FOREWORD

Basel Convention Regional Centre for South-East Asia (BCRC-SEA) in cooperation with the Secretariat of the Basel Convention (SBC) has developed this Technical Guidelines on the Reduce, Reuse, Recycle (3R) for the End-of-Life Electronic Products. This Technical Guidelines Development Project is funded by the Government of Japan through the Basel Convention Trust Fund. A research department, namely Laboratory of Solid and Hazardous Waste – Faculty of Civil and Environment Engineering-Bandung Institute of Technology, has been retained by BCRC-SEA to undertake the development of these guidelines.

The purpose of these guidelines is to provide methodological guidelines to all stakeholders particularly parties in region served by the BCRC-SEA in conducting reduce, reuse, and recycle (3R) for the end-of-life electronic products detailed at national level and, eventually, at regional level. Nevertheless, any other parties to the Basel Convention outside the Region and any other interested parties are welcome to use these Guidelines and give feedback for future revisions in order to make them more useful to all users.

The first Draft Guidelines were submitted in early March 2007 for review by all stakeholders in order to get suggestions and or comments as input for the development of the Final Guidelines. In a group work session during the Regional Workshop on the Environmentally Sound Management of E-Waste on March 2007 in Siem Reap, Cambodia, the first draft Technical Guidelines was comprehensively reviewed by a group of participants representing all stakeholders. A number of constructive recommendations for the improvement and finalisation of the Technical Guidelines have been received and accommodated under this final version of the Guidelines.

BCRC-SEA would like to express its thanks to the SBC, the Government of Japan, Laboratory of Solid and Hazardous Waste – Faculty of Civil and Environment Engineering - Bandung Institute of Technology, and to the countries in the region and all stakeholders involved for their comments, support and good cooperation in this Technical Guidelines Development Project.

Appreciation is also addressed to the others, whose names are not mentioned in this document, who have also contributed to this Project.

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I. INTRODUCTION

I.I. Background Information

1. The Basel Convention is an agreement between countries to control the international movement of hazardous waste. Electronic goods destined for disposal and recovery are classified as hazardous waste if they contain any of the hazardous materials contained in the annexes of the Convention. Some items of e-waste contain hazardous materials such as lead, chromium and mercury, Polychlorinated Biphenyls (PCBs), ozone depleting substances (ODS). Electronic waste items classed as hazardous include computer monitors, televisions (TVs), printed circuit boards of electronic appliances, etc.

2. Reduce, reuse, recycling (3R), repair and refurbishment activities of waste electrical and electronic appliances or scrap could be associated with hazardous materials as is presented in Annex I constituents of the Basel Convention. Therefore, electrical and electronic waste is important to be handled and those activities are necessary to be controlled. Improper handling (include reduce, reuse, recycle, repair and refurbishment activities) of that waste can lead to release of hazardous waste into environment and finally will affect to the human health.

3. Article 2, paragraph 8 of the Basel Convention defines environmentally sound management of hazardous wastes or other wastes as "*taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against adverse effects which may result from such wastes*." Article 4, subparagraph 2(b) requires that each party take the appropriate measures to "*ensure the availability of adequate disposal facilities for the environmentally sound management of hazardous or other wastes, that shall be located, to the extent possible, within it, whatever the place of their disposal*." While subparagraph 2(c) requires each party to "*ensure that persons involved in the management of hazardous wastes or other wastes within it take such steps as are necessary to prevent pollution due to hazardous wastes and other wastes arising from such management and, if such pollution occurs, to minimize the consequences thereof for human health and the environment*."

4. In its Preamble, the Convention recognizes also the need to continue the development and implementation of environmentally sound low-waste technologies, recycling options, good housekeeping and management systems with a view to reducing to a minimum the generation of hazardous wastes. It recognizes also the increasing desire for the prohibition of transboundary movements of hazardous wastes and their disposal in other countries, especially developing countries. Specific guideline on transboundary movement of hazardous waste destined for recovery operations can be found on the official Website of Basel Convention.

5. A central goal of the Basel Convention is "environmentally sound management" (ESM) of hazardous waste. The aim of ESM is to protect human health and the environment by minimizing hazardous waste generation whenever possible. ESM involves strong controls from the generation of a hazardous waste to its storage, transport, treatment (include repair and refurbishment), reuse, recycling, recovery, and final disposal.

I.2. Objectives

6. The present technical guidelines are principally intended to provide guidance, to Asia Pacific countries which are building their capacity to manage electronic waste (e-waste) in an environmentally sound and efficient manner, in their development of procedures or strategies for repairing, refurbishment and 3R (reduce, reuse and recycling) activities of used electronic appliances, and to encourage further recovery and recycling of used electronic appliances in an environmentally sound manner because of some components of e-waste contain heavy metals and hazardous compounds in forms and amounts that could be dangerous to workers and environment.

7. The project is intended as a guidance for reduce, reuse, recycle (3R), repair and refurbishment of electrical and electronic waste that is generic and relevant to a wider international audience.

8. It is acknowledged that this guideline is adopted from some references as presented in the References Section.

I.3. Scope of Guidelines

9. Compare to developed countries, the activities of repair and refurbishment in developing countries are dominant rather than activities of reduce, reuse and recycling. Therefore, the environmental sound management of repair and refurbishment as part of reuse activities of electrical and electronic waste is also important to be discussed in this guideline.

10. The electronic appliances which are subjected in this guide consist of:
    - Refrigerator and air conditioner
    - Washing machine
    - Televisions (TVs) and audio system
    - Personal computers (PCs)
    - Fluorescent lamps

11. This guideline only discuss the type of electronic appliances which are stated in paragraph 10 due to the limitation of the references and also those electronic appliances which are the most used appliances in the world. The guideline of the other type of electronic appliance which is now become problem, i.e. mobile phone was developed by the Mobile Phones Working Group under the Basel Convention Partnership Initiative and more detailed regarding with the handling of scrap computers can be seen at *the Technical guidance for the environmentally sound management of specific waste stream: Used and Scrap Personal Computers, developed by Working Group on Waste Prevention and Recycling-OECD.*

I.4. Topic of Guidelines

12. The structure of this guideline consists of some parts which are presented alternately as hereunder:
    - Technical guidance for facilities
    - Sorting and temporary storage
    - Collection
    - Transportation and handling

- Assessment of appliances
- Testing and repairing of used electronic appliances
- Labeling and marking
- Testing sequence
- General repairs and retesting
- Testing and repairing specific appliances
- Pretreatment before recycling and waste processing
- Dismantling end-of-life appliances
- Environmental concern
- Existing advance recovery technology for recycling electronic appliances components

II. TERMINOLOGY

13. Reduce is prevention or restriction of waste generation at its source by redesigning products or the patterns of production and consumption

14. Reuse is a process of using again a used electronic appliance or a functional component from a used electronic appliance, possibly after repair or refurbishment

15. Recycling is relevant operations specified in Annex IVB of the Basel Convention

16. Repair is an activity to restore electronic appliances to good condition by replacing parts or putting together something torn or broken

17. Refurbishment is a process of returning a used electronic appliance to satisfactory working condition, meeting applicable technical performance standards without replacing any parts

18. Some of the terms used in the guide may be new to readers. There is a glossary in the Annex 8 here terms and abbreviations are explained, and material flow of reduce-reuse-recycle- flowchart is presented in the Annex 4

19. Hazardous waste management policies are categorized by governments and international governmental organizations in the following order priority:
    Prevention or reduce the generating of hazardous wastes
    - Reduction at the source of the quantity and the hazardousness of the waste nonetheless generated through reuse, recovery and recycling
    - Treatment
    - Final disposal

20. Special consideration should therefore be given by governments by taking appropriate steps to ensure that the generation of the hazardous wastes, from activities of end-of-life e-products management, within their territories is reduced to as minimum as possible. An important component of this would be promoting the development and use of cleaner production methods as well as establishing the life cycle system of end-of-life e-products applicable to activities generating hazardous wastes and the recovery of hazardous wastes unavoidably generated by such activities.

III. TECHNICAL GUIDANCE FOR FACILITIES

21. The necessary measures for assuring environmentally sound recycling of used electronic appliances or waste electrical and electronic equipment are, to a large degree, facility-specific. This is because the potential for adverse impacts on worker health and the environment is very much dependent upon the nature of the refurbishment, dismantling or materials recycling activities that are used at a particular facility.

22. The appropriate degree of governmental control and oversight is dependent upon which of those activities are engaged in, as well as the magnitude of the operations. National, regional and local government programs, therefore, need to be tailored to the nature and size of these operations.

23. Facilities that are principally engaged in specific activities, such as refurbishment of used electronic appliances, derive their principal source of revenue from the resale of used electronic appliances for reuse. Any revenues from the sale of unusable components to another activities, such as dismantlers or raw material recovery activity are only a secondary, and generally minor, source of income.

III.1. General Requirements

24. Facilities that are principally engaged in the dismantling of used electronics appliances for recovery of usable parts and/or materials for raw material recovery range from very small operations to those that are quite large. They also range from those that extensively utilise manual labour for disassembly to those that are highly automated. The degree of hazard posed to workers and the environment also varies greatly and is dependent upon the specifics of individual facility operation.

Uncontrolled Dismantling Activity
(Source: Basel Action Network)

25. Facilities should be properly authorised by the local, regional or national government. Such authorization may take the form ranging from a local business license (in the case of small facilities) to a license or permit that provides worker health and safety guidance or very basic provisions for environmental protection (for larger facilities). The authorization for larger facilities should specifically address the management of processed and unpro- cessed components, with limits on the amount of hazardous waste that may be accumulated on site. Processed components should be regularly sent off-site to authorised recycling or disposal facilities.

26. Facilities should be located at intrinsically superior that, by virtue of their natural feature and land use setting, provide high degree of protection to public health and the environment. Feasibility study to determine suitable location is advised in order to assess the impact of the activities to the environment and society around the facilities.

27. If the operation is manual and only involves hand tools (not involving heat or shredding, for example), the degree of worker and environmental risks may be on a level similar to above operation and, thus, it may be appropriate to authorise such a dismantling facility on a part with refurbishment facilities.

28. Facilities that handle a significant volume of used electronics appliances should maintain a financial instrument that will assure that, in the case of (1) gross mismanagement of used electronic appliances or components or (2) closure of the facility; the facility will be properly cleaned up.

29. Business transactions that involve the transboundary movement of used electronic appliances and components should be based on contracts (or equivalent commercial arrangements) made in advance that detail the quantity and nature of the materials to be shipped. Through the keeping of records, a facility should be able to characterize, on at least an annual basis, the percent (by volume or weight) of used electronic appliances and components that are refurbished and/or repaired, and/or sent for recycling and/or sent for disposal.

Controlled Dismantling Activity
(Source: Environmental Information System)

30. All operations, including storage of inventory and unusable components, should be conducted indoors, with impervious floors. Storage areas should be adequate to hold all inventory and waste materials. The areas must be safe and practical, and must be large enough to accommodate staff and the number of waste appliances and components that are expected. Ideally each area will have sub areas for types of appliance, thereby keeping each type separate from other types.

31. The facilities should ensure that all items of used electronic appliances be managed in an environmentally sound manner and in accordance with the Basel Convention when destined for transboundary movement. Therefore facilities should be aware of the Basel Convention guidance documents on "Transboundary Movements of Hazardous Waste destined for Recovery Operation".

Uncontrolled Outdoor Activity
(Source: Foreign Policy)

Controlled Indoor Activity
(Source: Consultant Document)

III.2. Safety and Health Control Requirements

32. The facility needs to assure that personnel are properly trained with regard to material and equipment handling, worker exposure, controlling releases, health, safety and emergency procedures. Workers at a facility should be trained specifically for particular electronic appliance. They should be either certified technicians in their field and have received relevant trainings required.

33. Facilities operations should be inspected on a periodic basis by the competent authority for compliance with the facility license, as well as other safety, health and environmental requirements. The facility itself should conduct regular audits and/or inspections of its environmental compliance.

34. A facility should have the appropriate equipment for proper processing of the incoming materials as well as controlling environmental releases. A system needs to be in place for identifying and properly managing hazardous components that are removed from used electronic appliances during disassembly.

Right:
Uncontrolled Dismantling Activity
(Source: 2nd NIES Proceedings, 2005)
Left:
Controlled Dismantling Activity
(Source: 2nd NIES Proceedings, 2004)

35. The facility authorization (license or permit) should describe the capacity of the operation, particularly the amount of hazardous wastes that are allowed to be kept on site. This will assure that the capacity of storage areas is not exceeded and hazards to human health and the environment during operation or, in the case of unexpected facility closure, are minimized.

36. Facilities should manage all materials to minimize adverse exposures to workers and release to the environment that may the side effect of dismantling and/or others activities. Medical test for worker is important to be conducted periodically.

III.3. Environmental Control Requirements

Air sampling at TV Dismantling Hall
(Source: 3rd NIES Proceedings, 2006)

Uncontrolled Smelting Activity
(Source: 2nd NIES Proceedings, 2005)

37. Facilities should fulfil the applicable core performance elements for ensuring environmentally sound management of wastes, and used and scrap materials.

38. The facility should have procedures for monitoring, reporting and responding to pollutant releases and other emergencies, such as fires.

39. Facilities that engage in raw material recovery, e.g., smelting, will require a higher degree of governmental environmental oversight, commensurate with the environmental concerns that arise from their activities. Raw material recovery often involves the generation of emissions or residues that require careful control in order to avoid adverse impacts on worker health, as well as human health generally, and the environment.

40. With regard to metal recovery facilities, the metals contained in electronic appliances do not raise unusual or special environmental concerns, i.e., concerns which are different from those encountered in other metal and ore processing activities. However trace metals in electronic appliances-scrap (e.g. Beryllium), which is not normally present in ores and emissions resulting from organic compounds, should be taken into consideration.

III.4. Disposal System

41. Residues arising from the recovery facilities of end-of-life of electronic appliances can be hazardous, perhaps even more hazardous than the original wastes. Consequently, environmentally sound and safe disposal of these wastes should be ensured.

42. The facilities should dispose the residues, which cannot be used or cannot be recycled again, with an environmentally sound and appropriately authorised landfill. Procedure for disposal of hazardous residues will require specific licensing by the competent environmental authority.

43. The facilities should characterize the residues since it important when determining the appropriate pre-treatment of disposal method, such as solidification/stabilization process. Improper treatment or disposal of hazardous waste can lead to releases of the contaminant into the environment.

44. The facilities should encourage minimizing the land filling of used electronic appliances and materials and arranging for appropriate recovery where practicable. The facilities should also use the Basel Convention guidance documents to ensure that downstream materials recovery and recycling facilities operate in a manner that according to the relevant regulations.

Uncontrolled Landfill Site
(Source: 2nd NIES Proceedings, 2005)

Solidification Process before Land Filling
(Source: Consultant Document)

IV. SORTING AND TEMPORARY STORAGE

45. As well as being necessary for accreditation, having procedures for the sorting of appliances is good practice. These procedures will ensure the sorting and storage of appliances, components, hazardous substances and materials is operated in an efficient and safe manner, reducing the risk of harm to people's health and the environment.

46. Sort the appliances and store in specified areas for further checking. There must be no entry to any unauthorized personnel or members of the public to these storage areas.

47. The storage areas are required for spares from electronic appliances. Need a storage area for scrap to be recycled. Separate areas for appliance types are advisable but optional. Hazardous waste materials need to be contained. Whole waste appliances may need to be stored. Records and labeling for spares and stored materials must be set up. The records must identify the source, type, quantity, weight and the intended destination of the component or material.

48. Arranging manual handling between goods-in, storage areas, and the workshop is the key to an efficient and safe system. Handling time should be kept to a minimum and all areas should be on one level. All areas should be free of any obstacles, be clean, with adequate room between areas. The routes should allow for minimum crossover of traffic.

49. Clear labeling of appliances, components and scrap must be adopted. This should identify the origin and destination of the labeled goods, plus any details of parts removed or missing, and the identification of any faults.

50. Prior to moving into storage areas, specify and mark each appliance for further treatment based on the assessment.

Collecting the Scraps by Excavator
(Source: Consultant Document)

Labeling of Appliances before Processing
(Source: King County, Washington Gov.)

51. It is important to record movement and record the processes the machine has undergone and what other processes are still needed.

52. The following list describes the desirable facilities for storing and containing machines, components, waste, and materials:
    - A designated collection bay for first-point assessment and sorting, perhaps with part reserved for reusable and repairable appliances, and part reserved for doubtful appliances.
    - The number of storage areas for re-use and recovery separately is depending on the kinds of appliances being handled.
    - A storage area for appliances to be de-manufactured for scrap. Separate areas by type are advisable but optional.
    - An area for component recovery and secure storage of components.
    - Waste appliances storage.
    - Waste materials containers or bays.
    - Hazardous waste materials storage.
    - An area for tested appliances for sale and/or delivery.

53. The large of each area should be based on the need and the number of specific appliances or components. However, a common area with appliances having labels readable from a distance may be an easier option – but making sure any containing hazardous materials are kept apart.

V. COLLECTION

54. The sources of used electronic appliances can be both formal and informal sectors, namely:
- Households;
- Local retailers;
- Local authority amenity sites;
- Places where discarded appliances have been notified to the local authority;
- National retailer's regional depots.

55. The frequency of collection depends on the kind of appliances to collect, sources of used electronic appliances, staff in charge for collections and collections time, and type and availability of vehicle.

56. A good working relationship should be fostered with local authorities and retailers, and this can partly be achieved with well-organized collection. A second advantage from collecting from retailers is the better quality product likely to get. One-off bulk collections and a steadier flow of appliances produce a more cost-effective collection service. As with other activities connected to appliance re-use, collection will have to change if tighter legislation is introduced.

57. Collection will require prior arrangement with local authorities and the retail sector and will need to be incorporated into the overall waste management of in the region.

58. Organizations and regional networks are better to have service agreements to collect and handle discarded appliances in order for them to supply reusable equipment.

59. When collected appliances have been transported to the workshop, they are assessed on arrival, sorted and stored temporarily.

60. Instead of collecting appliances with other household goods, there may have to be separate collections in future.

61. Instead of scheduling the own collection, collectors/recyclers will need to adopt a national system to assure the sources that collectors/recyclers are fulfilling the contracts to handle the used appliances properly and that collectors/recyclers are recording recovery against targets.

Uncontrolled Temporary Storage
(Source: Greenpeace)

Collection of Used Electrical Equipment
(Source: United States Department of Agricultural)

Controlled Temporary Storage
(Source: Consultant Document)

VI. TRANSPORTATION AND HANDLING

VI.1. Vehicles Requirements

62. Organizations must have the appropriate vehicles and equipment, which should be appropriate to the load requirements of the vehicle (weight, height, space for desired amount of items).

63. If organizations set up larger collections with retailers and local authorities, the quantity of items collected may require them to use larger vehicles.

64. Assess whether the vehicle requires specific storage areas and bins for items such as scrap and spares.

65. Ensure items are secured in the vehicle and are in the correct position for transportation.

Transportation by Informal Sector
(Source: United Nations University)

Well Organized Vehicles and Equipment
(Source: Community Service Employment)

VI.2. Transportation Health and Safety

66. All collection staff must be trained to handle appliances, to assess for reusability, and to handle scrap items. It is crucial that items are loaded and handled correctly so that staff is safe from injury, and damage to the appliance is avoided.

67. Damage in transit is to be avoided. Handling and loading should be in a manner that does not affect reusability. Qualifications and training in handling and transporting these appliances will be required of all drivers and assistants.

68. When loading appliances for transit, precautions must be taken to safely secure them. For example, fridges and freezers should be transported upright, otherwise they need to settle and stabilize for a much longer period before they can be tested or used. All items must be easily accessible for unloading.

69. Reusable protective wrappings should be used in preference to throwaway materials such as bubble-wrap.

70. Items should be protected by a reusable wrapping. Doors may need to be taped up.

71. Some appliances need to handle with care because the doors and seals are vulnerable. They need to be protected or subsequently they may leak radiation. It may be advisable to wrap glass turntables, and secure the doors with tape.

72. Do a risk assessment to identify the risks associated with transportation and vehicle activities. Activities that must be assessed include the arrival and departure of vehicles, their movement within the workplace, and the loading and unloading of appliances.

73. Transportation checklist:
    - Chance of people being struck or run over by the vehicles and what might cause that.
    - Risk of people falling from vehicles, for example when attempting to gain access to the vehicle or while loading or unloading the vehicle
    - Layouts of the routes to be taken are appropriate for any vehicle and pedestrian activities in the organization’s premises.

- Traffic routes for the type and quantity of vehicles are suitable.
- Vehicle safety features are provided where appropriate.
- Vehicles are suitable for the activity for which they are used.
- All vehicles undergo appropriate maintenance.
- Organizations recruitment and training ensures drivers and other staff are capable of performing activities in a safe and responsible manner.
- What drivers and staff actually do when undertaking these activities.
- Through consultation with staff that the management and supervision is suitable.
- Certain maneuvers such as reversing are carried out safely.
- Drivers take care to park vehicles in safe locations.
- All loading and unloading operations from the vehicle are carried out safely, the vehicle is parked correctly, and the load is secure and distributed evenly.

74. Provisions concerning transport operations as well as safety and health aspect of transportation for hazardous goods contain in e-waste is strongly advised to follow the United Nation Recommendations on the Transport of Dangerous Goods and United Nation Globally Harmonized System for Classification and Labeling of Chemical**.** The recommendations are available on the United Nation official website (http://www.unece.org).

VII. ASSESSMENT OF APPLIANCES FOR WORKSHOP

75. As many components as possible that affect the working of an appliance should be checked at the collection point for re-use purposes. The appliance should be functional enough to give continued use for a number of years. The resale value of the appliance and the cost of repairing and testing the appliance must also be considered.

VII.1. Assessment of Collecting Items

76. The type of machine and model offered might affect acceptance or rejection due to its reparability or whether replacement components are available. Someone in the workshop needs to have that knowledge or it needs to be written and accessible.

77. The collector must be capable of assessing the appliances for reusability and spares requirements. Appliances must come with accessories and fittings. This could mean collectors will need to be shown how to assess quickly by briefly inspecting the appliance. Collectors should pay attention to:
    - Trims;
    - Knobs;
    - Switches;
    - Broken handles;
    - Dents;
    - Scratches;
    - Twisted doors;
    - Cracked or damaged piping (on refrigerators and air conditioners);
    - Missing accessories and fittings;
    - Oven heat damage or burn marks;
    - Damaged door seals on refrigeration appliances, etc.

78. If something is not reusable it may still be salvaged for some spares. Criteria must be set for what spares are required. The collector should try to make sure all the accessories and fittings are with the appliance, even if it is scrapped, they could make another appliance reusable.

VII.2. Assessment Criteria

79. Be aware of what is currently needed for sales. In particular, many appliances may be rejected because of their age and inefficiency. The 'age' of a machine can determine its reusability. Here the quality, reparability and scarcity of spares can eliminate older machines. The type or model of appliance can also have an impact on its 'salability'. If there is no demand for such an appliance then there is little reason for refurbishing it for re-use. In many cases, certain types of appliance will have little 'resale value' and would therefore be uneconomical to repair.

80. Look at condition (visual check) and any obvious and/or incurable problems such as damaged casing, and any fixtures or components missing.

81. Any appliance should be treated at this stage as being electrically unsafe. A Portable Appliance Testing (PAT) test at the assessment stage would be an ideal test to undertake, but whether it was necessary or viable at collection is a consideration. Performing the test at this stage would only result in informing the workshop it had passed or failed the test and would require remedial work. For an appliance to fail a PAT test does not exclude it from being reused following successful repair.

82. An audible check may then be required to determine if there are any obvious faults in the mechanical or safety features of the appliance. Drum or motor bearing problems can be identified in this manner.

83. The age of a machine can determine its reusability. The quality and reparability, and the scarcity of spares can eliminate older machines.

84. The type or model of appliance can also have an impact on its salability. If there is no demand for such an appliance then there is little reason for refurbishing it.

85. In many cases, certain types of appliance will have low resale value and would therefore be uneconomical to repair.

86. The economic viability of repairing an appliance will influence assessment. For most organizations this is a key decision. Certain faults will incur a high cost to repair. If a

number of faults are diagnosed then the accumulative cost may inhibit repair. Similarly, certain components that are required would bring the cost above that of the sale price.

87. The availability of spares can make re-use unviable.

88. Where components appear to be in a good state of repair, it can be worth collecting a number of common machines. These machines could be cannibalized to build the supply of spares for this type of machine.

89. Some used appliances will have a low value based on their cost as new. The value of this appliance would therefore make it unviable to repair. Many small appliances will fall into this category.

90. Many components can be easily or cheaply repaired. The cost effectiveness of repairing these will have a bearing on the assessment.

91. In some instances, there may be local expertise other than the facility that could make use of spares for re-use.

92. The assessment findings for each appliance should be recorded on the item's respective product sheet.

VIII. TESTING AND REPAIRING OF APPLIANCES

93. The principle standard sequence of tasks in the workshop will be:
    - Visual inspection;
    - Empowered mechanical check;
    - Audible test (if appropriate);
    - Safety test or PAT test;
    - Function test;
    - Diagnose faults;
    - Repair parts or replace parts:
    - Redo function test;
    - Redo safety test or PAT test;

94. Each appliance must be traceable from the point it was originally discarded or collected to the final destination when it leaves the organization. The records kept must identify the product, track its location at any time, describe the work carried out and any outcomes from that work, note every test carried out and results, detail any alterations made to the item, the person that carried out or supervised the work, and the date this took place.

95. It is also advisable to record not only the number of appliances and components reused or sent to be recycled, but to record the weight of these items. The recording, reporting and monitoring of product information and tasks will become increasingly more prominent in the daily workflow.

96. Upon receipt of any appliance the person responsible should record on a product record sheet the type, make, model and serial number of the machine. If any initial assessment can be carried out, a record of any findings should be noted at this point.

97. When the appliance is brought to the organization's premises a qualified or trained member of staff will assess the appliance for reusability. The person will decide whether it is feasible to repair, test and reuse the appliance, whether spare components can be recovered from an appliance that cannot be reused, or whether it should be sent to be recycled as a whole product or dismantled to its component parts for separate material recycling.

98. The outcome of this initial assessment should be recorded on the product record sheet. The appliance should then be marked or labeled with its intended destination, workshop, dismantling bay, or waste collection or transportation.

99. The intended storage area of the item should be labeled at the previous stage after assessment. The designated storage bay should be clearly identified by this label, e.g. refrigeration repair workshop storage bay, refrigeration parts recovery storage bay, refrigeration Chlorofluorocarbons (CFC) recovery storage bay, or the refrigeration waste collection point.

100. As an appliance is brought into the workshop, dismantling bay or material recovery bay, the date of entry must be noted on the product record sheet before any work is carried out.

101. When the appliance is brought into the workshop, an initial PAT or mega/meter test is carried out. The results of this test must be detailed on a product test sheet. The electrical safety testing includes the results of the earth continuity test, insulation resistance test, live to earth test, and the neutral to offload test. The results of this test will be recorded on the PAT tester report (hardcopy or on computer, dependent upon the test equipment). These results should also be recorded on the product test sheet.

102. The function safety test results must also be recorded on the product test sheet. These results should detail function test results such as the full working cycle with intermittent checks, working stresses, all heating elements, thermostats and insulation, motor, compressor, pressure chamber, condenser, bearings and brushes, switches and controls, bearings movement, suspension, leakage, mechanical safety and components and accessories are in position.

103. A separate product job sheet can be set up for this report, or the product test sheet can be used. On this sheet, organizations must record the type, model, serial number and any other job number or stock control number previously used.

104. The report must detail the date when tested and record the parts fitted (new or used), record the work undertaken and record function test results.

105. The product test sheet or product job sheet should show how all faults were traced, repaired and/or replaced. All functions should be rechecked once the work is complete and the results of this should be recorded. For appliances dismantled, a record of material recovered and components taken for spares must be clearly detailed on a waste product sheet. This should indicate the amount or weight of the recovered material or component, and if the component is to be reused a code or part number should be assigned, with reference to which appliance it originated from. The report must clearly show any product or part of said product is traceable.

106. After all repairs and function tests have taken place, a final electrical safety test must be carried out, and the results of this test recorded on the product job sheet, and passed or failed clearly indicated on the sheet and appliance label.

107. The product record sheet, product job sheet, product test sheet, and/or waste product sheet must identify the final destination of each appliance. This could include: customer, scrap dealer, spares department or some other. Details indicating the specific appliance reused must be identified on the customer sheets/receipts. Records of the materials to be disposed of, the places of disposal, and the category of scrap material should be indicated e.g. ferrous, non-ferrous, mixed, plastics etc.

108. Procedures of testing sequence, general repairing and retesting, and testing and repairing of specific appliances are presented in Annex 1, 2 , and 3 subsequently.

IX. LABELING AND MARKING

109. All appliances that pass through a re-use organization must be marked or labeled with notification of the processes undergone and the item's final destination. When an appliance is collected or enters the organization, the type, make and model and serial number must be recorded.

110. The workshop's green pass label or red fail label will detail the test date, name/initials of inspection person, appliance/job number model. Appliances should be passed on with a test certificate to illustrate the tests the item went through and, if possible, it is recommended that an instruction sheet should be included.

111. Appliances scrapped for recycling should be sprayed with indelible paint marking the appliance as scrapped, and label with reason for discard (this should be a red fail label if appliance failed safety test).

112. Recover components and scrap remainder should be sprayed with indelible paint marking the appliance as scrapped, less the component recovered, and label with reason for discard (this should be a red fail label if appliance failed safety test).

113. Appliance parts and components should be labeled and placed in a bay or container specific for their type of component or material.

114. Labeling and symbols are advised to follow the United Nation Transport of Dangerous Goods and Globally Harmonized System for Classification and Labeling of Chemical (http://www.unece.org).

X. PRETREATMENT BEFORE RECYCLING AND WASTE PROCESSING

115. If an appliance is deemed un reusable, it should be separated and stored into waste appliances storage, as it is described at paragraph 30 and 48.

116. A risk assessment should be carried out on all potential hazards within the areas. A competent staff member should advise all staff of the risks and how to reduce them.

X.1. Handling of PCBs and CFCs

117. Pretreatment may involve dismantling, shredding, cutting with a torch, or compressing and compacting specific components and materials. Before an appliance can be transported to a scrap processor or recycler, environmental problems such as PCBs and CFCs must be addressed.

118. Capacitors and other components with contaminants such as mercury switches should be removed before the appliance's metal, glass and plastic parts are recycled. Some scrap metal recyclers may also require the removal of compressors, motors, insulation, ballasts and other components before appliances are accepted. Thermocouples, found in some electronic appliances, may contain mercury. Transmission oil and compressor oil pose processing problems because they may contain high levels of CFCs. These activities may require to:
    - Register for permission to operate as a hazardous waste generator;
    - Prepare a special storage area for PCBs;
    - Contract for hazardous waste disposal.

119. The removal and management of CFCs (chlorofluorocarbons) and HCFCs (hydro chlorofluorocarbons) from discarded appliances is a complex process and involves more than buying a piece of equipment to remove the CFC gas. The recovery machine must be certified and the operator must be qualified. The collection method must not damage or rupture the components that contain CFCs.

120. The release of CFCs and HCFCs into the air can result in fines. So appliances such as refrigerators and air conditioners, which may contain CFCs, need special treatment. Puncturing the refrigerant system or the insulating foam walls in transit, in landfill compaction, or in baling or shredding appliances will release the CFCs into the air, clearly something to avoid.

121. To prevent the release of CFCs from discarded appliances, CFCs must be removed from the appliances before they are crushed or baled. Extraction machines are available that can remove the CFCs from most refrigerators and air conditioners and allow disposal in accordance with regulations.

122. CFCs and HCFCs have several properties that make them ideal for use as refrigerants:
- Very low toxicity.
- Non-flammable.
- Good insulation and heat transfer.
- Low chemical reactivity.
- Good behavior with oils.
- Suitable for use with copper pipe work.
- Comparative low price and availability.

123. Appliances that contain CFC or HCFC refrigerant gases include refrigerators, freezers, air conditioners, water coolers, heat pumps and dehumidifiers. CFCs are also found in wall panel insulating foam in freezers and refrigerators, packaging, aerosols and degreasing agents.

124. The used ODSs should be collected, handled and recovered in special tools and facilities.

125. PCBs are carcinogens that do not break down in the environment. Some appliances contain electrical parts such as capacitors that have PCBs. Previously, some scrap metal recyclers found the fluff (plastic, rubber, insulation, etc.) produced when appliances were shredded, contained PCBs above the allowable levels.

126. Appliances or other items that may contain capacitors include refrigerators, freezers, washing machines, microwave ovens, televisions, heating and cooling equipment

and electronic equipment. Shredding these products could produce waste contaminated by PCBs. Running capacitors, as opposed to starting capacitors, are filled with oil that may contain PCBs to help dissipate heat. A rectangular metal casing often identifies a running capacitor. Capacitors containing PCBs must be removed and disposed of properly prior to recycling.

127. Workshops should only degas CFC R12, R22 and R502 units. Occasionally absorption refrigerators, containing ammonia R717 will be collected, these do not have a standard compressor and may be scrapped. Ammonia R717 is not harmful to the environment but is hazardous to health. Typical of these types are caravan fridges, mini-bar types, and mains gas refrigerators. It is hazardous to open these systems without proper personal protection.

128. Facilities is also advised to be aware of the Guidance on the Recovery and Disposal of Controlled Substances Contained in Refrigerators and Freezers. This guideline can be found in the website of SEPA.

X.2. Refrigerant Recovery

129. Workshops should have to ensure any refrigerant collected for discarding is correctly degassed before disposal.

Waiting for Refrigerant Recovery
(Source: Consultant Document)

130. Workshops are required to conform to correct procedures and reporting of the transfer of controlled waste under the duty of care regulations.

131. Workshops should have to apply to register as a handler of refrigerant.

132. Personnel must be qualified to recover refrigerant and be competent at using the recovery equipment.

133. Workshops must ensure any third party who transports or takes receipt of the recovered refrigerant on their behalf is qualified, registered and authorized to do so. It is part of duty of care to ensure this happens.

134. The degassing of refrigerant can be undertaken at a number of sites. These will most likely be at civic amenity sites, prior to disposal at workshops, or at households upon collection.

135. Equipment required for refrigerant recovery:

- Refrigerant recovery machine.
- Mains power supply or
  generator if working on site.
- Generator.
- Inlet hose.
- Discharge hose.
- Gas recovery cylinder.
- Mains cable and plug.
- Piercing pliers.
- Protective gloves.

136. Procedures for refrigerant degassing and recovery are following respectively:

- Operation of recovery machines varies, therefore the manufacturer's instructions must be followed at all times.
- Any operator carrying out CFC recovery should have proper training and a CITB Safe Handling of Refrigerants certificate.
- Ensure that there is safe access to the premises or site.
- Ensure there is a safe distance between the operation of the machinery and any member of the public.
- Observe safe lifting practices as detailed previously in this guide. Do not allow any unauthorized person to lift the appliance.

- Always take care when handling pressurized gases.
- Avoid skin contact with refrigerant.
- Wear appropriate eye protection, clothing and gloves when handling refrigerant.
- Only a trained operator should recover refrigerants.
- Recovery equipment must be earthed.
- Make a pre-operation inspection of all equipment.
- Ensure the generator is at least one meter away from other equipment.
- Never overfill a gas recovery cylinder. Fill only 80 per cent of the cylinder's volume with the liquid, allow for expansion.
- Never use disposable refrigerant cylinders.
- If compressor burnout is suspected, carry out a test for acid. If recovery is still to be carried out, fit a burnout filter to the hose during recovery.
- Check the level of compressor oil before using equipment.
- Clamp on to the copper pipe only. This should be clamped at either the short pinched pipe protruding from the compressor or the curving evaporator pipes.
- Turn the recovery unit on.
- The pressure dial on the unit will show a maximum reading and this will drop as the gas is drawn out. Gauges on the recovery machine vary but will usually show the pressure in the equipment and the pressure in the system of the refrigerator being degassed.
- The system should be evacuated until a vacuum is shown.
- Shaking the appliance or the compressor will help release refrigerant dissolved in the compressor oil. The unit will indicate when the gas has been evacuated. Shake the appliance to release the remaining gas.
- Continue recovery until the appliance is fully degassed and the gauge indicates the appliance is empty of refrigerant.
- Turn the unit off and disconnect clamp and inlet hose.
- Let the unit continue to run to let any remaining gas pull through the unit into the cylinder.
- After degassing, each appliance must be marked as approved.
- Record the details of number of appliances degassed and the quantity of refrigerant recovered.

137. The workshop degassing and recovering the refrigerant must ensure safe transportation of all gas cylinders to a certified receiver of recovered, liquefied

gases. This receiver should operate a bulk collection service for recovered refrigerant and ensure the gas is correctly sent for reprocessing or destruction. The receiver should accept return of used refrigerant of single grade, and mixed grade.

138. The receiver should also provide empty gas recovery cylinders with a label for recording the grade of refrigerant contained, the weight, and the recovery organization's name. The recovery organization must complete a Controlled Waste Transfer Note with any delivery of gas. The weight of the gas must not exceed the amount or percentage of overall weight designated by the receiving service.

XI. DISMANTLING END-OF-LIFE APPLIANCES

139. Current practices at workshops do involve some dismantling of appliances in order to recover reusable spare parts, but in some countries this does not at present come under any scrutiny by regulators. The legislation of a country should result in industry and the regulators setting standards and codes of practice for the dismantling of waste appliances. It is therefore advisable that all workshops try to meet expected guidelines and become accredited.

140. A workshop where the main work is the repair of white goods, is not generally considered to be waste recovery operator. It follows that such refurbisher not carrying out a waste disposal operation or waste recovery operation would not need to inform the environment agency of a country. If a refurbisher cannot refurbish a machine, and sends that machine for recycling, the refurbisher would not need to be licensed. However, if a refurbisher was dismantling a significant number of machines on its premises to obtain spare parts, this could be seen as a recovery operation, which would mean the refurbisher would need to obtain a license.

141. All large domestic appliances have been deemed recyclable due to the size and weight, and the composition of the pressed steel used for their structures. They have therefore historically been a good source of steel for recycling. In addition, they have historically been reliant upon electrical systems rather than electronic. This results in simpler control systems with few electronic printed circuits. New processes for recycling will be required. These requirements should be seen as an opportunity for the re-use sector to offer new services and consequently gain better quality and more appliances, and a wealth of spares for repairs. The following are some of the requirements:

- The techniques for the dismantling of appliances must be optimal. Data should be collected to inform product designers about making recycling more efficient.
- The dismantling of appliances should provide components that can be used as spares.

- The components must be separated and stored based on the material composition and waste specification.
- Motors should be recycled because they contain valuable metals that can be extracted.
- Wiring contains copper, which has an intrinsic commercial value.
- Materials of a commercial value must be retained for sale.
- Low-value waste material should be collected for processing.

142. The technical skills and repair experience available within the workshop are valuable when embarking upon the new activity of appliance dismantling. For the country, which the codes of practice are made available for this activity, the organization must ensure any component or material from a stripped-down appliance, must comply with the new codes.

143. The main criteria for dismantling are:

- Are the activities to save money by reusing components?
- What are the faults found in the appliance?
- What is the condition and age of the appliance?
- Is it economically feasible to dismantle and recover any value from parts and materials?
- Do any pretreatment operations require the appliance to be dismantled?
- Is there a market for the material recovered?

144. Following recommendations are subjected for health and safety:

- Ensure the appliance is disconnected from the electricity mains.
- Disconnect all other services, such as water.
- Place rubber matting in the dismantling bay.
- Wear gloves and safety glasses.

Unsafe Dismantling Activity
(Source: Consultant Document)

145. Manual dismantling should be performed in order to reuse, recover and recycle the components of personal computer. Dismantling is better to be conducted manually for the purpose of:
   - The directly reusable components of personal components can be separated beforehand.
   - Materials obtained from recovery process have the high quality.

XI.1. Refrigerator

146. Components of refrigerator which can be separated are:
   - Compressor
   - Power cord
   - Condenser
   - Tray and case
   - Refrigerant CFCs

XI.2. Washing machine

147. Components of washing machine which can be separated are:
   - Motor
   - Condenser
   - Printed circuit board (low grade)
   - Power cord
   - Drainage hose
   - Washing tank and lid
   - Salt water

XI.3. Television (TVs)

148. Components of TV which can be separated are:
   - Demagnetized coil
   - Power cord
   - Printed circuit board (low grade)
   - Deflection yoke
   - Transformer
   - Speaker
   - Cabinet
   - Cathode ray tube (CRT)

XI.4. Personal computers (PCs)

149. Components of personal computer which can be separated are:

- CPU cover
- Power supply
- Cables
- Copper yoke
- Printed circuit board (high grade)
- Printed circuit board (low grade)
- Steel breakage
- Monitor cover
- Cathode ray tube (CRT)

XI.5. Air conditioner (AC)

150. Components of air conditioner which can be separated are:

- Heat Exchanger
- Condenser
- Printed circuit board (low grade)
- Compressor
- Copper pipe
- Power cord
- Motor
- Refrigerant CFCs
- Freezer oil

XI.6. Fluorescent lamp

151. Components of Fluorescent lamp which can be separated are:

- Mercury
- Phosphor
- Steel
- Aluminum
- Plastic
- Glass

152. The processes of recycling fluorescent lamps are shown in the Annex 7C.

XII. ENVIRONMENTAL CONCERN

153. Activities of reduce, reuse, recycling, repair and refurbishment will produce some residual, as the last resort, that need to be landfilled or incinerated or specific treatments. Different process residuals may require different measures to be taken both on-site and off-site. Accordingly, facilities should first characterize their process residuals, using testing or knowledge of the materials and process used at the facilities.

154. The facilities should ensure that residuals are delivered to landfill or incinerator that is suitable for specific residual, properly authorized by relevant regulators, well-maintained, and well-operated. Any residuals qualify as hazardous waste will be subject to stringent requirements for design and operation of units, labeling, manifesting, transport, pretreatment, and delivery to a permitted hazardous waste facility.

155. Facilities should also be aware of the other Basel Convention technical guidelines which are associated with the characteristics and handling of hazardous waste. Such guidelines are available from (at) the Basel Secretariat.

XII.1. Substances of Concern

156. Antimony: is a component in lead solder. CRTs of TV and PC monitor may contain antimony in the screen and/or cone glass.

157. Barium oxide: is contained in the getter plate of the electron gun of CRTs; some of the barium oxide from the getter becomes deposited on the interior surface of the screen and cone glass.

158. Beryllium: there is a small amount of beryllium, in the form of a copper-beryllium alloy (typically 98% copper, 2% beryllium) in the motherboard (printed circuit board), in the slots used for connection to daughterboards.

159. Cadmium: there is a small amount of cadmium in plated contacts and switches, and a very small amount of cadmium may have been used as a stabilizer in PVC wire insulation, which may have been used in a personal computer. Laptop computers often contain rechargeable nickel cadmium (Ni-Cd) battery.

160. Chlorine and/or Bromine: organic halogenated (brominated) flame retardants and inorganic flame retardants (e.g. antimony chloride) may be present in the plastic in printed circuit boards and cases. There is chlorine in any PVC insulation of wires and cables used in an electronic appliance.

161. Lead: there is a substantial amount of lead in the CRTs. As a rough average perhaps two to three kg in older models and 1 kg in new models, encapsulated in the form of leaded glass. There is also a much smaller quantity of lead in printed circuit boards in an electronic appliance, in the form of solder. Some portable (laptop) computers contain a sealed lead acid battery. Although these substances can present risks in recycling or disposal of used personal computers or TV, it is important to note that some of these substances are present in personal computers and TV for the purpose of lowering risks to human health during product use. These include the use of lead shields in CRTs to protect users from harmful x-rays and the use of flame retardants in plastics to reduce the risk of overheating and potential fires. There is no technical substitute for lead in the CRT glass.

162. Lithium: may be present in a small battery on printed circuit board an electronic appliance.

163. Mercury: in large flat panel displays, a small amount of mercury may be present in a lighting device used to illuminate the screen.

164. Phosphors: a phosphor coating, typically zinc sulphide and rare earth metals, are used on the interior of a CRTs screen of TV and PC monitor to convert the kinetic energy of an electron beam to light. However, cadmium sulphide has also been used in older CRTs. Phosphor is also component of fluorescent lamps.

165. PCBs: are principally used as a safe and effective cooling and insulating fluid for transformers and capacitors. PCB's have also been used as fire retardants and in lubricating oils and to improve the waterproofing qualities of surface coatings (e.g. paints).

XII.2. Exposure to substances of concern

166. Nearly all of the substances of concern in an electronic appliances are in solid non-dispersible form, and there is no cause for concern for human exposure or release into the environment in ordinary use and handling of electronic appliances. None of these substances will be released from electronic appliances through normal contact, including transportation and manual disassembly.

167. Human health and environmental concerns related to the presence of these substances in electronic appliances arise if this used equipment is land disposed or incinerated. In addition, concerns are present in certain reuse and recycling scenarios, for example, when its component parts are harvested using certain methods (such as melting of solder) or subjected to processing for metal or plastic reclamation using methods such as shredding, grinding, burning and melting. All of these exposures can be mitigated through appropriate.

168. Antimony: contained in the screen glass, may leach out under certain land disposal conditions;

169. Barium oxide: as dust, can be released during the dismantling and handling of CRTs of TV and PC monitor.

170. Beryllium: in a copper-beryllium alloy, may be released as beryllium oxide dust or fume during high temperature metal processing.

171. Cadmium: the small amount of cadmium in plastic may be released in the form of cadmium oxide dust if the plastic is burned prior to or in the course of metal reclamation. Cadmium in plated metal contacts and switches may be released as cadmium oxide dust or fume during high temperature metal processing. Incineration may also result in releases of cadmium to the environment.

172. Chlorine and Bromine: in plastics as brominated fire retardants, or chlorine in PVC insulation, may recombine with carbon and hydrogen in various disposal or recovery processes that involve heat, such as combustion or plastics extrusion, to form other halogenated organic compounds of environmental concern, particularly the chlorinated or brominated dibenzodioxins and furans.

173. Lead: in a CRT or printed circuit board, may leach out of the leaded glass under certain land disposal conditions. Incineration can result in release of lead to the air as well as deposition of lead in the ash, which is then land disposed. The lead in a printed circuit board may also be released in the form of lead fume if the board is heated to facilitate harvesting of components, or in the form of fine particulate if the board is burned or shredded prior to metal reclamation. The lead in a CRT or a printed circuit board may be released as lead oxide dust or lead fume during high temperature metal processing, such as smelting.

174. Lithium: in a battery, will be released if the battery is shredded with the circuit board to which it is attached. When released, it may react with oxygen and moisture, generating heat and potentially causing fire.

175. Mercury: can be released from certain flat panel displays upon the shredding and subsequent handling of this equipment. Landfilling and incineration of flat panel displays can also result in the release of mercury to the environment.

176. Phosphors: cadmium in the phosphor coating of some older CRT screens could present an inhalation hazard to workers in CRT glass breaking operations. Cadmium can also be leached in a landfill environment.

XII.3. Circuit boards and board components

177. Printed circuit boards are particularly valuable components of a used PC and other electronic appliances, as they may contain marketable chips that can be removed and sold for reuse, and because they contain valuable metals that can be recovered in a smelter. Dismantling facilities that recover marketable chips utilize heat to soften the solder holding the chips to the printed circuit boards. In this heating process, lead contained in the solder is emitted as a fume and must be captured to protect both workers and the environment. Equipment for the capture of the lead fumes includes the use of vacuum hoods and filters for removal of lead from the exhaust. The facility license should specifically address these required safeguards at facilities where the heating of lead solder is utilized.

178. Printed circuit boards contain a substantial quantity of copper and valuable concentrations of gold, silver and palladium. These metals are usually recovered through copper smelting followed by metal-specific refining. In almost all respects printed circuit boards serve as a substitute for primary copper concentrates from ore, because they contain not only a high concentration of copper, but also contain many other metals commonly found in copper ore, such as lead, cadmium, gold and silver.

179. Because of high economic value, a batch of circuit boards is often processed in advance of smelting, by shredding and burning of some or all of the batch at suitable facilities, in order to obtain a representative sample and metal assay. The shredded boards and components and ash are then smelted.

180. Shredding of circuit boards gives rise to dust, of which some fraction will be the metals of concern. Burning of circuit boards, whether before or during smelting, gives rise to concern regarding the release of these metals in furnace exhaust emissions, as well as the release of other products of combustion. Facilities that shred and/or burn printed circuit boards and non-ferrous smelters require attention to these concerns. Workers require training in management of hazardous materials (e.g., handling of dusts and ashes), as well as personal protection from exposure. Furnaces require proper furnace combustion conditions (e.g., temperature, residence time, oxygen levels), and furnace emission control systems appropriate for their feed stocks (such as acid gas scrubbers and particulate controls, or both). The facility permit regarding air emission controls should specifically authorize the processing of electronic scrap.

181. The presence of halogens (chlorine and bromine) in plastics which will be burned during metal recovery raises concerns which differ from those most commonly associated with copper ores. Attention must be given with such electronic scrap feedstock to the possibility of creation of dibenzofurans and dioxins in burning processes. Complete thermal destruction of hydrocarbons will substantially reduce the possibility of formation of dibenzofurans and dioxins in the furnace emission stream. Halogens will be converted to acids, and then to salts in an acid gas scrubber. Dioxin emission measurements would guarantee the efficiency of specific measures or gas cleaning units.

XII.4. Batteries

182. A personal computer and other electronic appliances motherboard contain a small battery to maintain electrical energy to computer settings such as the time and date. By far, the most common type is a lithium cell, approximately the size of a small coin, and referred to as a coin cell. A coin cell contains less than a gram of lithium, encased in solid form as the anode.

183. Batteries used in portable (notebook/laptop) computers and ether electronic appliances include rechargeable nickel cadmium (Ni-Cd), nickel metal hydride (NiMeH) and lithium ion batteries. Some lead acid batteries are also used. These batteries are all removable by hand, and should be removed in the dismantling process and then sorted by type. All battery cells shall be managed to avoid inadvertent external short circuits and current flows. Large inventories of batteries should be avoided, and batteries that cannot be reused, should be sent for metal reclamation. Ni-Cd and NiMeH batteries can be recycled for recovery of nickel, and for recovery of cadmium. Lithium ion batteries do not have the fire hazard problem associated with lithium metal batteries because the lithium is in the stable form of lithium hydroxide. Care should be taken by workers if lithium ion batteries are opened or broken, as lithium hydroxide is somewhat corrosive. The lithium contained in these batteries can be recycled.

184. The coin cell should be removed from the motherboard prior to shredding. If a cell remains on a board, the shredding operation should open the cell, exposing the lithium anode. If some of the lithium is un reacted, it may then react with oxygen in the air or with moisture, generating heat and, potentially, hydrogen gas. A fire may be started immediately in the shredding operation, or the lithium may smoulder and a fire may occur at a later time. Such a fire, in the midst of burnable circuit board fragments, may be difficult to control, and may cause hazardous air pollution.

185. A facility, which shreds printed circuit boards, requires visual inspection of motherboards for the presence of a coin cell, and removal if a cell is present. A coin cell may be removed without tools if it has been inserted into a mechanical holder. If, as in more recent electronic appliances, the coin cell has been soldered onto the board, hand tools will be required for removal.

186. Once separated, coin cells should not be accumulated in quantity without physical separation from each other, so that uncontrolled electrical discharge will not occur. Coin cells may be thermally processed with other components of an electronic appliance, as always with appropriate combustion and emission controls. A lithium coin cell does not present an additional problem in combustion or smelting. A coin cell cannot be recharged, but its lithium can be recovered, after it has been fully discharged to eliminate potential reactivity, by shredding and gravity separation.

187. More detailed information regarding with the handling management of used lead acid battery could be seen in the specific guideline, which is available in the official website of the Basel Convention. (http://www.basel.int/pub/techguid/tech-wasteacid.pdf).

XII.5. Capacitors

188. Capacitors are also present on the circuit boards of electronic appliances and are solid-state devices. Small electrolyte capacitors, still used in electronic appliances, may contain corrosive liquids and therefore are classified as a hazardous component by some countries.

189. There is some concern that PCB capacitors may have been used in personal computers and other electronic appliances in the past. Although their historic use in electronic appliances is not clear, it is known that PCB capacitors have been used in larger computer equipment such as mainframes and large printers.

190. Electrolyte capacitors can be sent for metal recovery. PCB capacitors and electrolyte capacitors not sent for metal recovery should be thermally treated in a state-of-the-art facility.

XII.6. Light emitting diodes

191. Light emitting diodes (LEDs) are also present on some of the circuit boards in personal computers. It is required to remove LEDs from the circuit boards, as they contain gallium arsenide.

XII.7. Cathode ray tubes (CRT)

192. A CRT contains by far the greatest amount of all substances of concern in a personal computer and TV. An older polychrome CRT can contain some 2-3 kilograms of lead, while a new one typically contain no more than 1 kg of lead. The cone glass (or funnel glass) contains about 20-24% PbO, the neck glass about 28-30 % PbO and the glass frit about 80% PbO, whereas the screen glass (or panel glass) normally contains no lead. The lead is encapsulated in glass, and cannot be released unless and until the glass is broken. However, the glass must be broken into relatively small pieces before significant levels of lead would be available for release into the environment. A CRT will also contain a small amount of copper in its yoke and internal wiring, but little if any other metal value. There are several options for environmentally sound management of the leaded glass in a CRT.

193. The leaded glass in a CRT can be recovered in new CRT manufacture. This can be done by removal of all non-glass components of the CRT, including the plastic monitor case, CRT yoke and electronics. These steps require aeration (release of the vacuum) by drilling into the CRT. This may be followed by the breaking of the bare CRT and careful separation of the glass parts, i.e., the faceplate, funnel and neck, according to their respective lead concentrations (which vary from CRT to CRT). Workers should be protected from inhalation of dust that may contain lead or barium oxide because of CRT breaking.

194. The CRT glass is cleaned and the phosphor coatings are removed. The cleaned, leaded glass fractions, with assayed lead concentrations, can then be used as a feedstock in the manufacture of new leaded glass components in the CRT manufacturing industry.

195. The lead in a CRT can also be recovered as lead by a lead smelter. This requires preliminary disassembly, particularly removal of the plastic monitor case, because lead smelters do not usually have pollution control systems suitable for burning of plastic. The glass also serves as a silicate flux in the lead smelting process, and is a substitute for silicate which the smelter would otherwise acquire and use. The glass used for lead smelting may be mixed and dirty CRT glass which is generally not acceptable by CRT glass manufacturers.

196. The leaded glass in a CRT can also be used as a silicate flux by a copper smelter, again as a substitute for silicate which the copper smelter would otherwise acquire and used. The copper smelter may also have a subsequent procedure in which the by-products from copper smelting and electro refining are treated for lead recovery. A copper smelter may also have a pollution control system, which permits it to burn plastic, and, therefore, may be able to treat the monitor from a personal computer and TV monitor without preliminary disassembly.

197. If the lead in a CRT is not recovered as leaded glass, but instead is placed in a smelting process, some or all of the lead may remain in the slag produced in that process. Lead in silicate slag is immobilized and may be disposed of in an environmentally sound and appropriately authorised landfill. Such disposal will require specific licensing by the competent environmental authority with oversight responsibility for the smelter.

198. Practices that would be considered as non-environmentally sound include the use of leaded CRT glass in construction materials (as a substitute for sand) and its use as blasting grit or other abrasive material. The use of CRT glass in making tiles and other ceramics are considered as non-environmentally sound. The contamination of other glass which does normally not contain lead, especially container glass, should be avoided. Lead free CRT-screen glass could be used e.g. in building products (e.g. mineral wool).

XII.8. Phosphors

199. The phosphor coatings on CRT glass can present an inhalation hazard if managed in a dry state. Wet processes are often used to remove the phosphors. The phosphors ultimately require either thermal treatment for destruction or stabilization prior to secure disposal in an environmentally sound and appropriately authorised landfill or storage in an adequate underground storage facility. Glass fines and filters generated during the cleaning process can be sent to a lead smelter.

XII.9. Getter

200. The electron gun of the CRT of PC monitor and TV contains a small getter plate, weighing approx. 1-2 grams including frame and bears barium and barium compounds (barium oxide is classified as a harmful substance). The getter should

be stored separately, any contact with water or humid air should be avoided as barium reacts with water and disintegrates (leachate; easily soluble). Preferably, the separately collected getters should be sent to an underground storage facility or incinerated in an environmentally sound and appropriately authorised incinerator with modern flue gas cleaning systems.

XII.10. Flat panel displays and portable computers

201. Flat panel screens and portable computers contain liquid crystal displays, which should be either sent for recovery operations (recently glass recovery involving the catalytic destruction of liquid crystal substances has started) or thermal treatment at an environmentally sound and appropriately authorised incinerator with modern flue gas cleaning systems.

202. The liquid crystal displays of a surface area greater than 100 cm2 should be managed separately as they are back-lighted with gas discharge lamps containing mercury. If these discharge lamps are removed, they should be sent to a specialised mercury recovery facility or to an environmentally sound and appropriately authorised hazardous waste incinerator with modern flue gas cleaning systems including iodated activated carbon filters or equivalent measures guaranteeing separation or immobilisation of mercury.

203. Portable computers (excluding batteries and, if applicable, gas discharge lamps containing mercury) can be sent to a smelter for recovery of non-ferrous metals on the condition that the smelter is equipped with flue gas cleaning systems for minimizing dioxin emissions and for separation or immobilization of mercury (e.g. iodated carbon filters). To increase the recycling rate, it is suggested that circuit boards and casings could be removed prior to processing.

XII.11. Insulated wire

204. Insulated electrical wire accompanying electronic appliances, such as its power cords, may be covered with polyvinylchloride (PVC), or with a plastic elastomer, or with some other plastic. The substance of concern is PVC, because of its chlorine content. In the past, the insulation was removed by burning, sometimes in uncontrolled combustion. This shall not be considered environmentally sound,

because the burning may be incomplete, emitting a variety of particles of incomplete combustion, and chlorinated dibenzofurans and dibenzodioxins may form in the exhaust emissions.

205. Insulated electrical wire should be separated from electronic appliances if the wire is accessible during dismantling, such as with computer power cords. It is not practical, however, to attempt to remove all insulated wire from the inside of an electronic appliance. The separated wire should then be shredded or chopped (or both) to a relatively small size (typically between one to ten centimetres in length). It can then be burned under controlled combustion with an air emission control system designed to prevent formation of chlorinated dibenzofurans and dibenzodioxins. Shredded or chopped wire can also be granulated to separate the insulation from the copper. The resulting mixed material can be separated by a variety of physical means, using water or air. The entire process, when properly executed, will produce clean copper and a plastic fraction, which is suitable for recycling in plastic. Other options for the separated plastic, although lower in waste hierarchy, include burning for energy recovery in an environmentally sound and appropriately authorised incinerator with modern flue gas cleaning systems and deposit residues on an environmentally sound and appropriately authorised landfill.

XII.12. Ferrous- and non-ferrous metals

206. In addition to the recovery of metals from circuit boards, as discussed above, both ferrous and non-ferrous metals from other components of used electronic appliances should be recovered. For example, refrigerator contain substantial quantities of steel, aluminium, copper and other non-ferrous metals that can be relatively easily separated from other refrigerator components, using manual or mechanical means. These metals can be sold to smelters who should be equipped with state-of-the-art flue gas cleaning systems.

XII.13. Plastics

207. Plastics (such as equipment casings and bases) are the one major category of material components for which recycling opportunities are currently quite limited. This is because (1) numerous resin types are used in electronic appliances equipment, (2) plastic parts are not labelled according to their type and (3) the presence of chlorine and bromine compounds in some of the plastics requires measures for the protection of human health and the environment in operations

where these plastics are shredded or heated. A wide variety of brominated flame retardants have been used as additives to some of the plastic components in an electronic appliance. Thus, opportunities for recycling need to regard not only the particular resin types of the various parts, but also the types of flame retardants that are present in the plastics, as the safety of the recycling may be affected.

208. When hard plastic components containing brominated flame retardants are shredded, workers can be exposed to dust containing these chemicals. Thus, workers in shredding areas should be protected through adaptations in shredder design, air flow controls, personal protective devices or a combination of these measures.

209. After preliminary processing, the recycling of plastics involves extrusion to make new products. The use of heat in the extrusion of plastics containing brominated flame retardants can cause the formation of brominated furans and dioxins. Thus, operations that involve the recycling of plastics from used PCs need to be carefully reviewed by the competent authority during the facility authorisation process

210. Further information about environmentally sound management and disposal of plastics can be found on the Basel Convention technical guidelines for the identification and environmentally sound management of plastic wastes and for their disposal.

XII.14. Polychlorinated biphenyls (PCBs)

211. Polychlorinated biphenyls (PCBs) are stable synthetic chemical compounds that are fire - resistant, do not conduct electricity, and have low volatility at temperatures below 40^{o}C. These properties make them effective for industrial applications. Shredding the item that may contain capacitors include refrigerators, freezers, washing machines, microwave ovens, televisions, heating and cooling equipment and electronic equipment produce waste contaminated by PCBs.

212. Adverse effects of PCB's on human health occur when PCB's enter the body by ingestion and absorption, and indirectly by inhalation. Health effects range from acute to chronic depending on varying levels of exposure and have the potential to bioaccumulate in higher organisms. Dioxins and furans are produced from

incomplete burning of PCB's. Many adverse health effects have been associated with inhalation of trace amounts of these chemicals.

213. Information related with the handling of PCBs is also available on the Basel Convention general technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (POPs)

XIII. TRANSBOUNDARY MOVEMENT

214. Hazardous waste contained in e-waste and other wastes should, as far as is compatible with their ESM, be disposed of in the country where they were generated. Transboundary movements of such wastes are only permitted under the following conditions:

(a) If conducted under conditions that do not endanger human health and the environment;
(b) If exports are managed in an environmentally sound manner in the country of import or elsewhere;
(c) If the country of export does not have the technical capacity and the necessary facilities to dispose the wastes in question in an environmentally sound and efficient manner;
(d) If the wastes in question are required as a raw material for recycling or recovery industries in the country of import; or
(e) If the transboundary movements in question are in accordance with other criteria decided by the Parties.

215. Any transboundary movements of e-waste is subject to prior written notification from the exporting country and prior written consent from the importing and, if appropriate, transit countries. Parties shall prohibit the export of hazardous wastes and other wastes if the country of import prohibits the import of such wastes. The Basel Convention also requires that information regarding any proposed transboundary movement is provided using the accepted notification form and that the approved consignment is accompanied by a movement document from the point where the transboundary movement commences to the point of disposal.

216. Furthermore, hazardous wastes and other wastes subject to transboundary movements should be packaged, labelled, and transported in conformity with international rules and standards.

217. When transboundary movement of e-wastes to which consent of the countries concerned has been given cannot be completed, the country of export shall ensure

that the wastes in question are taken back into the country of export for their disposal if alternative arrangements cannot be made. In the case of illegal traffic, the country of export shall ensure that the wastes in question are taken back into the country of export for their disposal or disposed of in accordance with the provisions of the Basel Convention.

218. Transboundary movements of hazardous wastes and other wastes are not permitted between a Party and a non-Party to the Basel Convention unless a bilateral, multilateral or regional arrangement exists as required under Article 11 of the Basel Convention.

219. Manifest system and documentation should be adopted in the transboundary movement of e-waste and such documentation better as according to the international standard.

220. Procedure to determine used electronic appliances, proposed for export, is or is not hazardous waste is presented in the Annex 7D.

XIV. EXISTING ADVANCE RECOVERY TECHNOLOGY

221. Annex 6, 7A, 7B, and 7C present the flow of recovery process of used electronic appliance components for recycling of raw materials. The process starts with manual dismantling of electronic appliance components as described in Section XI. After manual dismantling, the used electronic appliances components are sent to crushing (shredding), cleaning, and separating processes.

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ANNEXES

ANNEX 1

TESTING SEQUENCE

1.1. The tests should ensure the manufacturer's instructions, if available, are followed. Each test should be satisfactorily completed before proceeding to the next test. The work shall be carried out in the following sequence:

- Visual inspection.
- Electrical safety tests prior to function test.
- Function test.
- Electrical safety tests after function test.
- Recording of work.

1.2. Parts that affect safety should be checked to ensure they are not visibly damaged or unsuitable for the appliance. Some of the parts to check are:

- Fuses, especially their values;
- Plugs;
- External flexible cords;
- Strain relief devices and cord guards;
- Barriers preventing access to live parts, body panels and covers must be secure;
- Pressure relief valves;
- Markings providing safety information, for example ‘this appliance must be earthed’ labels.

1.3. If damage is found, corrective action of repairing or replacing the component has to be taken before testing the appliance.

1.4. External and internal inspections and inspection before connecting to electricity supply should be based on the manufacturer's instructions of specific appliance.

1.5. The measuring instruments used for testing should be maintained in accordance with the specifications of the instrument manufacturer. When using a measuring instrument, the operator should not be exposed to any danger. If mains operated measuring instruments are used, the measuring circuit of the instrument should be isolated from the supply mains and earth.

A. Electrical safety test before the function test

1.6. The following tests should be done for electrical safety tests before function test:

- Earth continuity
- Insulation resistance
- Live to earth
- Current leakage load test
- Neutral to offload test.
- Check where possible that internal wiring is intact. It may have been previously worked on and done poorly, or non-standard parts may have been fitted.

1.7. The earth continuity test only applies to class I appliances (Annex 5). It is carried out with the appliance isolated from the supply.

1.8. The connections between the various earthed parts should be checked as far as possible without further dismantling of the appliance. It may be necessary to tighten connections to ensure good continuity.

1.9. Earth continuity is checked by measuring the resistance of the circuit using an appropriate instrument. The open-circuit voltage of the measuring instrument should not exceed 24 V or be less than 4 V. It may be AC or DC. The current should not exceed 10 A or be less than 0.2 A. The appropriate instrument is usually a good multimeter, dual range insulation tester, or PAT tester. The earth resistance is measured between accessible conductive parts, which can become live in the event of a fault. Resistance should be measured from the:

- Earth pin of the plug for all plug connected appliances;
- Earth terminal of the appliance or any earthed part nearby for appliances with fixed wiring.

1.10. During the test, flexible cords should be manipulated to check for any breakage of the conductors. If the appliance is connected to earth by additional paths, for instance water connections, it may be necessary to disconnect the earth at the terminal in order to avoid false readings. Any faults have to be corrected before testing the appliance for insulation resistance.

1.11. The insulation resistance test is carried out with the appliance isolated from the supply. If the appliance is normally immersed in water, it is covered with water while the test is being carried out. All switches and controls are to be in the closed position in order to ensure all the insulation is covered by the test. It is carried out with the appliance isolated from the supply.

1.12. The insulation resistance test should not be carried out if the appliance contains parts that could be damaged if they are subjected to 500 V DC. All domestic white goods in general circulation can withstand this test.

1.13. If parts of the circuit require the appliance to be energized before they are connected to the supply, e.g. relays, such circuits will not be covered by the test. It may be necessary to test these circuits separately. In particular, the time delay door switch and lock fitted to many washing machines could be energized by connecting the machine, switching on briefly, and then disconnecting and testing within a minute or so.

1.14. The measuring instrument shall have a minimum DC output voltage not less than 500 V and not more than 550 V with a load resistance of 0.5 Mega-Ohm. Most insulation testers and also PAT testers conform to this standard.

1.15. The test is carried out between the input terminals connected together and accessible metal parts of the appliance.

1.16. If the relevant value is less than that stated, there is an insulation fault within the appliance. The fault has to be corrected before function testing the appliance.

B. Function test

1.17. The tests above are not enough to allow the appliance to go to a customer. Workshops must prove the appliance is safe and fit for its purpose. The appliance must be tested to ensure it is fit to do what it was designed to do.

1.18. A function test should be carried out to simulate the normal use of the appliance. If there is any indication of a fault affecting safety, the test should be stopped immediately and the appliance re-examined before proceeding.

1.19. The sequence of the function test is:

- Do function test – full cycle of machine with intermittent checks throughout cycle;
- Look for working stresses;
- Trace faulty components;
- Repair or replace faulty components;
- If fault treated, retest all functions.

1.20. If the appliance has different specific items to be checked, do appliance-specific test and better to do the test based on the manufacturer's instructions.

C. Safety labels

1.21. If the inspection of the appliance indicates a safety marking is damaged or missing, action should be taken. This may require the replacement or renewal of labels or the information they contain. Examples of markings that should be corrected are missing warning labels on covers and worn markings on rotating control knobs.

1.22. The results of all the tests should be recorded. If the appliance is in an unsafe condition, it should be clearly labeled accordingly and moved out of the testing and repair area.

ANNEX 2

GENERAL REPAIRS AND RETESTING

2.1. The sequence which will most often follow is:

- Electrical test and/or performance test of machine;
- Find and remove faulty part;
- Replace with suitable part (used or new);
- Check fault is resolved;
- Retest;
- Check for other faults, which may have been hidden by the first fault.
-

2.2. Diagnosis is different for each type and model of appliance. Some of the techniques and tools include:

- Working from first principles, making a logical evaluation of performance and thereby tracing faults;
- Function and performance testing followed by instrument testing and fault finding;
- Assessment of condition through visual and audible checks;
- Analyzing mechanical function and physical damage to the appliance or components;
- Analyzing pneumatic and hydraulic operations of the appliance or components;
- Portable appliance testing (PAT) for electrical safety;
- Metro test equipment, clamp ammeters are useful to determine correct earthling of each element.

2.3. Replacement parts should not alter the function and safety of the appliance. The re-use of recovered spares is encouraged, but a thorough checking of safety and fitness for use must be carried out. Some parts must be new because it would false economy or bad practice to fit a used part; these include belts, seals, and hoses.

2.4. Appliance components are connected in various ways and therefore the intricacy of their removal and replacement can vary. Many parts are fixed by nut and bolt, or screw, with pull-off electrical tags for the connectors. Some components are soldered and would need to be desoldered with a soldering iron and desoldering device.

2.5. Some of the physical ways parts are attached include:

- Nuts, bolts, screws, rivets and clips;
- Pipe work with clips, and terminators;
- Wiring held by connection blocks, screws, plugs and sockets.

2.6. Mechanical alteration could be done if:

- They are only minor;
- The safety can be guaranteed
- They will still conform to the manufacturer's specifications.

2.7. Following is a list of the common tests that need doing after the repair or replacement of an appliance:

- Perform full PAT test, if applicable to product type.
- Insulation test.
- Earth bond resistance test.
- Current leakage load test.
- Flash testing (if necessary).
- Fuse testing.
- If the appliance passes the tests, label it to make that clear.

ANNEX 3

TESTING AND REPAIRING OF SPECIFIC APPLIANCES

A. Refrigeration system (Refrigerator and AC)

3.1. Visual inspection of refrigeration system includes:

- Cabinet: damage, fractures, corrosion.
- Furniture and shelves: missing, broken.
- Base: feet, fractures, corrosion, damage to foam insulation.
- Door seals: undamaged, secure.
- Back panel: fractures, corrosion.
- Motor and mountings: securely in place, undamaged (if applicable).
- Plug: good condition, sleeved, correct fuse. A sleeved plug can be fitted later.
- Lead/cable: undamaged, correctly and securely connected.
- Visible connections, terminations and grips: correct, secure.
- Doors: fit, open, close.
- Door hinges and handles: secure.
- Door seals: undamaged, secure.
- Internal freezer doors: fully operational.
- Door liner: undamaged.
- Inner cavity walls: undamaged.
- Evaporator: secure.
- Evaporation tray: present/missing.
- Sockets and connections – burning, arcing.
- Heat exchanger/condenser – secure, undamaged.
- Connection to input wire – secure.
- Piping undamaged.
- No presence of oil stain.

3.2. The electrical safety test of refrigeration system includes:

- Earth continuity to the appliance's earth connection post must be less than 0.1 ohm.
- Earth continuity to the appliance's shell or cabinet must be less than 0.1 ohm.
- Insulation resistance must be greater than 2.0 Mega-ohm.
- Current leakage load test.

3.3. Function test and repair of refrigeration system consist of:

- If the appliance has been inverted or laid down, ensure appliance has been allowed to stand for 24 hours.
- Ensure the power supply to the appliance is protected by an RCD trip-rated at 30 mA.
- Switch on the appliance. Set thermostat(s) to midway setting. Check that the compressor starts up and continuously running. After 10 minutes check for signs of cooling and check the FLA using clamp ammeter.
- Undertake the following checks at various intervals during the extended test duration:
    - Ensure that the internal lamp/light bulb is in working order.
    - Check motor is operational and is not overheating, if applicable.
    - Place thermometers in freezer compartment and on top shelf of the fridge compartment.
    - The following temperatures should be achieved in an ambient temperature of 16 – 32 ^{o}C:

        Ensure fridge reaches 0 to 5 ^{o}C. Ensure freezer reaches: -18°C for three-star, -12°C for two-star, -6°C for one-star. Check thermostats are operational when set to desired temperature. Check pressure chamber.

        - Check condenser.
- Complete any repairs.
- Clean appliance.

3.4. Electrical safety retest consists of:

- Earth continuity to the appliance's earth connection post must be less than 0.1 ohm.
- Earth continuity to the appliance's shell or cabinet must be less than 0.1 ohm.
- Insulation resistance must be greater than 2.0 Mega-ohm.
- Current leakage load test.

B. Twin-tub washing machine

3.5. Visual inspection of twin-tube machine consists of visual checking of the components include:

- Cabinet: fractures, corrosion.
- Base: feet, wheels, fractures, corrosion, obvious leaks.
- Back panel: fractures, corrosion; remove if possible or remove cabinet.
- Plug: sleeved, correct fuse.
- Door seals: undamaged, secure fit.

- Door hinges and handle: secure, operational.
- Switches, knobs and handles: in place, undamaged.
- Lead/cable: undamaged, connected.
- Connections, terminations and grips: correct, secure.
- Electrical sockets and connections: burning, arcing.
- Internal wiring: overheating, deterioration of insulation.
- Motor and mountings: securely in place, undamaged.
- Suspension, connection mounts and supports: intact.
- Drive belts: wear, signs of slipping.
- Tubs (wash, spin): undamaged.
- Agitator spigot: excessive play.
- Spin drum: rotates.
- Tubs' upper seal: intact, leak proof.

3.6. Electrical safety test of twin-tube washing machine consists of some activities include:

- Earth continuity to the appliance's earth connection post must be less than 0.1 ohm.
- Earth continuity to the appliance's shell or cabinet must be less than 0.1 ohm.
- Insulation resistance must be greater than 2.0 Mega-ohm.
- Current leakage load test.
- Earth path to the drum, heater, motor and pump.

3.7. Function test and repair of twin-tube washing machine includes the activities of:

- Ensure the supply is protected by an RCD trip-rated at 30 mA.
- Connect all hoses and fill to normal level.
- If possible, fill drum with textile items.
- Run appliance when filled to maximum.
- Check spinner operation.
- Ensure spinner interlock is operational.
- Check door interlock is operational.
- Check the wash operation.
- Set to medium heat (about 50°C); check heater and thermostat operation.
- Check the timer function by setting to minimum time and allowing to time back to off.
- Check the pump circulation/drain operation.
- Check for any leaks from the pump, or from hoses and seals.

- Check the thermostat operation at low, medium and high heat settings.
- Check all filters for blockages.
- Check motor is operational and is not overheating.
- Check brushes.
- Check heating element is operational.
- Check capacitor if induction motor.
- Check for leaks under pressure.
- Clean appliance.
- Fit accessories, fill hose and spin mat.

3.8. Electrical safety retest of twin-tube washing machine includes:

- Earth continuity to the appliance's earth connection post must be less than 0.1 ohm.
- Earth continuity to the appliance's shell or cabinet must be less than 0.1 ohm.
- Insulation resistance must be greater than 2.0 Mega-ohm.
- Current leakage load test.
- Earth path to the drum, heater, motor and pump.

C. Automatic washing machine

3.9. Visual inspection of components of automatic washing machine includes:

- Cabinet: fractures, rust, corrosion.
- Door hinges and handle: secure, operational.
- Base: feet, fractures, corrosion around suspension legs.
- Back panel: fractures, corrosion; remove if possible or remove cabinet.
- Door seal: splits, leaks, internal rubber seal/gaiter.
- Drum: rotate and lift to check if bearings failed.
- Door hinges and handle: secure, operational.
- Switches, knobs and handles: in place, undamaged.
- Plug: sleeved, correct fuse.
- Lead/cable: undamaged, correctly connected.
- Connections, terminations and grips: correct, secure.
- Electrical sockets and connections: burning, arcing.
- Remove worktop and visually check all internal wiring: overheating, deterioration of insulation, loose or damaged cables.

- Pump, hoses and filters: blockages, previous leaks.
- Pressure chamber/vessel: check, clean out.
- Carbon brushes: change if more than half worn.
- Motor and mountings: securely in place, undamaged.
- Motor bearings: check movement.
- Suspension, springs, connection mounts and supports: intact.
- Drive belt: in place, undamaged, correct tension.
- Check water tub/closet.
- Drum: rotates smoothly, ensure it is empty.
- Drum bearings: excessive movement of drum.

3.10. Electrical test of automatic washing machine is almost same with that of twin-tube washing machine as is described above.

3.11. Function and repair of automatic washing machine includes the activities of:

- Ensure the supply is protected by an RCD trip-rated at 30 mA.
- Connect all hoses and check for leaks.
- If possible fill drum with textile items.
- Run the appliance on a full cycle. Set to programme A or number 1. Check some components and condition as follow:
    - Detergent dispenser and valve.
    - Leaks on all hoses including the drain hose.
    - The hot and cold inlet valves are operating correctly (where fitted).
    - Leaks under pressure.
    - Water fill level.
    - Heating.
    - Overfilling and leaks.
    - The hot inlet valve operation on first fill.
    - Observe drum action for motor, module or belt failing under load.
    - Suspension or bearing failure under load.
    - Thermostat operation.
    - Door interlock.
    - Electrical filter.

  - Capacitor if appliance has induction motor, with capacitor tester (bridge).
  - Motor brushes.

- Run appliance on lower temperature cycle, 0°C or 50°C, following with checking the components and condition as below:
  - Water fills level.
  - Heating.
  - Overfilling and leaks.
  - Thermostat operation.
  - Door interlock.
  - Rinse cycle.
  - Run on spin cycle.
  - Spin rotation and for noise, grinding or vibration.
  - Drain pumps operation.
  - Ensure water drains before spin.
  - Door interlock.
  - Check door may be opened once cycle complete, or may be delay.

- Retest at 60°C and do above checks.
- Fit new hot and cold hoses. Leave in drum.
- Clean appliance.

3.12. Electrical safety retest of automatic washing machine is almost same with that of the twin-tube washing machine as is described above.

D. Televisions (TVs) and Audio System

3.13. The visual inspection of TVs and audio systems include:

- Cabinet and external features: damage.
- TV tubes face for scratches.
- Knobs, switches and fixings: missing damaged.
- Check aerial, aerial socket and SCART sockets for damage.
- Base: fractures, corrosion.
- Back panel: fractures, corrosion.

- Input and output sockets: damage.
- Controls and remote controls: damage, ease of use.
- All accessories, speakers etc.
- Plug: sleeved, correct fuse.
- Lead/cable: undamaged, correctly connected.
- Connections, terminations and grips: correct, secure.
- Batteries and battery compartments: corrosion, damage.

3.14. The electrical safety test for automatic TVs and audio system for Class 1 appliance (see Annex 5) consist of:

- Earth continuity to the appliance's earth connection post must be less than 0.1 ohm.
- Earth continuity to the appliance's shell or cabinet must be less than 0.1 ohm.
- With insulation resistance test voltage at 500 V DC, resistance must be greater than 2.0 Mega-ohm.
- Current leakage load test.
- Appropriate PAT test.

3.15. The function test and repair for automatic TVs and audio system includes:

- Ensure the supply is protected by an RCD trip-rated at 30 mA.
- If run with covers removed, connect to mains via an isolation transformer. Maintain an earth free environment.
- Connect all ancillary parts of system and accessories.
- Run appliance.
- On color televisions, check reference oscillator frequency is 4.43MHz
- Check all functions and controls like tuning, remote, record control etc.

3.16. Electrical safety retest of TVs and audio systems is referred to the point 3.8 of the Annex 3

E. Personal Computer

3.17. Visual inspection of components of personal computer includes:

- Cabinet/casing: damage, fractures, corrosion.
- Base: feet, fractures, corrosion, damage to foam insulation.
- Back panel: fractures, corrosion.
- Fans: securely in place, undamaged (if applicable).
- Plug: good condition, sleeved, correct fuse. A sleeved plug can be fitted later.

- Lead/cable: undamaged, correctly and securely connected.
- Visible connections, terminations and grips: correct, secure.
- Sockets and connections: burning, arcing.
- Connection to input wire: secure.
- Power supply: undamaged, secure
- Knobs, switches and fixings: missing damaged.
- Input and output sockets: damage.
- All accessories, speakers etc.

3.18. Electrical safety test of personal computer is almost same with that of TVs and audio system as is described in the point 3.8 of the Annex 3.

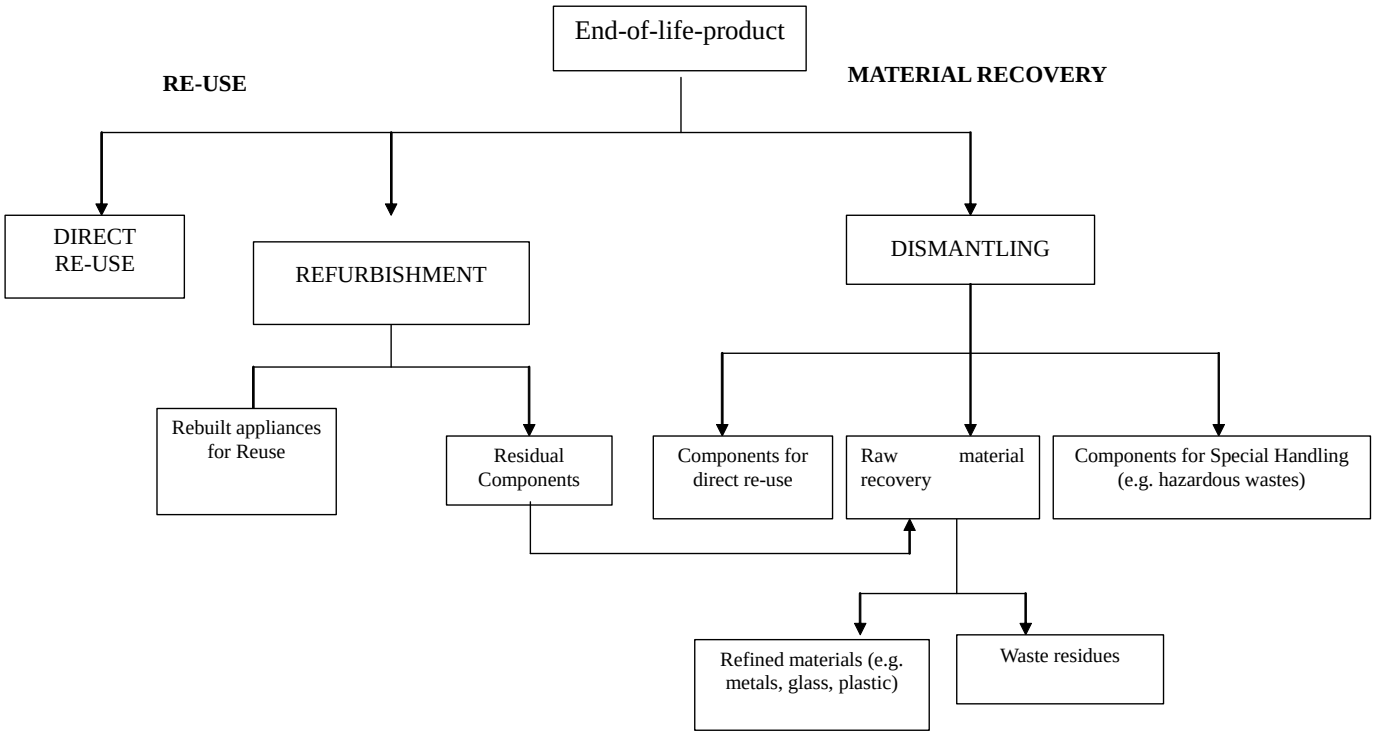
3.19. The function test and repair for personal computer includes:

- If run with covers removed, connect to mains via an isolation transformer. Maintain an earth free environment.
- Connect all ancillary parts of system and accessories.
- Check power supply and its stability
- Check the main board
- Check all functions of all peripherals include memory, hard disk, sound card, display card, etc
- Ensure all function of accessories
- Run appliance.
- For CRT monitor, check reference oscillator frequency is 4.43MHz, if possible.
- Clean the appliance

3.20. Electrical safety retest of personal computer is referred to the point 3.8 of the Annex 3.

ANNEX 4

MATERIAL FLOW OF REDUCE-REUSE-RECYCLE-FLOWCHART



ANNEX 5

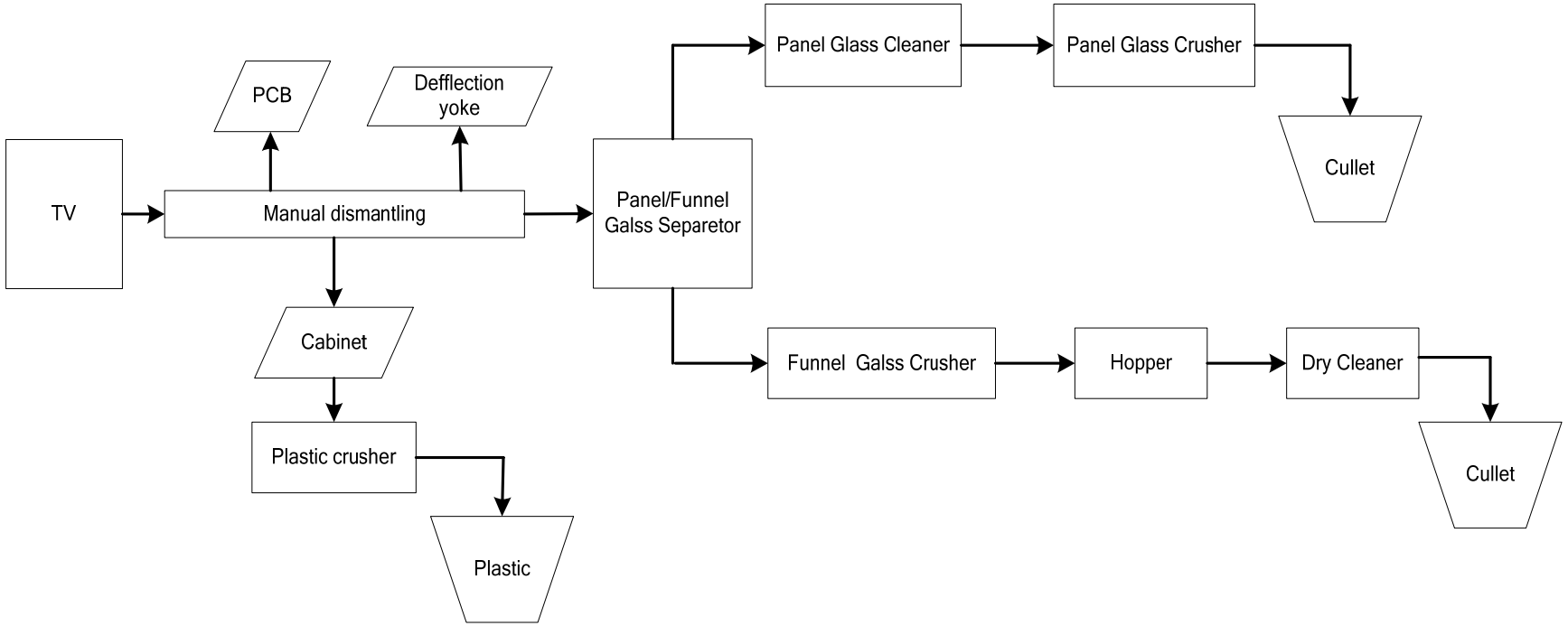
CLASSES OF APPLIANCE AND TEST VALUES

	Class 1	Class 2	Class 3
Description	An appliance that has insulated live parts and a protective earth. For example, washing machines, cookers, and kettles. Identified by 'This appliance must be earthed' tag.	An appliance where there are two separate layers of insulation between live parts and any exposed conductive parts – double insulated. For example, most vacuum cleaners, TVs. Identified by square-within-square symbol.	All insulated. As class 2, but no exposed conductive parts.
Insulation resistance (high power)	appliances as new, 2Ω; in service, 1Ω	over 3KW, 3Ω	class 3 appliances as new, 1Ω; in service, 0.5Ω
Insulation resistance (lower power)	heating and cooking appliances up to 3KW, 1Ω	class 2 heating and cooking appliances up to 3KW, 2Ω	
Insulation resistance (other)		other class 2 appliances as new, 7Ω; in service, 1Ω	

Adopted from: Craig Anderson, *Fit for re-use: A guide to the repair, refurbishment and re-use of domestic electrical appliances*, Furniture Re-use Network (FRN) Publication 2001

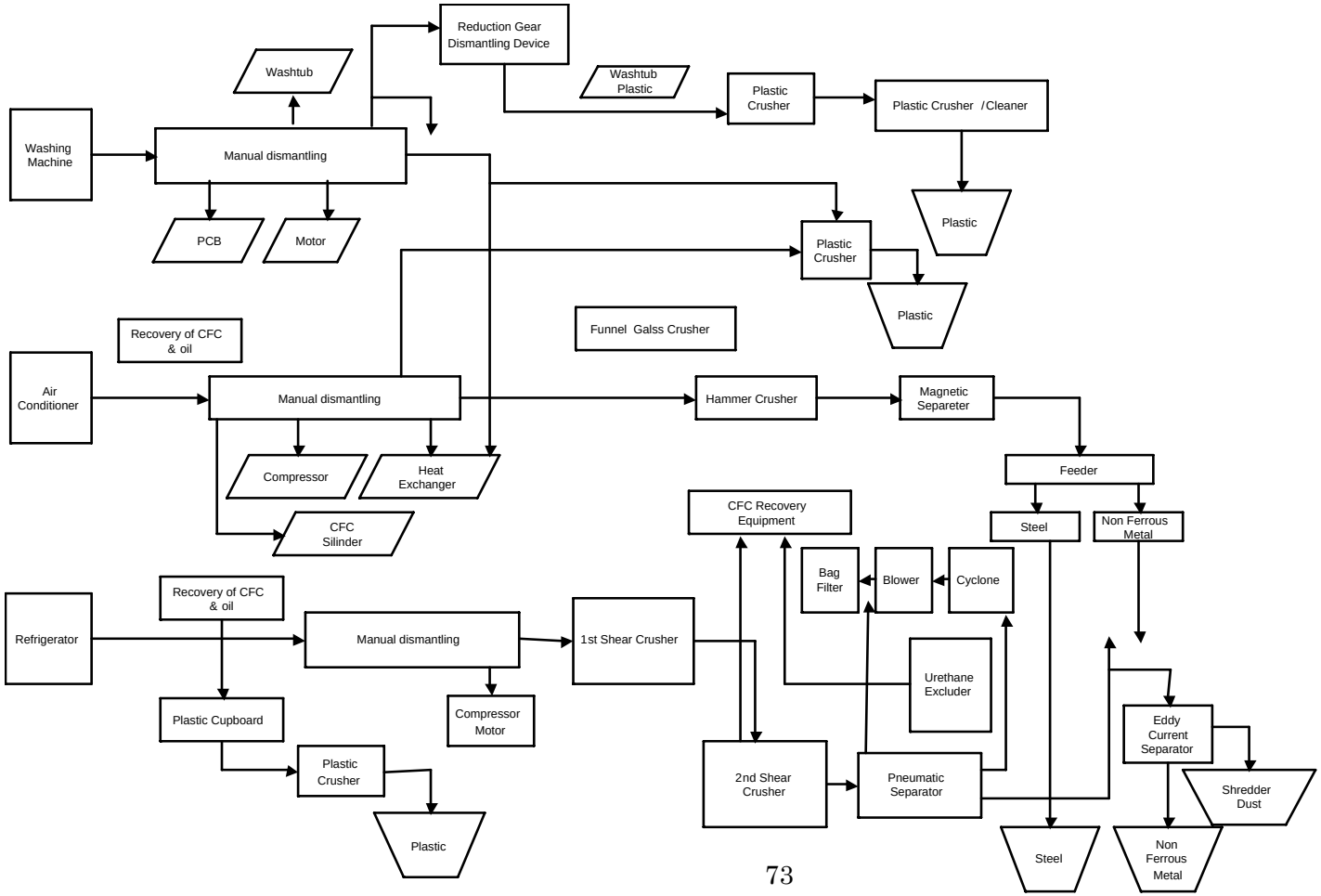
ANNEX 6

TECHNOLOGY RECOVERY PROCESS OF USED TV



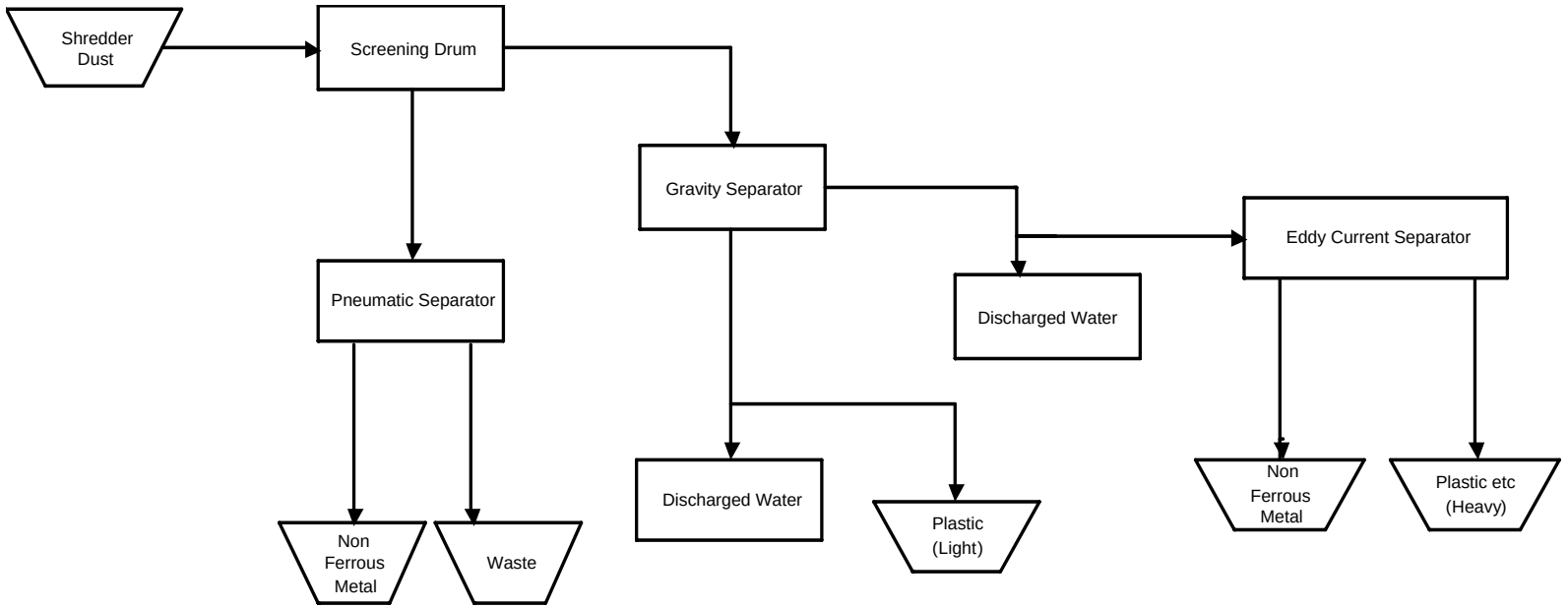
ANNEX 7A

TECHNOLOGY RECOVERY PROCESS OF USED WASHING MACHINE, AC AND REFRIGERATOR



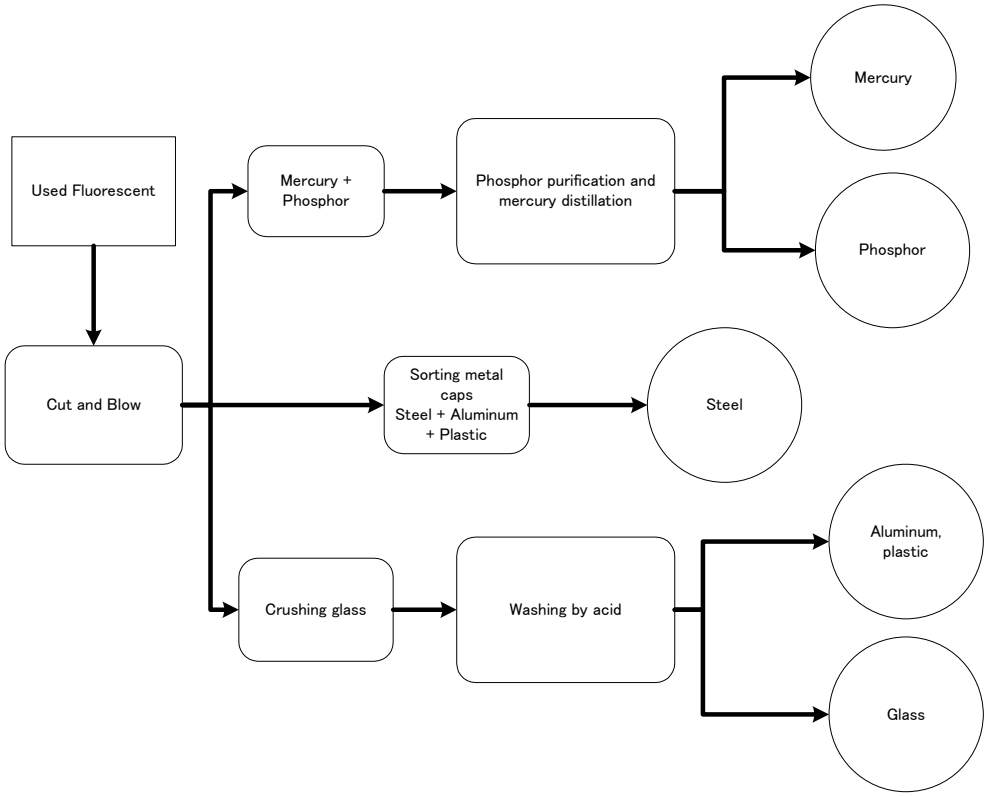
ANNEX 7B

TECHNOLOGY RECOVERY PROCESS OF SHREDDER DUST FROM E-WASTE

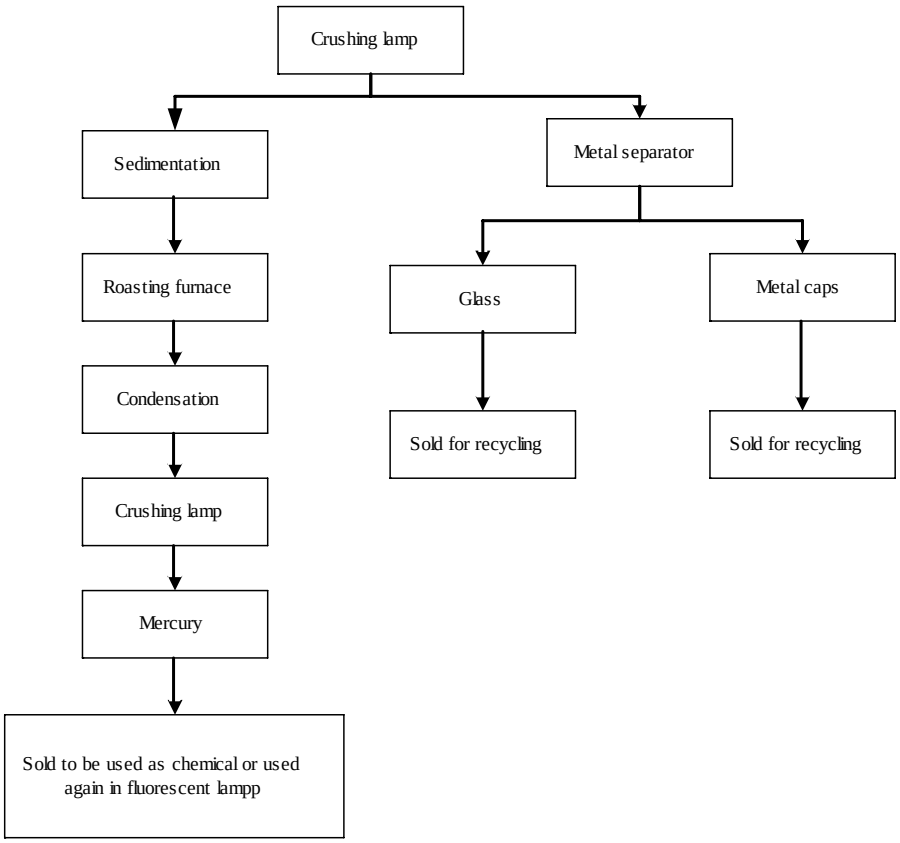


TECHNOLOGY RECOVERY PROCESS OF FLUORESCENT LAMP

TYPE 1



TYPE 2

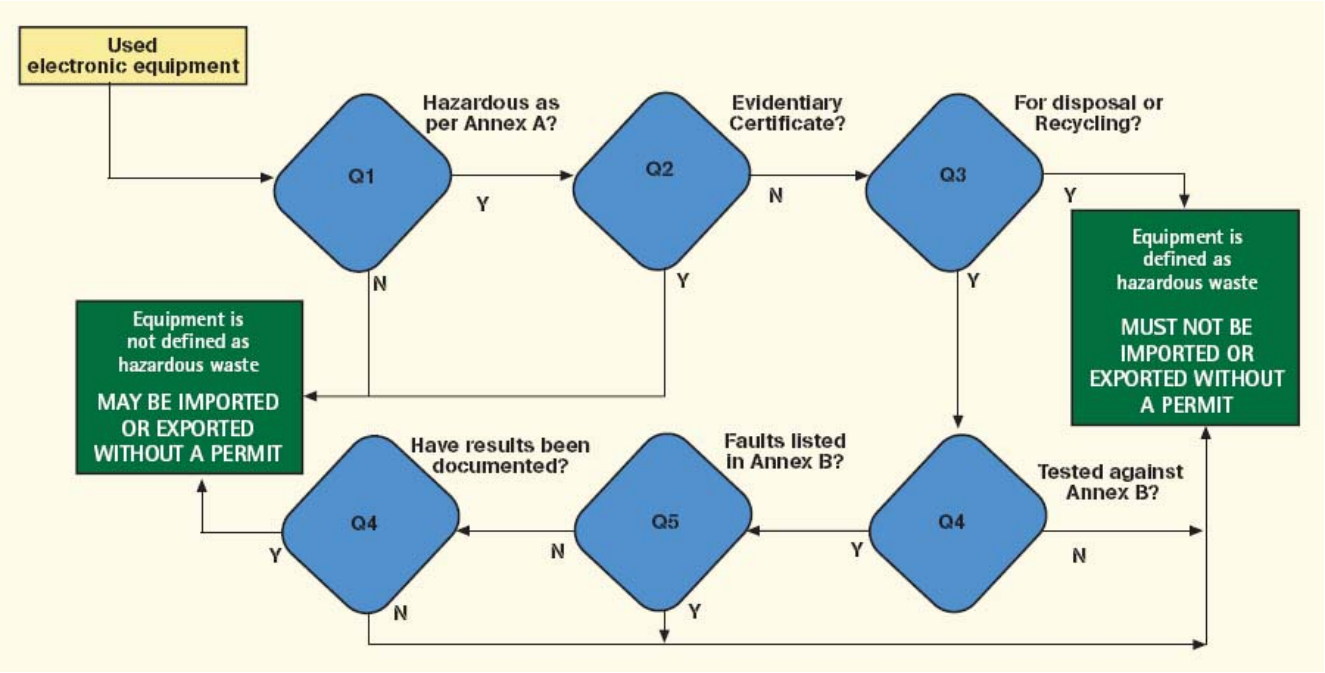


Adopted from: *Kokusai Kogyo Co., Ltd*

ANNEX 7D

PROCEDURE TO DETERMINE USED ELECTRONIC APPLIANCES, PROPOSED FOR EXPORT, IS OR IS NOT HAZARDOUS WASTE

		Questions	Answer	Action
Questions relating to status as hazardous waste	Q1	Is the equipment potentially hazardous, as defined in Annex A?	Yes	Go to Q2
			No	The equipment is not defined as hazardous waste and may be exported without permit
	Q2	Has the Minister made an evidentiary certificate that the equipment in question is not a waste?	Yes	Equipment that is certified not to be a waste may be exported without a permit
			No	Go to Q3
	Q3	Is the equipment pr any of its components destined for disposal operation, including recycling, as defined by the Act?	Yes	Equipment is defined as hazardous waste and must not be exported without a permit.
			No	Go to Q4
Questions relating to test status	Q4	Has the equipment has been tested in accordance with Annex B?	Yes	Go to Q5
			No	Equipment that has not been tested is defined as hazardous waste and must not be exported without a permit.
	Q5	Does the result of testing in accordance with Annex B define the equipment as waste, and hence as hazardous waste?	Yes	Equipment that is defined as hazardous waste must not be exported without a permit
			No	Go to Q6
	Q6	Have the results of the testing been documented and labeled in a way that conforms to Annex B?	Yes	After testing, equipment that has been documented as not being a hazardous waste may be exported without permit
			No	Equipment without documented test results is defined as hazardous waste and must not be exported without permit



Adopted from: *Dept. of the Environment and Heritage Australian Government*

ANNEX 8

TERMS AND ABBREVIATIONS GLOSSARY

Term	Definition
Cathode Ray Tube (CRT)	The display device used in most computer monitors and televisions. Disposed CRTs are toxic because of the phosphor which contains several toxic metals and the high lead content in the glass of the cone part of the CRT which is made of lead glass to block dangerous X-rays generated by the impact of the high-energy electron beam
Collection	Act of picking up wastes at home, business, commercial and industrial activities and other locations, loading them into collection vehicle to a facility for further processing
Crusher	Mechanical device used to break secondary materials into smaller pieces
Dangerous substances	Substance or preparation considered dangerous
Dioxin	A special group of dangerous chemicals known as persistent organic pollutants. Once dioxins have entered the environment or body, they are there to stay due to their uncanny ability to dissolve in fats and to their rock-solid chemical stability. They are formed as an unintentional by-product of many industrial processes involving chlorine, such as waste incineration, chemical and pesticide manufacturing and pulp and paper bleaching, but can also result from natural processes, such as volcanic eruptions and forest fires
Disposal	The process of throwing away or getting rid of something
Electrical or Electronic Equipment	Equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields falling under the categories set out in Annex IA and designed for use with a voltage rating not exceeding 1 000 Volt for alternating current and 1 500 Volt for direct current
Environmentally Sound management (ESM) of hazardous wastes or other wastes	Taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes

E-Product	See: "Electrical or Electronic Equipment"
E-Waste (WEEE)	Electrical or electronic equipment which is waste… including all components, sub-assemblies and consumables, which are part of the product at the time of discarding **(EU, 2003b).** Directive 75/442/EEC, Article I (a) defines "waste" as "any substance or object which the holder disposes of or is required to dispose of pursuant to the provisions of national law in force
Hazardous waste	Waste, or combination of waste, that may cause or significantly contribute to an increase in mortality or an increase in serious irreversible illness or that poses a substantial present or potential hazard to human health or to environment when improperly treated, stored, transported, disposed of, or otherwise managed.
Incineration	The process of destroying waste through burning
Landfill	An area designated to receive waste. Landfills can be harmful because they can leach toxins into the groundwater and methane and other toxic gases into the air. Landfilling e-waste is also undesirable because it permanently removes the material from further economic use
Mobile Phone	See : "Portable Phone"
Portable Phone	A portable telephone operated through a cellular radio network
Pretreatment	Depollute; make an appliance safe and fit for dismantling or scrap; activity to enable ease of reprocessing and the recovery of valuable or controlled substances
Printed Circuit Board (PCB)	See : "Printed Wiring Board (PWB)"
Printed Wiring Board (PWB)	A printed wiring board (PWB), also known as a printed circuit board (PCB), provides both the physical structure for mounting and holding electronic components as well as the electrical interconnection between components. It consists of a non-conducting substrate upon which a conductive pattern or circuitry is formed
Producer	Manufacturer, reseller, importer or exporter
Reclamation	Activity of reprocessing and upgrading a recovered controlled substance
Recovery	The extraction of a substance or energy from a source e.g the reclamation of useful substances from waste or refuse

Recycle	The reprocessing in a production process of the waste materials for the original purpose or for other purposes, but excluding energy recovery through direct incineration with or without other waste but with recovery of the heat
Reduce	Prevention or restriction of waste generation at its source by redesigning products or the patterns of production and consumption
Refurbish	To bring something back to a cleaner, brighter or more functional state
Repair	To restore something broken or damaged to good condition
Re-use	Any operation by which WEEE or components thereof are used for the same purpose for which they were conceived, including the continued use of the equipment or components thereof which are returned to collection points, distributors, recyclers or manufacturers.
Shredder	Machine used to break up waste materials into smaller pieces by cutting, tearing, shearing, and impact action
Scrap	Generic term for not reusable; not for pretreatment stage or may have been through pretreatment and had something taken that renders remainder scrap; for disposal by a third party
Toxic	Defined for regulatory purposes as substances containing poison and poisoning a substantial threat to human health and/or the environment
Transport	Transport of solid waste transferred from collection vehicles to a facility or disposal site for further processing or action
Treatment	Any activity after the WEEE has been handed over to a facility for depollution, disassembly, shredding, recovery or preparation for disposal and any other operation carried out for the recovery and/or the disposal of the WEEE
Waste	Substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law
Waste stream	Describe the total flow of solid waste from homes, business, institutions, and manufacturing plants that must be handling
White goods	Large worn-out or broken household, commercial, and industrial appliances

Abbreviation	**Definition**
3R	Reduce, reuse and recycling
°C	Degree Celsius
A	Ampere
AC	Alternate current
BeO	Beryllia (beryllium oxide)
DC	Direct current
CFCs	Chlorofluorocarbons
CRT	Cathode ray tube
EOL	End-of-life appliances
E-waste	Electronic waste
HCFCs	Hydro chlorofluorocarbons
K Cr $(SO_4)_2$	Potassium chrome disulphate
LEDs	Light emitting diodes
mA	Mili –Ampere
MHz.	Mega-Hertz
Mohm	Mega-Ohm
Ni-Cd	Nickel cadmium
NiMeH	Nickel metal hydride
NVQ	National vocational qualification
ODS	Ozone-depleting substance
PAT	Portable Appliance Test
Pb O	Lead oxide
PCs	Personal computers
PCBs	polychlorinated biphenyls
PVC	Polyvinylchloride
RCD	Residual current device
TVs	Televisions
V	Volt
WEEE	Waste electrical and electronic equipment