PARTNERSHIP FOR ACTION ON COMPUTING EQUIPMENT

PROJECT 1.1

GUIDELINE ON ENVIRONMENTALLY SOUND TESTING, REFURBISHMENT & REPAIR OF USED COMPUTING EQUIPMENT

Approved by the PACE Working Group

17 February, 2011

Acknowledgements

The Partnership for Action on Computing Equipment (PACE) Working Group would like to express its appreciation for the efforts of the Project Group 1.1 in the preparation of the guideline on environmentally sound testing, refurbishment, and repair of used computing equipment. Members of this Project Group are identified on page 6 of this report.

In addition, special thanks is extended to Co-chairs of the Project Group 1.1, Mr. Andy Howarth from the United Kingdom and Mr. Willie Cade from PC Rebuilders & Recyclers (PCRR) for their leadership in finalizing the guideline and for ensuring that all comments have been reviewed and incorporated in the guideline where appropriate.

The approved Guideline on Environmentally Sound Testing, Refurbishment, and Repair of Used Computing Equipment will be reviewed in a facility type of environment and revised to reflect the practical situation.

CONTENTS

PROJECT GROUP PARTICIPANTS LIST

The following members contributed to the work of the PACE Project Group 1.1 on Environmentally Sound Testing, Refurbishment & Repair of Used Computing Equipment:

Co-chairs:

1. Mr. Willie Cade, PC Rebuilders & Recyclers
2. Mr. Andy Howarth, United Kingdom, Department for Environment Food and Rural Affairs (Defra)

Participants

3. Mr. Aya Yoshida, National Institute for Environmental Studies, Japan
4. Ms. Claudia Luepschen, United Nations University (UNU)
5. Ms. Cori Ong, TES-AMM (Singapore) Pte Ltd
6. Ms. Dana Lapesova, Basel Convention Regional Centre (BCRC), Bratislava, Slovakia
7. Mr. David Parker, Oakdene Hollins
8. Mr. Eric Harris, Institute of Scrap Recycling Industries (ISRI)
9. Mr. Ibrahim Shafii, Secretariat of the Basel Convention (SBC)
10. Mr. Jim Puckett, Basel Action Network (BAN)
11. Ms. Karen Pollard, USA
12. Mr. Marco Buletti, Switzerland
13. Mr. Matthias Kern, Secretariat of the Basel Convention (SBC)
14. Mr. Michael VanderPol, Canada
15. Mr. Michikazu Kojima, Japan External Trade Organization (JETRO)
16. Mr. Mostafa Kamel, BCRC Egypt
17. Mr. Oladele Osibanjo, BCRC-Nigeria
18. Mr. Ole Thomas Thommesen, Norway
19. Ms. Patricia Whiting, USA
20. Mr. Paul Hagen, Information Technology Industry Council (ITI)
21. Mr. Ramkripal Pandey, TES-AMM (Singapore) Pte Ltd
22. Mr. Richard Goss, Information Technology Industry Council (ITI)
23. Mr. Ross Bartley, Bureau of International Recycling (BIR)
24. Mr. Ruediger Kuehr, United Nations University (UNU)
25. Ms. Sarah Westervelt, Basel Action Network (BAN)
26. Mr. Shunichi Honda, Japan
27. Ms. Susann Krause, Germany
28. Ms. Wen-Ling Chiu, Institute of Environment and Resource (IER)
29. Mr. Yorg Aerts, OVAM Belgium
30. Mr. John Myslicki, Consultant to SBC

EXECUTIVE SUMMARY

The purpose of this guideline on the environmentally sound testing, refurbishment and repair of used computing equipment is to promote greater reuse of such computing equipment, through environmentally sound refurbishment and repair and the environmentally sound management of any discarded equipment or components. Extending the life of computing equipment generally results in the best environmental outcome, reducing the demand for natural resources and increasing waste prevention. Refurbishing and repairing used computing equipment using environmentally sound management requires a broad set of skills and operational controls to enable the process to be efficient and to minimize impacts on human health and the environment. Given the complexity of the computing equipment market, it is the intention of this work to provide general guidelines that will be useful for years to come and to offer guidance for refurbishment facilities around the globe. It offers guidance in four parts:

Part 1 introduces the background, purpose and use of the guideline document. It also sets out a list of environmentally sound management criteria that are relevant to the refurbishment or repair of used computing equipment.

Part 2 provides guidance applicable to refurbishment facilities. This part covers measures that refurbishment and repair facilities and facility managers may put in place to better ensure the environmentally sound management (ESM) of used computing equipment, and addresses each of the ESM criteria from the PACE Ad Interim Project Group on ESM Criteria.

Part 3 provides additional guidance applicable to refurbishment and repair facilities to further support ESM. It includes a flow chart of the refurbishment process, guidance on the sorting of refurbishable and non-refurbishable equipment. It includes guidance on data security and destruction, and on disassembly. One of the most important elements is guidance on the testing of used equipment prior to reuse to ensure functionality, including batteries.

Guidance is included on labeling/documentation, packaging and storage and handling of refurbished and repaired equipment.

The guideline does not cover the management of materials, components or residuals destined for material recycling or disposal. Such issues are covered in the PACE Guideline on Environmentally Sound Material Recovery / Recycling of End-of-Life Computing Equipment.

Part 4 of the guideline includes guidance for the marketing, donation and redeployment of refurbished and repaired computing equipment and components. Guidance on the procedures relating to the transboundary movement of used and end of life computing equipment are not included in this guideline, but are covered in Chapter 3 of the PACE Guidance Document.

1. INTRODUCTION

1.1 Background

1. The Partnership for Action on Computing Equipment (PACE) was launched at the ninth meeting of the Conference of the Parties to the Basel Convention (COP IX), which took place in Indonesia in June 2008. PACE is a multi-stakeholder partnership that provides a forum for representatives of personal computer manufacturers, recyclers, international organizations, academia, environmental groups and governments to tackle the environmentally sound management, refurbishment, recycling and disposal of used and end-of-life computing equipment. The Partnership is intended to increase the environmentally sound management of used and end-of-life computing equipment, taking into account social responsibility and the concept of sustainable development, and promoting the sharing of information on life cycle thinking.

2. The Partnership aims to provide new and innovative approaches for addressing emerging issues. It also aims to:

- Promote sustainable development for the continued use, refurbishment and repair of used personal computers in developing countries and countries with economies in transition;
- Find incentives and methods to divert end-of-use personal computers from land disposal and burning into environmentally sound commercial material recovery/recycling operations;
- Develop technical guidelines for proper repair, refurbishing and material recovery/recycling, including criteria for testing, labeling of refurbished used equipment and certification of environmentally sound repair, refurbishing and recycling facilities;
- End shipments of end-of-life computing equipment to countries, in particular developing countries and countries with economies in transition; which are illegal to import under their domestic laws.

3. PACE actions also include pilot demonstration projects to assist developing countries and countries with economies in transition in assessing the current situation of used and end of life computing equipment in their countries, and to achieve partnership and Basel Convention objectives.

4. The PACE Working Group, established by the Conference of the Parties in its decision IX/9, is the operating mechanism for the Partnership and organizational matters, and serves as a forum for information sharing. Membership of the working group includes Parties or Signatories to the Basel Convention, intergovernmental and non-governmental organizations, all stakeholders, including manufacturers, recyclers, refurbishers and academia, and, Basel Convention Regional and Coordinating Centres (BCRCs) which have specific expertise and experience to support the activities of this group.

5. Project Group 1.1 on Environmentally Sound Refurbishment/Repair of Use Computing Equipment was established by decision of the PACE Working Group during its 5 May 2009 teleconference meeting. The key purpose of the Project Group is to develop a guideline on the Environmentally Sound Testing, Repair and Refurbishment of [Used] Computing Equipment.

6. The agreed objective of the Project Group is to:

- Develop tools (such as guidelines) and activities on environmentally sound testing, refurbishment and repair of used computing equipment, including criteria for certification and labelling. The Project Group has cooperated and coordinated with other PACE project groups working on ESM criteria recommendations, technical guidance for recycling, and pilot projects.

7. The key deliverables identified for this Project Group include the following:

- A list of technical guidelines and other sources of information regarding testing, refurbishment and repair of used personal computing equipment that promotes better environmental outcomes (Annex V);

- A guideline on refurbishment and repair of used personal computing equipment setting out environmentally sound criteria for testing, refurbishment and repair, and including criteria for certification and labelling;
- Field testing the draft guideline; and updating its content as necessary based on recommendations received from users prior to its finalization. Refurbishers are invited to volunteer to field test this document on behalf of the Basel Convention;

8. This guideline has been developed by Project Group 1.1, under the Partnership for Action on Computing Equipment under the Basel Convention. A number of sources of information been useful in the development of the guideline (see list at Annex V).

1.2 Purpose

9. It is acknowledged that in the interests of greater sustainability, facilities should promote environmentally sound management of used computing equipment destined for re-use, including all aspects of testing, refurbishing, and management of resulting scrap. In this respect re-use of used computing equipment represents one of the highest forms of environmental management leading to waste prevention and in general improved resource efficiency. This guideline sets out to promote re-use in a manner that is consistent with the Basel Convention, and benefits the environment, without compromising either product integrity or public health and safety.

10. This guideline is intended to encourage companies that refurbish and repair used computing equipment to implement environmentally sound practices which will protect public and worker health and safety, and the environment, and to facilitate a process whereby used computing equipment re-entering the market meets applicable regulatory requirements, including international trade laws and performance specifications.

11. The guideline is aimed at supporting capacity building and the transfer of know-how to developing countries and countries with economies in transition so they can build infrastructure to manage electronic waste generated in-country, and to enable informal refurbishment operations to improve their operation for the protection of their workers and the

environment. This guideline is not developed in order to create ESM facilities in developing countries or countries with economies in transition so that developed countries may transfer untested or non-working equipment which may result in the transboundary movement of hazardous wastes such as waste batteries, mercury lamps and circuit boards.

1.3 Use of the Guideline Document

12. This guideline is written for use by:

- Refurbishment and repair facilities
- Any organization that is involved in buying or selling refurbished computing equipment
- Any entity donating or receiving donated equipment
- Government bodies in all countries
- Environment and other regulatory agencies and authorities
- Environment and community groups
- Manufacturers
- Consumers of refurbished computing equipment
- Distributors of computing equipment.

13. The guideline is applicable to all facilities engaged in the testing, refurbishment and repair of used computing equipment, including facilities situated in developing countries and countries with economies in transition.

1.4 Environmentally Sound Management Criteria

14. ESM may be defined as taking all practicable steps to ensure that used and/or end-of-life products and wastes are managed in a manner which will protect human health and the environment. In the context of this work, criteria are defined as characteristics, attributes or traits deemed important to achieve a desired principle, in this case ESM.

15. The PACE Ad Interim Project Group on Environmentally Sound Management (ESM) Criteria established ESM criteria recommendations[1] that were modeled after existing and relevant guidance of international, country government, industry, and non-government organizations to the fullest extent possible as a measure to avoid duplication and support compatibility with existing approaches. Compatibility with ESM criteria and "core performance elements" under the work of the Basel Convention and Organization of Economic Cooperation and Development (OECD) was an important consideration in preparing the ESM criteria recommendations.

16. While not diminishing the importance of broad government and societal ESM criteria, efforts of the PACE Ad Interim Project Group on ESM Criteria focused on identifying facility-specific recommendations, which include ensuring that measures are in place to demonstrate conformity with the following ESM criteria.

i. **Top Management Commitment to a Systematic Approach:** Demonstrate commitment of top management to integrate a systematic approach to achieve ESM in all aspects of facility operations, which often includes an environmental health and safety management system.

ii. **Risk Assessment:** Identify actual and/or potential hazards and risks to public and worker health and safety, and the environment that are associated with activities, products and services.**iii. Risk Prevention and Minimization**: Eliminate where possible and in all cases strive to minimize actual and/or potential hazards and risks to public and worker health and safety, and the environment that are associated with activities, products and services.

iv. **Legal Requirements:** Identify, access and strive to fulfil applicable legal requirements, including for example: legislation, statutes and regulations; decrees and directives; permits, licenses and certificates of approval, or other forms of authorization; orders issued by regulatory agencies; and/or judgments of courts or administrative tribunals. Facilities should also take into consideration customary or indigenous law and treaties, conventions and protocols.

[1] Basel Convention, Partnership for Action on Computing Equipment (PACE). *Environmentally Sound Management (ESM) Criteria Recommendations.* Approved by the PACE Working Group, 9 March 2010. See: www.basel.int/industry/compartnership/docs/FinalApprovedReportESM-22March2010.pdf

v. **Awareness, competency and training:** Ensure employees have an appropriate level of awareness, competency and training with respect to the effective management of occupational risks.

vi. **Record-keeping and Performance Measurement**: Maintain records, monitor, track and evaluate facility performance at achieving ESM.

vii. **Corrective action:** Take appropriate action to address significant actual and/or potential risks to public and worker health and safety, and the environment and correct identified deficiencies in achieving ESM.

viii. **Transparency and Verification**: Provisions to support transparency and verification throughout each of the above building blocks, subject to appropriate protection for confidential business information, can help facilities to provide public assurances that operations and activities are compatible with ESM. Such provisions may include for example participating in third party audits and inspections.

17. In addition to the above, the PACE Ad Interim Project Group on ESM Criteria identified the following facility-specific recommendations:

- Facilities should review measures in place to support applicable recommendations contained within the Basel Convention's *Guidance Document on the Preparation of Technical Guidelines for the Environmentally Sound Management of Wastes Subject to the Basel Convention*[2].
- Facilities should review measures in place to support applicable recommendations contained within PACE guidance documents and other applicable guidance under the Basel Convention.
- Facilities located in OECD-member countries should also review measures in place to support applicable recommendations contained within the OECD *Council Recommendation C(2004)100 on the Environmentally Sound Management of Waste*[3] and OECD *Technical Guidance for the Environmentally Sound Management of Specific Waste Streams: Used and Scrap Personal Computers* (ENV/EPOC/WPWPR(2001)3/FINAL).

[2] See Annex A of PACE *ESM Criteria Recommendations* www.basel.int/industry/compartnership/docs/FinalApprovedReportESM-22March2010.pdf

[3] Ibid : See Annex B

2. FACILITY MEASURES TO SUPPORT ENVIRONMENTALLY SOUND MANAGEMENT (ESM)

18. The eight ESM criteria provide guidance concerning the major aspects needed to assure environmentally sound management within a facility setting. The following the paragraphs identify the types of facility measures that should be in place and/or specific actions that operators in refurbishing and repair facilities may carry out to demonstrate conformity with these criteria.

i. Top Management Commitment to a Systematic Approach to ESM:

> The commitment of top management is considered necessary within any facility to ensure that appropriate policies, programmes, resources (i.e. human, financial, etc.) and other facility measures are in place to achieve environmentally sound management. The term systematic approach encompasses the need to develop and implement plans, monitor their results and review their effectiveness, and take corrective action where necessary to support continually improvement. Without the ongoing commitment of top management to ESM, it is unlikely that a facility will consistently and increasingly perform its operations in ways that minimize its impacts on human health and the environment. Environmental management systems (EMS) are often used by facilities to support a systematic approach which provides an overall framework for top management to identify the priority environmental impacts of all facility operations and activities, and then plan, operate, measure and improve environmental performance on an on-going basis.
>
> Excerpt: *Environmentally Sound Management (ESM) Criteria Recommendations*

19. An Environment, Health and Safety (EHS) Policy appropriate to the nature, scale and negative EHS impacts of activities, products and services of the facility should be documented and implemented. The Policy should clearly demonstrate commitment to health and safety, pollution prevention, compliance with applicable legal requirements, and continual improvement to environmental, health and safety performance.

20. The EHS Policy should be regularly communicated to all new and existing personnel, sub-contractors and visitors that access the workplace. It should be reviewed and updated periodically for relevancy to the facility.

21. Relevant objectives, targets, programmes and other measures should be in place to achieve commitments identified in the EHS Policy and demonstrate conformity with the eight ESM criteria. Adequate financial resources, human resources, specialized skills, organizational infrastructures, and technologies should be made available to design, implement, maintain and continually improve policies, programmes and other measures supporting ESM.

22. Applicable roles, responsibilities, authorities and qualifications for designing and implementing policies, programmes and other measures supporting ESM should be defined, documented & communicated to all facility personnel.

23. Representatives of management should be appointed to oversee the design, implementation and maintenance of ESM provisions, including programmes and other measures in place to support ESM. Representatives should also report to top management organizational and facility performance at meeting ESM policies, objectives and targets.

24. Integration of an Environmental Management System (EMS), such as the ISO 14000 series for environmental management, European Eco-Management Audit Scheme (EMAS), or equivalent systems[4], should be considered to help identify and facilitate improvements to environment, health and safety within an organization and/or facility. Registration and certification to an internationally or locally recognized EMS will greatly help to demonstrate conformity of a facility to ESM criteria. However, registration and certification to an EMS alone cannot be expected to fulfill all prerequisites for environmentally sound management.

ii. Risk Assessment:

The identification of actual and potential risks to public and worker health and safety, and the environment that are associated with facility activities, products and services is an important aspect of ESM. This includes consideration of both normal and abnormal operating conditions, including for

[4] See Annex V for a fuller list of systems and schemes

example facility start-up and shut-down routines; equipment use, repair and maintenance; emergency situations and accidents; facility emissions and releases; and material and waste handling practices.

Excerpt: *Environmentally Sound Management (ESM) Criteria Recommendations*[5]

25. Roles, responsibilities, authorities and qualifications for planning and conducting risk assessments of facility operations and activities should be documented, implemented, communicated and maintained.

26. Procedures to identify, prioritize and assess EHS hazards and risks associated with new, existing and planned activities, products and services should be documented, implemented, communicated and maintained.

27. EHS risk and hazard information should be documented and kept current, and updated when appropriate to reflect changes in operational, constituent material, environmental or regulatory requirements, procedures and practices.

TIP: Examples of risks associated with reuse and refurbishing facility operations and activities. If your facility is processing equipment for material recovery, please also see the PACE Guideline on Material Recovery and Recycling of End-of-Life Computing Equipment.

- Cuts or punctures from handling sharp components and parts or tools
- Injury from lifting and handling heavy products, material and equipment
- Electrical discharge from batteries, capacitors or faulty equipment that can lead to fire or electrical shock;
- Toxic and hazardous materials that could enter the human body via absorption, inhalation, injection or ingestion if improperly managed. Examples include:
  - Mercury (used in backlighting of liquid crystal display screens and some batteries. Main risk arises when replacing back lights)
  - Lead (used in cathode ray tubes as radiation shielding, tin-lead solders, and plastic stabilizers. Main risks arise from circuit board components)
  - Cadmium (used in cathode ray tubes as phosphorescent, some batteries, colour pigments and plastic stabilizers. Main risk arises from broken CRTs)
  - Hexavalent chromium (used in colour pigments, plastic stabilizers, and anti-corrosion treatments).
  - Brominated flame retardants (used in plastic housings, circuit boards, cables, keyboards, etc.)

[5] Ibid

- Beryllium (used in contact clips and springs, and rotating mirrors in laser printers)

- Repetitive strain injury

28. A list of products and recyclable and waste materials that the organization is capable of processing, storing or otherwise handling in a safe and environmentally sound manner should be maintained, and made publicly available, so that facilities only accept materials they are able to manage in an environmentally sound manner.

iii. Risk Prevention and Minimization:

Most accidents in the workplace are preventable and usually occur because actual and/or potential hazards and risks are not identified, or are ignored or underestimated. Hazards and risks have many dimensions (e.g. health, safety, environment, financial, community trust, etc.), and the importance of each dimension may vary amongst interested parties (e.g. workers, investors, clients, regulators, public, etc.). Consequently, the inclusion of measures to prevent or minimize hazards and risks is considered to be an important aspect of environmentally sound management. Fundamentally, such provisions enable facilities to identify the types of hazards and risks; assess the scope, magnitude and likelihood of these hazards and risks; and ensure that all reasonable care is taken to prevent, minimize or otherwise address identified hazards and risks. These may include for example insurance policies and other financial guarantees to ensure that a means of adequate financial compensation or resourcing is in place to respond to specified damages, losses, or injuries related to workplace activities.

Excerpt: *Environmentally Sound Management (ESM) Criteria Recommendations*[6]

29. A working environment that is safe and protects the welfare of all employees, volunteers, contractors and visitors at the facility should be maintained at all times.

30. Measures to prevent unauthorized access to the facility premises and storage areas should be in place and in particular for data security reasons.

31. Emergency preparedness and response plans and procedures should be documented, implemented, communicated and maintained to identify potential emergency situations and accidents and how to prepare for and respond to them. Relevant plans and

[6] Ibid

procedures should be designed to prevent and mitigate EHS impacts during responses, and shared with authorities, such as local fire and police departments, for periodic review and input.

32. Emergency response procedures should be periodically tested and reviewed, especially after the occurrence of accidents or emergency situations. Facility closure plans and procedures should be documented, implemented, communicated and maintained to identify site decommissioning and site remediation requirements in the event of a sale, closure, abandonment, bankruptcy or other forms of dissolution.

33. An assessment of financial requirements necessary to respond to potential emergency, site decommission and site remediation situations should documented, and a mechanism for ensuring the availability of contingency funds should be in place, such as a security/performance bonds or other financial instruments. Adequate workers compensation coverage and insurance coverage for bodily injury, property damage, complete operations and contractual liability should be in place at all times.

34. Top management should ensure that staff are properly fitted for and are trained in the use of Personal Protective Equipment to safeguard worker health and welfare.

35. Where appropriate, material safety data sheets (MSDS) for products, chemicals and substances in use and storage at the facility or equivalent information should be readily available to employees. MSDS provide workers and emergency personnel with procedures for handling or working with a substance in a safe manner. MSDS include substance-specific information pertaining to physical properties (e.g. melting, boiling and flash points); reactivity, toxicity and health effects; personal protective equipment; storage and disposal; and first aid treatment and spill-handling.

36. Objectives and targets for risk prevention and minimization should be established for relevant functions and levels of the organization, fulfill EHS policy commitments, address significant environmental and health and safety risks, and support compliance with applicable

legal requirements. These objectives and targets should take into consideration: the availability of technological advancements; financial, operational and business requirements; business developments, including new or modified activities, products and services; and the views of interested parties.

37. Objectives and targets should be specific, measurable, achievable, realistic and timely. They should also be accompanied by performance indicators to identify whether objectives and targets are being met.

38. EHS programmes that minimize or eliminate hazards and risks to public and worker health and safety, and the environment that are associated with facility activities and services should be documented, implemented, communicated and maintained.

39. EHS programmes should be designed to achieve objectives and targets for risk prevention and minimization, and identify roles, responsibilities and authorities to meet objectives and targets for each relevant function and level of the organization.

40. Relevant and supporting procedures should be documented, implemented, communicated and maintained, especially where their absence could lead to deviation from EHS policies, programmes, objectives and targets. Such procedures should aim to eliminate and/or reduce environmental, health and safety hazards and risks at their source, and may pertain to operations and activities, products, services and equipment purchased and/or used by the organization, and workplace processes such as equipment use, operation, maintenance and installation or replacement. Some examples would be to have established procedures in the event of a breakage of a CRT, or an LCD backlight (see Annex V of useful information).

41. Procedures should be established and maintained for internal communication about significant EHS hazards and risks, and facility integration of ESM criteria. Procedures should also be established and maintained for receiving, documenting and responding to relevant communication from external interested parties, as it relates to significant EHS hazards and risks, and facility integration of ESM criteria.

42. Electronic products, components and hazardous materials and wastes should be handled and stored in a secured, indoor enclosure to protect against environmental elements such as dust, rain, snow, etc.

iv. Legal Requirements:

> Compliance with applicable legal requirements that pertain to the jurisdiction in which a facility is located is a prerequisite for bona-fide companies doing business, and therefore an essential requirement for environmentally sound management. Failure to comply with legal requirements can be very costly to an organization. Working with legally compliant suppliers and service providers is also an important consideration from the perspective of forging strong business relationships with environmentally sound organizations, and establishing or maintaining a good facility reputation with investors, regulators and the general public. Consulting regulatory agencies (e.g. national, regional, local), government publications and news releases, legal advisors, legal journals and commercial databases, and industry member associations can help to identify legal requirements applicable to facility activities. Identifying and ensuring conformity with applicable legal requirements will likely represent a particular challenge for facilities engaged in informal sector activities.
>
> Excerpt: *Environmentally Sound Management (ESM) Criteria Recommendations*[7]

43. Reuse and refurbishing organizations shall operate in accordance with all applicable local, regional and national laws, and possess all necessary permits to operate.

44. Procedures to identify and access legal requirements applicable to new, existing and planned activities, products and services should be documented, implemented, communicated and maintained. Applicable laws, regulations and other requirements should be documented, kept current and understood by relevant personnel to support legal compliance.

45. Refurbishers who export used and/or refurbished computing equipment for reuse should identify, understand and ensure compliance with applicable laws governing refurbished product trade, including prohibitions or restrictions that receiving countries may have in place.

[7] Ibid

46. Procedures to regularly monitor compliance with applicable legal and other requirements should be documented, implemented, communicated and maintained. Should issues on compliance be detected, top management should ensure action is taken to address them.

47. Where a facility works in partnership with another permitted facility, such as a recycler or repair facility, these partner facilities should also hold valid permits, licenses and or authorizations.

v. Awareness, competency and training:

> Awareness, competency and training is necessary to ensure employees are aware of risks identified within the workplace, and that they are trained and competent to ensure public and worker health and safety, and contribute to the protection of the environment through their activities. This includes the ability to identify, prevent and/or minimize hazards and risks, and effectively respond to emergency situations.
>
> Excerpt: *Environmentally Sound Management (ESM) Criteria Recommendations*[8]

48. Procedures to identify worker awareness, competency and training needs should be documented, implemented, communicated and maintained.

49. Measures should be in place to raise awareness amongst workers regarding the importance of ESM, including organization and facility measures to support ESM (such as related policies, objectives and targets, programmes and procedures).

50. Measures should be in place to ensure that workers are aware of actual and/or potential EHS hazards and risks linked to job tasks, including any changes to the workplace that may affect EHS hazards and risks.

51. Training plans and training programmes should be established and maintained to provide workers with appropriate training on how to mitigate occupational hazards and risks

[8] Ibid

and communicate worker roles and responsibilities in support of achieving ESM provisions at the workplace. Such training may pertain to proper use and maintenance of personal safety equipment, vehicles, machinery and equipment; management requirements for products, dangerous goods and hazardous wastes/materials; and reporting and responding to workplace accidents and emergencies. Workers should also be made aware of the importance of adhering to operating procedures and consequences of failing to do so, for example the facility policies on what equipment to accept for refurbishment or repair.

52. Where appropriate, written instructions, photographs and diagrams should be used to train people engaged in facility operations and activities to prevent injury.

53. Training records should be established and maintained for each worker, documenting training events, contents and dates.

54. Measures should be in place to ensure that job tasks associated with actual or potential significant EHS hazards and risks are undertaken by workers that are competent to perform these duties on the basis of education, training and/or experience.

vi. Record-keeping and Performance Measurement:

> Record-keeping and performance measurement enables an organization to make informed decisions regarding whether programmes, investments, and acquisitions are achieving desired results or if it is necessary to implement corrective actions. In some cases, record-keeping and performance measurement may be identified as a legal obligation and/or used to demonstrate facility compliance with legal requirements.
>
> Excerpt: *Environmentally Sound Management (ESM) Criteria Recommendations*[9]

55. Documents and records should be in place to demonstrate that facility measures are in place to support all ESM criteria, including related policies, programmes, procedures, records, audits, etc. Such documents may include EHS policies, EHS programme plans, emergency plans, facility closure plans, financial guarantees for contingency measures, training plans, operating procedures, etc. Such records may include training records,

[9] Ibid

equipment inspection, servicing and maintenance records, monitoring records, accident and safety records, records of audit results, records of management reviews.

56. Procedures that provide guidance on document approval prior to use and instructions for reviewing, updating and re-approving documents should be documented, implemented, communicated and maintained.

57. Current versions of all documents should be legible, dated, organized, easily retrievable, and protected from damage, loss and deterioration in proper locations throughout the facility. Documents prepared by external sources and used internally should be undergo periodic review for updated versions.

58. Obsolete documents should be promptly removed from all areas using them. Obsolete documents retained for legal or knowledge preservation purposes should be archived and clearly marked as being no longer current.

59. Procedures that provide guidance on the identification, storage, protection, retrieval, retention, and disposal of records should be documented, implemented, communicated and maintained.

60. Records should be legible, dated, organized, easily retrievable, and protected from damage, loss and deterioration in proper locations throughout the facility. Records should be easily traceable to the activity, product or service involved.

61. Procedures to monitor facility operations and activities associated with significant EHS hazards and risks should be documented, implemented, communicated and maintained. Such procedures should include provisions to monitor both reactive measures of performance (e.g. compliance with EHS policies, objectives and targets, programmes, and legal requirements) and reactive measures of performance (e.g. accidents, illnesses, incidents, near misses, and other evidence of deficient ESM performance). Such procedures should provide direction for monitoring each of the performance indicators associated with identified EHS

objectives and targets, and identify methods for calibrating monitoring and measurement equipment. Examples of areas to cover would include facility air quality, accidental releases to the environment, breakages (e.g. LCD backlights) other incidents likely to affect worker safety or the environment.

62. Data and results of monitoring and measurement should be recorded to facilitate facility analyses for corrective and preventive action.

63. Procedures should be in place requiring review and periodic audit of facility performance against all ESM criteria, including EHS policies, objectives and targets, should be documented, implemented, communicated and maintained.

64. Roles, responsibilities, authorities and qualifications for planning and conducting audits and retaining associated records should be documented, implemented, communicated and maintained.

65. Facility audits should be performed periodically to determine whether or not facility measures effectively meet all ESM criteria, including EHS objectives and targets, and to identify recommendations, opportunities and requirements for corrective and preventive actions.

66. Such internal audits should be conducted by properly trained individuals who do not have direct responsibilities for the activity being examined to ensure objectivity and impartiality of the audit process.

67. Audit findings should be documented and identify the status of follow-up action items and recommendations from previous audits. Serious deficiencies in meeting all ESM criteria, including EHS policies, and objectives and targets, should be communicated to top management.

vii. Corrective action:

> Corrective action is necessary to remedy weaknesses that are identified with respect to achieving ESM. It also helps to ensure that facility approaches to ESM undergo continual improvement.
>
> Excerpt: *Environmentally Sound Management (ESM) Criteria Recommendations*[10]

68. Procedures to identify, investigate and take timely action to avoid recurrence of actual and potential nonconformities or deficiencies in meeting ESM criteria should be documented, implemented, communicated and maintained.

69. Corrective and preventive actions should be appropriate for the scope and magnitude of actual and/or potential environmental, health and safety issues identified.

70. Top management should approve recommendations for corrective action and continual improvement, specifically issues pertaining to non-conformity with applicable legal requirements. They should assess the need for changes in EHS policy, objectives and targets, and other measures supporting ESM based on facility needs, client expectations, changing circumstances, and commitments for continual improvement. Results of corrective and preventive actions should be documented and maintained at the facility, and the effectiveness of corrective and preventive actions should be reviewed on a periodic basis.

viii. Transparency and Verification:

> Transparency and Verification are considered important to provide public assurances that facility operations and activities demonstrate conformity with each of the identified ESM Criteria.
>
> Excerpt: *Environmentally Sound Management (ESM) Criteria Recommendations*[11]

71. The EHS policy should be made available to the public.

72. Information should be available to customers and clients to demonstrate due diligence or duty of care with respect to the facility operations and activities. For example customers, regulators and external auditors should be provided with information on the

[10] Ibid
[11] Ibid

management of waste and materials from the facility in compliance with applicable laws and conformity with environmentally sound management.

73. Reports should be made available to shareholders and society, which include information pertaining to organization and facility performance with respect to environmental, health and safety issues.

74. Mechanisms should be in place to verify and demonstrate conformity with applicable ESM guidelines under the Basel Convention and Organization for Economic Co-operation and Development.

75. Provisions should be in place to assure the public that facility operations and activities are compatible with ESM. Such provisions may include for example participating in accredited third party certifications, audits and inspections.

76. Provisions to support transparency and verification are subject to appropriate protection for confidential business information.

3. GUIDANCE APPLICABLE TO REFURBISHMENT AND REPAIR FACILITIES TO SUPPORT ENVIRONMENTALLY SOUND MANAGEMENT

3.1 Processing and Management of Equipment and Components destined for re-use

77. This section addresses the Environmentally Sound Management of used computing equipment that is accepted by a refurbishment organization for refurbishment and/or repair. The best possible outcome for any device accepted by a refurbisher is for that equipment to be reused either as designed or repurposed.

78. Recent advances in operating system (OS) software (e.g. Microsoft Windows 7, Linux, iOS (Apple), and the anticipated Chrome OS from Google) require significantly less "computing power" than previous OSs. If computing equipment is not appropriate for general use it may have an appropriate next life as a single task system, like a print server, file server or completely repurposed for something like monitoring the electrical grid. The physical life of the equipment is significantly longer than the software. Care should be taken to differentiate between software problems (that are typically correctable) and hardware issues (that require greater expertise to correct).

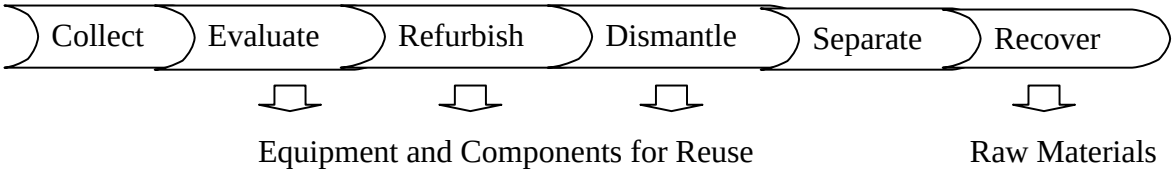
79. Care should be taken to preserve the physical integrity of the personal computing equipment prior to refurbishment. Generally speaking personal computer hardware is designed to withstand a certain amount of robust handling without damage or the impairment of function. Equipment requiring particular care includes laptop screens, flat panel monitors and other display equipment.

80. When used computing equipment is refurbished or repaired, any hazardous substances, or parts containing hazardous substances that are being replaced, consideration should be given to replace them with readily available parts containing benign substitutes (non hazardous) and in line with national legislations, and regional and international conventions prescribing phase out strategies. Discarded or broken parts and hazardous materials should be carefully packaged and transported to an environmentally sound recycling facility for appropriate treatment and where appropriate, licensed/ permitted by governments.

Where a transboundary movement of a hazardous waste is envisaged, the refurbisher should ensure that it is in compliance with the Basel Convention.

81. The management of used computing equipment can be described in the following simple diagram:

Figure 1 Chain of Management of used computing equipment



82. The first step is to **collect** the used equipment. This step can be challenging, but is critical. Computing equipment that is discarded in household waste or by organizations may never reach the next steps, and may be lost for further beneficial use, and not managed in an environmentally sound manner. In some countries the informal sector will collect used or end of life computing equipment either directly from consumers or from informal stockpiles, as used and end-of-use computers have value for reuse. There is also value for end-of-life computing equipment for its material content, but this can lead to problematic management where materials are extracted using environmentally unsound techniques. In some countries, formal collection takes place by municipal authorities or there are "bring" or "take back" schemes to effect collection of used and end-of-life computing equipment. In some cases these are funded through extended producer responsibility schemes[12]. Collection of used computing equipment from business, commerce and public sector organizations is important because of the large numbers that may be involved, and they may be a particularly good source of used and end of use and end-of-life computing equipment for refurbishment as well as for material recovery.

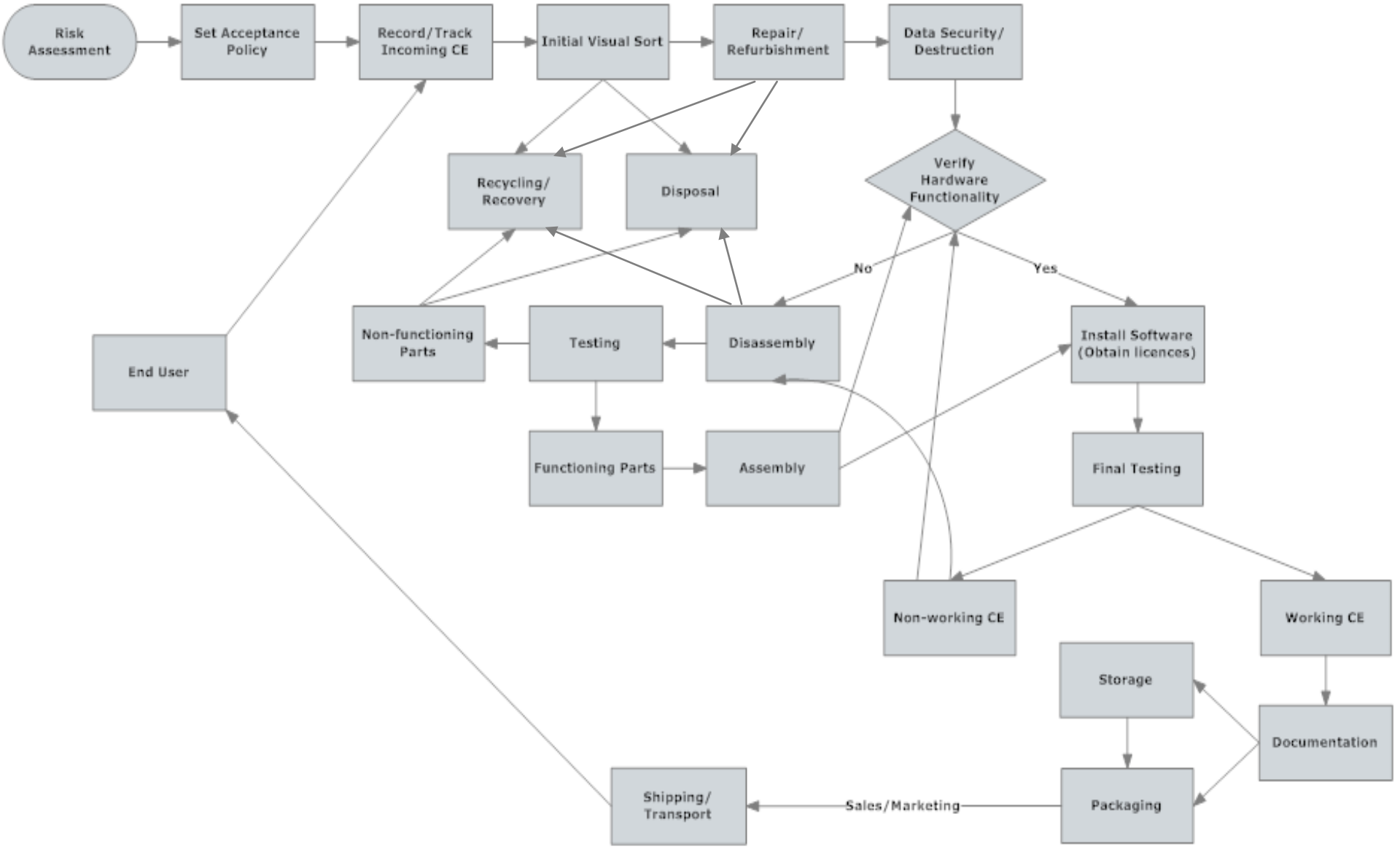
83. The second step is to evaluate the used or end of use computing equipment. Once it has been collected, computing equipment should be evaluated to determine whether it can

[12] See OECD references at:
http://www.oecd.org/document/19/0,3343,en_2649_34281_35158227_1_1_1_1,00.html

still be used as computing equipment, or whether it should be used only for material recovery. This evaluation requires expertise, and the rest of this guideline considers the steps to take in the case of refurbishment or repair.

Figure 2 below is an example flow chart showing the refurbishment and repair process in a typical facility.

Figure 2: FLOW DIAGRAM OF A TYPICAL REFURBISHMENT AND REPAIR PROCESS



3.1.1 Establish policy for what is accepted into facility

84. Each refurbishment organization needs to create and maintain their own policy for equipment that is a candidate for refurbishment in their facility. Selection of the equipment can be made because of hardware functionality, anticipated end user suitability, cosmetic considerations, anticipated reliability, operating system (OS) requirements, availability of technological expertise, user upgradability, or other factors. If the facility receives equipment it chooses not to work on, care should be taken to either find a refurbisher(s) that is/are committed to Environmentally Sound Management or an organization that supports Environmentally Sound Management of Material Recovery as discussed in Project Group 2.1 of the PACE initiative. Refurbishment facilities should accept only equipment that they are prepared to reuse/refurbish or send to an environmentally sound material recovery operation. Staff or personnel must be trained to handle equipment that it can fully process. **Box 1** gives an example of a specification set by one organization that accepts donations of used computing equipment.

85. Equipment that the refurbishment facility is not willing to accept may be acceptable for environmentally sound recycling. Any used equipment that is rejected by the refurbishment facility should be sent for environmentally sound management. As a first option this may be to another ESM refurbishment facility, or failing that to a fully permitted

Box 1 Example Specifications of accepted used computing equipment:

Some refurbishers set minimum specifications of the equipment they are willing to accept for refurbishment. Given advances in computer software design and the changing demands of consumers, these minimum specifications are likely to vary over time, and could go up as well as down. For example, at the time of writing (July 2010), Computer Aid International only accepts working donated equipment with at least the power of a Pentium 4 or equivalent, rated at 1.4 Ghz upwards. They also accept 15" and 17" colour monitors (CRTs) manufactured after the year 2002, and any sized flat screens. They also welcome power cables, keyboards and mice, as well as other peripherals and spare parts. They do not accept ink jet printers. See www.computeraid.org for the latest accepted equipment specifications.
Some refurbishers accept all equipment, but ask for a contribution towards any recycling costs of equipment not suitable for refurbishment.

ESM recycling facility. The refurbisher should take steps to confirm that the receiving facilities conform to ESM.

86. Facilities should encourage and take reasonable steps to ensure that incoming equipment to the facility is packaged as far as possible in order to protect it from damage.

3.1.2 Receiving incoming computing equipment

87. **Initial Visual Sort:** Facilities should undertake an initial sorting of computing equipment and components in order to identify and separate that which has potential for reuse as a whole or for re-use of parts, from equipment that should be recycled (see **Box 2** for possible reasons for sending equipment to recycling rather than refurbishment).

Box 2 Possible reasons for sending used computing equipment for recycling following visual inspection:

- Damage, through wear and tear, e.g. cracked casing or sharp edges that could cut or scratch, exposed wiring, parts that could lead to electric shock, injury or risk of fire
- Water damage or damage caused by leaking battery: equipment not to be connected to electrical supply
- Age: Performance assessed to be below consumer demanded specifications
- Having a poor resale value
- Missing critical components or parts that will impair functionality and/or impact value (e.g. missing cables or transformers or batteries)
- Inadequate parts, facility unable to refurbish a particular item.

Note: Cosmetic damage; minor blemishes may be acceptable depending upon equipment type and the intended market.

88. Refurbishment facilities should take certain steps to identify and sort used computing equipment that are to be refurbished or repaired from those that should undergo recycling and materials recovery. For instance:

- Computing equipment destined for refurbishment or repair should be managed in a manner that will avoid damage so as to maximize reuse value.

- Computing equipment not suited for refurbishment or repair and should be stored and transported in conformance with applicable laws and regulations, and in accordance with the PACE guideline on Environmentally Sound Material Recovery/ Recycling of End-of-life used Computing Equipment.

- Computing equipment can be sorted into different types (display units, CPUs, printers etc) in order to distribute the equipment to specific areas of the facility for refurbishment.

89. When assessing the suitability of used computing equipment for refurbishing or repair, condition alone is not always the only deciding factor for reuse. Market demand for individual models of refurbished or repaired computing equipment will be a major factor in the destiny of the product. The personal computer industry is in the midst of a paradigm shift. The newest operating systems (OS) (Windows 7, Linux, iOS and Google's anticipated Chrome OS) require significantly less computing power. This is the first time in the history of personal computing that a new OS has required less power than its predecessor. This has resulted in a dramatic shift for refurbishers whereby equipment previously considered obsolete is in fact capable of refurbishment.

90. Refurbishment and repair facilities will have an economic and environmental incentive to receive and manage used computing equipment in a manner that optimizes its value upon remarketing or distribution as determined by their purposes. Refurbishers can be expected to have receiving, screening and sorting operations that will divert some portion of computing equipment to materials recovery.

91. Refurbishment facilities should store and handle used computing equipment prior to refurbishment in a manner that protects the computing equipment and reduces the potential for toxic releases into the environment and injuries to workers.

92. Used computing equipment destined for refurbishment should be tested for electrical safety before it is connected to a power supply, as electrically unsafe equipment can

cause death or serious injury from electric shocks and can also catch fire. International electrical safety test guidelines should be followed[13].

3.1.3 Data Security and Destruction

93. Refurbishers should take care not to compromise any personal or sensitive data stored on equipment they receive and process. For an example of a detailed discussion of the various types of data storage and appropriate procedures, see the US National Institute of Standards and Technology Special publication 800-88[14]. Other countries may also release guidance or set out recommended tools on how to wipe or purge data[15] and it is recommended that refurbishment facilities consult and use national security approved tools for data destruction of protected data where they are available. It is an appropriate goal for all data stored on personal computing devices to be destroyed as soon as possible. Care should be taken to assure the security of data and subject it to verifiable digital data destruction. For example access to incoming used computing equipment should be limited to those staff involved in the initial assessment of the equipment or in the data destruction process. The primary methodology of digital data destruction should be done electronically. In other words the data destruction methodology should not compromise the physical integrity of the equipment. Many myths abound that suggest that data destruction requires complete physical destruction. Scientific studies suggest otherwise. The major risk in data destruction comes not from failures of a specific digital data destruction process but from human error implementing those processes. Therefore it is advisable to implement procedures that test and verify effective data destruction and adherence to pre defined procedures. **Box 3** gives more information on data security and destruction.

[13] See for example HB 10194 *Code of Practice for in-service inspection and testing of electrical equipment*. The Institution of Engineering and Technology.

[14] See: http://www.nist.gov/customcf/get_pdf.cfm?pub_id=50819

[15] See for example: UK Government's National Technical Authority for Information Assurance (CESG) Directory of Infosec Assured Products, Section 7 for information on approved data destruction systems (http://www.cesg.gov.uk/publications/media/directory.pdf)

Box 3: Examples of industry practice on data security and destruction

It is possible to run specific software on a personal computer or lap top that wipes or purges the hard drive to acceptable industry standards. See for example Darik's Boot and Nuke (see www.dban.org) which is a free product. Care should be taken that workers at refurbishment facilities are trained in wiping hard drives before the computing equipment is tested, so that no information stored on the hard drive is accessed inappropriately. If the hard drive cannot be successfully wiped or purged, then the drive should be destroyed physically.

3.1.4 Disassembly

94. When disassembling computing equipment the Refurbisher should ensure the appropriate tools are used where necessary to prevent damage. Care should also be taken to preserve the value of the component or material to a practical extent and protect workers and the environment. Care should be taken to avoid risk of electrical discharge, from batteries and capacitors that can lead to fire or electric shock. Once removed, laptop battery electrodes should be covered to prevent accidental electrical discharge. Equipment should be disconnected from the electrical supply before any disassembly is undertaken.

95. In most instances personal computers can be disassembled with a screwdriver and some knowledge or experience with personal computer design. Disassembly of components is typically not undertaken by Refurbishers because repair is near impossible unless undertaken by highly skilled and specialized facilities.

96. The risks associated with disassembly and repair operations are generally related to electrical shock and sharp objects, but also from mercury lamp removal and any broken glass (from displays), as well as the replacement of faulty capacitors and batteries, which can be corroded. There can also be some occupational health and environmental risks. In general terms all these risks can be assessed and mitigated by taking the broad steps outlined in section 2.

3.1.5 Cleaning Used Computing Equipment

97. Most personal computing equipment has been designed to be easily cleaned and maintained. For most purposes a damp cloth and soap or a vacuum cleaner is sufficient to clean the equipment. The damp cloth is typically used clean the equipments' case. A vacuum is used to carefully extract dust that has collected over time. Depending on end user cosmetic requirements, stronger solutions may be required to clean the cases. If so, care should be taken to provide for worker safety and conform to applicable regulation(s).

3.1.6 Repair

98. Given the complexity and specificity of personal computer components, repair requires a high level of skill and training. On-line manuals and tools exist to assist with some of the techniques involved (see for example www.ifixit.com). Most often personal computing equipment is returned to functionality by replacing non-working components with tested, working components. Once a component has been determined to be faulty, care should be taken to have it repaired or properly recover the materials. Disposal is a last resort.

99. Particular care should be taken with the removal of potentially hazardous or dangerous components such as the fluorescent lights used for backlighting liquid crystal displays (LCDs), batteries, capacitors or sharp components or parts in order to avoid risk of damaging worker safety and health or damage to the environment.

100. Removal of faulty mercury lamps from LCDs is a particularly specialized activity, and given the hazardous and fragile nature of this component, should only be undertaken by facilities with the necessary knowledge, expertise and authorizations required for their environmentally sound management of mercury-containing wastes.

101. Where such lamps are removed, stored or transported, extreme care should be taken not to break the lamps, which contain mercury vapour and fine powder contaminated with small amounts of mercury. Such fluorescent discharge lamps should be managed by a specialized and appropriately authorized facility.

102. Where batteries are removed, the electrical contacts should be sealed with insulating tape and/or wax, or otherwise insulated from each other, in order to prevent unintentional discharge, short circuits or fires.

103. Repair operations involving the soldering of printed circuit boards or replacement of faulty capacitors should be undertaken only by workers with the necessary knowledge, experience and training. Additional requirements may exist.

3.1.7 Separation and segregation of waste generated during the refurbishment/ repair process

104. During refurbishment and repair operations, waste is generated when non-working or unwanted parts or devices are removed and sometimes replaced with working components. In a number of cases, non-working components contain hazardous materials, and must be removed, packaged, stored and transported safely. For example, as noted above, faulty backlights on LCD screens, non-functioning batteries or circuit boards, faulty capacitors, may need to be replaced in order to restore a device to working condition. It is critical that care be taken in segregating and managing the waste generated during refurbishment or repair activities, in order to protect human health and the environment.

3.1.8 Refurbishment

105. The process of refurbishment of a computer is twofold. The first step in the refurbishment process is to verify the hardware functionally through initial testing, remove old data and software, and install new hardware (parts), as needed (see repair section 3.1.6). During this preparatory process, digital data destruction software can remove all software including the basic set of instructions called an operating system (see data destruction section 3.1.3). It is helpful to imagine a computer at this point as a polished mirror, awaiting a new set of instructions. The second step is to install the required instruction sets (software, both the operating system and applications) that control the hardware and provide desired user functionality.

106. Prior to installing a new operating system, sufficient hardware functionally can be tested with a class of software know as utilities. There are tens of thousands of different hardware components that can be combined in a personal computer. Each piece of hardware requires a unique set of instructions (know as drivers or software drivers) unique to each operating system. Drivers and operating systems need to be updated on a regular basis to correct programming errors. Given the large number of permutations of hardware and software, refurbishment has been difficult and costly. Recently there have been significant advances made that allow for automating the refurbishment process such as one company's Refurbishers Preinstall Kit. These can include testing utilities, driver selection, driver injection and software selection during the refurbishment process. These advances should make refurbishment easier and more reliable.

107. Information and instructions on the type and use of software programmes and packages would normally be delivered with the software product itself. Further information may be available through the manufacturer's website or from other on line sources.

3.1.9 Remanufacturing of printer cartridges

108. Simple refilling of printer/toner cartridges by non experts is not recommended due to product reliability and occupational and environmental concerns. Indeed, while printer cartridges can be refilled professionally, toner cartridge remanufacturing may require access to specialty parts such as imaging drums, toner of the proper granularity, etc. It is highly recommended therefore, that only specialized facilities attempt the remanufacturing of printer cartridges. Improperly treated toner cartridges pose a risk to printers. Overall, the remanufacturing of toner cartridges is beyond the scope of this document.

3.1.10 Software Use

109. A range of software is available to support refurbishment operations, including the loading of operating systems. Some of this software is available free of charge and does not require license fees. Most of the software requires some expert knowledge to operate and utilize properly. Refurbishers should ensure that any licenses required by local or national laws, are obtained.

3.1.11 Testing of equipment and components (hardware) prior to reuse to ensure full functionality

i) Used Computing Equipment

110. The following functionality tests are proposed for used computing equipment to confirm that the equipment is fully functional and is suitable for re-use (see table 1). This corresponds to the functionality test referenced in the decision tree procedure in Appendix B of the PACE Discussion Paper on the Transboundary Movement of Used and End-of-Life Computing Equipment (see Chapter 3 of the PACE Guidance Document).

Table 1: Functionality tests for used computing equipment

Computing Equipment	Functionality Tests	Test results
Central Processing Units (CPUs), including Desk Top PCs	**Power on self test (POST)*** Switching on the computer and successfully completing the boot up process. This will confirm that the principal hardware is working, including power supply and hard drive. • A working monitor would need to be used if none present • Ensure that cooling fans are functioning	**Computer** should boot up successfully. **Computer** should respond to keyboard and mouse input. **Cooling fans** should operate normally.
Laptops/notebooks	**Power on self test (POST)*** Switching on the laptop and successfully completing the boot up process. This will confirm that the principal hardware is working, including power supply and hard drive. • Test screen • Test battery functionality • Ensure the display is fully functional • Ensure cooling fan(s) is functional	**Laptop** should boot up successfully. **Laptop** should respond to keyboard and mouse input. **Display** turns on during boot up. Image should be clear and colors contrast and brightness correct with no screen burned images, scratches or cracks (see also below for display devices).

Computing Equipment	Functionality Tests	Test results
		Laptop Battery able to retain a minimum of 1 hour[16] of run time; or battery tested to determine the Full Charge Capacity in watt-hours also with a minimum of 1 hour remaining (see Laptop batteries section below, paragraph 120)
Keyboards	Connect to computer and ensure they successfully interface. Test keys for functionality.	Computer should respond to **keyboard** input. **Keyboard** should have no missing or non functioning keys.
Mice	Assess mouse casing, cable and parts. Plug into computer or laptop to assess functionality.	**Mouse** should have all parts present (e.g., the roller ball). Computer should respond to **mouse** input. Visible cursor on screen should not judder.
Cables and power cords	Assess cable insulation and inspect plugs.	**Cabling and plugs** should be complete and free of damage, e.g., has no cracked insulation
Display devices	Plug in display and test the picture quality for pixels, color, contrast and brightness. Software based diagnostic testing for display devices are readily available on line[17], and should be used Visual inspection for screen burn (CRTs) or "image persistence" (flat screens), scratches or other damage to screen or housing. Cabling should be inspected and present.	**Display devices** The picture should not be fuzzy, or have damaged pixels, or be too dark. LCD backlights should all function. Colors, brightness, hue and straightness of lines should be considered. The software diagnostic test should be positive. Cabling should free from damage.

[16] 1 hour is a minimum charge a battery should hold, although some users of laptops may request more useable runtime. It should be noted that some end users will also be able to make use of batteries with less capacity, for example a battery able to hold 40 minutes capacity need not be discarded, and can have use for those principally connecting the laptop to a reliable electricity supply using the charger, however, for the purposes of this guideline and for export, batteries must hold at least a one hour charge.

[17] See for example: http://www.softpedia.com/progDownload/Nokia-Monitor-Test-Download-464.html

Computing Equipment	Functionality Tests	Test results
Laser and inkjet printers	A test page can be successfully printed. This can be standalone but also from a computer or local area network to assess connectivity. For inkjet printers, check that the ink heads are not clogged with dry ink.	**Printers** should successfully print a test page and not jam, or produce smudged or incomplete copy.
Components (removed from equipment) including mother boards, other circuit boards, sound cards, graphics cards, hard drives, power supplies and cords/ cables	Components should be tested for functionality either before removal from the host computer or laptop, or by insertion in a test bench computer using diagnostic software, or a known working device as applicable.	**Components** should be fully functional **Power supplies and cords/ cables** should be complete and free of damage, e.g., has no cracked insulation

* The Power on self test (POST) is automatically engaged when a personal computer or laptop is switched on. The POST is a software based system integral to all PCs and laptops. The POST will check that the hardware systems of the computer are functioning, including the hard disk drive, computer ports, the motherboard, and video cards. The POST will deliver an audible beep or set of beeps to the refurbisher/operator should any of the hardware systems be faulty. On line guidance exists for better understanding of the beep codes. For example see: http://www.poweronselftest.com/ and http://www.computerhope.com/beep.htm

ii) Laptop Batteries

111. It is important to note that there are a wide variety of battery sizes, capacities and technologies currently in use in computing equipment, although almost all new laptop batteries are of lithium-ion type with some older laptops based on nickel metal hydride or occasionally nickel cadmium (Ni Cd). While this section is concerned with the assessment of laptop batteries, it is worth noting that there are also other multiple uses for batteries in computing equipment, such as small button cell batteries that are attached to circuit boards, and additional batteries that are used in wireless keyboards and mice. There are also battery back-up systems in use in some countries to provide an uninterrupted power supply, and which provide emergency power to desktop computers when the principal power source fails. In contrast to the batteries used in the actual computing equipment, these electricity supply back-up system batteries are typically lead-acid.

112. A used laptop battery's current charge capacity relative to its original capacity can provide important information for the user or refurbisher because over time, the capacity of a battery to hold charge deteriorates. A battery's current capacity can be measured as a percentage of the amount of charge the battery was able to hold when new. However, a simpler approach to determining a battery's appropriateness for reuse is ensuring that it is still capable of holding a minimum charge of 1 hour (see Table 1). The actual remaining capacity of a used laptop battery, rather than the percentage of the original capacity, will vary depending on a number of factors:

113. First, there are 4-cell, 6-cell and 9-cell batteries in used in laptops as of the writing of this document. For example, a used 9-cell battery at 50% capacity may contain more charge than a brand new 4-cell battery at 100%.

114. Second, there are different original battery ratings within the same battery category. For example, a new 4-cell battery may be rated for 5 amp-hours, while another brand-new 4-cell battery may only be designed to carry 3 amp-hours.

115. Third, the rate at which a battery is discharged, which affects how many times it needs to be recharged and therefore the remaining battery life is also largely dependent on the device that contains it. For instance, newer laptops often contain power-saving features such as low-power processors, low-power memory, energy-saving disk drives and screens. Older devices may not include these features and will thus draw down the same battery at a faster rate under similar conditions. Similarly, netbooks, which run very basic applications, will typically be able to run longer on the same battery capacity.

116. Finally, identical laptops under different use conditions will draw power at different rates. For example, a laptop running in standby mode will draw significantly less power than a laptop running multiple applications and devices.

117. The cost of a new laptop battery may equal or even exceed the value of the used laptop that contains it, so there is an added incentive amongst users and refurbishers not to discard batteries which are able to complete a circuit and hold a charge for a minimum of 1

hour. In other cases, users in countries where the electrical grid is unreliable may need a battery that can hold charge for longer in order to continue working when no electricity is otherwise available. In many cases, however, users discard fully functional laptop batteries prematurely, when many could be retained in use or for re-use.

118. Bearing in mind this technical information, the following testing methods are proposed for laptop batteries:

1) Method 1 Demonstration

119. This is the most commonly used and represents a simple test, able to be undertaken by all refurbishers. The system/battery combination is tested to ensure it can hold an appropriate charge[18] and meet the minimum run time/charge of one hour. The laptop battery should be inserted into the laptop and then fully charged. The system[19] should be started with the screensaver disabled, and allowed to run functions to demonstrate the capability of operating off the power grid. The time for the battery to fully drain is recorded, with at least 1 hour run time. In some situations the end user may request a longer lasting battery according to their needs.

2) Method 2 Self-managing the Smart Battery

120. This test is more sophisticated and requires some expertise and knowledge and applies to newer batteries. All new laptop batteries now incorporate "smart" battery technology which enables the battery to be assessed using a battery check programme provided by the manufacturer. For a laptop powered by a "smart" battery, the calculated method may be used. The power used[20] by the laptop should be determined in watts (W).

[18] "Hold an appropriate charge" means a battery, when used in a particular system, is capable of powering the system for a time period which meets the needs of a target user, and for at least 1 hour. "Time period which meets the needs of a target user" is the end user expected operational time for the mode of operation expected. Users may be using a system computer predominantly when connected to the grid, the battery serving as a backup to allow the work product to be saved in the event of a power outage. 1 hour is regarded as the minimum acceptable time for this function. Other users may use the system in a portable manner demanding additional run time.

[19] A "System" is a laptop, notebook, netbook or other portable computer.

[20] The "Power Used" is the actual power used by the System when the System is operating

The battery shall be interrogated or tested to determine the Full Charge Capacity[21] in watt-hours (Wh). The runtime[22] is determined by:

Run time in hours (h) = FCC(Wh)/Power used (W).

3.1.12 Cosmetic condition of equipment and components

121. The cosmetic condition of the equipment typically does not affect its functionality, but care should be taken to assure that cosmetic damage does not expose equipment to future harm or failure. Equipment in poor cosmetic condition may be rejected for reuse by potential new users leading to potential inappropriate repair, recycling or disposal of functional equipment. It is important, therefore, for refurbishers to provide functional equipment that is also in an acceptable cosmetic condition.

3.1.13 Final Testing (hardware and software)

122. Final testing should be conducted by the refurbisher after the computing equipment has been refurbished or repaired to full functionality and is ready for reuse, and prior to sale, donation or export for reuse. Final testing of computing equipment and newly installed software should ensure the device and software conforms to user needs and will help to ensure compliance with controls in importing countries if the equipment is exported. This generally includes a Power on Self Test (POST), Operating System boot with all drivers resolved and some applications tests to ensure software functionality.

3.1.14 Labeling/Documentation for Refurbished and Repaired Computing Equipment

123. In addition to keeping on-site records of the diagnostic testing results, repairs and upgrades completed and final test results, there are additional types of documentation that

[21] "Full Charge Capacity" (FCC) is the energy storage capacity of a battery, measured in watt-hours (Wh). This value is obtained from the microcontroller which is a part of a "smart battery," from design specifications, or is measured using equipment capable of determining the full discharge capability of a battery.

[22] 1 hour is regarded as the minimum acceptable time.

refurbishers should provide. Information should clearly inform the subsequent purchaser/recipient of used equipment that the products are used and/or refurbished/repaired.

124. Refurbishers should provide detailed documentation of each device or components going for reuse (directly or indirectly from the refurbisher). It is intended that these labeling and/or documentation provisions will provide the subsequent purchaser/recipient with the contact and product information necessary in the case of a faulty product. This information can be communicated to subsequent purchasers by way of a label placed on the product or on an invoice. Additional information can be provided on the product packaging, or through a product information insert.

125. For refurbished computing equipment or components, any information regarding the status of the equipment should conform to the labeling and/or documentation requirements as follows: the labeling or documentation should include the name, address, and complete contact information for the refurbisher, the unique identification number of each refurbished device (e.g. original serial number), the testing that was performed, and confirmation that the refurbished/repaired equipment is fully functional. Other labeling elements can include the date testing was completed, the need for additional software, etc. Tested laptop batteries should be labeled with the result of the test, for example the calculated run time in accordance with guidance in paragraph 120.

126. In addition to the above, if the refurbishers are selling or donating shipments of repaired/refurbished computing equipment or components, they should provide detailed documentation of each device in the shipment (as described in the next paragraph), with such documentation accessible so that shipments do not have to be unpacked (e.g. by customs officials) in order to find the documentation. The refurbisher should fill out and sign a Declaration of Testing and Determination of Full Functionality and Reuse Destination of Exported Used Computing Equipment, as set out in Appendix C of the PACE Discussion Paper on the Transboundary Movement of Used and End-of-Life Computing Equipment (see Chapter 3 of the PACE Guidance Document).

127. This declaration document requires the consignor (refurbisher selling or donating equipment or components) to provide contact information for the exporter, the consignee, and the user, as well as list each unit's type of equipment, model and serial numbers, year of manufacturing, testing information, and a signed declaration that all of the devices and components are fully functional and being exported/imported for the purpose of reuse, and not for recycling, further processing, or final disposal (See Chapter 3 of the PACE Guidance Document).

128. In addition, a refurbisher or other party who refurbishes and repairs computing equipment should ensure that their practices are consistent with applicable IT, data security and other legislation. In some countries an organization making certain changes to computing equipment would then be regarded as the new supplier to the market and hence responsible for demonstrating the same compliance provisions as the original manufacturer. This may not be the case in all countries and is likely to vary with the extent of product repair.

129. It is also the case that there may be specific labeling requirements via IT or other regulations for such refurbished or repaired computing equipment. These distinctions may be especially important where the device is intended for resale in another country. Where repair affects the original manufacturer's guarantee provisions, consumers should be aware of this fact. Such labeling may be on the equipment itself or documented in the product packaging as determined by applicable regulations.

130. Where possible, information on opportunities for subsequent users to recycle the refurbished and/or used computing equipment should also be provided through use of a label on the product, or on the product packaging, or invoice or through a product information insert.

131. Where possible, and where labelling is used, a standardized label should be applied to provide all the information listed above, to ensure that subsequent users have access to this information in a uniform manner. Additional information can be provided on

the product packaging, or through a product information insert. Where individual product labelling is not used, documentation should provide this information.

3.1.15 Storage and Handling[1] of Used Computing Equipment after refurbishment/ repair

132. Refurbishment and repair facilities should store and handle used computing equipment after refurbishment in a manner that protects the equipment and reduces the potential for damage, protects the environment and safeguards workers. Computing equipment should be stored indoors.

3.1.16 Packaging equipment and components for shipping for direct reuse, or reuse after refurbishment or repair

133. Facilities should ensure that refurbished and repaired computing equipment and components are packaged and shipped in order to protect them from damage during shipping, whether for the domestic or international market.

134. Typically laptops and flat panel monitors should be packaged and shipped vertically as opposed to horizontally. This will minimize screen breakage.

135. To the extent that any shipped materials may be hazardous materials, the applicable regulations (if any) will depend upon various factors such as the nature of the hazards, the quantities shipped, the packaging utilized, and the modes of transportation employed (e.g. truck or aircraft). Relevant requirements may address such issues as packaging, hazard communication (e.g. labeling, marking, or placarding), shipping papers, emergency response, registration, training, and security.

136. Although refurbishment facilities should ensure that the materials they are sending off-site are prepared for shipment and transported properly, they may need or want to work with the relevant carrier(s) that transport materials to determine the specific measures that are

required under the regulations or are otherwise appropriate. In some cases, the transportation provider may also implement one or more of these measures.

137. The following guidelines may be used to distinguish proper packaging from improper packaging.

138. For shipments[23], the following packaging guidelines would apply in order to help preserve the value and reusability of the equipment, and represent only one criterion among others to help distinguish waste from non waste:

- Each piece of computing equipment should be protected with cushioning material appropriate to preserve asset value (e.g., bubble-wrap, packaging foam).
    - **Laptops** and their chargers should be packed together in boxes reasonably fitted to the unit.
- **Cables, keyboards and mice** should be packed in separate boxes.
- Stacked layers of **computing equipment** should be separated by appropriate intermediate packaging to preserve asset value (e.g., cardboard, bubble-wrap, packaging foam) and shrink wrap should be used to secure shipments to pallets.
- Stacking of equipment should be no more than as follows:
    - **Display devices** – 4 layers only, unless 17" (43.2 cm) or larger, in which case 2 layers; flat panel displays should be stacked vertically;
    - **Desktop PCs** – 15 layers;
    - **Laptops** – 5 layers stacked vertically; and
    - **Printers** – 5 layers.
- **Batteries** – should be packaged in a way to avoid contact with their terminals, to avoid short circuits and fires;
- **LCD backlights** – Due to their fragile nature, where removed, LCD backlights should be individually packaged in a rigid container that prevents breakage during the transport and should also be sealed in a foil laminated bag in case of any breakage during the transport. In general, removing and packaging LCD backlights for reuse is a specialist activity generally to be undertaken by professionals with detailed knowledge and experience of handling these hazardous components.
- Each load should be properly secured to the pallet (e.g. with plastic shrink-wrap).

Small, individual items of computing equipment should be packed in a box, properly encased with cushioning material, and include sufficient fill to prevent movement. For multiple items within the same box, each part should be separated with appropriate intermediary packaging.

[23] These provisions are in addition to applicable requirements under the UN Recommendations on the Transport of Dangerous Goods (i.e., UN Orange Book): Model Regulations, 15th revised edition, 2007, or later version.

Boxes should be suitable for the length and type of shipping being used. Where pallets are used, boxes should be secured to pallets using shrink wrap or other means.

3.2 MANAGEMENT OF MATERIALS, COMPONENTS AND RESIDUALS DESTINED FOR RECYCLING OR DISPOSAL

3.2.1 Handling of Computing Equipment and Components Destined for Materials Recovery, Recycling and Disposal

139. Refurbishment facilities may receive or generate used computing equipment components and materials that are not reused. These used computing equipment components and materials can include hazardous components such as faulty mercury lamps, batteries, capacitors and printed circuit boards. Components and materials should be managed on site in a manner that protects human health and the environment and preserves their value for material recovery and recycling, and energy recovery if appropriate. Section 3.1.6 gives further information on the management of potentially hazardous and dangerous components and materials, and further information is in the PACE Guideline on Material Recovery and Recycling of End-of-Life Computing Equipment as prepared by PACE Project Group 2.1.

140. Refurbishment facilities should avoid the landfilling of used computing equipment components and materials and instead arrange for appropriate environmentally sound recovery. Refurbishment facilities should use the Basel Convention guidance documents to ensure that downstream materials recovery and recycling facilities operate in a manner that protective of the environment and worker health and safety. Such recycling facilities should take into consideration the PACE Guideline on Material Recovery and Recycling of End-of-Life Computing Equipment. This PACE 2.1 Guideline addresses the material recovery, recycling and disposal of used computing equipment, their components and materials.

141. Some materials destined for material recovery and recycling, such as certain types of batteries, may pose a hazard during transportation. In order to minimize such hazards and protect against releases into the environment, it is essential that the materials be shipped in a safe and secure way. Such handling is also important to preserve the materials being shipped

so that they can be recycled properly. For further information please refer to the relevant UN recommendations on transport of dangerous goods[24].

142. In the case of domestic movements, refurbishment facilities should ensure that all computing equipment, components (e.g. batteries), and residuals destined for materials recovery and recycling are prepared for shipment and transported in a safe and secure manner that complies with any applicable hazardous materials transport regulations of local government and the country and/or region. Refurbishers should take steps to ensure that wastes are managed in an environmentally sound manner.

143. In the case of transboundary movements, refurbishment facilities should ensure that all computing equipment, components (e.g. batteries, CRT displays, circuit boards), and residuals destined for materials recovery and recycling are prepared for shipment and transported in full compliance with the Basel Convention (see Chapter 3 of the PACE Guidance Document) and other multilateral waste trade agreements.

[24] Ibid

4. GUIDANCE FOR THE MARKETING, DONATION AND REDEPLOYMENT OF REPAIRED AND REFURBISHED COMPUTING EQUIPMENT AND COMPONENTS

4.1 Marketing

144. Any organization that remarkets used computing equipment should ensure that this equipment continues to meet all applicable industry and government standards and requirements for the operation of computing equipment, including the original product's rated operational characteristics or higher and on electrical safety. It is worth noting that computing equipment designed for a particular market, or region, may only be compliant with standards relevant to that market or region and only remarketing in that particular market or region is appropriate.

145. In addition, those seeking to remarket refurbished used computing equipment should be aware that some countries prohibit the import of any used computing equipment, or used computing equipment greater than a specified age.

146. Documentation accompanying the used and refurbished/ repaired equipment should verify and document that they are fully functional equipment and components, fit for its intended end use, and destined for a reuse market.

4.2 Donations

4.2.1 Minimum Specifications

147. A 'minimum' specification for computing equipment is an attractive target, but hard to achieve in practice as base computer specifications evolve constantly. It is likely that any such specification will be driven more by customer (i.e. receiver) software operating system demand than by hardware, and as is noted earlier in this guideline, end user demands are changing, with recent advances in operating system (OS) software (e.g. Microsoft Windows 7, Linux, iOS (Apple), and the anticipated Chrome OS from Google) requiring

significantly less "computing power" than previous OSs. As an example, Windows XP-capable machines can readily be upgraded to Windows 7.

148. Overall therefore, the receiver should receive refurbished/ repaired equipment capable of operating the current operating system. At a minimum, this should be the previous two generations. As a guide, resellers in early 2010 note that there is little demand for anything less than a P4 processor, 256 MB RAM and 20 GB hard drive. Such a machine would be capable of running Windows XP.

149. A set of principles for donors of functioning used computing equipment is set out in Annex III.

4.2.2 Good Practice Case Studies

150. A number of good practice case studies for the donation, refurbishment and re-use of used computing equipment are included in Annex IV.

4.3 Compliance with Import/Export requirements

151. Chapter 3 of the PACE Guidance Document on the "Transboundary Movement of Used and End-of-life Computing Equipment" provides guidance on the procedures to follow in the event of transboundary movement of used computing equipment and components. Where refurbishers are exporting refurbished computing equipment or components to other countries, either directly or through others, including contracted agents, they should ensure compliance with all applicable laws governing product and used product imports, technical standards, labeling and health and safety requirements in the importing and exporting countries.

5. RECOMMENDATIONS

5.1 Recommendations relating to facility measures to support environmentally sound management (ESM)

i) Top management of the facility should ensure that a systematic approach is in place to create an environmentally sound operation. This policy should be fully documented and implemented through a plan of action on ESM. The plan should include a review and continual improvement component. Care should be taken to appropriately communicate and document the organization's policies and operational controls on ESM to all staff, sub contractors and visitors.

ii) Management should seek to identify hazards and risks to worker health and safety, and the environment that are associated with refurbishment and repair activities, products and services.

iii) Once management has assessed the risks they should seek to minimize or eliminate hazards and risks to worker health and safety, and the environment that are associated with refurbishment and repair activities and services establishing and maintaining a working environment that is safe and adequate for the welfare of all people engaged in used and end of life computing equipment refurbishment and repair activities, and put in place high quality awareness raising and training systems on these issues for their workers.

iv) Refurbishment and repair facilities (RRFs) should perform evaluations at regular intervals to identify all applicable laws, regulations and authorizations and determine how these requirements apply to the facility, and ensure compliance with these requirements.

v) Records of the inspections, testing and assessment of facilities performance on the environmentally sound refurbishment and repair of used computing equipment should be maintained and be readily accessible to customers, auditors and regulators in compliance with applicable laws and conformity with environmentally sound management.

vi) RRFs dealing with materials that are potentially hazardous to the health and safety of their workers and the environment should have procedures in place, documented or otherwise, to ensure reduction or elimination of hazards, and should perform regular, scheduled internal audits and monitoring of hazards. In addition there may be regulatory requirements that must be satisfied.

vii) A certification of facility conformance with an accredited comprehensive environmental management system and electronics recycling standard is desirable, and will assist concerned governments and other interested persons in evaluating refurbishment and repair operations and facilities. If possible, this certification should be made by an independent certification body which is accredited to audit to the respective standards. See Annex V for additional information.

5.2 Recommendations relating to the refurbishment/ repair process

viii) Facility managers should establish a policy specifying what used computing equipment is accepted into their facility for refurbishment or repair based on their technical capacity.

ix) Facilities that refurbish or repair used computing equipment should take steps to identify and sort used computing equipment that is to be refurbished or repaired from that which should undergo recycling and materials recovery.

x) Refurbishers should adhere to selling, transferring or transporting only computing equipment that is evaluated to be refurbishable or that is appropriately tested to assess the equipment's functionality.

xi) RRFs should store and handle used computing equipment prior to refurbishment in a manner that protects the computing equipment and reduces the potential for toxic releases into the environment and injuries to workers.

xii) Refurbishers should take care not to allow the release of data stored on used computing equipment they receive and process, and should seek to destroy such data through electronic means.

xiii) RRFs should ensure that proper labelling or documentation of refurbished/ repaired equipment is undertaken. The labeling or documentation is intended to cover, where appropriate and possible, the type of equipment, the model and serial numbers, the year manufactured, the refurbishment/ repair date, possible evaluation and testing that was performed, an overall confirmation that the refurbished/ repaired equipment is fit for re-use.

xiv) Refurbishment facilities should use the Basel Convention guidance documents to ensure that downstream materials recovery and recycling facilities operate in a manner that is protective of the environment and worker health and safety and is compliant with the requirements of the Basel Convention. Such recycling facilities should take into consideration the PACE Guideline on Material

Recovery and Recycling of End-of-Life Computing Equipment, as prepared by PACE Project Group 2.1.

xv) Refurbishment facilities should ensure that, in the case of transboundary movements, all computing equipment, components (e.g. batteries, CRT devices, mercury-containing devices, circuit boards) and residuals destined for materials recovery, recycling and disposal are prepared for shipment and transported in full compliance with all applicable laws, including national implementation of the Basel Convention (see Chapter 3 of the PACE Guidance Document) and other multi-lateral waste trade agreements.

5.3 Recommendations relating to marketing and redeployment of refurbished/ repaired computing equipment

xvi) Any organization that remarkets used computing equipment should ensure that this equipment continues to meet all applicable industry and government standards and requirements, including the original product's rated operational characteristics or higher.

xvii) Documentation accompanying the used and refurbished/ repaired equipment should certify the testing undertaken on the equipment to verify that it is working equipment and that it is fit for its intended end use.

xviii) Where refurbishers are exporting refurbished computing equipment to other countries, either directly or through others, care should be taken to ensure compliance with all applicable laws governing product and used product imports, technical standards, labeling and health and safety requirements. Chapter 3 of the PACE Guidance Document provides guidance on the procedures to follow in the event of transboundary movement of used computing equipment and components.

Annex I: Glossary of Terms

Note: *These terms were developed for the purpose of the report on ESM criteria recommendations, individual project guidelines and overall Guidance Document developed under PACE, and should not be considered as being legally binding, or that these terms have been agreed to internationally. Their purpose is to assist readers to better understand these PACE documents*.

Assemblies: Multiple electronic components assembled in a device that is in itself used as a component.

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

Cleaning: Removal of dirt, dust, and stains; and making cosmetic repairs.

Component: Element with electrical or electronic functionality connected together with other components, usually by soldering to a printed circuit board, to create an electronic circuit with a particular function (for example an amplifier, radio receiver, or oscillator).

Computing Equipment: Computing equipment includes: personal computers (PCs) and associated displays, printers and peripherals, personal desk top computers, including the central processing unit and all other parts contained in the computer; personal notebooks and laptop computers, including the docking station, central processing unit and all other parts contained in the computer; computer monitors, including the following types of computer monitors: (a) cathode ray tube (b) liquid crystal display (c) plasma; computer keyboard, mouse, and cables; computer printer: (a) including the following types of computer printer: (i) dot matrix; (ii) ink jet; (iii) laser; (iv) thermal; and (b) including any computer printers with scanning or facsimile capabilities, or both.

Defective/Defect: Defective **Computing Equipment** is equipment that is delivered from the supply chain and last manufacturer in a condition that is not as it was designed to be sold, or the equipment breaks or malfunctions due to a condition that is not as it was designed. Defective equipment does not include equipment that loses functional or cosmetic value as a result of normal wear and usage or as a result of consumer negligence.

Direct reuse: Continued use of **computing equipment** and **components** by another person without the necessity of repair, refurbishment, or hardware upgrading, provided that such continued use is for the intended purpose of **computing equipment** and **components**.

Dismantling: Taking apart **computing equipment**, **components**, or **assemblies** in order to separate materials and/or increase options for **reuse, refurbishment, or recycling,** and to maximize recovery value.

Disposal: Any operations specified in Annex IV of the Basel Convention (Article 2, paragraph 4 of the Basel Convention, and Annex VI in this document).

Donation: Comprises any action to transfer **computing equipment** or its **components that are still fully functioning for its intended use,** for charity to another owner without any monetary rewards, or benefits, or barter.

End-of-life computing equipment: Individual **Computing equipment** that is no longer suitable for use, and which is intended for **dismantling** and recovery of spare parts or is destined for **material recovery** and **recycling** or final disposal. It also includes off-specification or new **computing equipment** which has been sent for **material recovery** and **recycling,** or final disposal.

End-of-Use: Computing equipment that is no longer used as intended by the previous owner, but may be fully functional and used appropriately by others.

Environmentally sound management (ESM): Taking all practicable steps to ensure that used and/or end-of-life products or wastes are managed in a manner which will protect human health and the environment.

Evaluation: The initial process by which used **computing equipment** is assessed, to determine whether or not it is likely to be suitable for refurbishment/repair or material recovery /recycling**.**

Essential Key Function: The originally-intended function(s) of a unit of equipment or component that will satisfactorily enable the equipment or component to be reused.

Final Disposal: Relevant operations specified in Annex IVA of the Basel Convention (Annex VI A in this document).

Fully Functional/Full Functionality: Computing equipment or **components** are "fully functional" when they have been tested and demonstrated to be capable of performing the **essential key functions** they were designed to perform.

Hydrometallurgical processing: Uses of aqueous chemistry for the recovery of metals from ores, concentrates, or recyclable wastes or products. Typically Hydrometallurgy consists of three steps of (a) Leaching using an acidic or basic aqueous solution to dissolve the desired metal at ambient or elevated pressures and temperatures; (b) Solution concentration, purification, then metal recovery using methods such as: precipitation, cementation, solvent extraction, gaseous reduction, ion exchange, electrowinning or electrorefining and (c) recycling of reagents and treatment of effluents. Hydrometallurgical operations in authorised industrial scale facilities are distinct from unauthorised and illegal environmentally harmful practices in the informal sector.

Incineration: A thermal treatment technology by which wastes, sludges or residues are burned or destroyed at temperatures ranging from 850°C to more than 1100°C .

Labelling: The process by which individual or batches of **computing equipment** are marked to designate their status according to the PACE guidelines.

Landfilling: The placement of waste in, or on top of, ground containments, which is then generally covered with soil. Engineered landfills are disposal sites which are selected and designed to minimize the chance of release of hazardous substances into the environment, e.g. using plastic landfill liners and **leachate** collection systems.

Leachate: Contaminated water or liquids resulting from the contact of rain, surface and ground waters, or other pollutants with waste.

Material Recovery: Relevant operations specified in Annex IVB of the Basel Convention (Annex VI B in this document).

Mechanical Separation: Process of using machinery to separate **computing equipment** into various materials **or components**.

Potential for reuse (reusable): Computing equipment and its **components** that possess or likely to possess quality necessary to be directly reused or reused after they have been refurbished or repaired.

Pyrometallurgical processing: Thermal processing of metals and ores, including roasting, smelting, and remelting.

RoHS: Directive of the European Parliament and the Council on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (URL: http://ec.europa.eu/environment/waste/weee/index_en.htm).

Recycling: Relevant operations specified in Annex IVB of the Basel Convention (Annex VI B in this document).

Redeployment: Comprises any action of new deployment or use by the owner of previously used **computing equipment** or its **components.**

Refurbishable: Computing equipment that can be refurbished or reconditioned, returning it to a working condition performing the essential functions it was designed for.

Refurbishment: Process for creating **refurbished or reconditioned computing equipment** including such activities as cleaning, data sanitization, and software upgrading.

Refurbished computing equipment: Computing equipment that has undergone **refurbishment** returning it to working condition functional for its originally conceived use with or without upgrades and meeting applicable technical performance standards and regulatory requirements and possible upgrades.

Remarketing: Any action, including marketing activities, necessary to sell previously used **computing equipment** or its **components** directly or indirectly to customers.

Remanufacture: Any action necessary to build up as-new products using **components** taken from previously used **computing equipment** as well as new **components**, if applicable. The output product meets the original OEM functionality and reliability specifications. To remanufacture a product may require the complete or partial disassembly of the unit, replacement or reprocessing of all components not meeting specifications, and testing to determine the new product is fully functional. Depending on the applied components this process may significantly change the unit's composition, purpose, and design.

Repairing: Process of only fixing a specified hardware fault or series of faults in computing **equipment.**

Reuse: Process of using again used **computing equipment** or a functional **component** from used **computing equipment** in the same or a similar function, possibly after **refurbishment, repairing, or upgrading.**

Segregation: Sorting out **computing equipment** from other (electronic) wastes for possible **reuse** or for **treatment** in downstream processes that may include **recycling/**reclamation**/refurbishment/repair/reuse/disposal**.

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

Small and Medium Size Enterprises (SME): According to the European Commission small and medium–sized enterprises are those businesses which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million.

States concerned: Means parties which are States of export, or import, or transit whether or not Parties.

Testing: Process by which used **computing equipment** is assessed against established protocol to determine whether or not it is suitable for **reuse**.

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

Treatment: Any physical, chemical or mechanical activity in a facility that processes computing **equipment** including **dismantling**, removal of hazardous components, **material recovery, recycling** or preparation for disposal.

Upgrading: Process by which used **computing equipment** is modified by the addition of the latest software or hardware in order to increase its performance and/or functionality.

Used Computing Equipment: Computing equipment, which its owner does not intend to use it any longer, but is capable of being reused by another owner, recycled, refurbished, or upgraded by another owner.

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

Wastes: 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 (Article 2, paragraph 1 of the Basel Convention).

Annex II: Risk assessment process for refurbishment operations

A refurbishment facility should undertake a formal risk assessment process related to every aspect of its refurbishment operation, including, but not limited to, assessing potential worker exposure to hazardous substances and materials, ergonomic risks, workplace hazards, and releases to the environment.

Depending on the type of operation, what types of devices are being refurbished, the extent of repairs made, and whether or not any processing for recycling is occurring in the same facility, many refurbishment operations will present multiple risks, worker hazards, and potential environmental 'aspects' (impacts). Some of these areas, typical of refurbishment operations, are as follows:

- Receiving equipment
  - Ergonomic stresses
- Cleaning equipment
  - Dust inhalation
- Processing equipment, e.g.:
  - Electrical shocks
  - Cuts, abrasions
  - Worker exposure to and workplace contamination by mercury resulting from accidental breakage of mercury lamps during replacement operations,
  - Worker exposure and workplace contamination by cadmium and rare earth metals resulting from accidental breakage of CRTs,
  - Bulging or exploding capacitors as a result of upgrading computer capacity; etc.
- Usage, storage and disposal of cleaning products and materials;
- Storage of equipment, parts, scrap, e.g.
  - Storage of batteries where unintentional discharges can occur when contacts touch;
  - Storage of removed mercury lamps prior to shipping to mercury recovery operations;
  - Outdoor storage for electronics;
  - Storage on non-pervious flooring (indoors or outdoors)
- Packaging operations and materials, e.g.:
  - packaging for LCD back lights for transportation to mercury recovery operations;

- Transporting equipment – assessment to include trucking, loading, unloading, etc.;
- Cleaning supplies, including products and materials used to apply them;
- Juxtaposition of work areas and worker eating areas;

Annex III: Principles for Donors of Functional Used Computing Equipment

1. **Provide a useful product:** Donor will provide only equipment that is expected to have a significant life-span and is functional under the expected conditions and needs in recipient countries and communities.

2. **Provide an appropriate product:** Donor will ensure that the hardware and software can operate and be operated within the limitations and conditions of the recipient country and community.

3. **Ensure and verify availability of technical support:** Donor will encourage a maintenance/technical support program exists in the recipient community – either from donor or in recipient community.

4. **Test, certify and label functionality:** Donor should provide proof of testing for functionality

5. **Ensure availability of training:** Donor may support the recipient with training or training programs.

6. **Ensure full transparency, contract and notification and consent prior to delivery**: Donor will ensure that the recipient community consents in writing to receiving the material in accordance with the terms and conditions of the contract.

7. **Export controls:** Donor should export in accordance with applicable national and international controls (see also Chapter 3 of the PACE Guidance Document)

Annex IV: Good Practice Case studies of Donation, Refurbishment and Re-use of used computing equipment

Ateliers Sans Frontieres (ASF) case study: ASF is a small not-for-profit NGO operating in France that refurbishes and recycles used computing equipment. ASF established a program to help rehabilitate people who find it difficult to hold onto regular jobs because of drug addictions and other problems by employing them to disassemble used computing equipment. Companies pay ASF to handle the cost of collecting and disassembling used computing equipment, which helps fund ASF refurbishment activities. A film illustrating the project may be viewed at www.digitalpipeline.org

Close the Gap international case study: Close the Gap is a European not-for-profit organization that helps bridge the digital divide by offering projects in the developing world access to cost-efficient ICT equipment. Close the Gap collects computers from its donors and has a partnership with an external private partner called Flection for refurbishing these donated assets. By doing so Close the Gap offers a quality service towards its donors in terms of data wipe, recycling and reporting. Quality is also assured to the project partners in the developing world who can obtain a cost-effective IT tool that is configured according to the requirements of the end-users. See http://www.close-the-gap.org/ for further information.

Computer Aid International: See Computer Aid International's website (http://www.computeraid.org/about-us.asp) which notes that Computer Aid International exists to tackle the causes and effects of poverty through practical ICT solutions. They work with not-for-profit organizations in developing countries to provide equipment and support where it is most needed by poor communities in areas such as agriculture, health and education.

Computer Aid International is the world's largest and most experienced provider of high-quality, professionally refurbished PCs to developing countries and works with partners to deliver training and technical support to end-recipients.

RDC Case Study: RDC is a British company that manages computing equipment for a number of large organizations. It began operations in 1991, and is now a leader in the environmentally responsible handling of used computer equipment. RDC operates a comprehensive system for managing and tracking the used equipment it collects. Companies that send RDC their used computing equipment receive most of the revenue from the resale of the refurbished equipment, with RDC taking a commission. See www.rdc.co.uk for more information.

UNIDO case study: This shows how commercial refurbishers can operate in developing countries. Donors such as business and government organisations who are considering donating used IT to donation schemes need to be reassured that their confidential data is being eradicated. Donors risk multi-million pound costs of remedying any data breaches. In the EU, the creator of a data record is responsible to ensure it is not released to unauthorized persons and to pay for the costs of remedying any breaches that do occur. A US insurance industry review of 2009 calculated the average total per-incident costs in 2009 were $6.75 million (say £4.5 million).

Annex V: List of sources of information

Data security and destruction

See for example the UK Government National Technical Authority for Information Assurance (CESG) Directory of Infosec Assured Products, Section 7 for information on approved data destruction systems
http://www.cesg.gov.uk/publications/media/directory.pdf

See also Darik's Boot and Nuke which offers a free download
http://www.dban.org/download

Example Refurbishment techniques and information

Creating a Successful Computer Reuse Programme – a guide.
http://www.computersforclassrooms.org/Building%20Successful%20Manual%202-18-10.pdf

Guidelines for electrical safety tests: HB 10194 *Code of Practice for in-service inspection and testing of electrical equipment*. The Institution of Engineering and Technology. http://www.theiet.org/publishing/books/wir-reg/cop.cfm

Repair of computing equipment

Ifixit step by step repair guide.
www.ifixit.com

Cleaning up broken fluorescent lights/ mercury back lights

See US EPA guide on what to do is a CFL breaks in the home (transferable to refurbishment operations)
www.epa.gov/cfl/cflcleanup.html

Example certification schemes

Note: *These schemes were identified by PACE Project Group 1.1 participants and have not been evaluated by the Project Group 1.1 to determine if the listed certification schemes conform to ESM criteria and address management of used or end-of-life electrical or electronic equipment.*

ISO 14000 series for environmental management
http://www.iso.org/iso/iso_14000_essentials

Canada: Electronics Recycling Standard / Electronics Recycler Qualification Program 2010
www.epsc.ca/

Canada: Electronics Reuse and Refurbishing Program (ERRP)
www.estewardship.ca/

e-Stewards
http://e-stewards.org/

European Eco-Management and Audit Scheme (EMAS)
http://ec.europa.eu/environment/emas/index_en.htm

EU WEEE Forum WEEELABEX scheme
http://www.weee-forum.org/

France FEDEREC's CERTIREC
http://www.federec.org/qualification-certification/certirec.html

Germany Efb
www.gesetze-im-internet.de/bundesrecht/efbv/gesamt.pdf

United Kingdom PAS 141 (Publicly Available Specification) on Reuse of Used and Waste Electrical and Electronic Equipment
http://shop.bsigroup.com/Navigate-by/PAS/

USA R2 (Responsible Recycling Practices for Use in Accredited Certification Program for Electronics Recyclers)
http://www.r2solutions.org

USA RIOS (Recycling Industry Operating Standard)
http://www.isri.org/rios

USA R2/RIOS
http://www.CertifiedElectronicsRecycler.org

Annex VI: Basel Convention-Annex IV Disposal Operations

A. Operations which do not lead to the possibility of resource recovery, recycling, reclamation, direct re-use or alternative uses

Section A encompasses all such disposal operations which occur in practice.

D1	Deposit into or onto land, (e.g., landfill, etc.)
D2	Land treatment, (e.g., biodegradation of liquid or sludgy discards in soils, etc.)
D3	Deep injection, (e.g., injection of pumpable discards into wells, salt domes of naturally occurring repositories, etc.)
D4	Surface impoundment, (e.g., placement of liquid or sludge discards into pits, ponds or lagoons, etc.)
D5	Specially engineered landfill, (e.g., placement into lined discrete cells which are capped and isolated from one another and the environment, etc.)
D6	Release into a water body except seas/oceans
D7	Release into seas/oceans including sea-bed insertion
D8	Biological treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations in Section A
D9	Physico chemical treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations in Section A, (e.g., evaporation, drying, calcination, neutralization, precipitation, etc.)
D10	Incineration on land
D11	Incineration at sea
D12	Permanent storage (e.g., emplacement of containers in a mine, etc.)
D13	Blending or mixing prior to submission to any of the operations in Section A
D14	Repackaging prior to submission to any of the operations in Section A
D15	Storage pending any of the operations in Section A

B. Operations which may lead to resource recovery, recycling reclamation, direct re-use or alternative uses

Section B encompasses all such operations with respect to materials legally defined as or considered to be hazardous wastes and which otherwise would have been destined for operations included in Section A

R1	Use as a fuel (other than in direct incineration) or other means to generate energy

R2	Solvent reclamation/regeneration
R3	Recycling/reclamation of organic substances which are not used as solvents
R4	Recycling/reclamation of metals and metal compounds
R5	Recycling/reclamation of other inorganic materials
R6	Regeneration of acids or bases
R7	Recovery of components used for pollution abatement
R8	Recovery of components from catalysts
R9	Used oil re-refining or other reuses of previously used oil
R10	Land treatment resulting in benefit to agriculture or ecological improvement
R11	Uses of residual materials obtained from any of the operations numbered R1-R10
R12	Exchange of wastes for submission to any of the operations numbered R1-R11
R13	Accumulation of material intended for any operation in Section B