Basel Convention

Partnership for Action on Computing Equipment (PACE)

Guidance Document on the Environmentally Sound Management of Used and End-of-Life Computing Equipment

Approved by the
PACE Working Group
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1 Introduction

1.1 Purpose of the guidance document

1. The objective of the document is to provide guidance for the environmentally sound management of used and end-of-life computing equipment with an emphasis on reuse and recycling, thereby diverting such used and end-of life products from final disposal operations such as landfills or incinerators.

2. To this end, this document provides general guidance pertaining to the environmentally sound management of used and end-of-life computing equipment that includes such considerations as: ESM criteria recommendations; transboundary movement procedures; testing, refurbishment and repair; material recovery and recycling.

3. This guidance document is considered as a complement to technical guidelines that were prepared by various project groups, and approved by the PACE Working Group. It summarizes the information contained in the report prepared by the Ad Interim Project Group on Environmentally Sound Management (ESM) Criteria Recommendations, discussion paper prepared by the Sub-group on Transboundary Movement (TBM), and guidelines prepared by Project Groups 1.1(Environmentally Sound Testing, Refurbishment and Repair of Used Computing Equipment), 2.1(Environmentally Sound Material Recovery and Recycling of End-of-Life Computing Equipment).

4. Together with the report on ESM criteria recommendations, individual project guidelines, and procedures for transboundary movement it is intended to be used to raise awareness and further the implementation of the best practice activities associated with various stages of the environmentally sound management of used and end-of-life computing equipment. The information contained in this document can be used to transfer current know-how on the refurbishment and repair of used computing equipment; and best practices for material recovery and recycling. As such, the guidance document provides a foundation for a training programme or workshops aimed at helping to implement the recommendations and actions developed by the project groups established under the PACE. The material found in the guidance document can also be used by Basel Convention regional centres to assist them in developing training materials on the topics covered in it.

5. This guidance document is not a legally binding document under the Basel Convention.

1.2 Contents

6. The document contains general provisions of the Basel Convention, some background information on computing equipment and PACE; executive summaries and recommendations from reports, technical guidelines and relevant appendices pertaining to: (1) ESM criteria recommendations; (2) procedures for transboundary movement; (3) testing, refurbishment and repair; and (4) material recovery and recycling.

7. Throughout the guidance document, references to Annex I, II, III, or IV refer specifically to the annexes to the Basel Convention.

1.3 General provisions of the Basel Convention

8. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted on 22 March 1989 and entered into force on 5 May 1992. The Basel Convention emphasizes, amongst other principles, environmentally sound management of hazardous wastes, which is defined as taking all practicable steps to ensure that hazardous wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes. The Convention stipulates a number of specific objectives, including the following:

    - The reduction of transboundary movements of hazardous and other wastes subject to the Basel Convention.
    - The prevention and minimization of the generation of hazardous wastes.
    - The active promotion of the transfer and use of cleaner technologies.

9. These objectives are supported by a regulatory system for the monitoring and control of hazardous wastes that has been set up and is set forth in the full text of the Convention. Some of the key elements of the regulatory system of the Basel Convention are prior notice and informed consent; prohibition of exports to countries which are not contracting Parties to the Convention; legal provisions for the duty to reimport; and the responsibilities of Parties involved in transboundary movements. One of the provisions under the Basel Convention which places an obligation on the state of export is to provide advance notice to and obtain approval from importing and transit countries before any shipment of hazardous waste is initiated. It should be recognized that all countries have the sovereign right to ban the entry or disposal of foreign hazardous wastes and any other wastes in their territory.

10. Countries of export and import are required to assure themselves that wastes destined for final disposal or recycling will be managed in an environmentally sound manner. No transboundary movement should be allowed to proceed if the exporting and importing countries believe that the wastes in question will not be managed in an environmentally sound manner. Lastly, each shipment of hazardous waste or other waste must be accompanied by a movement document from the point at which a transboundary movement begins to the point of disposal. Once consents have been obtained, wastes must be transported with the appropriate packaging and labelling, as required by international transport rules such as the United Nations Recommendations on the Transport of Dangerous Goods and Model Regulations[i].

11. Article 11 of the Convention addresses bilateral, multilateral and regional agreements or arrangements regarding the transboundary movement of wastes. It is prohibited for Parties to the Convention to trade in hazardous wastes destined for disposal with non-Parties unless there is an Article 11 agreement or arrangement. This provision was introduced to prevent Parties from engaging in transboundary movements of hazardous wastes with countries which do not abide by the rules and principles established by the Convention. Under paragraph 2 of Article 11, Parties may enter into such agreements or arrangements with non-Parties so long as those agreements or arrangements do not derogate from the environmentally sound management of hazardous wastes, as required by the Convention, and those agreements or arrangements stipulate provisions which are not less environmentally sound than

those provided for by the Convention, in particular taking into account the interests of developing countries and countries with economies in transition.

12. Therefore, Article 11 agreements or arrangements must include: consistent scope of coverage; prior notification and consent; prohibition of shipments without consent; efforts to reduce transboundary movements; use of authorized facilities that operate in an environmentally sound manner; prohibition of exports if the country of import has prohibited such imports; shipments only by authorized persons; alternate measures for stranded shipments; and the use of tracking documents (in accordance with decision II/10 Annex).

1.4 Why computer equipment was selected for the second partnership under the Basel Convention

13. Computing equipment was selected for the second partnership under the Basel Convention for the following reasons:

- People in all countries can relate to this high-visibility product.
- The technology has global application.
- Recovery of computing equipment is highly topical issue.
- Mismanagement of used and end-of-life computing equipment may pose risks to public health, worker safety and the environment.
- There is a limited number of computing equipment manufacturers, as compared to all electrical and electronic products, facilitating consensus-based project management.

14. Within the past three decades, citizens in countries around the world have rapidly gained access to computer technology, representing important progress in the achievement of the United Nations Millennium Development Goal[ii] of making available the benefits of new technologies, especially those related to information and communications. As markets continue to expand and more communities gain access to information technology, many countries, especially developing countries and countries with economies in transition, face new challenges in managing used and end-of-life computing equipment and other electronic products.

15. All stakeholders have a role in promoting environmentally sound management of used and end-of-life computing equipment. The technology and skills to do that is available, including proper refurbishment and repair that can extend use, provide employment, and make valuable equipment available to the citizens of less developed countries. Furthermore, those products which cannot be reused can be directed to environmentally sound material recovery and recycling, perhaps in other countries, which can reclaim base and precious metals, adequately treat problematic substances and conserve resources and energy.

16. From Figure 1 below it can be seen that personal computer (PC) sales has significantly increased in all regions from 2000 to 2010, where the use of personal computers has grown exponentially from about 170 million units sold globally in 2000 to about 370 million units sold in 2010, and this trend will continue until 2014.

It is projected that sales in 2014 will reach an estimated 470 million units. It more than doubled in the last 10 years with the largest growth in the Asia region.

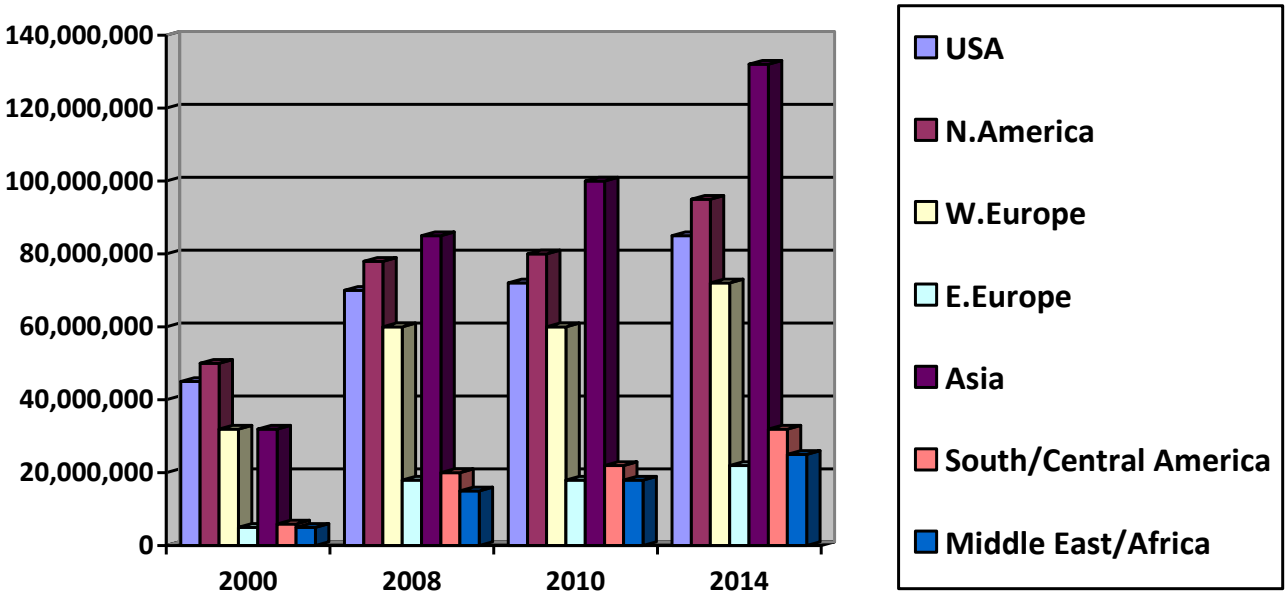


Figure 1: Personal Computer (PC) Sales by Regions[iii]

17. With this growth it should be remembered that sooner or later, all these personal computers must be discarded and this quite often takes place sooner rather than later as personal computers are usually taken out of use well before they cease to operate in many industrialized countries. UNEP found that personal computers generally have a lifespan of less than four years before they are replaced by new ones because their owners want newer features. The result of that growth is second hand products available for refurbishment and reuse or e-waste when such computing equipment reaches the end of its life. According to UNEP[iv] some 20 to 50 million metric tonnes of e-waste are generated worldwide every year, comprising more than 5% of all municipal solid waste. When the millions of computers purchased around the world every year become obsolete and not managed in an environmentally sound manner, they leave behind lead, cadmium, mercury and other hazardous substances, which would have an impact on our environment.

18. Also, according to USEPA[v], while it's not a large part of the waste stream, e-waste shows a higher growth rate than any other category of municipal waste in the EPA's report. Overall, between 2005 and 2006, total volumes of municipal waste increased by only 1.2%, compared to 8.6% for e-waste. This shows that personal computers should not be neglected at the end of their lives. They can be refurbished, repaired and reused; or send to environmentally sound material recovery and recycling facilities where various materials can be recovered and recycled to new products.

19. It should also be recognized that quickly growing markets for used and refurbished computing equipment exist in many developing countries. There are many shipments from developed to developing countries to satisfy this increasing market. At the same

time one should note that in many developing countries and countries with economies in transition, there exists an informal sector collecting used and end-of-life computing equipment for refurbishment, repair and re-use and also to recover materials such as copper, and gold from electronic and electrical waste. Unfortunately, due to the prevalence of an informal sector, the recycling material recovery operations are not always safe and/or environmentally sound, exposing people involved in this activity to hazardous substances and highly risky operations. Furthermore, studies have shown that workers in the informal collection, repair and reuse, and recycling sectors often lack the necessary education and training to properly manage collection, refurbishment, repair and recovery of materials in an environmentally sound manner. Finally, most developing countries lack the basic infrastructure and industrial capacity to recycle end-of-life computing equipment in an environmentally sound manner, and therefore must rely on facilities outside their country.

1.5 Partnership for Action on Computing Equipment

20. The Partnership for Action on Computing Equipment (PACE) was launched by the ninth meeting of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, which took place in Bali, Indonesia in June 2008. PACE is a multi-stakeholder public-private partnership under the umbrella of the Basel Convention that provides a forum for representatives of personal computer manufacturers, recyclers, international organizations, associations, academia, environmental groups and governments to tackle environmentally sound refurbishment, repair, material recovery, 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, amongst other things, social responsibility, the concept of sustainable development, and information-sharing on life cycle thinking.

21. For the purpose of the PACE, computing equipment is defined as: *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 computer, 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 printer with scanning or facsimile capabilities, or both.*

22. Some examples of computing equipment:

    a) CPU & personal desk top computer;

b) a monitor or display

c) devices to input information such as a keyboard and a mouse

d) a printer and a scanner

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

    a) Promote sustainable development for the continued use, refurbishment and repair of used computing equipment in developing countries and countries with economies in transition;
    b) Find incentives and methods to divert end-of-life computing equipment from land disposal and burning into environmentally sound commercial material recovery/recycling operations;
    c) Develop technical guidelines for proper refurbishing, repair and material recovery/recycling, including criteria for testing, labeling of refurbished used equipment and certification of environmentally sound repair, refurbishing and recycling facilities;
    d) End shipments of used and 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.

24. PACE actions also include launching pilot demonstration projects to assist developing countries and countries with economies in transition in assessing and improving the current management of used and end of life computing equipment in their countries, raising awareness on PACE and initiating training activities to achieve Partnership and Basel Convention objectives.

25. 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, industrial associations, academia and ENGOs; and Basel Convention Regional and Coordinating Centres for Capacity Building and Technology Transfer (BCRCs) which have specific expertise and experience required for the activities of this group.

26. Subsequently the PACE Working Group discussed its tasks, developed its Terms of Reference, and decided to set up five project groups and two sub-groups to carry out its work programme, with their objectives identified below:

The Ad Interim Project Group on ESM Criteria

27. The objectives of the Ad Interim Project Group were identified as follows:

    1. Identify relevant existing international, country-specific, industry and other ESM guidance material that may be used to support other project groups which have been established under the PACE Working Group.
    2. Propose recommendations[vi] for ESM core criteria for use by PACE project groups when developing guidelines or launching pilot projects. A sub-set of criteria for specific operations may also be developed by the project group where required.

Project Group 1.1 on Environmentally Sound Refurbishment/Repair of Used Computing Equipment

28. The objective of the Project Group was identified as to develop tools (such as guidelines) and activities on environmentally sound refurbishment and repair, including criteria for testing, certification and labelling. The Project Group is to cooperate and coordinate with other PACE project groups working on ESM principles, recycling standards, and pilot projects.

Project Group 2.1 on Environmentally Sound Material Recovery/Recycling of End-of-Life Computing Equipment

29. The objective of the Project Group was identified as to recognise risks and benefits of collecting, reviewing, and disseminating - through a guideline – practices for environmentally sound material recovery and recycling of computing equipment. The Project Group is to cooperate and coordinate with other PACE project groups working on ESM principles, refurbishment standards, and pilot projects.

Project Group 3.1 on Collection and Management of End-of-Life Computing Equipment from Informal Sectors

30. The objective of the Project Group was identified to develop and promote pilot schemes for environmentally sound management of used and end-of-life computing equipment towards the achievement of the Millennium Development Goals and to increase funds that will be available for pilot projects on collection and management of used and end-of-life computing equipments and to ensure long term financial sustainability of these projects.

Project Group 4.1 on Awareness Raising and Training

31. The objective of the Project Group was identified as to develop a list of awareness raising and training products and to implement them to better promote PACE, reports and guidelines that have been developed under PACE.

Sub-group on Transboundary Movement of Used and End-of-Life Computing Equipment

32. The objective of the Sub-group was identified as to review rules that may apply to transboundary movement of used and end-of-life computing equipment taking into consideration the guideline on the transboundary movement of collected mobile phones developed under the Mobile Phone Partnership Initiative (MPPI).

Sub-group 3.1.1 on Resource Mobilization and Financial Sustainability

33. The objective of the Sub-group was identified as to increase funds that will be available for pilot projects on collection and management of used and end-of-life computing equipments and to ensure long term financial sustainability of these projects.

2 ESM criteria recommendations[vii]

2.1 Summary

34. This section of the guidance document identifies recommendations for ESM criteria that were developed by the Ad Interim Project Group on Environmentally Sound Management (ESM) Criteria under the Partnership for Action on Computing Equipment (PACE). The report of the Ad Interim Project Group is available from the Secretariat of the Basel Convention (http://www.basel.int/industry/compartnership/documents.html).

35. The purpose of the report of the Ad Interim Project Group is specifically to identify recommendations for ESM criteria for use by other PACE Project Groups in devising guidelines to assist all countries in implementing the principle of environmentally sound management for computing equipment, and for PACE pilot projects in developing countries and countries with economies in transition. The report may also be used by country governments and facilities as an information resource for general guidance on ESM. For the purpose of PACE and as defined in the Glossary of Terms (Appendix 1), ESM was 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.*

36. ESM criteria recommendations were modelled 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 was an important consideration in preparing the ESM criteria recommendations. Identifying the needs of developing countries and countries with economies in transition was also an important aspect of this work. These needs not only include best management practices at the facility but often include the need for effective legal systems and infrastructure to protect workers, communities, and the environment, that individual facilities need to use and rely on to achieve ESM.

37. It is recognized that ESM capacity varies greatly from country to country, often dependent upon political, social and economic considerations beyond the scope of PACE. As such, development of new recommendations for national governments would require broad consultation with and approval of organizations outside of the Basel Convention's public-private PACE partnership. Consequently, ESM criteria recommendations for national governments identified in this document simply recap pre-existing and pre-approved recommendations under the work of the Basel Convention and Organization for Economic Cooperation and Development.

38. While not diminishing the importance of broad government and societal ESM criteria, efforts focused on identifying facility-specific recommendations, which include ensuring that measures are in place to demonstrate conformity with the following ESM criteria:

1. **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.
2. **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.
3. **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.
4. **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.
5. **Awareness, Competency and Training:** Ensure employees have an appropriate level of awareness, competency and training with respect to the effective management of occupational risks.
6. **Record-keeping and Performance Measurement**: Maintain records, monitor, track, and evaluate facility performance at achieving ESM.
7. **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.
8. **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.

39. Lastly, it was recommended that PACE Project Groups should take into consideration all recommendations contained within the report on ESM criteria recommendations during the design and implementation of their technical guidance and pilot projects.

2.2 Recommendations

2.2.1 Country-specific Recommendations

2.2.1.1 Countries should review measures in place to implement obligations under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal and 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[viii]

2.2.1.2 OECD-member countries should review measures in place to support applicable recommendations contained within the OECD *Council Recommendation C(2004)100 on the Environmentally Sound Management of Waste* (see Annex B)[ix] and the OECD *Technical Guidance for the Environmentally Sound Management of Specific Waste Streams: Used and Scrap Personal Computers* (ENV/EPOC/WPWPR(2001)3/FINAL)[x].

2.2.1.3 In the event that domestic Environmental Management Systems (EMS) are employed as part of a national approach to ESM, special consideration should be given to provide specifically tailored EMS systems for SMEs. Whatever EMS system will be selected, it is recommended that the government or large companies have a programme in place to provide support for SMEs in terms of information and know-how sharing.

2.2.1.4 Domestic policies and/or programmes implemented in accordance with Basel PACE technical guidance shall facilitate the ability to meet applicable international agreements and protocols and domestic legal requirements concerning the management of such wastes.

2.2.2 Facility-specific Recommendations

2.2.2.1 Facilities should ensure measures are in place to demonstrate conformity with the following ESM criteria:

1. **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.
2. **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.
3. **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.
4. **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.
5. **Awareness, Competency and Training:** Ensure employees have an appropriate level of awareness, competency and training with respect to the effective management of occupational risks.
6. **Record-keeping and Performance Measurement**: Maintain records, monitor, track, and evaluate facility performance at achieving ESM.
7. **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.

8. **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.

2.2.2.2 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*[xi].

2.2.2.3 Facilities should review measures in place to support applicable recommendations contained within PACE guidance documents and other applicable guidance under the Basel Convention.

2.2.2.4 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* and OECD *Technical Guidance for the Environmentally Sound Management of Specific Waste Streams: Used and Scrap Personal Computers* (ENV/EPOC/WPWPR(2001)3/FINAL).

2.2.3 Recommendations to PACE Project Groups

2.2.3.1 Project Groups should take into consideration all recommendations contained within this document during the design and implementation of their technical guidance and pilot projects.

2.2.3.2 Project Groups should consider inclusion of a waste management hierarchy in the development of technical guidance documents and pilot projects. The hierarchy is proposed as follows in descending order of preference: prevention; minimization; reuse; recycling, energy recovery; and disposal. Ideally, all feasible opportunities for waste management will be taken at higher levels of this hierarchy. This does not preclude possible consideration of additional issues linked to the various stages of the product life cycle, and impacts from facility operations such as the generation and potential release of hazardous waste and opportunities to reduce and/or avoid greenhouse gas emissions.

2.2.3.3 Project Groups should take into account the differences between hazardous and non-hazardous waste, and between dangerous and non-dangerous processes, in formulating their technical guidance, and pilot projects.

2.2.3.4 Project Groups should ensure that their technical guidance and pilot projects do not discourage refurbishing or recycling recognising, in

particular, the flexibility appropriate for each country to increase the rates of environmentally sound recovery of low risk waste.

2.2.3.5 Project Groups should identify facility measures or specific actions including any appropriate verification that operators in facilities may carry out for use in demonstrating conformity to each of the ESM criteria.

2.2.3.6 Project Groups should develop "tiered checklists" of facility measures for each of the eight ESM criteria. A tiered checklist can support the continual improvement of ESM by enabling facilities to readily identify what types of measures that they should have in place in order to graduate from lower to higher tiers of Environmentally Sound Management[xii].

2.2.3.7 Project Groups should identify realistic options and potential resources available to integrate the informal sector operations within local, regional and national programs of developing countries and countries with economies in transition, with the ultimate goal of facilitating the transition of these operations into the formal sector.

2.2.3.8 Project Groups should identify self-sustainable and economically-viable solutions to support the long-term implementation of PACE pilot project activities designed to collect, refurbish and recycle used and end-of-life computing equipment in a manner that is consistent with the ESM criteria.

2.2.3.9 Project Group technical guidance and pilot projects may consider the inclusion of incentives and/or relief measures for facilities that fulfil PACE technical guidance.

2.2.3.10 Project Groups should take into account the size of the enterprise, especially the situation of small and medium-sized enterprises (SMEs), the type and amount of waste, the nature of the operation and their domestic legislation when developing technical guidance and pilot projects.

2.2.3.11 Procedures for achieving any certification/registration and reporting requirements under Project Group technical guidance and pilot projects may be simplified for SMEs in comparison with large facilities. Also the environment, health and safety report could be made publicly available every three years (an annual requirement for large facilities). However, such incentives and/or relief measures should not compromise suitable and effective protection of public and worker health and safety, and the environment as part of the facility's approach to achieving environmentally sound management. Consequently, it was recognized that it would not be appropriate to allow less complicated and fewer facility audits for SME facilities in non-OECD countries.

2.2.3.12 Project Groups should take into account that SMEs whose operation presents little or no risk would need a significantly more limited emergency plan within their technical guidance and pilot projects.

40. For more detailed information on ESM criteria recommendations and its Annexes, see the document entitled" Environmentally Sound Management (ESM) Criteria Recommendations"[xiii]

3 Transboundary movement of used and end-of-life computing equipment

3.1 Summary

41. This section of the guidance document addresses transboundary movement of collected used and end-of-life computing equipment. Once collected, computing equipment should be evaluated and/or tested, and labelled, to determine whether it is suitable for reuse[xiv], possibly after repair, refurbishment, or upgrading, or if it is destined for material recovery and recycling (Appendix 2 B operations in this document) or final disposal (Appendix 2 A operations in this document).

42. This procedure should be of assistance to regulatory agencies and authorities, exporters, importers, manufacturers, repair, refurbishment and recycling facilities and any organization that is involved:

    a) In the export or import of used computing equipment for reuse.

    b) In the movement of used computing equipment suitable for reuse, possibly after repair, refurbishment, or upgrading in the importing country.

    c) In transboundary movements of end-of-life computing equipment destined for material recovery and recycling (Appendix 2 B operations in this document) or final disposal (Appendix 2 A operations in this document).

43. The type of transboundary movement procedure to be applied depends on the constituents and hazardous characteristics and on the disposal operation chosen for collected computing equipment after evaluation and/or testing and labelling or documentation[xv] of testing results. To determine what is and what is not covered under the Basel Convention, the Convention defines the "wastes" to be covered in Article 2.1 of the Convention, and stipulates that wastes are 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. The Convention then defines disposal by reference disposal operations listed in Annex IV (Appendix 2 in this document). Hazardous constituents and characteristics of such wastes are then defined and classified by a series of Basel Convention technical annexes (I, II, III, VIII and IX). In addition, every Party may determine, by its own national legislation, to define additional substances and objects as wastes and hazardous wastes[xvi].

44. It is recommended that Basel Convention transboundary movement controls should be implemented for end-of-life computing equipment destined for material recovery and recycling (Appendix 2 B operations in this document**)** or final disposal (Appendix 2 A operations in this document) where the end-of-life computing equipment contains Basel Convention Annex I constituents, unless it can be demonstrated that these end-of-life computing equipment are not hazardous using Basel Convention Annex III characteristics.

45. Regarding transboundary movements of used computing equipment for repair and refurbishment in the importing country, and subsequent reuse, the following procedures should apply:

    45.1 If, following Article 2.1 of the Basel Convention or national legislation, at least one of the States concerned involved in a transboundary movement has determined[xvii] that used computing equipment destined for repair or refurbishment in the importing country is classified as wastes, then the decision tree procedure (Appendix 4 (b)) should be used. The Basel Convention control procedure would

then apply where such waste computing equipment is hazardous wastes in accordance:

a) with Article 1.1(a) and contain Basel Convention Annex I constituents, unless it can be demonstrated that these used computing equipment are not hazardous using Basel Convention Annex III characteristics, or

b) with Article 1.1(b) and is considered hazardous waste by the national legislation of one of the Parties involved.

45.2 However, the Basel Convention control procedure will not apply, only if, following Article 2.1 of the Basel Convention and national legislation, none of the States concerned involved in a transboundary movement have determined that computing equipment destined for repair or refurbishment in the importing country is classified as wastes. In such circumstances the voluntary notification procedure (Appendix 4 (a)), or the decision tree (Appendix 4(b)) should be considered by the countries involved to ensure that such movements are being monitored, and the importing country is given an opportunity to react (consent, object, or identify conditions) to such movements.

46. Both procedures, the voluntary notification and the decision tree, as described in Appendix 4 (a) and 4 (b) respectively, should be subject to further review at specific time intervals in order to ensure that the objective of environmentally sound management is upheld and to reflect the knowledge and experience gained, including those from the proposed Partnership for Action on Computing Equipment (PACE) pilot projects.

47. The transboundary movement of collected computing equipment that has been tested and labelled or documented as suitable for reuse without further repair, refurbishment, or upgrading is outside the scope of the Basel Convention and applicable recommendations, and can be shipped as products as long as a reuse destination in the receiving country is assured and unless such equipment has been classified as hazardous waste by States concerned, or is otherwise restricted under applicable national law such as by a prohibition on import of such used goods by States concerned.

3.2 Recommendations

3.2.1 All used computing equipment that has been collected should be first evaluated to determine whether it is suitable for direct reuse, reuse following repair or refurbishment, or for material recovery. Computing equipment that is suitable for reuse should be further tested for functionality and be labelled or have appropriate documentation and declaration of testing results (Appendix 7), prior to any transboundary movement.

3.2.2 When computing equipment destined for reuse is to be tested the test should utilize at minimum an effective test method to confirm that the equipment is fully functional (Appendix 5) and a battery test (Appendix 6) to determine to what extent they are suitable for reuse with or without repair, refurbishment or upgrading.

3.2.3 Except as provided in paragraph 3.2.7, used computing equipment that has been collected but has not been evaluated and/or tested and labelled or documented as suitable for reuse is subject to Basel Convention procedures, unless it can be demonstrated that the end-of-life computing equipment is not hazardous using Basel Convention Annex I and Annex III characteristics.

3.2.4 End-of-life computing equipment destined for material recovery and recycling (Appendix 2 B in this document) or final disposal (Appendix 2 A in this document) containing Basel Convention Annex I constituents are subject to Basel Convention transboundary movement controls, unless it can be demonstrated that the end-of-life computing equipment is not hazardous using Basel Convention Annex III characteristics.

3.2.5 Where used computing equipment that has been evaluated and assessed to be likely suitable for reuse[xviii], possibly after repair, refurbishment or upgrading in the importing country, has been classified as waste by at least one of the States concerned involved in their transboundary movement, the decision tree (Appendix 4 (b)) should be used.

3.2.6 Where used computing equipment destined for repair or refurbishment in the importing country are not classified as waste by any of the States concerned, a voluntary notification procedure (Appendix 4 (a)), or the decision tree procedure (Appendix 4 (b)) should be considered by the countries involved to ensure that such movements are being monitored, and the importing country is given an opportunity to react (consent, object or identify conditions) to such movements.

3.2.7 The following shipments are normally considered outside the scope of these procedures and the Basel Convention unless the computing equipment is defined as or considered to be hazardous wastes under the Article 1.1b) of the Basel Convention, or unless restricted under applicable national law such as by a prohibition on import of such used goods by states concerned:

3.2.7.1 Collected computing equipment that has been tested and labelled or documented and declared as being fully functional[xix] and intended for direct reuse[xx] as per Appendix 7.

3.2.7.2 Shipments by individual customers of their own defective computing equipment under warranty or subject to a law allowing for a right of the return of the equipment, for repair and refurbishment and where the same type or similar product is intended to be returned to the customer. This does not include equipment from take back programs.

3.2.7.3 Batches of defective computing equipment under warranty or subject to a law allowing for a right of the return of the equipment, that has been collected from individual customers or consolidated by manufacturers, original component suppliers, or their contractual agents, sent back to the manufacturer, original component suppliers, or their contractual agents, and for which the same type or similar product has been or will be returned to the customer,

Each shipment, mentioned in the recommendation 3.2.7, must be accompanied by a customer invoice and/or other shipping document completed prior to the transboundary shipment, including the information contained in Appendix 8.

3.2.8 When hazardous wastes/residues arising from the refurbishment/repair and/or material recovery/recycling operations from imported used or end-of-life computing equipment are to be sent back to the original exporting country or to a third country, the Basel Convention notification procedures are to be followed. As appropriate, these documents should include references to original documents to ensure effective tracking.

3.2.9 In situations where hazardous wastes/residues arising from the refurbishment/repair and/or material recovery/recycling operations are to be sent back to the original exporting country or to a third country, it is recommended that the contract between the exporter and importer specify details of the return of the hazardous waste, return dates and financial responsibilities.

3.2.10 All transboundary movements of used and/or end-of-life computing equipment should follow applicable transport rules.

3.2.11 Consistent with the PACE guidelines and report on ESM criteria, importing countries should take measures to establish an appropriate infrastructure to ensure that computing equipment which reach the final end of their lives are collected and recycled in environmentally sound facilities, be those located within or outside the country.

3.2.12 All transboundary movements of used computing equipment intended for refurbishment or repair and subsequent reuse should have proper packaging, to ensure protection of the asset value of the equipment as well as protection of human health and the environment during transport, see Appendix 3.

4 Testing, refurbishment and repair of used computing equipment[xxi]

4.1 Summary

48. This section of the guidance document provides information on the environmentally sound testing, refurbishment and repair of used computing equipment based on the technical Guideline on Environmentally Sound Testing, Refurbishment and Repair of Used Computing Equipment[xxii], which can be obtained from the Secretariat of the Basel Convention. The guideline also promotes greater reuse of such computing equipment, and the environmentally sound management of any discarded computing equipment or components. A typical refurbishment and repair process is shown in Appendix 9. 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 to provide general guidelines that will be useful for years to come and to offer guidance for refurbishment facilities around the globe.

49. The technical Guideline on Environmentally Sound Testing, Refurbishment and Repair of Used Computing Equipment is divided into 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. It also includes guidance on labeling/documentation, packaging and storage and handling of refurbished and repaired equipment.

- Part 4 of the guideline includes guidance for the marketing, donation (principles for donors are listed in Appendix 10), and redeployment of refurbished and repaired computing equipment and components.

50. The information should also assist individuals, companies and agencies involved in collection schemes and transportation of used and refurbished computing equipment, and consumers who use the refurbished computing equipment. Lastly, any organization that is involved in buying or selling computing equipment for reuse should also find this information useful.

4.2 Recommendations

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

4.2.1.1 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.

4.2.1.2 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.

4.2.1.3 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.

4.2.1.4 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, ensuring compliance with these requirements.

4.2.1.5 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.

4.2.1.6 RRFs dealing with products 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 scheduled inspection and monitoring of hazards. In addition there may be regulatory requirements that must be satisfied.

4.2.1.7 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 Appendix 13 for additional information on certification schemes.

4.2.2 Recommendations relating to the refurbishment/repair process

4.2.2.1 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.

4.2.2.2 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.

4.2.2.3 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 (Appendix 5).

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

4.2.2.5 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.

4.2.2.6 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.

4.2.2.7 Refurbishment facilities should use the Basel Convention guidelines 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 Chapter 5 of this Guidance Document and the PACE Guideline on Material Recovery and Recycling of End-of-Life Computing Equipment, as prepared by PACE Project 2.1.

4.2.2.8 Refurbishment facilities should ensure that in the case of transboundary movements, refurbishment facilities should ensure that 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 this guidance document) and other multi-lateral waste trade agreements.

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

4.2.3.1 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.

4.2.3.2 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 (Appendix 7).

4.2.3.3 Where refurbishers are exporting refurbished computing equipment to other countries, 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 this guidance document provides guidance on the procedures to follow in the event of transboundary movement of used computing equipment and components.

5 Material recovery and recycling of end-of-life computing equipment[xxiii]

5.1 Summary

51. This section of the guidance document provides information on the environmentally sound material recovery and recycling of end-of-life computing equipment based on the technical Guideline on Environmentally Sound Material Recovery and Recycling of End-of-Life Computing Equipment[xxiv], which can be obtained from the Secretariat of the Basel Convention. This guideline provides guidance on best practices for the environmentally sound material recovery and recycling of end-of-life computing equipment and addresses the recycling of all components of computing equipment, which include: personal computers and peripherals: central processing units (CPUs), both desktop and laptop; monitors using CRT and LCD flat screen technology; keyboards and mice; printers and scanners. It also discusses the adequacy of the present material recovery and recycling infrastructures and their capacity for handling the increasing number of computing equipment which will become obsolete and be directed to material recovery and recycling facilities rather than to landfills, incinerators or some other form of final disposal.

52. The technical Guideline on Environmentally Sound Material Recovery and Recycling of End-of-Life Computing Equipment is divided into several parts:

- Parts 1, 2, 3 and 4 provide: executive summary, introduction, identifies the type of material covered, and identifies a number of common materials found in computing equipment.
- Part 5 provides guidance on initial recycling facility practices, supported by series of flow charts.
- Part 6 identifies how materials should be safely stored, and how it should be transported when shipped for further processing.
- Parts 7 and 8 discuss material recovery processes, plus management and disposal for different types of residues derived from the recovery operations.
- Part 9 identifies legal requirements for material recovery and recycling facilities, steps to be taken to comply with all applicable health, safety and environmental laws and regulations.
- Part 10 identifies commercial considerations when establishing material recovery operations that are economically and environmentally sound.
- Part 11 provides recommendations to national authorities regarding programmes and policies which may be implemented to ensure environmentally sound and also an economically efficient material recovery and recycling of end-of-life computing equipment.

53. In theory, every part of end-of-life computing equipment can find continued beneficial use through the value chain management (Appendix 11), from direct reuse as a complete computer to a part of a slag-construction aggregate. In practice, there are economic limits

to material recovery, and some process residues from all of the six steps will need final disposal, with careful attention for protection of the environment.

54. Computing equipment contains more than 60 types of metals and other materials, some in large amounts, "primary constituents" such as steel, some in small amounts, "minor constituents" such as silver, and some in very minute amounts, "micro or trace constituents" such as gold. Of course, the exact materials are different for each manufacturer, for each piece of equipment, and they are always changing as the technology changes. Facilities that recover material from end-of-life computing equipment must be prepared for new and old equipment, with new and old technology.

55. Some of these materials present little or no special hazard or concern, e.g., steel. Certain other materials may present a hazard when they are broken, crushed, shredded or melted, unless environmentally sound management practices are employed. In addition, other substances may be used in recycling, or may be produced. There are three main groups of substances that may be released during material recovery, and that should be of concern: original constituents of computing equipment, such as lead, mercury, etc., substances that may be added in some recovery processes, such as cyanide; and substances that may be formed by recycling processes, such as dioxins.

56. To protect their workers and their communities, material recovery facilities should take steps that are guided by environmentally sound management criteria. These criteria work together to both guide and assist a materials recovery facility to achieve environmentally sound management of computing equipment and its recovery. Facilities will need to obtain more detailed technical information than the guideline can provide in order to accurately determine the most appropriate and effective technology and practices, but should find that the guideline provides an overview of many material recovery steps, and how they work together.

57. Applying these environmentally sound management criteria, a material recovery facility must first collect end-of-life computing equipment, but only the kinds that it is prepared, qualified and licensed to accept and process. Then it must carefully remove and separate the most problematic constituents - those that contain hazardous substances that may contaminate other materials – such as mercury, batteries, CRTs, which usually need additional processing and/or environmentally sound final disposal. After that, material recovery from remaining computing equipment generally consists of a long series of steps and processes, some going on for a number of months, with each step adding value. All of these processes may also release hazardous substances, and careful worker training and protection, as well as community protection, are necessary parts of sound facility management. The general intent at each step is that complex materials should be sorted and separated as much as possible into similar types of materials, e.g., steel with steel, aluminum with aluminum, copper with copper, etc. At each step a more concentrated output material becomes a more valuable input into another process, until a material is ready for the market as a new material. And material recovery from computing equipment not only minimizes waste disposal, it can also be much more environmentally sound than mining the same raw materials.

58. Material recovery facilities can sometimes use manual labor in recovery processes, and can sometimes use mechanized and advanced sorting processes. Many facilities use both, depending on which is most efficient for a particular step. In developing countries and countries with economies in transition, if costs of manual labor are low, the manual

disassembly path is more often taken. Even in developed countries, in some circumstances manual disassembly and sorting may also be more efficient or necessary in material recovery. It does not require significant technological skills, although worker training to safely carry out specific tasks is always important. It can produce clean sorted materials and working components, such as electronic chips and wires/cables for additional value. These steps are not without risks of exposures to hazardous substances, however, so health, safety and the environment must be strong concerns.

59. Mechanized material recovery processes, using shredders, grinders and separation technology, are more likely to be high speed - high volume operations, with several shredding steps followed by very modern, sophisticated identification and separation of plastics and metals by optical and X-ray technology, ferrous metals by electromagnets, copper and aluminium by eddy current, etc.

60. When concentrated streams of metals have been produced, they are usually further refined in metal-specific pyrometallurgical and/or hydrometallurgical processes. Scrap steel can be used in electric arc furnaces to produce new steel. Scrap aluminum can be used in secondary aluminum furnaces to produce new aluminum. Scrap copper, scrap precious metals, and some other non-ferrous (special) metals are commonly recovered from computer circuit boards and other components/fractions in pyrometallurgical processing and/or by metal-specific hydrometallurgical refining. Informal recovery operations, such as acid leaching, on circuit boards and other precious metal-bearing materials are inefficient, and expose workers, communities and the environment to cyanides, strong acids, hazardous gasses and other hazards.

61. Some functional cathode ray tubes (CRTs) may be re-used without change, or may be used to produce televisions or other electronic displays. If they cannot be re-used, clean and sorted CRT glass may be used in the remaining CRT manufacturing facilities to produce new CRT glass. CRT leaded glass can also be used in lead smelters to produce lead.

62. Most screens with liquid crystal display (LCD) contain mercury lamps as backlights which have to be carefully and manually removed before processing or managed in closed, highly mechanized systems (emerging technologies). The mercury lamps should be properly packaged and sent to specialized mercury recovery facilities. Regular monitoring should be done in the working areas for the presence of atmospheric and environmental levels of mercury.

63. Plastics may be recycled if they are separated by type, are mostly free of metals and other contaminants, and do not contain certain hazardous brominated flame retardants (BFRs), unless they can be removed or can legally continue to be used as flame retardants. Plastics can be used in smelting operations as fuel and as reducing agents, if the smelter emissions are well controlled, especially for dioxins and furans.

64. Batteries, derived from computing equipment, now almost always based on lithium and nickel metal hydride chemistry, should be evaluated for continued use as batteries, for which there is a good market (See the PACE Guideline 1.1 for battery standards). If a battery is no longer useable, it should be processed only in specialized facilities that are permitted to safely manage hazardous characteristics such as corrosivity or toxicity. The primary metals of interest are cobalt, nickel and copper, and lithium may also become a valuable target for recovery.

65. Residues from processing and pollution control systems that cannot be efficiently recovered are likely to contain metals and other substances of concern, which must be

carefully managed, often as hazardous waste. These include bag house filters and dust, sweepings, glass fines, phosphors, plastics and slags. Because these waste residues are likely to contain metals, plastics and halogens, disposal in an incinerator that does not have efficient pollution control systems is not suitable. Similarly because process residues may leach hazardous constituents, disposal in an uncontrolled landfill is also not suitable.

66. Because many residues generated in the material recovery chain are intended for further recovery processes, or for final disposal, and will be classified as hazardous waste, it is important that material recovery, energy recovery and disposal facilities be properly authorized and licensed, and comply with all applicable laws – local, national, regional, multilateral and international, which may include implementation of the Basel Convention, where transboundary movement is undertaken, as is often the case with end-of-life computing equipment.

5.2 Recommendations

5.2.1 Goals and Objectives

5.2.1.1 Material recovery, energy recovery and disposal facilities must be properly authorized and licensed, and comply with all applicable laws – local, national, regional, multilateral and international. This will include national implementation of the Basel Convention whenever transboundary movement is undertaken, as is often the case with end-of-life computing equipment and residuals. For information on transboundary movement procedures see Chapter 3 of this guidance document.

5.2.1.2 Parties and Signatories of the Basel Convention are encouraged to implement policies and/or programs which promote the environmentally and economically sound material recovery and recycling of end-of-life computing equipment.

5.2.1.3 Consistent with the Basel Ministerial Declaration on Environmentally Sound Management, used computing equipment should be diverted from disposal practices, such as landfilling and incineration, by a robust collection program, to the more environmentally sound practices of reuse, refurbishment, material recovery and recycling.

5.2.1.4 It is very important that end-of-life computing equipment be collected effectively (which is usually not the case today, even in industrialised countries). Funding for collection should be arranged and provided where necessary.

5.2.1.5 Environmentally sound material recovery and recycling of end-of-life computing equipment requires setting up an effective recycling chain, comprising the steps of robust collection of used computing equipment, evaluation, testing/refurbishment/reuse if appropriate, preparing/dismantling of non-reusable computing equipment or parts, separation into material streams, final recovery of marketable raw materials, and disposal of non-recyclable fractions and processing residues. Some hazardous fractions may have to be sent to destruction facilities to ensure they are taken out of use. Parties and persons involved in each step should understand and communicate with persons involved in the entire chain. ESM recycling facilities should ensure that computing equipment and materials derived

from it are only managed in environmentally sound management facilities that are licensed and permitted to manage these materials.

5.2.1.6 There are a number of components and materials of concern, such as batteries and mercury lamps, that may release hazardous substances in processing for material recovery and these must be identified and carefully removed to avoid their entry into more intensive processing such as shredding.

Environmentally sound material recovery and recycling of computing equipment is not simple, and can cause exposures to hazardous substances if not done correctly. It should be well understood, managed and performed consistent with the practices contained in this guideline, to protect workers, communities and the environment. All steps should be taken to ensure that unsound computing equipment material recovery and recycling practices are avoided, such as those where proper worker and environmental protections are not implemented (e.g., primitive and "backyard" operations) and those where there is no attempt to maximize material recovery.

5.2.1.7 Priority should be given to material recovery processes that adhere to and increase the benefits of the waste management hierarchy: waste prevention; waste minimization; reuse; recycling; energy recovery; and disposal. Such processes result in high efficiency recovery from computing equipment, minimize loss and final disposal of valuable materials, and reduce the use of energy, generation of greenhouse gases, and other negative environmental and health impacts.

5.2.2 Development of Recycling Infrastructure

5.2.2.1 The Basel Principles of national self sufficiency, proximity, least transboundary movement, and ESM, as well as the necessity of economic efficiency, should be taken into account when considering investments in computing equipment material recovery and recycling facilities or operations, as well as when developing domestic policies for environmentally sound material recovery and recycling.

5.2.2.2 Because conformance with this guideline may mean an increase in recycling costs, Parties, industry including producers and other involved stakeholders should collaborate to ensure that there is adequate financing for computing equipment material recovery and recycling. Recognizing that certification and auditing can be very expensive, the procedures needed for recovery and recycling facilities to achieve certification need to be affordable and achievable for facilities around the world. The support of multilateral and regional development banks and bilateral donors will be highly valuable in setting up significant and attractive investment programs in developing countries aimed at the development of recycling infrastructure compliant with ESM.

5.2.3 Facility-Level Guidelines

5.2.3.1 Top management should systematically plan and execute environmentally sound material recovery and recycling operations and facilities. Without the ongoing commitment of top management, 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. Facilities are encouraged to develop and use a certified

comprehensive system of environmental, health and safety management to plan and monitor their environmental, health and safety practices, which includes specific elements for environmentally sound material recovery and recycling of used and end-of-life computing equipment (Appendix 12).

5.2.3.2 A certification of facility conformance with an accredited comprehensive management system is desirable, and will assist concerned governments, other material recovery facilities, and other interested persons in evaluating and approving environmentally sound material recovery operations and facilities. If possible, this certification should be made by an independent and qualified auditor, and an accredited certification body.

5.2.3.3 Facilities should develop a procedure to identify, access, and comply with applicable legal requirements. These requirements might be found in many places, such national and local statutes and regulations, as well as in permits and licenses, and special professional expertise may be needed. Regulatory agencies, government publications and news releases, legal advisors, legal journals and commercial databases, and industry associations may help to identify applicable legal requirements. Facilities should also take into consideration customary or indigenous law and international treaties, conventions and protocols.

5.2.3.4 Recycling facilities should dismantle and separate, through manual and mechanical processing, the computing equipment that are not directed to reuse and direct them to properly-equipped materials recovery facilities. Facilities should send potentially hazardous substances (such as batteries, items containing mercury) to processing, recovery or treatment facilities that are properly licensed to receive and utilize technology designed to safely and effectively manage the removed material. Facilities should not try to recover components or materials if they do not have proper capabilities.

5.2.3.5 Recycling facilities should, before beginning operations and systematically thereafter, identify hazards and assess occupational and environmental risks that exist, or that could reasonably be expected to develop. This practice of hazard identification and risk assessment should be incorporated into the facility management system, and employees should have an appropriate level of awareness, competency and training with respect to the effective management of such hazards and occupational risks. Environmental, health and safety measures should then be taken, including engineering controls (substitution, isolation, ventilation, dust control, emergency shut-off systems, fire suppression), administrative and work practice controls (regular, documented health and safety training, job rotation, safe work practices, medical surveillance, safety meetings) and personal protective equipment (respirators, protective eyewear, cut-resistant gloves).

5.2.3.6 Facilities that dismantle, process, smelt, refine or perform other steps in computing equipment material recovery and recycling should identify themselves to their relevant regulatory authorities. Permitting and inspecting authorities with jurisdiction should inspect and verify that these companies are practicing health, safety and environmentally sound management.

5.2.3.7 Material recovery facilities that process electronic equipment should perform due diligence to select downstream vendors, and to assure themselves that subsequent handlers and processors are practicing environmentally sound management. Their due diligence should look for a documented management system of hazards identification, risk assessment and corrective actions, environmental permits, compliance with applicable legal requirements, and other general principles included in the guideline.

5.2.3.8 A facility should monitor, track and evaluate facility performance, and maintain records to demonstrate its activities. Record-keeping and performance measurement enable an organization to make better-informed decisions regarding whether it is achieving desired results or if it is necessary to implement corrective actions. In some cases, record-keeping and performance measurement may be a legal obligation.

5.2.4 Design for Recycling

5.2.4.1 The material recovery and recycling phase of end-of-life computing equipment should be taken into account by manufacturers during product design, by considering the issues of increased recyclability and reduction in toxicity.

5.2.4.2 A number of materials that are being used in the manufacture of new computing equipment, such as beryllium, mercury, flame retardants, etc., have been identified in this document as substances of particular concern during the processing of end-of-life computing equipment. Manufacturers should give consideration to the use of substitute materials that perform the same function.

5.2.4.3 Computing Equipment manufacturers should collaborate to address the recyclability of plastics in computing equipment. Specifically, consideration should be given to greater consistency in material selection during the design stage for all computing equipment which would allow plastics recyclers to eliminate sorting steps necessary to achieve compatibility of plastics types.

5.2.5 Future Collaborative Steps

5.2.5.1 Parties of the Basel Convention are encouraged to extend the role of the Basel Convention Regional Centres to develop training and technology transfer regarding the environmentally sound material recovery and recycling of end-of-life computing equipment, in order to help developing countries and countries with economies in transition implement regulatory frameworks for the environmentally sound management of end-of-life computing equipment, including regulations on transboundary movements.

5.2.5.2 An audit checklist or similar tools should be developed to assist parties and others in performing inspections and due diligence audits based on the guideline.

Appendix 1

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 Appendix 2 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 (Appendix 2 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 (Appendix 2 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 (Appendix 2 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).

Appendix 2

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

Appendix 3

Packaging Guidelines

1. The following guidelines may be used to distinguish proper packaging from improper packaging for computing equipment and components destined for direct reuse or reuse.

2. For shipments[xxv], 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).

3. 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. 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.

Appendix 4 (a)

Voluntary Notification Procedure

1. In cases where used computing equipment is sent regularly to the same repair, refurbishment or upgrading facility by the same exporter, and if there is no existing agreement between the exporter and the government authorities (importing and exporting countries), the exporter will provide a Statement of Evaluation and Intent to Reuse ("the Statement") to the Governmental Authorities[xxvi] of the countries of export and import, and transit (if any), by means of e-mail, fax or other agreed method, prior to the departure of the shipment from the country of export. One Statement is sufficient for shipments within a defined time period of up to one year, or other time period as agreed by the parties involved.

2. In the case of single shipments of greater than 5 units of used computing equipment, or other quantity as agreed to by the parties involved (especially of trial shipments to a new repair or refurbishment facility), that have been evaluated and assessed to be likely suitable for reuse, the exporter will provide a Statement to the Governmental Authorities of the countries of export and import, and transit (if any), by means of e-mail, fax, or other agreed method, prior to the departure of the shipment from the country of export. In this case, the Statement would substitute an actual count of the shipment for a maximum count.

3. Statements, as described in paragraphs 1 and 2 above, would include the following:

(a) A commitment by the exporter that PACE guidelines will be followed and assurances that such shipments will be managed in an environmentally sound manner;

(b) A description of the shipment, in particular, content, maximum count and packaging;

(c) An indication of whether the information is for a single shipment or multiple shipments, and estimated frequency at which such shipments are to be exported;

(d) An indication of the proposed date of the first and the last shipment during the defined time period;

(e) Identification of the ports of export and import;

(f) Identification of and contact information (name, address and phone number) for the importer and exporter;

(g) A description of the evaluation used to determine that the used computing equipment in the shipment is suitable for reuse, possibly after repair, refurbishment or upgrading;

(h) Identification of and contact information (name, address, and phone number) of local persons associated with the importer and exporter who can provide any additional information about the shipment;

(i) Information on how residues and wastes arising from repair, refurbishment or upgrading operations will be managed.

4. All computing equipment, individually or in partitioned batches, must be appropriately documented with reference to the aforementioned Statement, or by other suitable method, so that recipients in the importing country are properly informed.

5. The Governmental Authorities should acknowledge by e-mail, fax or other agreed method the receipt of the Statement within the three calendar days, or other agreed time period, and should send that acknowledgement to the States concerned and to the exporter and the importer. After this time period has elapsed, any evidence of effective delivery of the Statement to the Governmental Authorities will be deemed as the acknowledgement date.

6. If the Governmental Authorities have provided authorization or have not responded within 14 calendar days from the acknowledgement date, transboundary movement may commence for the single shipment or the shipments within the period of time defined in the Statement. An updated Statement may be submitted at any time. However:

(a) If further information[xxvii] is requested by the Governmental Authority of the State of export, import or transit, the shipment must not commence until the requested information has been provided;

(b) If the response indicates that there is no objection but suggests conditions, then the shipment may commence only after the necessary conditions have been taken into account.

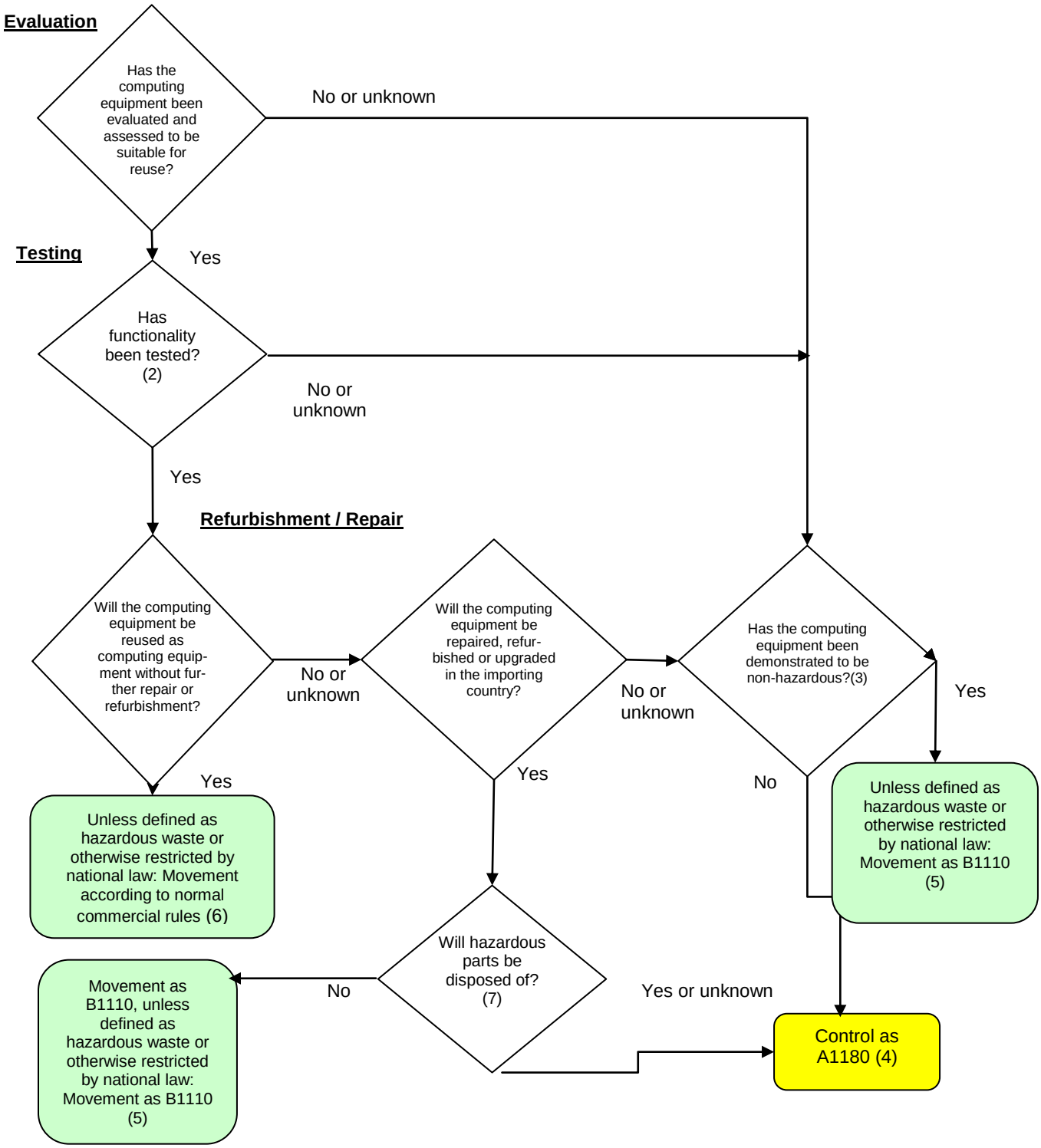
7. The Statement is provided solely for use by the Governmental Authority and is not for disclosure to third parties if the statement is marked as business confidential.

8. The content of this procedure should be reviewed at specific time intervals in order to ensure that the objective of environmentally sound management is upheld and to reflect the knowledge and experience gained, including those from the proposed PACE pilot projects.

Appendix 4 (b)

Decision Tree Procedure

Decision tree for transboundary movements of collected used and end-of-life computing equipment (1)



Further recommendations and explanations

(1) Movement within OECD or European Union countries, subject to bilateral agreements, or those defined, as products under national legislation may not be subject to this procedure.

(2) Results of evaluation and/or testing should be available through labeling or appropriate documentation (serial number referencing, or other suitable methods)

(3) End-of-life computing equipment is hazardous if it contains Annex I constituents, unless it can be shown (through testing or other evidence) not to possess an Annex III characteristic. If batteries are present, they should be considered as part of the analysis (see the decision tree on transboundary movement of collected batteries).

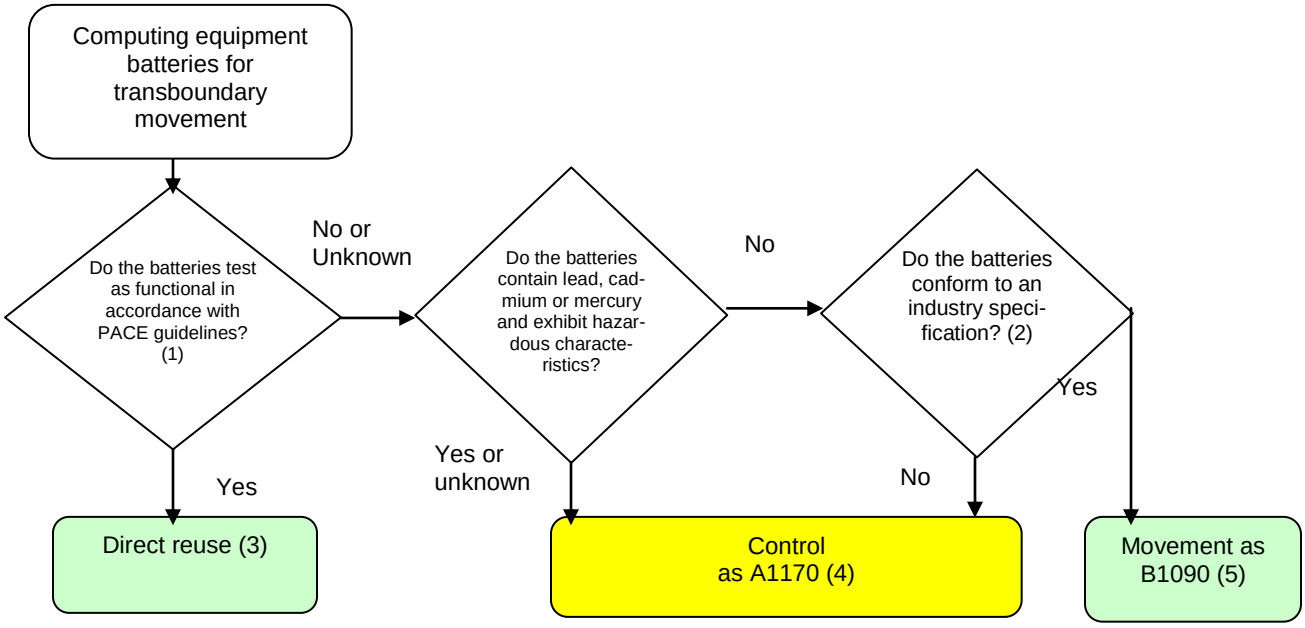
(4) The material should be controlled as hazardous waste under the Basel Convention. The code refers to the Annex VIII category. If one of the States concerned is not a Party, then a valid Article 11 agreement must be in place.

(5) The material should not be controlled as hazardous waste under the Basel Convention, unless it is considered as a hazardous waste under Article 1.1.b by a Party or otherwise prohibited from importation by a State Concerned. The code refers to the Annex IX of the Convention. Exporters should nevertheless ensure there are neither export restrictions in place from the country or region of export nor import restrictions from the country of import applicable to these used computing equipment.

(6) The material should not be considered as a waste, but rather as a commodity unless it is considered as a hazardous waste under Article 1.1.b by a Party or otherwise prohibited from importation by a State Concerned. Has the equipment or its constituents been defined as hazardous waste by the importing country under Article 1.1.b of the Basel Convention? Is there knowledge of other national or regional applicable restrictions? If so, then the equipment should be managed as A1180. Otherwise such equipment should be recorded and declared as being fully functional and intended for direct reuse utilizing Appendix C. Subsequently it can then be shipped using the commercial shipping codes found under the Harmonized Commodity Description and Coding System, including those codes listed under section 8471 for computers and accessories and those codes under section 8443 32 for printers. For computing equipment with batteries, those batteries should have been tested to determine whether they can hold an appropriate charge (see Appendix 6)

(7) If the repair, refurbishment or upgrading will not be conducted in compliance with the PACE guidelines or if components or parts of used computing equipment, involved in a transboundary movement, contain Annex I constituents and are untested, non functional, or are expected to be replaced, or otherwise likely to be destined, as a consequence of repair or refurbishment, to go to an Annex IV destination in the importing country, then shipments should be considered as a controlled hazardous waste shipments, unless it can be shown that the components or parts do not exhibit Annex III characteristics. The Governmental Authorities will make a determination as to the appropriate de minimis waste quantities and values (level of contamination) above which Basel Convention controls will be exercised. In Annex IX of the Basel Convention, the waste entry B1110 (“Electrical and electronic assemblies”) has two footnotes:
1. “In some countries, these materials (used computing equipment) destined for direct reuse are not considered wastes.”
2. “Reuse can include repair, refurbishment or upgrading, but not major reassembly” in the importing country.

Decision tree for transboundary movements of collected computing equipment batteries



No.	**Further recommendations and explanations**
(1)	In order to determine whether a battery should be considered suitable for reuse and be considered non-waste it should be tested as described in the PACE guidelines to determine whether it can hold an appropriate charge (see Appendix 6)
(2)	All computing equipment battery shipments should be sorted and/or pre-treated to meet appropriate national or internationally recognized specifications.
(3)	If the battery has been tested, as described in the PACE guidelines, to determine whether it can hold an appropriate charge and has passed the test (see Appendix 6), then it is considered a commodity and not a waste. Such batteries should be recorded and declared as being fully functional and intended for direct reuse utilizing Appendix C.
(4)	If the battery shipment does not meet the conditions of not containing lead, cadmium or mercury and does not conform to appropriate national or internationally recognized specifications, it should be controlled under the Basel Convention. The number here refers to Basel Convention Annex VIII hazardous waste category. If one of the States concerned is not a Party then a valid Article 11 agreement must be in place.
(5)	The number here refers to the Basel Convention Annex IX hazardous waste category. Exporters must nevertheless ensure there are neither export restrictions in place from the country or region of export nor import restrictions from the country of import applicable to that Annex IX category.

The content of this decision tree procedure should be reviewed at specific time intervals in order to ensure that the objective of environmentally sound management is upheld to reflect the knowledge and experience gained, including those from the proposed PACE pilot projects.

Appendix 5

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)**[1] 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)**[2] 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). **Laptop Battery** able to retain a minimum of 1 hour[3] 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)

[1] 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

[2] Ibid

[3] 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.

Computing Equipment	Functionality Tests	Test results
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[4], 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.
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

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

Appendix 6

Testing Methods for Laptop Batteries

Method 1 Demonstration

1. 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[5] 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[6] 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.

Method 2 Self-managing the Smart Battery

2. 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[7] by the laptop should be determined in watts (W). The battery shall be interrogated or tested to determine the Full Charge Capacity[8] in watt-hours (Wh). The runtime[9] is determined by:

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

[5] "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.

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

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

[8] "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.

[9] 1 hour is regarded as the minimum acceptable time.

Appendix 7

Declaration of Testing and Determination of Full Functionality and Reuse Destination of Exported Used Computing Equipment

Information to be provided on testing

Consignor/Holder (responsible for testing): Name: Address: Phone No: E-mail**:**	**Exporter (if different than Consignor):** Name: Address: Phone No: E-mail:	**Carrier** Name: Address: Phone No: E-mail:
Importer Name: Address: Phone No: E-mail:	**User, Retailer, Consignee (if different than Importer):** Name: Address: Phone No: E-mail:	**Country of Export:** **Country of Import:**

Declaration:

I the legal holder of the below listed computing equipment hereby declare that prior to export the used computing equipment in this shipment, listed below, was tested after it was removed from service, or after it was repaired/ refurbished, and is in good working condition and fully functional[10]. I confirm that this equipment is being imported for the purpose of direct reuse[11] and not for recycling, or final disposal.

Name: Date: Signature:

Type of Equipment[12]	Model #	Serial # (if applicable)	Year Manufactured	Date of Testing	Type of Tests and Comments

[10] **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.

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.

[11] 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**.

[12] List all equipment in the shipment and identify types of whole equipment such as: PC, laptop, printer, scanner, etc. Component parts such as: circuit board, memory, hard drives, power supplies, or batteries can be sent in the batch without the details, required in columns 2 and 3, but still will need to be tested.

Appendix 8

Information Accompanying Shipments of Computing Equipment Returned Under Warranty, or Otherwise Excluded from Control Procedures

(Recommendations 3.2.7.2 and 3.2.7.3)

1. Person who arranges the shipment/Exporter: Name: Address: Contact person: Tel.: Fax: E-mail:	**2. Importer** Name: Address: Contact person: Tel.: Fax: E-mail:	**3. Consignee/Receiving Facility** **(if different than Importer)** Name: Address: Contact person: Tel.: Fax: E-mail:	**4. Description of the Shipment/Reasons for Shipments:** ☐ warranty returns or subject to a law allowing for a right of return (3.2.7.2) ☐ batches under warranty or subject to a law allowing for a right of return (3.2.7.3)
5. Actual quantity/volume:		**6. Actual date of shipment:**	

7. (a) First Carrier[1] Name: Address: Contact person: Tel.: Fax: E-mail: Means of transport: Date of transfer: Signature:	**7 .(b) Second Carrier** Name: Address: Contact person: Tel.: Fax: E-mail: Means of transport: Date of transfer: Signature:	**7.(c) Third Carrier** Name: Address: Contact person: Tel.: Fax: E-mail: Means of transport: Date of transfer: Signature:

8. Countries/States concerned:

Export/dispatch	Transit	Import/destination

9. Declaration of the owner of the equipment: I declare that the used computing equipment in this shipment is defective equipment being returned to the manufacture, original component supplier or its contractual agents as the result of a warranty, or pursuant to a law allowing for a right of return.

Name: Date: Signature:

10. Declaration of the person who arranges for the shipment/exporter: I declare that the above information is complete and correct to the best of my knowledge.

Name: Date: Signature:

TO BE COMPLETED BY THE RECEIVING FACILITY

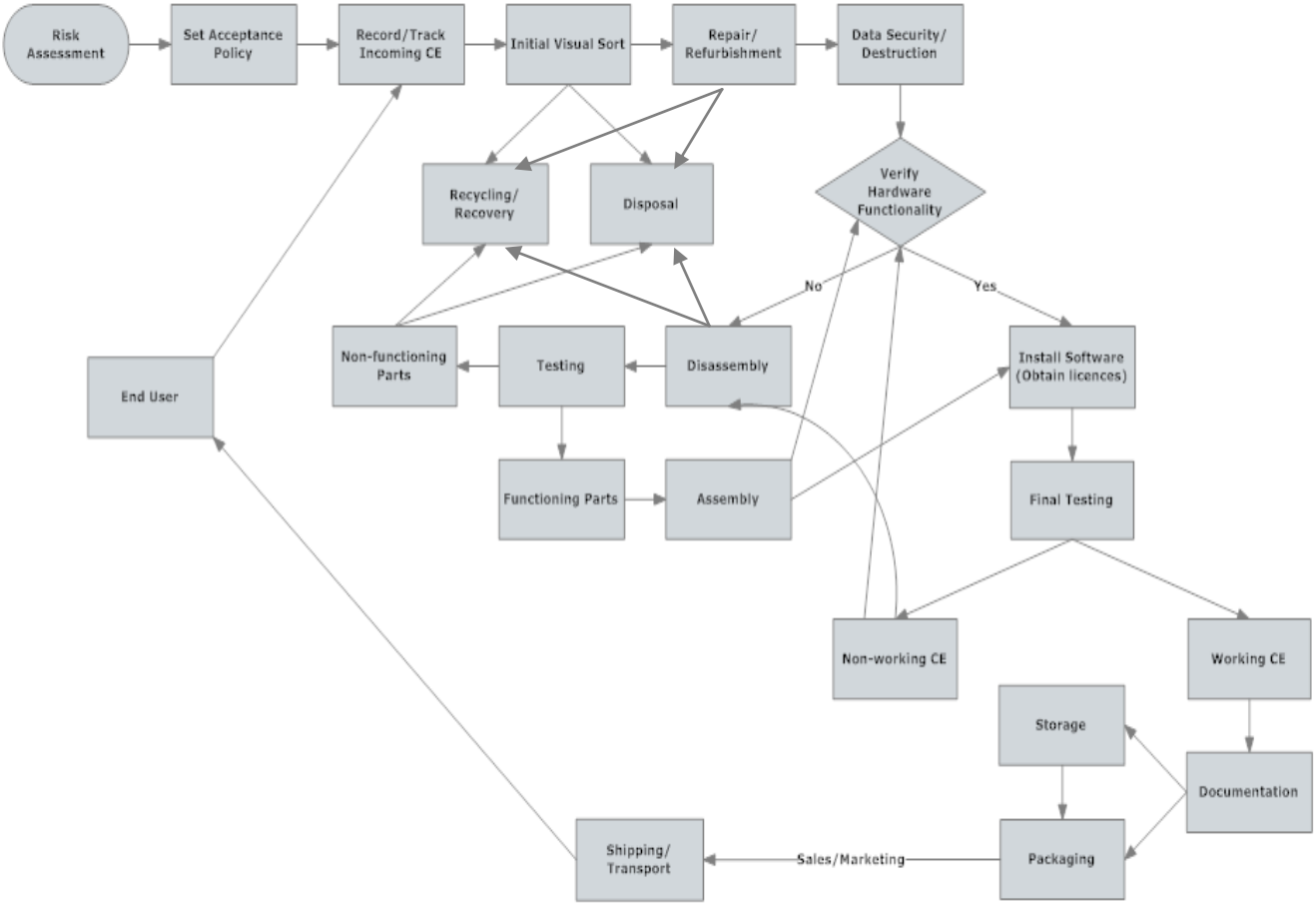
11. Shipment received at the receiving facility: ☐ **Quantity/volume received:**

Name: Date: Signature:

[1] If more than three carriers attach information as required in blocks 7(a), (b) and (c).

Appendix 9

Flow Diagram of Typical Refurbishment and Repair Process



Appendix 10

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

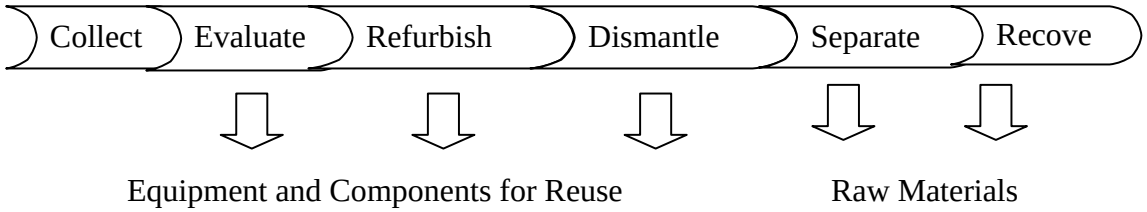
5. **Ensure availability of training:** Donor may support the recipient with training or training programs.

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)

Appendix 11

Value Chain of Management of Used Computing Equipment



1st step - **collect** - This step can be challenging, but is critical. Computer equipment that is discarded in household trash may never reach the next steps, may then be lost for further beneficial use, and may be mismanaged. In some countries, informal scavengers may look at everything before it is finally discarded and used and end-of-life computers often have enough value to be collected by them. These scavengers, and informal and second-hand markets, are important sources of electronic scrap. In other countries, greater effort and expense is needed to collect computers, and it may be necessary to find ways to subsidize collection systems.[xxviii] Special collection events are often organized, or collection may be regularly ongoing in retail stores, or by mail-in collection. Charities sometimes collect computers for reuse. Collection of computers from businesses is important because of the large numbers of computing equipment that may be involved, and may be a particularly good source of recent-model computers for refurbishment, as well as for material recovery.

2nd step - **evaluate** – Once it has been collected, computing equipment should be evaluated to determine whether it can still be used as computing equipment, or whether it should be used only for material recovery. This may be done at the initial collection site, or at a later step before computing equipment is dismantled. Continued use of computing equipment preserves the high value added in original manufacture, conserves resources and energy needed to manufacture new computing equipment, and makes inexpensive computing technology available to persons who cannot afford to purchase new computers. The methods of such evaluation are not within the scope of this guideline (see guideline produced by PACE Project Group 1.1), but an experienced, knowledgeable person can often decide quickly - based on model, age, condition and appearance - whether computing equipment has potential market value in continuing use, or should be scrapped for materials recovery. This step overlaps to some degree with the third and fourth steps – refurbish and dismantle - because it will sometimes be necessary to see what parts are inside, whether parts are still working, what parts need to be replaced.

3rd step - **refurbish** – Computing equipment that has been evaluated and can still be used as computing equipment may need to be refurbished. This includes replacement of hardware and software as needed, and cleaning, labelling and distribution, and puts a useful computer and/or component back into the market for continuing use. This guideline does not describe refurbishment activities or standards, and reference should be made to PACE Project Group 1.1 for its refurbishment guideline.

4th step - **dismantle** – Computing equipment often needs to be opened to see if it is working and can still be used as computing equipment, or to begin the material recovery processes. Dismantling should be done by hand if it is intended to keep a used or end-of-life computer in

working condition. Computers are usually held together by screws and simple fasteners that can be easily removed, although some parts are welded or soldered and are more difficult to separate. Dismantling can also be the beginning of material recovery. Manual dismantling can recover not only working components, but also clean materials for recovery, e.g., steel cases. It may also involve powerful mechanical separation of parts and components, and may begin to release substances as dust. It will be necessary to first manually remove components such as mercury lamps, batteries, etc., so they are not shredded and their contained substances, some of which are hazardous are not released and/or mixed with other materials. Toner cartridges should also be removed unless recycling or shredding equipment has been specifically designed to handle environments where high dust concentrations in air might occur. Like many organic materials in powdered form, toner can form explosive dust-air mixtures when finely dispersed in air. Hazardous substances should not be released and/or mixed with other materials. Protection of worker health and safety and the environment is necessary in such conditions, including engineered control systems, personal protective equipment such as gloves and eye protection, dust or respiratory masks, etc. should be used as appropriate.

5th step - **separate** – Separation is the process of sorting materials into separate batches and consolidating them for specialized material recovery. Computing equipment that has been evaluated to have no continuing value through refurbishment, and no remaining valuable working components, will be taken apart, manually or mechanically, and separated into steel, plastics, circuit boards, etc. Higher levels of worker and environmental protection are needed, sometimes much higher depending upon the separation process and the material being processed. Some of these separated categories can be quickly returned to markets, e.g., steel cases into a scrap steel market, while others require further separation in more complex recovery steps.

6th step - **recover** – Recovery takes these separated batches of materials into more specialized processes, often into a series of them, e.g., circuit boards first into copper recovery, followed by specialized refining of the residues to recover other metals, or engineered thermoplastics into size reduction and granulation. These processes often involve high temperature, e.g., smelting and other pyrometallurgical processes, or very strong chemicals, e.g., hydrometallurgical processing by acids or cyanide, or hazardous process emissions, and require very high levels of process technology as well as monitoring and worker and environmental protection.

Appendix 12

Facility Measures to Support Environmentally Sound Material Recovery and Recycling of End-of-Life Computing Equipment

To protect workers and communities, material recovery facilities should take steps that are guided by the following ESM criteria (all of which are described more fully in the paragraphs immediately below):

1. Top Management Commitment to a Systematic Approach
2. Risk Assessment
3. Risk Prevention and Minimization
4. Legal Requirements
5. Awareness, Competency and Training
6. Record-keeping and Performance Measurement
7. Corrective Action
8. Transparency and Verification

1. *Top Management Commitment to a Systematic Approach:* A material recovery facility should have the clear commitment of top management to a systematic policy approach to achieve and continually improve environmentally sound management in all aspects of facility operations, including pollution prevention and environmental health and safety. Adequate financial and human resources should be made available. The policy should be documented, implemented, and communicated to all personnel, as well as to contractors and visitors as appropriate. Policy performance should be reported and reviewed periodically by top management. In larger material recovery organizations, specific management representative(s) should be appointed to oversee the implementation of the policy through design, implementation and maintenance of a management system.

2. *Risk Assessment:* Material recovery facilities conduct heavy industrial operations involving powerful machinery, very high temperatures and strong and hazardous chemicals. While each facility will be different, with different operations and locations, they will all present multiple risks to workers' health and safety, and potential environmental impacts both within and beyond the facility location. Material recovery facility management should seek to identify and document hazards and risks to worker health and safety and to the environment that are associated with their own existing and planned material recovery activities, products and services. It is especially important to identify emergency situations and accidents that might occur, and how to respond to them, and these response procedures should be periodically tested and reviewed, especially after the occurrence of accidents or emergency situations. The hazards and risks of eventual site decommissioning and closure should also be identified and a site plan should be prepared, including remediation, with financial mechanisms to secure long term care if it would be necessary.

3. *Risk Prevention and Minimization:* Once material recovery facility management has assessed the hazards and risks of facility activities, products and services, it should systematically seek to minimize or eliminate these hazards and risks. This systematic approach should first address significant existing environmental and health and safety risks, as well as noncompliance with applicable legal requirements. It should consider technological, operational and business changes, including improved procedures, improved

equipment, and different business practices. Beyond significant existing hazards and risks, a material recovery facility should look to continually improve the design of the workplace, process, installations, machinery, operating procedures and work organization with the aim of eliminating and/or reducing EHS hazards and risks at their source. All of these improvements should be documented and communicated to all personnel, as well as to contractors and visitors as appropriate. It is particularly important to have good communications to suppliers and buyers of recovered materials about the content and risks associated with those materials in the very specific circumstances of material recovery processing.

4. *Legal Requirements:* Material recovery facilities dealing with used and end-of-life computing equipment are required to have all operating permits, licenses, or other authorizations that apply to their operations, especially if these materials are defined by their nation or other governmental entity as being "waste", as is often the case. A facility should always be in compliance with these permits, licences and authorizations. A systematic approach to environmentally sound management includes evaluation at regular intervals to identify applicable law, including amendments and new laws, and to determine how these requirements specifically apply to the facility and its operations. A systematic approach also includes periodic communication, and a sound working relationship, with competent authorities. Because material recovery operations may involve transboundary movement of supplies, wastes and products, a material recovery facility should also take care to ensure compliance with applicable international laws and laws of other concerned countries.

5. *Awareness, Competency and Training:* Facility managers should ensure that all people engaged in material recovery operations are well trained to carry out their responsibilities in a safe manner. This means that employees must be trained not only in how to carry out facility operations, but also must be given an appropriate level of awareness of hazards and risks, and must achieve competence with respect to the effective management of these hazards and risks, including how to respond to and deal with foreseeable emergencies or accidents. This should follow from the Risk Assessment and Risk Prevention and Minimization steps described above. Worker competence also requires access to special tools associated with material recovery operations, test equipment, materials handling equipment, and information such as material safety data sheets for all substances, and training in understanding and using these. Where possible, photographs and diagrams should be added to written instructions to train workers in material recovery operations.

6. *Record-keeping and Performance Measurement:* A systematic approach to environmentally sound management includes the creation and maintenance of documents that record the details of that management. When an operating procedure has been documented, it can be properly executed in a consistently safe manner, and regularly improved. Documents that record the training of employees can be reviewed to ensure that such training is complete for the appropriate work assignment. Inspections, testing and assessment of used computing equipment can be reviewed to ensure that efficient and environmentally sound management is taking place in accordance with facility and legal requirements. There is little or no activity at a materials recovery facility that will not be improved by appropriate records of that activity, accompanied by periodic review with intent to improve.

7. *Corrective Action:* A materials recovery facility should take appropriate action to address risks to worker health and safety and the environment that it identifies in Risk Assessment or that are brought to its attention by others, such as Competent Authorities or concerned third parties. Deficiencies in achieving ESM should also be addressed. Preventative and corrective actions should be appropriate and proportionate, and should be documented. The need for corrective action should be presented to senior management, as well as the results of such action.

8. *Transparency and Verification:* Material recovery facilities deal with end-of-life computing equipment that may be hazardous to the health and safety of their workers and the environment. They should have regular scheduled inspection and monitoring of these hazards, following documented procedures. If possible, such inspections and monitoring should be conducted by persons independent of environmental management within the facility operations, or should be conducted by third parties. Such documented inspection and monitoring procedures may be regulatory requirements, but should in any case be used as part of a systematic approach to environmentally sound management. A facility's environment, health and safety policy, and its inspection and monitoring schedule and results should be available to the public, and to customers and clients who perform due diligence investigations of facility activities and operations.

Appendix 13

References

(These documents were considered during the working period of Project Groups. Some of these documents may have undergone update, revision or substitutions).

United Nations

1. Draft technical guidelines on the environmentally sound recycling/reclamation of metals and metal compounds (R4). Basel Convention (http://www.basel.int/meetings/cop/cop7/docs/08a3e.pdf).
2. E-waste Take-back System Design and Policy Approaches. Solving the E-waste Problem (StEP). (January 28, 2009) (http://www.step-initiative.org/pdf/white-papers/StEP_TF1_WPTakeBackSystems.pdf).
3. Guidance document on the environmentally sound management of used and end-of-life mobile phones. Basel Mobile Phone Partnership Initiative (Sep 15, 2008) (http://www.basel.int/industry/mppi/MPPI%20Guidance%20Document.pdf).
4. Guidance Document on the Preparation of Technical Guidelines for the Environmentally Sound Management of Wastes Subject to the Basel Convention (http://www.basel.int/meetings/sbc/workdoc/framewk.doc) .
5. Guideline on Material Recovery and Recycling of End-of-Life Mobile Phones (Approved Draft). Basel Mobile Phone Partnership Initiative Project 3.1. (March 25, 2009) (http://www.basel.int/industry/mppiwp/guid-info/guidmaterial.pdf).
6. Guideline on the Awareness Raising-Design Considerations (Revised and Approved Draft). Basel Mobile Phone Partnership Initiative Project 4.1. (March 25, 2009) (http://www.basel.int/industry/mppiwp/guid-info/guiddesign.pdf).
7. Guideline for the Transboundary Movement of Collected Mobile Phones (Approved Final Draft). Basel Mobile Phone Partnership Initiative Project 2.1. (March 25, 2009) (http://www.basel.int/industry/mppiwp/guid-info/guidTBM.pdf).
8. Guideline on the Collection of Used Mobile Phones (Approved Draft). Basel Mobile Phone Partnership Initiative Project 2.1. (March 25, 2009) (http://www.basel.int/industry/mppiwp/guid-info/guidcoll.pdf).
9. Guideline on the Refurbishment of Used Mobile Phones (Revised and Approved Draft). Basel Mobile Phone Partnership Initiative Project 1.1. (March 25, 2009) (http://www.basel.int/industry/mppiwp/guid-info/guidrefurb.pdf).
10. One Global Understanding of Re-Use - Common Definitions. Solving the E-waste Problem (StEP). (March 5, 2009) (http://www.step-initiative.org/pdf/white-papers/StEP_TF3_WPCommonDefinitions.pdf).
11. Social and Environmental Responsibility in Metals Supply to the Electronic Industry. Global e-Sustainability Initiative (GeSI). (June 20, 2008) (http://www.gesi.org/files/20080620_ghgm_ser_metalstoelectronics.pdf).
12. The Entrepreneur's Guide to Computer Recycling. United Nations Educational, Scientific and Cultural Organization (UNESCO) (http://www.ticethic.com/guide).

OECD

13. Council Recommendation C(2004)100 on the Environmentally Sound Management of Waste (9 Jun 2004) (http://webdomino1.oecd.org/horizontal/oecdacts.nsf/linkto/C(2004)100).
14. Guidance Manual for the Implementation of the Council Recommendation C(2004)100 on the Environmentally Sound Management of Waste. (2007) (http://www.oecd.org/dataoecd/23/31/39559085.pdf).
15. Technical Guidance for the Environmentally Sound Management of Specific Waste Streams: Used and Scrap Personal Computers (18 Feb 2003) (http://www.olis.oecd.org/olis/2001doc.nsf/LinkTo/NT000009E2/$FILE/JT00139462.PDF).

North America

16. Basel Action Network (BAN) Electronics Recycler's Pledge of True Stewardship (http://www.ban.org/Pledge/electronics_recycler_pledge.pdf).

17. Best Management Practices for Electronic Waste. California Integrated Waste Management Board (April 2004)(http://www.ciwmb.ca.gov/Publications/electronics/63004005.pdf).
18. Canada: Electronics Recycling Standard / Electronics Recycler Qualification Program 2010 www.epsc.ca/
19. Canada: Electronics Reuse and Refurbishing Program (ERRP) www.estewardship.ca/
20. Closing the Loop Electronics Design to Enhance Reuse/Recycling Value. Green Electronics Council (January 2009) (http://www.greenelectronicscouncil.org/documents/0000/0007/Design_for_End_of_Life_Final_Report_090208.pdf).
21. Creating a Successful Computer Reuse Programme – a guide (http://www.computersforclassrooms.org/Building%20Successful%20Manual%202-18-10.pdf).
22. Dell's Recovery and Waste Disposition ChannelsEnvironmental Guidelines (December 2005) (http://www.dell.com/downloads/global/corporate/environ/Disposal_Guidelines.pdf).
23. e-Stewards Standard for Responsible Recycling and Reuse of Electronic Equipment (http://www.e-stewards.org/documents/e-StewardStandard_ExcerptedVersion.pdf).
24. Hewlett-Packard Standard 007-2 Vendor Requirements for Hardware Recycling (October 13, 2008) (http://www.hp.com/hpinfo/globalcitizenship/environment/recycle/finalrecstds.pdf).
25. Implementation Guide for Information Technology Equipment Disassembly and Sorting Centres. Centre québécois de développement (http://www.nrcan-rncan.gc.ca/mms-smm/busi-indu/rad-rad/pdf/cfe-imp-eng.pdf).
26. Ifixit step by step repair guide (www.ifixit.com).
27. Plug-In To eCycling: Guidelines for Materials Management. USEPA (May 2004) (http://www.epa.gov/epawaste/partnerships/plugin/pdf/guide.pdf).
28. Recycler Vendor Qualification Standard. Electronic Product Stewardship Canada (Mar 2006) (http://www.epsc.ca/pdfs/March2006_RVQP_standard.pdf).
29. Recycling Industry Operating Standard (RIOS), Institute of Scrap Recycling Industries (ISRI) (http://www.firstenvironment.com/html/environmental_management_syste7.html).
30. Recycling Vendor Qualification Guidance Document. Electronic Product Stewardship Canada (Mar 2006)(http://www.epsc.ca/pdfs/March2006_RVQP_GD.pdf).
31. Recycling Vendor Qualification Process. Electronic Product Stewardship Canada (Mar 2006) (http://www.epsc.ca/pdfs/March_2006_FINAL_Recycler_Qualification_Proce_ss.pdf).
32. Responsible Recycling "R2" Practices for use in Accredited Certification Programs for Electronics Recyclers (October 30, 2008) (http://www.decideagree.com/R2%20Document.pdf).
33. US EPA guide on what to do is a CFL breaks in the home (transferable to refurbishment operations) (www.epa.gov/cfl/cflcleanup.html).
34. USA e-Stewards http://e-stewards.org/
35. USA R2 (Responsible Recycling Practices for Use in Accredited Certification Program for Electronics Recyclers) http://www.r2solutions.org
36. USA RIOS (Recycling Industry Operating Standard) http://www.isri.org/rios
37. USA R2/RIOS http://www.CertifiedElectronicsRecycler.org
38. Waste Diversion Ontario's Draft Waste Electrical and Electronic Equipment Diversion Standard (Oct 2007) (http://www.ene.gov.on.ca/envision/land/WDA/electronics/finalWEEProgramPlan-appendices.pdf).

Europe

39. Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE). Consolidated version (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2002L0096:20080321:EN:PDF).
40. European Eco-Management Audit Scheme(EMAS) (http://ec.europa.eu/environment/emas/index_en.htm).
41. EU WEEE Forum WEEELABEX scheme (http://www.weee-forum.org/index.)

42. France FEDEREC's CERTIREC
http://www.federec.org/qualification-certification/certirec.html
43. Germany Efb
www.gesetze-im-internet.de/bundesrecht/efbv/gesamt.pdf
44. HB 10194 *Code of Practice for in-service inspection and testing of electrical equipment*. The Institutio
Engineering and Technology (http://www.theiet.org/publishing/books/wir-reg/cop.cfm).
45. Reuse of waste and used electrical and electronic equipment, UK Publicly Available Specification (PAS 1
to be published January 2011 (http://shop.bsigroup.com/Navigate-by/PAS/)
46. United Kingdom PAS 141 (Publicly Available Specification) on Reuse of Used and Waste Electrical and
Electronic Equipment (to be published 2011)
http://shop.bsigroup.com/Navigate-by/PAS/
47. UK Government National technical Authority for Information Assurance(CESG) Directory of Infosec Assu
products, Section 7 for information on approved data destruction
systems (http://www.cesg.gov.uk/publications/media/directory.pdf).

Developing Countries and Countries with Economies in Transition

48. E-waste assessment in Uganda: A situational analysis of e-waste management and generation with special emphasis on personal computers. UNIDO, Microsoft. (2008) (http://ewasteguide.info/system/files/Finlay_2008_eWASA.pdf);http://ewasteguide.info/Wasswa_2008_UCPC-Empa).
49. E-waste Assessment South Africa. Hewlett Packard, DSF, EMPA. (November 2008) (http://ewasteguide.info/system/files/Finlay_2008_eWASA.pdf).
50. E-waste Management in Kenya. Hewlett Packard, DSF, Empa. (July 2008) (http://ewasteguide.info/system/files/Waema_2008_KICTANet.pdf); http://ewasteguide.info/Waema_2008_KICTANet).
51. Guidelines for Environmentally Sound Management of E-waste. India Central Pollution Control Board (CPCB) and Ministry of Environment & Forests (March 12, 2008) (http://www.cpcb.nic.in/e_Waste.php).
52. Technical report on the assessment of e-waste management in Morocco. Hewlett Packard, DSF, EMPA. (August 2008) (http://ewasteguide.info/system/files/Laissaoui_2008_CMPP.pdf).

Other

53. Darik's Boot and Nuke which offers a free download (http://www.dban.org/download)
54. ISO 14000 series for environmental management (http://www.iso.org/iso/iso_14000_essentials).
55. ISO 14001 Environmental Management Systems - Requirements with Guidance for Use (second edition 2004-11-15) (http://www.iso.org).
56. ISO 14004 Environmental Management Systems - General Guidelines on Principles, Systems and Support Techniques (second edition 2004-11-15) (http://www.iso.org).
57. Occupational Health and Safety Management Systems – Specification (BSI - OHSAS 18001: 1999)
58. Tools for Environmentally Sound Management, Bureau of International Recycling (BIR) (EN 2006 / ES 2008 / FR 2009) (http://www.bir.org/pdf/GuideESM.pdf (English); (http://www.bir.org/pdf/GuideESM_FR.pdf (French); (http://www.bir.org/pdf/GuideESM_ES.pdf) (Spanish).

Appendix 14

Endnotes

[i] UN Recommendations on the Transport of Dangerous Goods (i.e., UN Orange Book): Model Regulations, 15th revised edition, 2007, or later version.

[ii] http://www.un.org/millenniumgoals/

[iii] eTForecasts publishes market research reports for the PC and Internet industries

[iv] Press Release, "Basel Conference Addresses Electronic Wastes Challenge." November 27, 2006, United Nations Environment Programme (UNEP) and Press Release, "Basel Conference Addresses Electronic Wastes Challenge." November 27, 2006, United Nations Environment Programme (UNEP

[v] Electronic Waste Management in the United States, Approach 1" Table 3.1 EPA530-R-08-009 US Environmental Protection Agency, July 2008

[vi] Recommendations will take into consideration Principle 11 of the Rio Declaration

[vii] PACE Interim Project Group, Report on ESM Criteria recommendations, March, 2009

[viii] http://www.basel.int/meetings/sbc/workdoc/framewk.doc

[ix] http://webdomino1.oecd.org/horizontal/oecdacts.nsf/linkto/C(2004)100

[x] http://www.olis.oecd.org/olis/2001doc.nsf/LinkTo/NT000009E2/$FILE/JT00139462.PDF

[xi] http://www.basel.int/meetings/sbc/workdoc/framewk.doc

[xii] Ad Interim Group, report on ESM Criteria Recommendations

[xiii] http://www.basel.int/industry/compartnership/documents.html

[xiv] Reuse: a process of using again a used computing equipment or a functional component from a used computing equipment, possibly after repair, refurbishment or upgrading (from the PACE glossary of terms)

[xv] The documentation shall accompany the movement and refer to the computing equipment in the shipment

[xvi] Such determination should be made through Parties' obligations as per Articles 3 and 13 of the Basel Convention. Each Party has the obligation to inform each other, through the Basel Secretariat, of their national definitions and of any subsequent changes, which includes any additional substances and/or objects as wastes and hazardous wastes, URL: http://www.basel.int/natreporting/index.html

[xvii] Ibid

[xviii] Glossary of Terms, Appendix 1

[xix] 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

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

[xx] Glossary of Terms, Appendix 1

[xxi] PACE Project Group 1.1, Guideline on Environmentally Sound Testing, Refurbishment and Repair of the Used Computing Equipment, January, 2011

[xxii] Ibid

[xxiii] PACE Project Group 2.1, Guidelines on Environmentally Sound Material Recovery/ Recycling of End-of-Life Computing Equipment , January, 2011

[xxiv] Ibid

[xxv] 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

[xxvi] Governmental Authority means a governmental authority designated by a Party or Signatory to be responsible within such geographical area under the legal jurisdiction of the Party or Signatory as the Party or Signatory deems appropriate for implementing relevant rules and regulations and to receive information related to transboundary shipments of used computing equipment destined for reuse, possibly after repair, refurbishment or upgrading

[xxvii] The request for such information may indicate that more stringent provisions are to be applied, like those of the Basel Convention

[xxviii] Examples of funding mechanisms:

- Advanced disposal fees – paid by the consumer at sale, either a visible fee (shown on the receipt as a separate item) or an 'invisible' fee (just part of the total sale price).
- Levy on import – paid by the importer of the product at the point of entry into the country (either collected and managed by the industry or by the Government)

- "waste arisings" – collection/recycling costs paid for by the producer at the time the product enters the waste stream. The costs can be based on current market share or calculated on historic market shares and may or may not include legacy and orphan wastes.
- End-User-Pays – the end-user pays a fee for the collection/recycling costs at the point of disposal
- Rate-payer – the collection/recycling costs are covered by all tax payers through their rates payments
- Short-term grant funding – grants can be awarded for short-term projects such as initial collection infrastructure and are available from a variety of sources – private sector, Trusts, government, Lottery, landfill tax etc