminated plastics such as laminated or painted plastics are removed;

c) shear-shredder and hammer mills are generally used for size reduction and liberation of metals (coarse fraction) followed by granulation and milling for further size reduction;

d) magnetic separators are used for ferrous metals separation, while eddy current separators are used for non ferrous metals separation;

e) air separation system can be used to separate light fractions such as paper, labels and films;

f) resin identification can be carried out by using a number of techniques like turboelectric separator, high speed accelerator and X-ray fluorescence spectroscopy;

g) X-ray fluorescence spectroscopy is effective in identifying heavy metals as well as flame retardants.

h) after identification and sorting of different resins, they are extruded and palletized.

4.7.1.4 Chemical recycling process: mixed plastic waste is de-polymerized, de-halogenated, metals removed and hydrogenated to produce high quality products like off gas and syncrude obtained by hydro-treatment, which are sent to the petrochemical process.

4.7.1.5 Thermal recycling process: plastics recovered in the second level treatment are used as fuel to provide energy. Since plastics have high calorific value, which is equivalent to oris greater than coal, they can be combusted to produce heat energy in cement kilns

4.7.2 Metals recycling

Metal recycling includes lead recycling, copper recycling and precious metals recycling. After sorting of metal fractions, they are sent to metal recovery facilities.

4.7.3 Integrated e-waste facility

4.7.3.1 Integrated facilities shall be fully licensed by competent authorities. The licensing requirement will vary depending upon the size and nature of the facility.

4.7.3.2 Necessary Environmental Clearances (EC) shall be obtained based on the scale of operations as prescribed by the Environmental Impact Assessment (EIA) process.

4.7.3.3 Integrated Facilities shall implement the Environmental Management System (EMS) according to ISO 14001.

4.7.3.4 Integrated Facilities shall take sufficient measures to safeguard occupational and environmental health and safety according to RS ISO 45001 and ISO 14001.

4.7.3.5 Integrated Facilities shall have an up-to-date, written hazardous materials identification and management plan that specifically addresses at least the following:

a) lead;

b) mercury;

c) beryllium;

d) cadmium;

e) batteries;

f) toner;

g) phosphor compounds;

h) PCBs;

i) brominated flame retardants; and

j) other halogenated materials, with particular focus on possible generation of by-product dioxins and furans.

4.7.3.6 Where materials are shredded or heated, appropriate measures shall be taken to protect workers, the general public and the environment from hazardous dusts and emissions. Such measures shall include adaptations in equipment design or operational practices, air flow controls, personal protective devices for staff and visitors, pollution control equipment or a combination of these measures.

4.7.3.7 An up-to-date, written plan for reporting and responding to exceptional pollutant releases, including emergencies such as accidents, spills, fires, and explosions shall be done in accordance with clause 8.2 of ISO 14001.

5 E-waste disposal

5.1 Disposal facilities shall be designed in a way to minimize the contamination of water and soil with impermeable surface associated with a sealed drainage system and may be needed even where weatherproof covering is used.

5.2 Spillage collection facilities shall include the impermeable pavement and sealed drainage system as the primary means of containment shall be provided. However, spill kits to deal with spillages of oils, fuel and acids shall be provided and used as appropriate.

Annex A
(normative)

Categories of electrical and electronic products covered under the scope of this Committee Draft

A.1 List of products which shall be taken into account for the purpose of this standard includes, but are not limited to:

S/N	Categories of Electrical and Electronic Equipment
A	**Information Technology and Telecommunication Equipment:**
01	Centralized data processing
02	Mainframes, Minicomputers
03	Personal computing
04	Personal computers (Central processing unit with input and output devices)
05	Laptop computers (Central processing unit with input and output devices)
06	Notebook computers
07	Notepad computers
08	Printers including cartridges
09	Copying equipment
10	Electrical and electronic typewriters
11	User terminals and systems
12	Facsimile
13	Telex
14	Telephones
15	Pay telephones
16	Cordless telephones
17	Cellular telephones
18	Answering systems
B	**Consumer electrical and electronics**
01	Television sets (including sets based on (Liquid Crystal Display and Light
02	Emitting Diode technology), Refrigerator, Washing Machine
03	Air- Conditioners excluding centralized air conditioning plants

A.2 Toys, leisure and sports equipment:

S/N	Equipment
01	Electric trains or car racing sets
02	Hand-held video game consoles
03	Video games
04	Computers for biking, diving, running, rowing, and other similar gadgets
05	Sports equipment with electric or electronic components
06	Coin slot machines

A.3 Monitoring and control instruments:

S/N	Instrument
01	Smoke detector
02	Heating regulators
03	Thermostats
04	Measuring, weighing or adjusting appliances for household or as laboratory equipment
05	Other monitoring and control instruments used in industrial installations

A.4 Automatic dispensers:

S/N	Dispenser
01	Automatic dispensers for hot drinks
02	Automatic dispensers for hot or cold bottles or cans
03	Automatic dispensers for solid products
04	Automatic dispensers for money

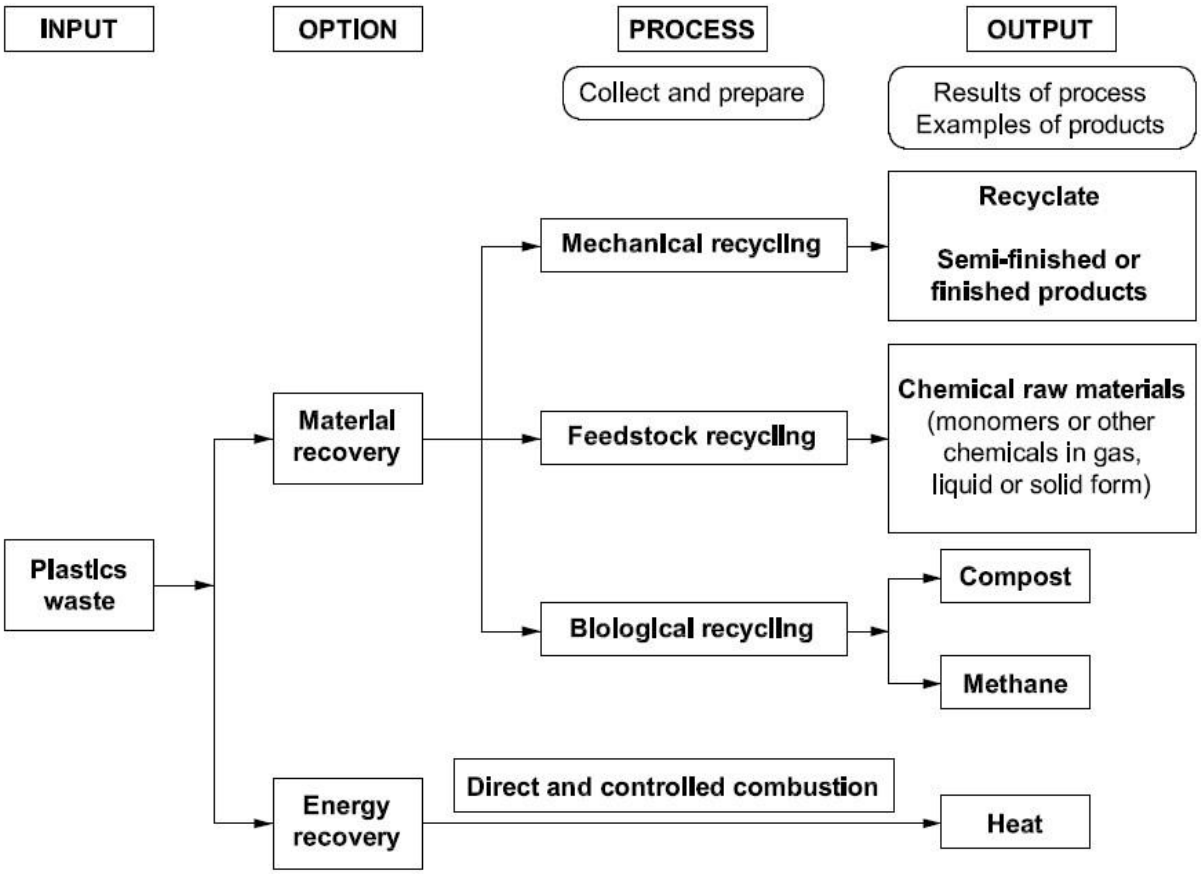
A.5 The following equipment shall not be taken into account:

S/N	Equipment
A	**Medical devices (with the exception of all implanted and infected products)**
01	Radiotherapy equipment
02	Cardiology
03	Dialysis
04	Pulmonary ventilators
05	Nuclear medicine
06	Laboratory equipment for in-vitro diagnosis

07	Analysers
08	Freezers
18	Other appliances for detecting, preventing, monitoring, treating, alleviating illness, injury or disability
B	**Security and military equipment**
C	**Transformers and capacitors**

Annex B
(normative)

Schematic diagram of some plastics recovery options



Annex C
(normative)

CRT treatment technology

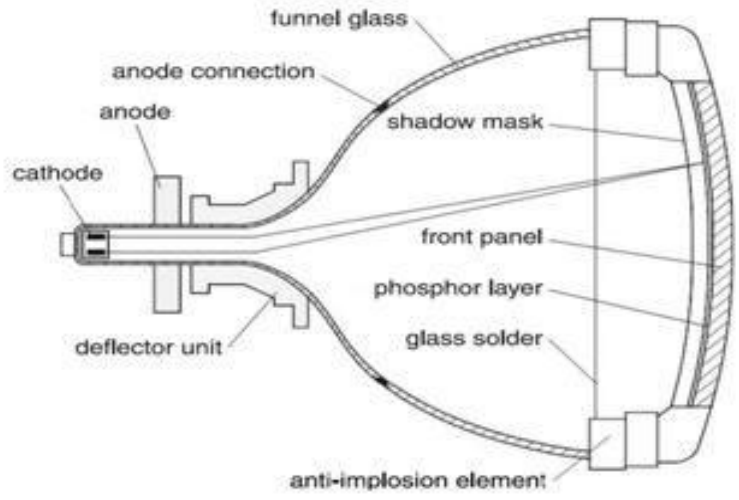
C.1 Structure of CRT of Monitors and TVs

C.1.1 Front panel: a very homogeneous barium –strontium glass, of a greenish whose weight is about two-third of the whole CRT;

C.1.2 Cone or funnel glass: a lead glass, whose weight is about one third of the whole CRT

C.1.3 Neck: a glass with a very high lead content enveloping the electron gun;

C.1.4 Glass solder of frit (the junction between the panel and the cone): a low melting lead glass, included only in colour CRTs.



C.2 Treatment process

C.2.1 Input: CRT segregated after first level e-waste treatment.

C.2.1.1 Unit operations:

C.2.1.1.1 Dismantling: CRT is manually removed from plastic/wooden casing.

C.2.1.1.2 De-pressurization and Splitting: Picture tube is split and the funnel section is then lifted off the screen section and the internal metal mask can be lifted to facilitate internal phosphor coating. Different types of splitting technology used are given below:

C.2.1.1.2.1 NiChrome hot wire cutting: a NiChrome wire or ribbon is wrapped round a CRT and electrically heated for at least 30 seconds to cause a thermal differential across the thickness of the glass. The area is then cooled (e.g. with a water-soaked sponge) to create thermal stress which results in a crack. When this is lightly tapped, the screen separates from the funnel section.

C.2.1.1.2.2 Thermal shock: the CRT tube is subjected to localised heat followed by cold air. This creates stress at the fritline where the leaded funnel glass is joined to the unleaded panel glass and the tube comes apart.

C.2.1.1.2.3 Laser cutting: a laser beam is focused inside and this heats up the glass. It is immediately followed by a cold water spray that cools the surface of the glass and causes it to crack along the cut line.

C.2.1.1.2.4 Diamond wire method: in this method, a wire with a very small diameter, which is embedded within dustrial diamonds is used to cut the glass as the CRT is passed through the cutting plane.

C.2.1.1.2.5 Diamond saw separation: diamond saw separation uses either wet or dry process. Wet saw separation involves rotating the CRT in an enclosure while one or more saw blades cut through the CRT around its entire circumference. Cool ant is sprayed on to the surface of the saw blades as they cut. This is to control temperature and prevent warping.

C.2.1.1.2.6 Water jet separation: this technology uses a high-pressure spray of water containing abrasive, directed at the surface to be cut. The water is focused through a single or double nozzle-spraying configuration set at a specific distance.

C.2.1.1.2.7 Cleaning: internal phosphor coating is removed by using an abrasive wire brush and a strong vacuum system to clean the inside and recover the coating. The extracted air is cleaned through an air filter system to collect the phosphor dust.

C.2.1.1.2.8 Shredding: the main outputs of shredding are metals, plastic and glass cullet. The cullet glass is reused as a raw material by CRT manufacturers. Recovered CRT glass also goes to the lead smelter, where they act as fluxing agent in the smelting process.

Annex D
(normative)

Electromagnetic, eddy current and density separation using water

D.1 Electromagnetic and eddy current separation utilises properties of different elements like electrical conductivity, magnetic properties and density to separate ferrous, nonferrous metal and precious metal fractions.

D.2 Plastic fractions consisting of sorted plastic after 1st level treatment, plastic mixture and plastic with flame retardants after second level treatment, glass and lead are separated during this treatment. The efficiency of this treatment determines the recovery rate of metal and segregated e-waste fractions for third level treatment.

D.3 The salient features of this treatment technology and process are given below:

D.3.1 The proposed technology for sorting treatment including recycling and disposal of e-waste is fully based on dry process using mechanical operations.

D.3.2 The pre-comminuting stage includes separation of Plastic, CRT and remaining non CRT based e-waste. Equipments like hammermill and shear shredder will be used at comminuting stage to cut and pulverise e-waste and prepare it as a feed stock to magnetic and eddy current separation.

D.3.3 A heavy-duty hammermill grinds the material to achieve separation of inert material sand metals.

D.3.4 After separation of metals from inert material, metal fraction consisting of Ferrous and Non-Ferrous metals are subjected to magnetic current separation. After separation of Ferrous containing fraction, Nonferrous fraction is classified into different non-metal fractions, electrostatic separation and pulverisation.

D.3.5 The ground material is then screened and dusted subsequently followed by separation of valuable metal fraction using electrostatic, gravimetric separation and eddy current separation technologies to recover fractions of Copper (Cu), Aluminium (Al), residual fractions containing Gold (Au), Silver (Ag) and other precious metals.

D.3.6 This results in recovery of clean metallic concentrates, which are sold for further refining to smelters. Sometimes water may be used for separation at last stage.

D.3.7 Electric conductivity-based separation separates materials of different electric conductivity (or resistivity) mainly different fractions of non-ferrous metals from e-waste. Eddy current separation technique has been used based on electrical conductivity for nonferrous metal separation from e-waste.

D.3.7.1 Its operability is based on the use of rare earth permanent magnets. When a conductive particle is exposed to an alternating magnetic field, eddy currents will be induced in that object, generating a magnetic field to oppose the magnetic field.

D.3.7.2 The interactions between the magnetic field and the induced eddy currents lead to the appearance of electro dynamic actions upon conductive non-ferrous particles and are responsible for the separation process.

D.3.8 The efficacy of the recycling system is dependent on the expected yields/output of the recycling system. The expected yields/output from the recycling system are dependent on the optimisation of separation parameters. These parameters are given below:

a) particle size;

b) particle shape;

c) feeding rate/ RPM; and

d) optimum operations.

D.3.8 Particle shape is dependent on comminuting and separation. Since hammermills and screens will be used in the proposed technology, the variations are expected to be the same as that of Best Available Technology (BAT).

D.3.9 The feeding rate can be optimised based on the speed and width of the conveyor.

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