JRC TECHNICAL REPORTS

Development of European Ecolabel Criteria for Personal & Notebook Computers

TECHNICAL REPORT
Criteria Proposals, Revision v3
(Draft) Working Document

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1. INTRODUCTION

This document is intended to provide the background information for the revision of the Ecolabel criteria for Personal and Notebook Computers and the development of Green Public Procurement (GPP) criteria for this product group (see separate report). The study has been carried out by the Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) with technical support from the Oeko-Institut. The work is being developed for the European Commission's Directorate General for the Environment.

The main purpose of this document is to evaluate the current criteria and discuss if the criteria are still relevant or should be revised, restructured or removed. This document is complemented and supported by the preliminary report, which consists of a series of task reports[1] addressing:

- Scope and definitions (Task 1 report),
- Market analysis (Task 2 report),
- Technical analysis (Task 3 report),
- Improvement potential (Task 4 report), and
- First criteria proposals (Task 5 report).

Furthermore, during the course of the revision process two general questionnaires on the scope and improvement potential as well as queries specific to certain criteria were sent out to selected stakeholders. The target groups were industry, Member States, NGOs and research institutions. The specific information, views and suggestions arising from questions about the scope, improvement potential and criteria revision were reflected mainly in the Task 1 and Task 4 reports and taken into consideration as far as possible in the proposals for the criteria revision.

The draft version of the technical report (Task 5) has built the basis for the first Ad-Hoc Working Group (AHWG) meeting taken place in October 2013. The current Task 6 report provides an update of the criteria development process based on new

[1] The previous Task 1-5 reports and further information can be downloaded at http://susproc.jrc.ec.europa.eu/computers/stakeholders.html

information (stakeholders' discussion at the AHWG meeting, further stakeholder inputs following the meeting, further desk research).

For each of the criteria, boxes are provided with the current criteria (grey), the first proposal (yellow) and a second proposal (green) for revised criteria. After each box a discussion of the rationale for the proposed change (or not) to the criterion is made, based on the stakeholder feedback and further research. Proposals for *new* criteria have also been made together with the rationale behind each proposal.

This second version of the technical report will bring together the scientific arguments for the proposed new criteria document to provide input for another stakeholder discussion at the second AHWG meeting taking place in May 2014, before finally being voted upon by the EU Ecolabelling Board.

The current scope of the EU Ecolabel criteria for Desktop and Notebook Computers

Currently, two separate sets of Ecolabel criteria exist for personal computers (Commission Decision 2011/337/EU) and notebook computers (Commission Decision 2011/330/EU). They consist of fifteen and fourteen criteria for personal and notebook computers respectively which are listed in Table 1.

Table 1: Current Ecolabel criteria for Personal and Notebook Computers according to Commission Decisions 2011/337/EU and 2011/330/EU

Current EU ecolabel criteria for "Personal Computers"	**Current EU ecolabel criteria for "Notebook Computers"**
Criterion 1 – Energy savings	Criterion 1 – Energy savings
Criterion 2 – Power management	Criterion 2 – Power management
Criterion 3 – Internal power supplies	---
Criterion 4 – Mercury in fluorescent lamps	Criterion 3 – Mercury in fluorescent lamps
Criterion 5 – Hazardous substances and mixtures	Criterion 4 – Hazardous substances and mixtures
Criterion 6 – Substances listed in accordance with Article 59(1) of Regulation (EC) No 1907/2006	Criterion 5 – Substances listed in accordance with Article 59(1) of Regulation (EC) No 1907/2006
Criterion 7 – Plastic parts	Criterion 6 – Plastic parts
Criterion 8 – Noise	Criterion 7 – Noise
Criterion 9 – Recycled content	Criterion 8 – Recycled content
Criterion 10 – User instructions	Criterion 9 – User instructions
Criterion 11 – User reparability	Criterion 10 – User reparability
Criterion 12 – Design for disassembly	Criterion 11 – Design for disassembly

Current EU ecolabel criteria for "Personal Computers"	Current EU ecolabel criteria for "Notebook Computers"
Criterion 13 – Lifetime extension	Criterion 12 – Lifetime extension
Criterion 14 – Packaging	Criterion 13 – Packaging
Criterion 15 – Information appearing on Ecolabel	Criterion 14 – Information appearing on Ecolabel

The revised Ecolabel criteria document is proposed as covering both product groups; thus common criteria proposals for both personal computers and notebook computers have been developed, with differentiation made between technical product characteristics where necessary.

Furthermore, within the parallel revision processes for EU Ecolabel criteria for televisions and computers it has been discussed[2] to remove the product subcategory "computer display" from the current scope of the Ecolabel criteria for personal computers and move it to a revised scope of Ecolabel criteria for "Electronic Displays", subsuming television sets, television monitors and external computer displays. Thus, the following sections highlight the revised criteria proposals but exclude specific requirements for computer displays, which are considered and presented within the Technical Report and Criteria Proposals for Televisions.

The key environmental impacts associated with the product group

Based on the LCA review presented in the Task 3 report the overall findings indicate that the production phase and the use phase are associated with the most significant environmental impacts during the life cycle of computer products.

Within the manufacturing phase of desktop PCs, specific environmental 'hot spot' components identified as being of significance are the motherboard and other Printed

[2] As stated in the previous technical report Task 1 of the revision process for the development of EU Ecolabel criteria for televisions, there is a functionality overlap between computer displays and television sets placed on the EU market. Computer displays are being used to watch content normally only viewed on televisions and television sets are increasingly enabled for web browsing. Thus, it is becoming more and more difficult to distinguish between the two product categories. In the current review process of the EU Ecodesign and Energy Labelling Regulations for televisions, the discussion paper (presented and discussed with stakeholders at the Consultation Forum meeting of 8 October 2012) proposed to change the scope from solely "televisions" to "electronic displays", including television sets, television monitors, and external computer displays.

Wiring Boards of the desktop unit, the screen (LCD panel), as well as the power supply, CD ROM and the hard disk drive (HDD).

Within the manufacturing phase of notebooks, the production processes of the motherboard and the display have the most significant environmental impact, followed by battery production. One of the reasons is that critical raw materials are concentrated in these components, whose extraction and processing is associated with major material requirements, the transformation of land and the consumption of energy, and cause severe environmental impacts: specifically silver, gold and palladium in the motherboard and other Printed Circuit Boards; indium and gallium in the display and background illumination, and cobalt in batteries.

The potential for the direct influence of ecolabel criteria on the production of single computer components is considered to be limited. However, by improving design (e.g. design for durability and disassembly) or indirectly by extending the lifetime or by reusing parts, the impacts of the manufacturing phase can be reduced as secondary resources from recycling or extended product lifetime avoid primary production stages. Thus, the allocation of benefits from re-use and recycling is an area specifically highlighted in Task 4 (improvement potential) and in the criteria proposals.

A number of issues are currently not addressed by the EU Ecolabel criteria although evidence exists for the potential environmental and / or social impacts (e.g. fluorinated greenhouse gases, conflict-metals). Proposals to include them in the revised criteria are provided in this technical report.

The proposed framework for the revision

The following table provides a proposal for a new schematic to cluster and allocate the existing as well as possible new criteria to certain thematic fields which reflect the identified hotspots for computers:

Table 2: New proposed criteria cluster and allocation of sub-criteria for the revision of the Ecolabel criteria for personal and notebook computers

New proposed criteria cluster	Proposed allocation of sub-criteria
1 Energy consumption	Criterion 1.1 – Energy savings
	Criterion 1.2 – Power management
	Criterion 1.3 – Internal power supplies
2 Environmentally hazardous substances	Criterion 2 – Hazardous substances in computers
3 Life time extension	Criterion 3.1 – Expansion facilities
	Criterion 3.2 – Lifetime of batteries
	Criterion 3.3 – HDD reliability
	Criterion 3.4 – Notebook durability testing
	Criterion 3.5 – Upgradeability and repairability
	Criterion 3.6 – Data deletion enabling second-hand usage
4 End-of-life management: Design and material selection	Criterion 4.1 – Material selection and material information
	Criterion 4.2 – Design for disassembly and recycling
	Criterion 4.3 – Packaging
5 Corporate production / supply chain management	Criterion 5.1 – Labour conditions during manufacture
	Criterion 5.2 – Use of “conflict-free minerals” during production
6 Further criteria	Criterion 6.1 – Noise
	Criterion 6.2 – Ergonomics
	Criterion 6.3 – Emission of fluorinated GHG during LCD production
7 Information	Criterion 7.1 – User instructions
	Criterion 7.2 – Information appearing on the Ecolabel

The following sections and criteria proposals follow the revised schema and criteria clusters in Table 2. Note: The final numeration of the single criteria could change in the course of discussions with stakeholders and the final decisions on the criteria.

2. PRODUCT GROUP DEFINITION

Present scope, Decisions 2011/337 and 2011/330
The product group 'personal computers' shall comprise: desktop computers, integrated desktop computers, thin clients, displays and keyboards (as a stand-alone item) as defined in Article 2. Notebook computers, small-scale servers, workstations, gaming consoles and digital picture frames shall not be considered personal computers for the purpose of this Decision.
1. The product group 'notebook computers' shall comprise devices which have the following characteristics: (a) They perform logical operations and process data and are designed specifically for portability and to be operated for extended periods of time either with or without a direct connection to an AC power source; (b) They utilise an integrated computer display and are capable of operation off an integrated battery or other portable power source. If a notebook computer is delivered with an external power supply this power supply is considered part of the notebook computer. 2. For the purpose of this Decision, tablet personal computers, which may use touch-sensitive screens along with or instead of other input devices shall be considered notebook computers. 3. Digital picture frames shall not be considered notebook computers for the purpose of this Decision.

Major proposed changes (first proposal)

Proposed scope (first proposal)
The product group 'computers' shall comprise: desktop computers, integrated desktop computers, notebook computers and tablet computers, thin clients, workstations, and small-scale servers. Gaming consoles and digital picture frames shall not be considered computers for the purpose of this Decision.

- The so far separate EU ecolabel criteria documents for personal computers and notebook computers to be subsumed under one criteria document 'computers'.
- External computer displays are proposed to be excluded from the revised scope of the EU ecolabel for computers and moved towards the revised scope of the Ecolabel criteria for "Electronic Displays", subsuming television sets, television monitors and external computer displays.
- Keyboards (as stand-alone item) are proposed to be excluded from the scope due to their minor relevance in comparison to the other product sub-categories.
- Workstations and small-scale servers are proposed to be included in the revised scope.

For more details cf. Task 1 report ("Scope and Definitions").

Stakeholder feedback on product scope and definition

At the first AHWG meeting, Competent Bodies did not appear to see a problem with the separation of the computer and display criteria. In the case that the two are sold as a bundle then reference shall be made to the display criteria document.

The general view of the discussion at the AHWG meeting was that the scope should not be narrowed, but should be aligned with Energy Star. GPP is significant for computer *and* display products. The implications of dividing those subcategories into two different Ecolabel criteria sets for the GPP criteria set 'Office IT equipment' should be clarified.

Written feedback from one stakeholder following the AHWG meeting further explained that basic keyboards are not exceptional for the functioning of a specific computer and are often exchanged for more functionality keyboards (not so with a delivered external power supply). Criteria for a keyboard should be more extensive in ergonomic design and not only cover environmental criteria. Therefore a keyboard should have a separate criteria document and have the eco label on the marking label of the keyboard since it will likely in its product life become separated from the computer.

Another MS stakeholder gave feedback that the proposed harmonization of the scope with Energy Star is welcomed and the fact that stand-alone keyboards will be out of the scope would be an acceptable consequence.

Second proposal for the product scope of the EU Ecolabel

It is recommended to maintain the first proposal for the revised scope.

Proposed scope (second proposal)
The product group ‘computers’ shall comprise: desktop computers, integrated desktop computers, notebook computers, tablet computers, thin clients, workstations, and small-scale servers. Gaming consoles and digital picture frames shall not be considered computers for the purpose of this Decision.

Third proposal for the product scope of the EU Ecolabel

With the introduction of Energy Star v6.1 new definitions have been introduced for tablets, two-in-one notebook computers and portable all-in-one computers. It is

therefore proposed to update the scope with these new products and their associated definitions.

The broad scope of product form factors now proposed suggests also that the product group might more appropriately described as *'stationary and portable computers'*. From a practical point of view this would better reflect the range of products which could be licensed.

3. CURRENT ECOLABEL CRITERIA AND PROPOSED CHANGES

3.1 Cluster 1 – Energy Consumption

3.1.1 Criterion 1.1 – Energy savings

Present criteria, Decisions 2011/337 and 2011/330
(a) Energy savings for desktop computers, integrated desktop computers and thin clients The energy efficiency performance of desktop and integrated desktop computers shall exceed the appropriate category energy efficiency requirements set out in the Agreement as amended by Energy Star v5.0 by at least the following: - category A: 40 %, - category B: 25 %, - category C: 25 %, - category D: 30 %. The energy efficiency performance of thin clients shall meet at least the energy efficiency requirements for thin clients set out by Energy Star v5.0. Capability adjustments allowed under the Agreement as amended by Energy Star v5.0 may be applied at the same level, except in the case of discrete graphics processing units (GPUs) where no additional allowance shall be given. *(b) Energy savings for computer displays* The computer display's energy efficiency performance in active mode shall exceed the energy efficiency requirements set out in Energy Star v5.0 by at least 30%; computer display sleep mode power must not exceed 1 W; computer displays shall have an energy consumption in on-mode of ≤ 100 W measured when set to maximum brightness; computer monitor off mode power shall not exceed 0.5 W. *Assessment and verification*: The applicant shall declare compliance of the product with these requirements to the competent body.
Energy savings for notebook computers The energy efficiency performance of notebook computers shall exceed the appropriate category energy efficiency requirements set out in the Agreement as amended by Energy Star v5.0 by at least: category A: 25%; category B: 25%; category C: 15%. Capability adjustments allowed under the Agreement as amended by Energy Star v5.0 may be applied at the same level, except in the case of discrete graphics processing units (GPUs) where no additional allowance shall be given. *Assessment and verification*: The applicant shall declare compliance of the product with these requirements to the competent body.

3.1.1.1 Major proposed changes (First proposal)

Proposed revised criteria (first proposal)
The energy-efficiency performance of computers shall meet the appropriate energy-efficiency requirements set out in the Agreement as amended by Energy Star v6.0. Tablet computers shall be exempted from energy savings requirements. *Assessment and verification*: The applicant shall declare compliance of the product with these requirements to the competent body.

- The criteria for energy savings are proposed to be aligned to the Energy Star program requirements for computers, version 6.0 which will be effective from 28 April 2014.
- The differences compared to Energy Star (exclusion of additional allowances for discrete graphics processing units (GPUs)) have been removed.
- As tablet PCs (slate computers) are not covered by Energy Star v6.0 (they are expected to be included in the next version of Energy Star) and as this product sub-group does not consume much electricity (estimated being around 4 kWh per year) it is proposed to exempt tablet PCs from the requirements on energy savings.

For more details cf. Task 4 report “Improvement Potential”, section 4.2.1.1 “energy efficiency”.

Consultation questions
• Should the criterion on energy savings include a dynamic approach in order to better react to market developments with regard to energy efficiency gains? 1. Variant: “The energy-efficiency performance of computers shall meet the appropriate energy-efficiency requirements set out in the Agreement as amended by the most recently published Energy Star standard for computers on the date of application.” 2. Variant: No later than 2 years after the criteria for EU Ecolabel for Computers have entered into force, the Commission shall evaluate the market penetration of Computers meeting the criterion on "energy efficiency requirement of Energy Star V6.0" and, if justified, present to the EUEB and Regulatory Committee an amendment of this criterion. 3. Variant: “The energy-efficiency performance of computers shall meet and exceed the appropriate energy-efficiency requirements set out in the Agreement as amended by Energy Star v6.0 as follows: 1. One year from the date of adoption of the Decision: 5-10% (tbd) 2. Two years from the date of adoption of the Decision: 10-20% (tbd)”

3.1.1.2 Stakeholder feedback and further evidence

<u>Dynamic approach:</u>

- According to the discussion at the first AHGW meeting, there was general support to **align the criteria with Energy Star v6.0 but on a dynamic basis**. An analysis of the market is required to support the criteria proposal. One has to consider that the revised criteria will not come into force until, at the very earliest, summer 2015. It is difficult to foresee how products will have developed

by then. In general above proposed Options 1 and 2 were considered to be the most favoured. However, in the case of Option 1 there is no clear schedule for when Energy Star revisions will take place, so in the meantime the market share of compliant models may rise to a significant market share. The ability to extend the validity of licenses will be important. It was clarified that license holders can submit new information in order to comply with revised criteria requirements. Further, DG Environment confirmed that the criteria must refer to a specific version of Energy Star, so that Option 1 referring to each the "most recently published Energy Star" is not feasible from a legal position. This also implies that for a dynamic approach the likelihood of future ECom support for Energy Star revisions needs to be taken into account.

- Written stakeholder feedback following the first AHWG meeting recommended on the one hand that criteria state that the product shall be 3rd party approved in accordance to the most recent version of Energy Star energy efficiency criteria; on the other hand, **Variant 2** was in favour. It was proposed that based upon up-to-date market data during the further discussion process, it shall be reassessed if Energy Star v6.0 can serve as an ambitious starting point when the EU ecolabel enters into force probably in summer 2015 (approximately 1 ½ years after applying Energy Star version 6.0).

Further research and evidence

- Comparing the **Base Allowances for the Typical Energy Consumption (TEC_{BASE})** of Desktop and Notebook computers within the current and upcoming Energy Star and Ecodesign versions (cf. Figure 3.1 and Figure 3.2), it can be seen that Energy Star version 6.0 currently has the lowest base allowances in all product sub-categories[3]. So from today's point of view, basing the energy criteria for the EU Ecolabel on Energy Star version 6.0 seems

[3] Please note that Energy Star Version 6.0 introduces new definitions of sub-categories, thus the products subsumed are not directly comparable. Nevertheless, the maximum TEC allowances provide an indicative comparison.

appropriate and is going beyond legally binding Ecodesign requirements starting from 2016.

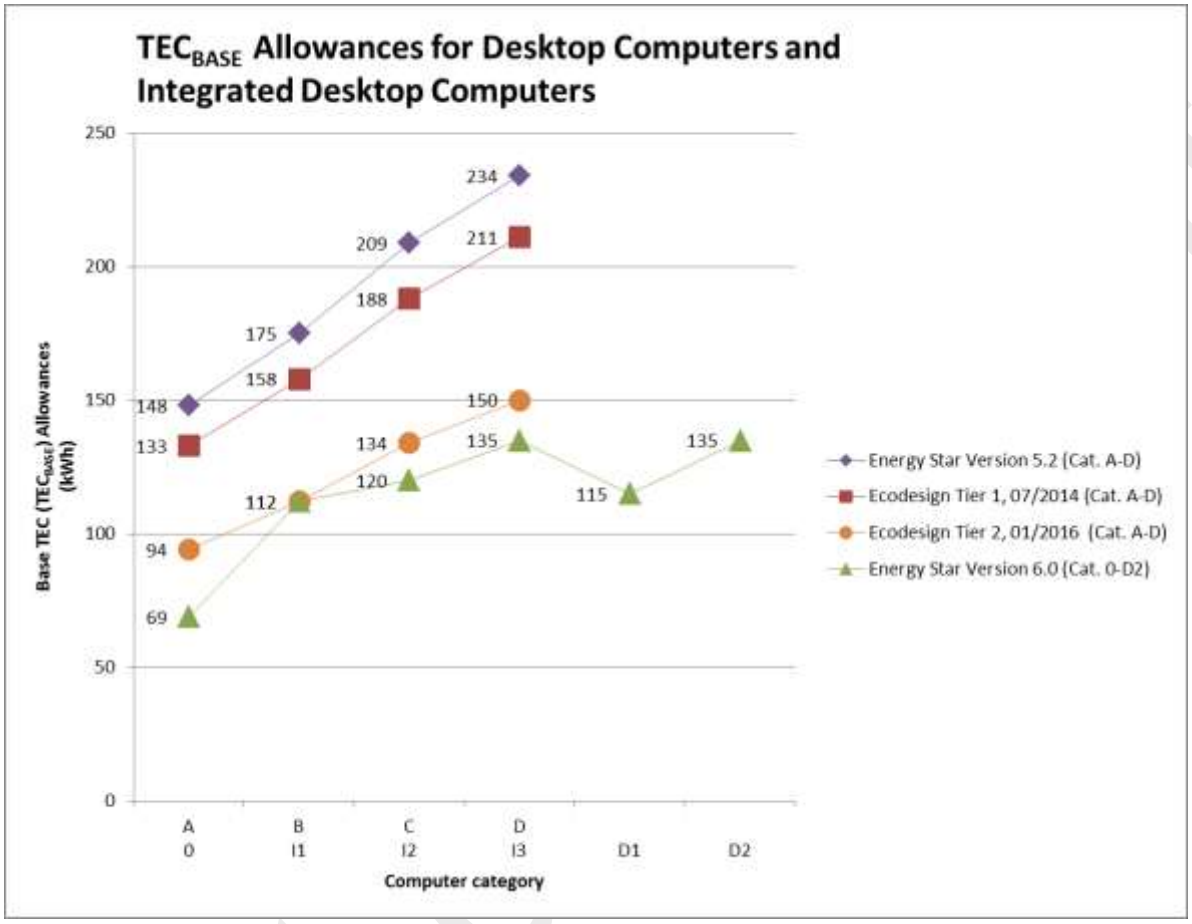


Figure 3.1 : Comparison of TEC_{BASE} Allowances of Energy Star versions 5.2 and 6.0 with Ecodesign Tier 1 and Tier 2 for Desktop and Integrated Desktop Computers

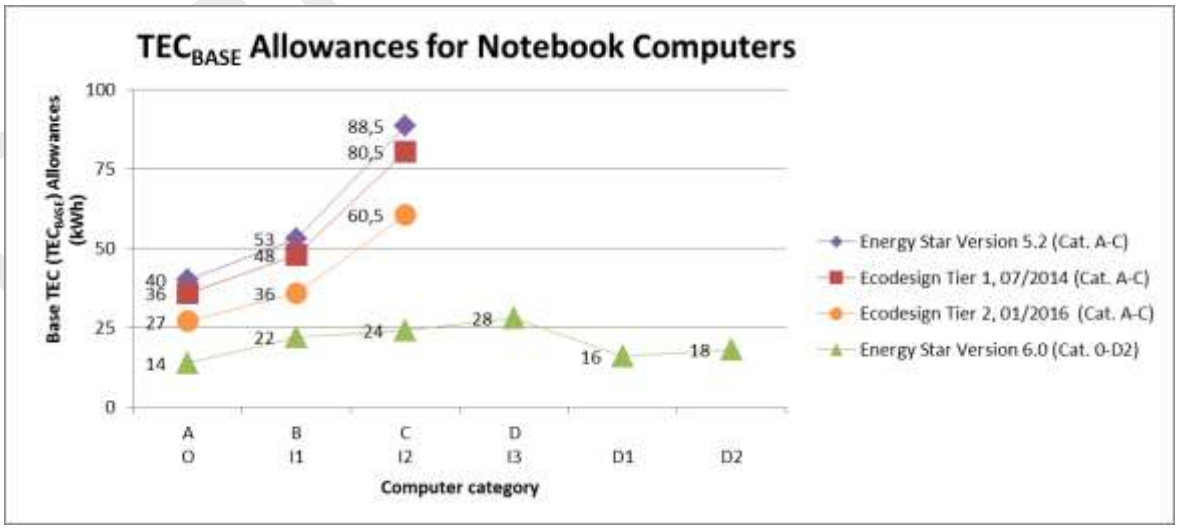


Figure 3.2: Comparison of TEC_{BASE} Allowances of Energy Star versions 5.2 and 6.0 with Ecodesign Tier 1 and Tier 2 for Notebook Computers

Allowances for discrete graphics processing units (GPUs):

According to written stakeholder feedback, allowances for discrete graphic adders can sometimes be huge and represent as much as the core consumption of the computer. Thus it is required to keep the existing sub-criterion not giving any allowance for discrete GPU. If this would not be supported, other options suggested:

- Leave the allowances for graphic adders as recommended in the draft criteria proposal, but set a maximum to the total amount of allowances (to make sure a highly consuming gaming PC with several graphic cards cannot get the Ecolabel). This maximum is proposed to be set at 90 W for Desktop PCs and 33 W for Notebook PCs. This would correspond to the allowance for one single G6 adder in Ecodesign Tier 2016 and be a similar approach to the power cap for the TV Ecolabel.
- Allow discrete graphic adders only if they are switchable or highly scalable (i.e. they are nearly consuming zero when the computer does not need them).

Further research and evidence

Discrete graphics are used for high performance professional and consumer applications (HD video, video gaming, 3D etc.) providing better picture quality and speed compared to **integrated graphics**, where the GPU is attached to or integrated into the computer's motherboard sharing resources with the central processing unit and system memory. Those are typically less powerful and slower, being sufficient for basic office applications, web browsing etc.

Switchable graphics provide a functionality that allows Discrete Graphics to be disabled when not required in favour of Integrated Graphics**.** For example[4], switchable graphics are designed to switch the graphics operation between integrated graphics and discrete graphics without rebooting the notebook allowing

[4] Source: http://www.amd.com/us/products/technologies/switchable-graphics/Pages/switchable-graphics.aspx

the discrete card to be used for graphics intensive applications when under AC power (plugged into the power socket) and the integrated graphics to be used in battery mode, requiring less energy to operate and yielding improved battery life.

Figure 3.3 and Figure 3.4 provide a comparison of maximum allowances regarding the Typical Energy Consumption for graphics ($TEC_{GRAPHIC}$) of Desktop and Notebook computers within the current and upcoming Energy Star and Ecodesign versions. It can be seen that Energy Star version 6.0 is nearly in line with Ecodesign Tier 1 starting from 1 July 2014 for the product sub-categories G1 to G3, i.e. rather not exceeding the legal requirements, whereas it is slightly stricter for the categories G4 to G7. Taking into account that the Ecolabel criteria will be implemented not before summer 2015, it is proposed to already align the allowances for discrete graphics cards of the EU Ecolabel to the values of Ecodesign Tier 2 thus preventing the Ecolabel falling back behind legally binding requirements from 1 January 2016.

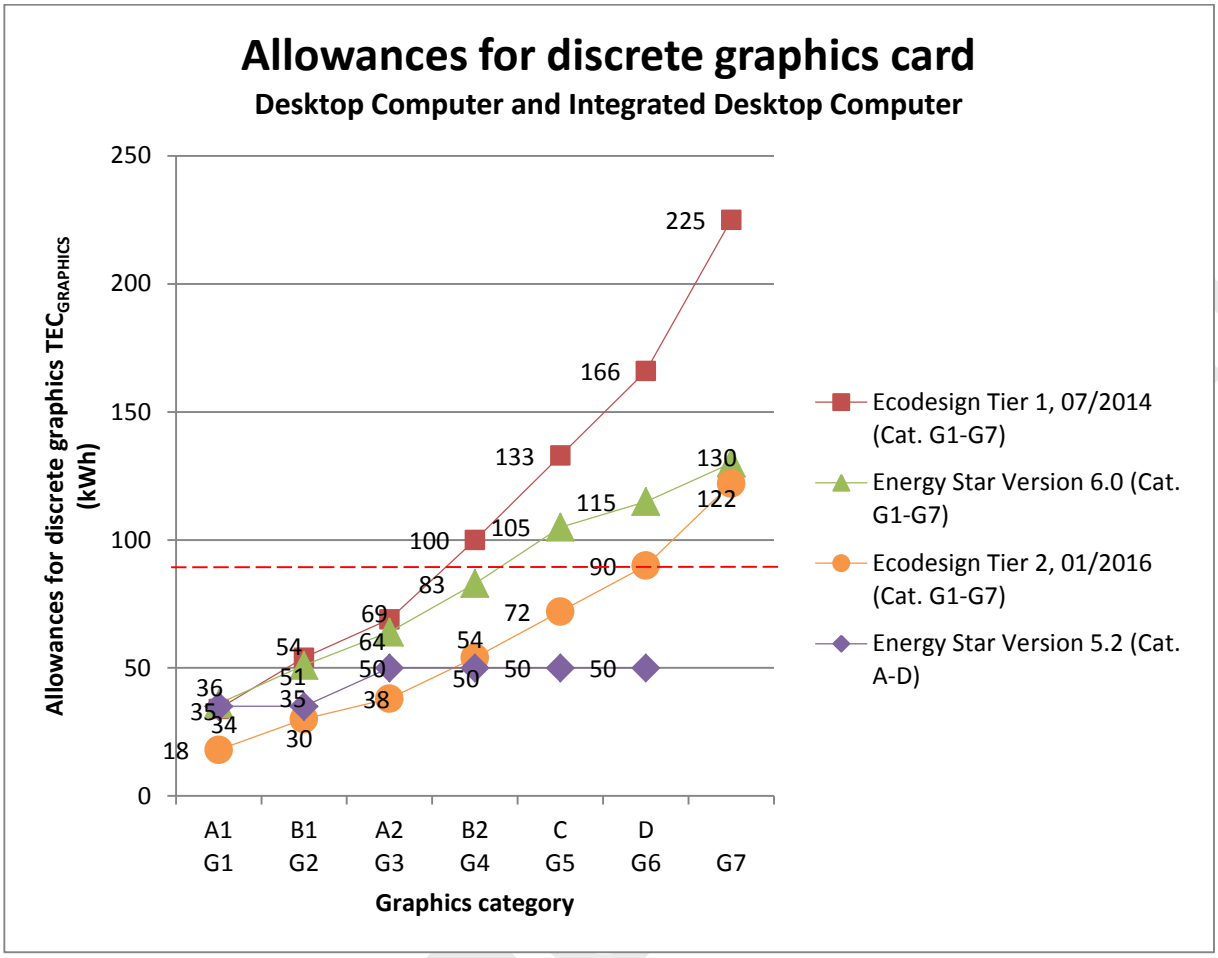


Figure 3.3: Comparison of $TEC_{GRAPHIC}$ Allowances of Energy Star versions 5.2 and 6.0 with Ecodesign Tier 1 and Tier 2 for Desktop and Integrated Desktop Computers

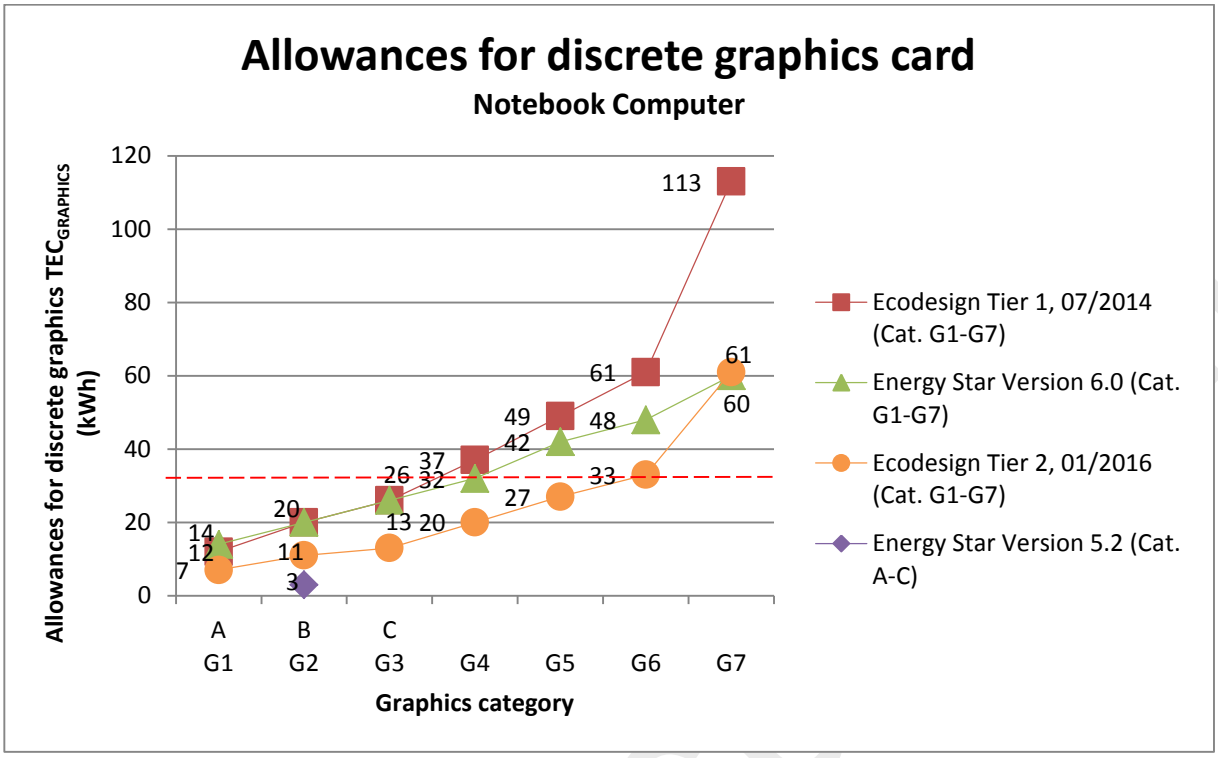


Figure 3.4: Comparison of $TEC_{GRAPHIC}$ Allowances of Energy Star versions 5.2 and 6.0 with Ecodesign Tier 1 and Tier 2 for Notebook Computers

- **Verification**: A number of stakeholders expressed a strong preference for a test report to verify performance with the energy savings criteria.
- It is proposed to provide clear communicable criteria for this product group: Standby energy use = 0.0 Watt in full-charged and non-charge mode (even if left in plug!); Zero-charging, even if plugged, becomes more and more normal. And even only 0.2 Watt standby count up when plugged in for 24 hours in 100 million homes.

3.1.1.3 Second proposal for energy savings criteria

Proposed revised criteria (second proposal)
Energy savings The energy efficiency performance of computers shall meet the appropriate energy-efficiency requirements set out in the Agreement as amended by Energy Star v6.0. Capability adjustments allowed under the Agreement as amended by Energy Star v6.0 may be applied at the same level, except in the case of discrete graphics processing units (GPUs) where maximum additional allowance shall be given to • Desktop Computers: 90 W; • Notebook Computers: 33 W. Tablet computers shall be exempted from energy savings requirements. *Assessment and verification*: The computer must be tested according to the Energy Star v6.0 test methods for computers and the test report shall be submitted to the competent body with the application. *Note*: No later than 2 years after the criteria for EU Ecolabel for Computers have entered into force, the Commission shall evaluate the market penetration of Computers meeting the criterion on "energy efficiency requirement of Energy Star v6.0" and, if justified, present to the EUEB and Regulatory Committee an amendment of this criterion.

Major proposed changes:

- The criteria for energy savings are aligned to the Energy Star program requirements for computers, version 6.0 which will be effective from 28 April 2014.
- According to stakeholder feedback, maximum values for additional allowances for discrete graphics processing units (GPUs)) are proposed as allowances for discrete graphic adders sometimes represent as much as the core consumption of the computer. By setting this maximum allowances, highly energy consuming gaming PCs with several graphic cards (graphics categories G5-G7) will be excluded from getting the EU Ecolabel – comparable to the current EU Ecolabel power cap for very large TVs.
- A dynamic approach to the energy criteria has been included to provide the possibility to adjust and tighten them during the validity period of the EU Ecolabel in the face of a fast developing market.
- The assessment and verification has been changed from self-declaration to submission of a test protocol.

3.1.1.4 Stakeholder feedback and further evidence

Summary of stakeholder feedback
There was general support for the approach of harmonising with Energy Star v.6.0 as well as a commitment to review the criteria within a 2 year time frame. Based on concerns that the market can move very fast some stakeholders did, however, propose a performance requirement 10-20% better than Energy Star v6.0 either in the Decision or in a stepwise approach in 2 years and 4 years, or if the market share of Energy Star exceeds 30% the performance improvement shall be xy%. The actual date that v.6.0 enters into force should be checked – it was understood that there has been a delay. It was queried by a manufacturer how the new generation of detachable devices fitted within the product definitions. A product may be a hybrid of a notebook and a tablet. This is not dealt with under Energy Star v.6.0. A tablet may also have a higher energy consumption, but they are currently proposed to be excluded from the criterion. It was queried whether tablets were excluded because they are not addressed under Energy Star or because of their energy consumption. The scope of different forms of tablets that may be procured and variabilities in energy consumption may require further consideration. For example, Panasonic's tablets have high-end performance. It was proposed that the tablet requirements be revised if new requirements are brought in under Energy Star. There were differing views on the cap on allowances for graphics capabilities. On one hand a stakeholder felt that these should reflect Ecodesign Tier 2 (effective from 2016) and the criterion wording should explicitly state that *'allowances for discrete graphics processing units (GPUs)…shall meet the levels applicable from 1 January 2016 in Regulation EU 617/2013'* and set an overall cap. On the other hand there was felt to be the need to better define graphics processors that are increasingly integrated with the CPU. It was highlighted by a manufacturer that only a small proportion of discrete GPU's in portable devices are not switchable

i.e. they consume no additional energy whilst the capability is not required. This is to preserve battery power in the case of notebooks. Certain applications such as video editing may require additional capabilities.

Entry into force of Energy Star v6.0

The v6.0 revision of Energy Star came into effect in the USA from the 2nd June 2014. This revision was to have been adopted in the EU but it has now been decided to adopt the v6.1 which includes some updates to the scope which are of significance to the ecolabel. There is no definitive time estimate for adoption, but it is understood that the EU Energy Star Board will make a decision before the end of 2014. Moving directly to v6.1 would be of benefit to the ecolabel because its scope includes tablets, hybrid notebooks and, a new product form factor to have emerged, portable all-in-one computers.

Setting of a requirement stricter than Energy Star v6.0

Energy Star is intended to reflect the most efficient 20-25% of computer models on the market. The criteria were devised based on a database of models compiled in 2011/12 so it is inevitable that there may have been changes in performance in the market since then. This suggests that sub-criteria can be used to make the ecolabel criteria as a whole future proof by addressing significant or growing proportions of a computers' energy demand in the $E_{TEC\text{-}MAX}$ calculations.

Reviewing the formulae and allowances, as well as the example calculations provided by the US EPA, it can be seen that the most significant influences on the $E_{TEC\text{-}MAX}$ threshold are:

- Graphics capability, with discrete graphics units being able to qualify for the $TEC_{GRAPHICS}$ allowance that may be greater than the TEC_{BASE} allowance;
- Enhanced Performance Displays, which qualify for the $TEC_{INT\_DISPLAY}$ allowance which, depending on screen size and resolution, can be at least 30-75% greater.

Moreover, a recent market survey showed that the manufacturers quickly respond to new Energy Star revisions. This suggests that, following the precedent set by Imaging equipment, and because the criteria must refer to an Energy Star version, a review of market penetration shall be proposed after a minimum of two years.

Addressing high performance tablets and hybrid devices

As already noted Energy Star v6.1 includes within its scope tablets (also referred to as slates) and hybrid tablet/notebooks (referred to as two-in-one notebooks). The following definitions are provided:

> *Slate/Tablet: A computing device designed for portability that meets all of the following criteria:*
>
> *a) Includes an integrated display with a diagonal size greater than 6.5 inches and less than 17.4 inches;*
>
> *b) Lacking an integrated, physical attached keyboard in its as-shipped configuration;*
>
> *c) Includes and primarily relies on touchscreen input; (with optional keyboard);*
>
> *d) Includes and primarily relies on a wireless network connection (e.g., Wi-Fi, 3G, etc.); and*
>
> *e) Includes and is primarily powered by an internal battery (with connection to the mains for battery charging, not primary powering of the device).*
>
> *Two-In-One Notebook: A computer which resembles a traditional Notebook Computer with a clam shell form factor, but has a detachable display which can act as an independent Slate/Tablet when disconnected. The keyboard and display portions of the product must be shipped as an integrated unit. Two-In-One Notebooks are considered Notebooks in the remainder of this specification and are therefore not referenced explicitly.*

No new Total Energy Consumption (TEC) calculation method is provided for these two form factors. Instead their TEC shall be calculated using the formulae and

allowances for notebook computers. This means that more energy efficient high specification tablets, for example those with high definition displays or functioning as two-in-one notebooks, will be encouraged by the $E_{TEC-MAX}$ calculation.

Energy Star v6.1 additionally introduces a new form factor to have emerged onto the market – portable all-in-one computers. These represent a further evolution of integrated desktop computers towards touch screen functionality in place of a keyboard and limited portability provided by introducing a battery. The following definitions are provided:

> *Portable All-In-One Computer: A computing device designed for limited portability that meets all of the following criteria:*
>
> *a) Includes an integrated display with a diagonal size greater than or equal to 17.4 inches;*
>
> *b) Lacking keyboard integrated into the physical housing of the product in its as-shipped configuration;*
>
> *c) Includes and primarily relies on touchscreen input; (with optional keyboard);*
>
> *d) Includes wireless network connection (e.g. Wi-Fi, 3G, etc.); and*
>
> *e) Includes an internal battery, but is primarily powered by connection to the ac mains.*

The TEC for this form factor shall be calculated using the formulae and allowances for integrated desktop computers.

Restricting the energy use associated with graphics capabilities

Graphics capability is the most significant influence within the overall E_{TEC_MAX} calculation that sets the qualifying energy benchmark for each computer. The energy use associated with graphics capabilities is accounted for in two elements of the E_{TEC_MAX} formula – the TEC_{BASE} and $TEC_{GRAPHICS}$ allowances.

The TEC_{BASE} allowance may be between 57% and 96% higher for desktops and integrated desktops and between 14% and 100% higher for notebooks. A further $TEC_{GRAPHICS}$ allowance may then provide a further uplift of between 52% and 188%

for desktops and integrated desktop and between 100% and 429% for notebooks. The graphics capabilities categories G1-G7 are understood to reflect segments of the market, as illustrated by the Information Technology Industry Council (ITI) in the USA [5]. This reflects stakeholder comments that a users' requirement will depend on what they are using the computer for, which could encompass 'mainstream' consumer (e.g. gaming) and 'high-end' professional use (e.g. video editing).

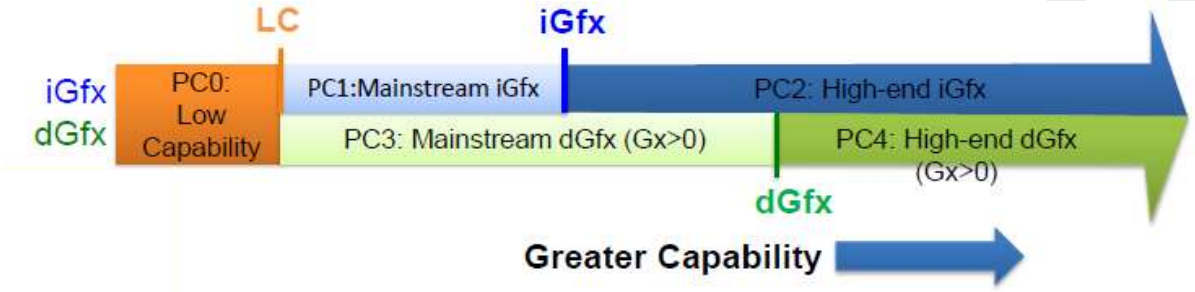


Figure 3.5. ITI proposal for graphics allowances based on performance classes

Source: ITI (2013)

A comparison was made in Figure 3.3 and Figure 3.4 between the additional Energy Star v6.1 $TEC_{GRAPHICS}$ allowance and the capability adjustments required under Ecodesign Regulation No 617/2013 [6] to be implemented by all computers sold in the EU market from January 2016. This showed that the legal minimum for the first graphics card installed will be stricter than Energy Star.

Some caution is needed in making a direct comparison between Energy Star and Ecodesign because of differences in the $TEC_{BASE,}$ which for Energy Star v6.1 is lower. Nonetheless the Ecodesign requirements highlight differing assumptions on performance of discrete graphics units available on the market. Also noteworthy is that Category D desktops and Category C notebooks with G7 graphics capabilities are exempted from the annual total energy consumption requirements in the Regulation – reflecting the 'high end' user requirements in Figure 3.5.

[5] Presentation at an Energy Star v6.0 webinar, 23rd May 2012, http://www.energystar.gov/products/spec/computer_specification_version_6_0_pd

[6] Commission Regulation (EU) No 617/2013 of 26 June 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to *ecodesign requirements for computers and computer servers*

A study carried out in 2012 by CLASP and NRDC in the USA looked at the impact of graphics cards on desktop energy consumption [7]. Tests were carried out in order to compare the additional energy consumption of graphics cards. Whilst a modified test method and a relatively small sample was used the findings and recommendations are still of relevant to the ecolabel because they provide useful market insight.

The study suggests that for high end (G6 and G7 capabilities) energy consumption related to the unit can vary considerably and does not always increase in function of the capability. Moreover, mainstream manufacturers such as AMD and NVIDIA are bringing forward units that demonstrate a significant improvement in performance over the Energy Star v6.1 allowances. This is reflected in the recommendations for the 10th and 20th percentile in Table 3, which are notable for the lower G6 and G7 allowances.

Table 3. CLASP/NRDC recommended Energy Star v6.0 target adder levels for desktops

dGfx category (Gigabytes/second) [1]	TEC Allowance (kWh/year)	
	20th percentile	10th percentile
G1 (≤16)	32	30
G2 (16<FB_BW≤32)	40	37
G3 (32<FB_BW≤64)	51	47
G4 (64<FB_BW≤96)	67	62
G5 (96<FB_BW≤128)	82	76
G6 (FB_BW>128) with data width <192 bit)	82	76
G7 (FB_BW>128) with data width ≥192 bit)	97	90

Notes:

1. Categories are defined according to the frame buffer bandwidth in gigabytes per second (GB/s)

[7] CLASP and NRDC, *The impact of graphics cards on desktop computer energy consumption*, September 2012.

3.1.1.5 Third proposal for energy savings criteria

Proposed revised criteria (proposal v3)
1(a) Total energy consumption of the computer The total energy consumption of computers shall meet the appropriate energy-efficiency requirements set out in the Agreement as amended by Energy Star v6.1. Capability adjustments allowed under the Agreement 8 as amended by Energy Star v6.1 may be applied at the same level, with the exception of: • Discrete Graphics Processing Units (GPUs): See sub-criterion 1(c); • Internal power suppliers: See sub-criterion 1(d) • Enhanced-performance integrated displays: See sub-criterion 1(e); Assessment and verification: The applicant shall submit a test report for the computer model(s) carried out according to the Energy Star v6.1 test methods for computers which are specified in the Eligibility Criteria.

Summary rationale for the proposed changes

- Energy Star v6.1 will be adopted in the EU instead of v6.0. This is likely to take place in beginning to mid 2015. The proposal has therefore been revised to align with Energy Star v6.1.
- Discrete graphics units, category D desktops and category C notebooks are associated with higher energy useage, but it should be recognised that they may be required for some high-end uses.
- The initial proposal of a cap on discrete graphics units has therefore been revised to provide $TEC_{GRAPHICS}$ allowances for all unit capabilities. These have been mostly aligned with the Ecodesign capability adjustments that will come into force in 2016, with the exception of G6 and G7, which are proposed to reflect recommendations made in to US Energy Star by CLASP/NRDC. These reflect the market potential for much more energy efficient units.
- For the purpose of this ecolabel criterion the Ecodesign exemption from graphics capability adjustments for Category D desktops and Category C

[8] Regulation (EC) No 106/2008 of 15 January 2008 on *a Community energy-efficiency labelling programme for office equipment*

notebooks will not be permitted so as to encourage the most efficient products.

3.1.2 Criterion 1.2 – Power management

Present criteria, Decisions 2011/337 and 2011/330
The computer shall comply with the following power management requirements ([1]): (a) Power management requirements Personal computers shall be shipped with the power management system enabled at the time of delivery to the customers. Power management settings shall be: (i) 10 minutes to screen off (display sleep); (ii) 30 minutes to computer sleep (system level S3, suspended to RAM) ([2]). (b) Network requirements for power management (i) Personal computers with Ethernet capability shall have the ability to enable and disable wake on LAN (WOL) for sleep mode. (c) Network requirements for power management (applies to personal computers shipped through enterprise channels only) (i) Personal computers with Ethernet capability must meet one of the following requirements ([3]): — be shipped with WOL enabled from the sleep mode when operating on AC power, or — provide control to enable WOL that is sufficiently accessible from both the client operating system user interface and over the network if computer is shipped to enterprise without WOL enabled. (ii) Personal computers with Ethernet capability shall be capable of both remote (via network) and scheduled wake events from sleep mode (e.g. real time clock). Manufacturers shall ensure, where the manufacturer has control (i.e. configured through hardware settings rather than software settings), that these settings can be managed centrally, as the client wishes, with tools provided by the manufacturer. *Assessment and verification*: The applicant shall provide the competent body with a declaration to certify that the computer has been shipped in the power management settings stated above or better. ([1]) As defined in Energy Star v5.0 except for display sleep requirement. ([2]) Not applicable to Thin Clients. ([3]) Thin clients — only applies if software updates from the centrally managed network are conducted while the unit is in sleep or off mode. Thin clients whose standard framework for upgrading client software does not require off-hours scheduling are exempt from the requirement.
Notebook computers shall comply with power management requirements ([1]) as follows: (a) Power management requirements Notebook computers shall be shipped with the power management system enabled at the time of delivery to the customers. Power management settings shall be: (i) 10 minutes to screen off (display sleep); (ii) 30 minutes to computer sleep (system level S3, suspended to RAM). (b) Network requirements for power management (i) Notebook computers with Ethernet capability shall have the ability to enable and disable Wake on LAN (WOL) for sleep mode. (c) Network requirements for power management (applies to notebook computers shipped through enterprise channels only) (i) Notebook computers with Ethernet capability shall meet one of the following requirements: — be shipped with Wake On LAN enabled from the sleep mode when operating on AC power,

Present criteria, Decisions 2011/337 and 2011/330
or — provide control to enable WOL that is sufficiently-accessible from both the client operating system user interface and over the network if notebook computer is shipped to enterprise without WOL enabled. (ii) Notebook computers with Ethernet capability shall be capable of both remote (via network) and scheduled wake events from Sleep mode (e.g. Real Time Clock). Manufacturers shall ensure, where the manufacturer has control (i.e. configured through hardware settings rather than software settings), that these settings can be managed centrally, as the client wishes, with tools provided by the manufacturer. *Assessment and verification*: the applicant shall provide the competent body with a declaration to certify that the computer has been shipped in the power management settings stated above or better. ([1]) As defined in Energy Star v5.0 except for display sleep requirement.

3.1.2.1 Major proposed changes (first proposal)

Proposed revised criteria (first proposal)
Computers shall comply with power management requirements as defined in Energy Star v6.0 except for display sleep requirement. Display sleep: Power management settings for display sleep shall be 10 minutes to screen off. Tablet computers shall be exempted from power management requirements. *Assessment and verification*: the applicant shall provide the competent body with a declaration to certify that the computer has been shipped in the power management settings stated above or better.

- The criteria for power management are proposed to be aligned to the forthcoming new Energy Star program requirements for computers, version 6.0 which shall be effective from 2 June 2014.
- As tablet PCs (slate computers) are not covered by Energy Star v6.0 and as this product sub-group does not consume much electricity (estimated at around 4 kWh/year) it is proposed to exempt tablet PCs from the requirements on power management.

For more details cf. Task 4 report “Improvement Potential”, section 4.2.1.2 “power management”.

Consultation questions
• Should the current, stricter power management settings for display sleep (after 10 minutes instead of 15 minutes as required by Energy Star) be kept in the revised criteria? • Are there any additional software solutions that can be pre-installed/promoted that provide more advanced guidance on power management for users, particularly for notebook users?

3.1.2.2 Stakeholder feedback and further evidence

According to the discussion at the first AHWG meeting, it was questioned what the benefit will be of moving from shipping a product with 10 minutes instead of 15 minutes to sleep mode. On the other hand, *less* than 10 minutes could lead people to switching off the sleep mode at all. A complete harmonization with Energy Star is suggested.

Further research / evidence

The Ecodesign Regulation 617/2013 for computers and computer servers legally requires from 1 July 2014 that "the computer shall be placed on the market with the display sleep mode set to activate within 10 minutes of user inactivity".

According to written stakeholder feedback, it is proposed to include a criterion stating that a screen saver should not be enabled by default; currently, the effect that screen savers result in greater energy use is only addressed within the criterion on user information (c. section 3.7.1).

3.1.2.3 Second proposal for power management criteria

Proposed revised criteria (second proposal)
Power management Computers shall comply with power management requirements as defined in Energy Star v6.0. Tablet computers shall be exempted from power management requirements. *Assessment and verification*: The computer must be tested according to the Energy Star v6.0 test methods for computers and the test report shall be submitted to the competent body with the application.

Major proposed changes

- As the requirements for display sleep mode being activated after 10 minutes of user inactivity are becoming legally binding by the Ecodesign regulation starting from 1 July 2014, this exemption from the power management requirements of Energy Star v6.0 will be kept indirectly in the EU Ecolabel criteria.
- The assessment and verification has been changed from self-declaration to submission of a test protocol.

3.1.2.4 Stakeholder feedback and further evidence

Summary of stakeholder feedback
A stakeholder emphasised that in addition to meeting Energy Star requirements it is important that sleep mode is more difficult to disable. It was proposed that a message be displayed to the user when software is using additional energy as a result of graphics requirements. A proposal was made that the requirements are 40% more ambitious than Ecodesign by specifying a sleep mode requirements of 3 Watts (desktop) and 1.8 Watts (notebooks).

3.1.2.5 Third proposal for power management criteria

Proposed revised criteria (proposal v3)
1(b) Power management Whenever the user or a software attempts to deactivate the default power management settings, a warning message shall be displayed communicating to the user that an energy saving setting will be disabled and giving the option to retain the setting. ***Assessment and verification:*** The applicant shall provide the description of the power management settings that appears in the model's user manual, accompanied by screen shots of example instances when warning messages are displayed.

Summary rationale for the proposed changes

- The incorporation of power management system requirements into Energy Star v6.0/6.1, together with the stricter power demand requirements of Ecodesign, suggests that the focus for more ambitious sub-criterion relating to TEC allowances should be on energy in use.
- Reflecting how the best pre-installed power management software works it is proposed to include a requirement that the user is informed if they attempt to disable a power management function.

3.1.3 Criterion 1.3 – Internal power supplies

Present criteria, Decisions 2011/337 and 2011/330
Internal power supplies shall meet at least the energy efficiency requirements for internal power supplies set out by Energy Star v5.0. *Assessment and verification*: The applicant shall declare the compliance of the product with these requirements to the competent body.

3.1.3.1 Major proposed changes (first proposal)

Proposed revised criteria (first proposal)
Internal power supplies of desktop PCs, integrated desktop PCs, desktop-thin clients, workstations and small-scale server shall meet at least the energy efficiency requirements of (a) 88% efficiency at 50% of rated output power; (b) 85% efficiency at 20% and 100% of rated output power; (c) Power factor = 0.9 at 100% of rated output power. Internal power supplies with a maximum rated output power of less than 75W are exempted from the power factor requirement. *Assessment and verification*: The applicant shall declare the compliance of the product with these requirements to the competent body. Additionally, a test protocol on the basis of the document "Generalized Test Protocol for Calculating the Energy Efficiency of Internal Ac-Dc and Dc-Dc Power Supplies, Revision 6.5" shall be provided to the competent body.

- The criteria for internal power supplies are proposed to exceed those of the currently developed Energy Star program requirements for computers, version 6.0 being effective from 28 April 2014. These correspond mostly to the so called 80plus-label, class bronze. For the revision, it is proposed to align the minimum requirements for internal power supplies to those of the 80plus-label, class silver, or possibly gold, as research suggests that there are a range of certified power supplies available in the market.
- The assessment and verification has been changed from self-declaration to submission of a test protocol.

For more details cf. Task 4 report "Improvement Potential", section 4.2.1.3.

3.1.3.2 Stakeholder feedback and further evidence

At the first AHWG meeting, it was noted by JRC-IPTS that external power supplies have been omitted because the current Ecodesign requirements are understood to still be the strictest on the market. Moreover, they will be revised further based on a Code-of-Conduct developed by JRC.

For internal power supplies, *according to the discussions of stakeholders at the first AHWG meeting*, the potential additional cost of 80Plus compliance power supplies (PSU) needs to be considered. Feedback was given that consumers don't look to spend money on a better power supply. The difference between models certified with silver and gold and market sales needs to be explored further. There was a general feeling that in view of the need to attract license holders it was best to focus on the energy criteria on the overall system performance of the computer.

Further written stakeholder feedback following the discussions at the AHWG meeting

- On the one hand the proposal is being supported by some stakeholders to align the minimum requirements for internal power supplies to those of the 80plus-label class gold as research as it suggests that there are a range of certified power supplies available on the market;
- On the other hand stakeholders indicated that asking for the 80plus-Label class silver or gold might be too ambitious (too early yet) and too costly for applicants. In a very cost competitive market, customers are not willing to pay more for a slightly more energy efficiency PSU, which on the product system level might only reduce the energy consumption by a few % whilst the reduced energy bill (due to the high percentage of fixed energy fees) is hardly noticeable.
- Information on the cost difference between an 80+ bronze PSU compared to PSU with silver and gold standard was provided. For example, for a 300W power supply unit, changing from 80+ bronze to the 80+ silver standard would double the cost for consumers from around 5 to around 10 US Dollars.

Table 4: Approximate pricing of Power Supply Units with different 80+ standards as of July 2013 (Source: Stakeholder input)

Efficiency Baseline APFC 68% Efficient	300 Watts Cost OEM/Consumer	460 Watts Cost OEM/Consumer	270 Watts Cost OEM/Consumer
80+ Bronze	$3.45/$5.18	$2.65/$3.98	$3.25/$4.88
80+ Silver	$6.90/$10.35	$8.22/$12.33	$6.00/$9.00
80+ Gold	$8.10/$12.15	$10.95/$16.43	$7.95/$11.93
80+ Platinum	$11.25/$16.88	$14.35/$21.53	$11.45/$17.18

Finally, written stakeholder feedback indicated that there is a more recent version of the "Generalized test protocol for calculating the Energy Efficiency of Internal Ac-Dc and Dc-Dc Power Supplies" available, Revision 6.6 as of 2 April 2012 [9].

Further research / evidence

Energy Star generally follows the so called TEC approach, calculating the maximum total energy consumption (TEC) including all specific allowances for different components, inter alia internal power supply units. This means that when requiring stricter energy efficiency for the internal PSU, on the other hand higher specific allowances for PSU apply (see Table 5).

Table 5: Power supply efficiency allowances (Source: Energy Star v6.0)

Computer type	Minimum efficiency at specified proportion of rated output current				$Allowance_{PSU}$
	10%	20%	50%	100%	
Desktop	0.81	0.85	0.88	0.85	0.015
	0.84	0.87	0.90	0.87	0.03
Integrated Desktop	0.81	0.85	0.88	0.85	0.015
	0.84	0.87	0.90	0.87	0.04

3.1.3.3 Second proposal for internal power supplies criteria

Proposed revised criteria (second proposal)
Internal Power Supplies Internal power supplies shall meet at least the energy efficiency requirements for internal power supplies set out by Energy Star v6.0. *Assessment and verification*: The applicant shall declare the compliance of the product with these requirements to the competent body. Additionally, a test protocol on the basis of the document "Generalized Test Protocol for Calculating the Energy Efficiency of Internal Ac-Dc and Dc-Dc Power Supplies, Revision 6.6" shall be provided to the competent body.

Major proposed changes:

- The criteria for internal power supplies are aligned to the Energy Star program requirements for computers, version 6.0 being effective from 28 April 2014.

[9] Cf. http://www.plugloadsolutions.com/docs/collatrl/print/Generalized_Internal_Power_Supply_Efficiency_Test_Protocol_R6.6.pdf

3.1.3.4 Stakeholder feedback and further evidence

Summary of stakeholder feedback
A Member State supported alignment of energy sub-criterion with Energy Star v6.0. A stakeholder expressed concern that the proposed requirements only reflect Ecodesign Tier 1, which applies from June 2014 onwards. It was proposed instead to align with the optional stricter allowance in Energy Star v.6.0 (see table 5), as per the first criterion proposal: • 88% efficiency at 50% of rated power output • 85% efficiency at 20% and 100% rated power output A Member State requested clarification as to whether the minimum requirements under Energy Star v.6.0 were equivalent to bronze under the 80Plus scheme. A stakeholder stated that if the requirements are the same as for Ecodesign then it would be better not to address power supplies as a sub-criterion . Clarification was requested as to which scheme (Energy Star, 80Plus) the test protocol would need to be certified against.

Cross-check of Energy Star, Ecodesign and 80Plus requirements

The minimum legal requirements set by Ecodesign are 82% efficiency at 20 W, 85% at 50 W and 82% at 100 W. To obtain a TEC_{PSU} allowance under Energy Star the internal power supply shall perform to efficiencies set out in Table 5 which confer allowances which increase the overall E_{TEC_MAX} energy performance requirement by 1.5% or 3% depending on the efficiency chosen, offsetting in part the energy savings.

A comparison of these requirements with the independent labelling scheme 80Plus is provided, as requested by stakeholders, in Table 6. Ecodesign provides a 1% improvement on 80Plus Bronze at 20% and 100%. The lower requirement in Energy Star v6.1 is comparable with Silver and the higher requirement is intermediate to Silver and Gold. However, when the overall benefit of the Energy Star requirement is adjusted to reflect the TEC_{PSU} allowance received it can be seen that the improvement potential when compared with Ecodesign is reduced.

Table 6. Comparison of desktop internal power supply efficiency requirements for 80Plus, Energy Star v6.1 and the Ecodesign Regulation

Minimum efficiency at:	230 V Input power			
	Power factor (100% rated output)	20 % of rated output	50 % of rated output	100 % of rated output
80plus bronze	-	81 %	85 %	81 %
80plus silver	-	85 %	89 %	85 %
80plus gold	-	88 %	92 %	88 %
80plus platinum	-	90 %	94 %	91 %
80plus titanium	90 %	94 %	96 %	91 %
Energy Star v6.0 (i) Minimum efficiency (ii) Adjusted for allowance	-	85-87 % 83.5-85.5%	88-90% 86.5-88.5%	85-87% 83.5%-85.5%
Ecodesign computers	90 %	82 %	85 %	82 %

Even including for the additional energy use permitted by the allowance the Energy Star requirements are stricter than Ecodesign. It is also important to note that neither Energy Star or Ecodesign account fully for energy in a desktop computers active (working) mode, as illustrated in Figure 3.6, because this cannot be predicted. A more efficient power supply would therefore also ensure that energy savings are made in a working mode.

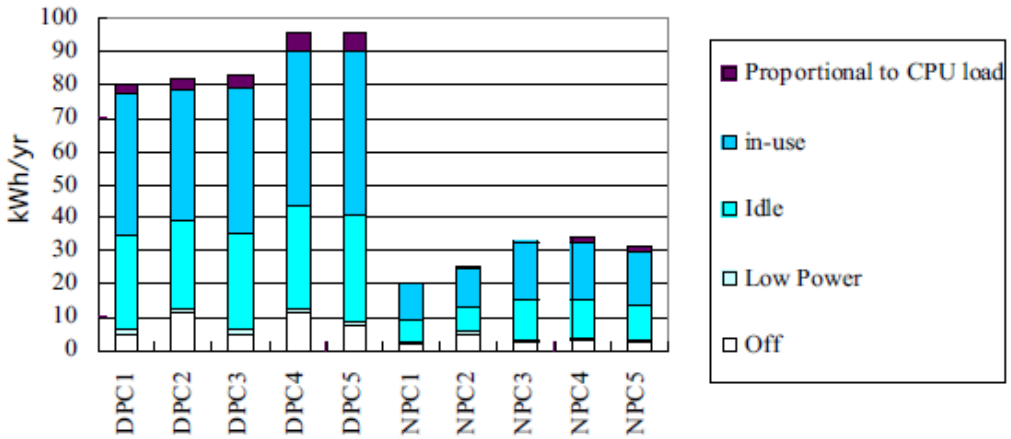


Figure 3.6. . Illustrative annual energy use for desktop computers in an office

Source: Kawamoto,K et al (2005)

3.1.3.5 Third proposal for internal power supplies criteria

Proposed revised criteria (proposal v3)
1(d) Internal Power Supplies Internal power supplies in desktop and integrated desktop computers shall qualify for the TECPSU allowances of Energy Star v6.1 and shall achieve minimum efficiencies as a proportion of the rated output current of 0.87 at 20%, 0.90 at 50% and 0.87 at 100%. ***Assessment and verification:*** The applicant shall declare compliance of the models internal power supply according to requirements of the test report for Energy Star v6.1.

Summary rationale for the proposed changes

- The most significant environmental impacts associated with the lifecycle of desktop computers relates to energy during the use phase.
- The efficiency of the power supply influences energy use in all modes of operation, including the active (working) mode which is not addressed by Ecodesign or Energy Star.
- The minimum requirements under Ecodesign set the benchmark for comparison with Energy Star v6.1 which only has optional allowances for power supplies.

- Adjusting for the allowances conferred from having a more efficient power supply, Energy Star v6.1 is stricter than Ecodesign and is comparable with 80Plus Silver for the lower allowance and intermediate to Silver and Gold, for the higher allowance.
- Given that energy use is the most significant criteria for desktops it is therefore proposed to require that ecolabelled desktops qualify for the TEC_{PSU} allowance. Moreover, this would be the higher allowance to maximise the benefit in working mode.
- Verification would be provided as part of the test specifications for Energy Star v6.1 (Criterion 1a)

3.1.4 Criterion 1.4 – (New proposal) Enhanced performance displays

Higher resolution LED and OLED screens and energy consumption

Closer analysis of the E_{TEC_MAX} allowances reveals that an additional allowance can be obtained for enhanced performance integrated displays. The main factors influencing calculation of the allowance are screen diameter in inches, screen area in square inches and the screen resolution in megapixels. Enhanced performance displays are defined by Energy Star v6.1 as follows:

> *Enhanced-performance Integrated Display: An integrated Computer Display that has all of the following features and functionalities:*
>
> *(1) A contrast ratio of at least 60:1 at a horizontal viewing angle of at least 85°, with or without a screen cover glass;*
>
> *(2) A native resolution greater than or equal to 2.3 megapixels (MP); and*
>
> *(3) A color gamut of at least sRGB as defined by IEC 61966-2-1. Shifts in color space are allowable as long as 99% or more of defined sRGB colors are supported.*

With the trend towards higher resolution screens such as Apple's Mac Book Pro models which incorporate 'Retina' displays and Samsungs Galaxy tablet models

incorporating AMOLED screen technology there could be an implication for the number of computer models receiving an additional allowance for display energy use.

Taking the Retina technology as an example the potential increase in the $TEC_{INT\_DISPLAY}$ allowance can be illustrated. The technology integrates more pixels a 15 inch screen than in a 60 inch diameter High Definition television screen [10]. The resulting specification is 2880 by 1800 megapixels. Using a Toshiba Satelite C series (15.6 screen, 1920 by 768 pixels) and an Asus N Series (15.6 screen, 1920 by 1080 pixels) as benchmarks for comparison it can be seen that the r factor in the $TEC_{INT\_DISPLAY}$ calculation would increase from 1.05 and 2.07 megapixels respectively to 5.18. Combining the overall 0.30 allowance with the increase in screen resolution could therefore increase the (estimated) energy consumption within the E_{TEC_MAX} equation by 60-70%.

Automatic Brightness Control as an improvement measure

Automatic Brightness Control (ABC) is a feature installed in televisions and which is now becoming more common as an energy saving measure in notebooks. An Ambient Light Sensor is installed which dims the screen backlight in function of the ambient light. If calibrated correctly this could have the potential for up to 30% savings in energy use associated with an LED display [11].

Manufacturers have, however, commented that the systems currently used are the subject of many complaints from users, who may as a result switch of the ABC function. A paper by manufacturer AMS highlights the importance of ensuring that the ALS is sensitive enough to distinguish between, for example, office working conditions and dimly lit conditions in a home but not so much that the transitions are noticeable or cause irritation to the user [12].

[10] Apple, *MacBook Pro*, https://www.apple.com/macbook-pro/features-retina/
[11] Enenkel,J, *Automatic mobile display backlight control: techniques to improve user experience*, AMS technical article.
[12] Luidolt,M and D,Gamperl, *How to comply with the Energy Star v6.0 standard for LED TVs*, AMS Technical article.

Validation of ABC according to the routine in the Energy Star v6.0 requirements for televisions is cited by AMS as being sufficient to ensure a minimum practical improvement. This is because the routine tests power useage at 50 lux ambient light in addition to 10, 100 and 300 lux [13]. The addition of 50 lux reflects user surveys which suggested that 50 lux was a common background light level. It cannot, however, be inferred whether this assumption can also be applied to computers or, in fact, whether the ratio between 100 lux and the higher lux level of 300 for office lighting is of greater importance.

3.1.4.1 Proposal for enhanced performance display criteria

Proposed revised criteria (proposal v1)
1(e) Enhanced-performance displays Integrated desktop and notebook computers that incorporate Enhanced Performance Displays shall automatically adjusts the picture brightness to the ambient light conditions. This Automatic Brightness Control (ABC) function shall be installed as the default setting. The ABC shall be validated according to the following test procedure: Test (i) $(\frac{P_{50}-P_{10}}{P_{10}}) \geq 5$ Test (ii) $(\frac{P_{100}-P_{50}}{P_{50}}) \geq 5$ Test (iii) $P_{300} \geq P_{100}$ Where P_n is the Power consumed for On Mode with ABC enabled at *n* lux with a direct light source. ***Assessment and verification:*** The applicant shall submit a test report for the computer model showing compliance with the specified validation procedure.

Summary rationale for criterion proposal

- The $TEC_{INT\_DISPLAY}$ allowance is given to enhanced performance displays with higher resolutions and colour gamuts.
- The new generation of OLED displays have the potential, based on the allowance calculated for a model from a leading computer brand, to increase the allowance for a display by 60-70%.
- Advanced Brightness Control is a feature which, if calibrated correctly to reflect the real-life lighting conditions that users may experience, has been estimated to have the potential to save 20-30% of display energy use.

[13] See the Eligibility Criteria for Energy Star v6.0 Televisions

- ABC is incorporated into notebook screens by many of the leading notebook manufacturers, including Apple, HP, Dell and Lenovo.
- Given the potential increase in market penetration of portable and integrated computers with higher resolution displays it is therefore proposed to require ABC feature calibrated according to the requirements in Energy Star v6.0 Televisions.

3.2 Cluster 2 – Hazardous substances

The research results from the background paper on hazardous substances in computers, displays and televisions has highlighted the need for an interpretation of Articles 6(6) and 6(7) of the Ecolabel Regulation (EC) 66/2010 that is workable for such complex products. These two Articles place restrictions on the presence of hazardous substances in ecolabelled products, using REACH and CLP as their main reference points.

The requirements of the Ecolabel Regulation have up until now been interpreted by a standard legal text addressing 'hazardous substances and mixtures' which has, since 2010, been added as a criteria for each product group. This can be seen in Criteria 5 of Decision 2011/337/EU for personal computers and Criteria 4 of Decision 2011/330/EU for portable computers (see below). This requirement has not yet been integrated into the television criteria.

Defining computers as complex articles

A computer or television comprises a number of different articles, or components. For example, a desktop computer would include a monitor, keyboard, hard drive, DVD reader/writer and power cable. In accordance with the Ecolabel Regulation it could therefore be considered to be a 'complex article' (i.e. an article composed of many individual articles). A definition is suggested as being:

> *'An object composed of an assembly of different articles which during production is given a special shape, design, structure and component*

configuration which determine its function to a greater degree than does its chemical composition or its constituent articles'

The Ecolabel Regulation also refers to homogenous parts of a complex article which could be interpreted to homogenous plastic and metals components. Whilst no specific definition can be found in REACH of CLP, the RoHS Directive 2011/65/EU defines a homogenous material as:

'one material of uniform composition throughout or a material, consisting of a combination of materials, that cannot be disjointed or separated into different materials by mechanical actions such as unscrewing, cutting, crushing, grinding and abrasive processes'

Components or homogenous parts of a complex article may also be treated with or incorporate chemical mixtures or additives that impart specific functions to the sub-component or the product. For example:

- circuit boards and plastic housings may be required to have flame retardant properties;
- Plastic housings may contain colorants such as pigments;
- Power cables may contain plasticizers such as phthalates;
- Solder may contain metals such antimony and beryllium;
- Lithium ion batteries contain hazardous electrolyte but are fundamental in achieving long notebook and tablet battery lives.

This distinguishment between articles, complex articles and chemical mixtures is important because it will influence how hazards within a computer product are assessed and verified.

Proposed approach to hazard screening and criteria development for computers

Subject to discussion with stakeholders it is proposed to apply a new approach to the computer product group. This would follow an adapted version of the proposed approach developed by JRC-IPTS for the EU Ecolabel's Horizontal Task Force on Chemicals.

An initial screening has been carried out of the bill of components/materials (see section 2.4 of the Hazardous Substances paper) followed by an initial identification of substance groups by their function (see also section 2.5). This reflects the broad approach outlined in the box below.

Case studies and restricted substance listings have been collated that will then enable the state-of-the-art in hazard substitution to be defined for these substance groups.

Additional input will also be required from stakeholders in order to identify substitutions that have been made and also, if required, to identify derogations that may also be required if substitutions are not currently possible for technical reasons. According to the Ecolabel Regulation derogations are only to be granted

> *"in the event that it is not technically feasible to substitute them as such, or via the use of alternative materials or designs, or in the case of products which have a significantly higher overall environment performance compared with other goods of the same category,"*

And furthermore, additional rules apply to Substances of Very High Concern:

> *"No derogation shall be given concerning substances that meet the criteria of Article 57 of Regulation (EC) No 1907/2006 and that are identified according to the procedure described in Article 59(1) of that Regulation, present in mixtures, in an article or in any homogeneous part of a complex article in concentrations higher than 0,1 % (weight by weight)."*

Substitution proposal and derogation request forms will be circulated to stakeholders following the first Ad-Hoc Working Group meeting on the 10th October 2013.

Proposed approach to the hazard screening of complex articles (first proposal)
• Identification of the main homogenous materials within the bill of materials i.e. metals, alloys, polymers, glass, ceramics; • Alloys and polymers to which no potentially hazardous additives, coatings or treatments have been applied are proposed for exemption, with reference to Article 23 of Regulation (EC) No 1272/2008 and Annex I point 1.3.4; • Identification of functional additives, coatings and treatments that are related to components of the complex article. These should then be screened for hazards and/or risk of potential release;

- Separate screening of hazards associated with the chemistry of batteries;
- The identification of relevant Candidate List and Article 57 substances by reference to industry declaration lists, European Commission initiatives (e.g. Endocrine disruptors) and Member State intentions;
- Check that the alloys and/or polymers to which hazardous additives or treatments have been applied would pass design for recycling/dismantling requirements (see the Cluster 4 criteria proposals).

Screening and identifying substances and hazards

As a starting point for an investigation on the functional level the table below presents a preliminary overview of computer substance groups by function, and gives example substances for each of them. *Feedback is required from stakeholders in order to complete their identification and where in the product they may arise.*

Substance groups	**Where in product?** *To be completed by means of stakeholder input*	**Substances (examples)**
Flame retardants	e.g. PWB, plastic casing, housing, connectors	• TBBP-A • Hexabromocyklododekan (HBCDD), • tris(2-chloroethyl)phosphate (TCEP) • Short and medium chain chlorinated paraffins (SCCP and MCCP)
Colorants / dye / pigments	e.g. Plastic casing	• Antimony and its compounds; • Lead/lead compounds • Azo dyes • Lead chromate molybdate sulfate red (C.I. Pigment Red 104) • Lead sulfochromate yellow (C.I. Pigment Yellow 34)
Solder		• Antimony or bismuth and its compounds • Cadmium/cadmium compounds
Catalysts : a) flame retardant catalyst b) curing catalyst for silicone resin and urethane resin		a) • Antimony or beryllium and its compounds b) • Dibutyltin (DBT) • Dioctyltin (DOT)
Plasticizer		• Phthalates (including DEHP, BBP, DINP, DIDP, DNOP, DHNUP, DIHP) • Short Chain Chlorinated Paraffins (SCCPs)
Additives (e.g. in metal, glass and plastics)		• Phthalates (plasticizers in plastics) • Arsenic compounds (in glass)

Substance groups	Where in product? *To be completed by means of stakeholder input*	Substances (examples)
Adhesives		• Phthalates
Anti-corrosion surface treatments		• Cadmium/cadmium compounds
Lubricants / Surfactant		• Phthalates • Nonylphenol • Nonylphenolethoxylates
Anti-microbial agents/coatings		• Selenium and its compounds, • Triclosan • Organotins Tributyl tin oxide (TBTO) Dibutyltin dichloride (DBTC) Dibutyltin (DBT) Dioctyltin (DOT)
Ceramics		• Beryllium oxide (BeO)
Electrolytes (in batteries)		• Bis(2-methoxyethyl) ether
Stabilizer		• Cadmium/cadmium compounds • Lead/lead compounds • Dibutyltin (DBT) for PVC • Dioctyltin (DOT) for PVC
Surface finish/treatment: Ink, paint, plating[14]; anti-corrosion layer		• Cadmium/cadmium compounds
Fluorescence		• Cadmium/cadmium compounds

Relevant substance restrictions arising from this exercise would then be entered into a restricted substance list. This list would be specified to reflect the state-of-the-art within industry and ecolabel substance restrictions. It is likely that in the process the list would remove a range of hazards from the computer product, including Article 57 and 59 (Candidate List) SVHC's.

The list could be structured with reference to electronics industry declaration protocols such as the Joint Industry Guide (JIG) and IEC 62474. For example, the JIG establishes three criteria that determine whether substances shall be declared:

- Criteria 1 – R (Regulated)

[14] Surface covering in which a metal is deposited on a conductive surface

Substances that are subject to enacted legislation that (a) prohibits their use; or (b) restricts their use; or (c) requires reporting or results in other regulatory effects (e.g. RoHS).

- Criteria 2 – A (For Assessment Only)

  Substances that are likely to be subject to enacted legislation (e.g. Authorisation under REACH of SVHC's) but where the substance specific effective dates of the regulatory requirements are uncertain.

- Criteria 3 – I (For Information Only)

  Substances that are not regulated but where there is a recognised market requirement for reporting their content in computer products (e.g. to be in compliance with ecolabel criteria).

Substances used within computers would then need to be screened for the hazards listed in the table below. The preferred approach would be to screen at substance group level which, as illustrated by screening exercises in the background paper comparing flame retardants, allows for the comparison of substitutes. Given the complexity of the products existing studies will be used as far as possible.

Acute toxicity	
Category 1 and 2	**Category 3**
H300 Fatal if swallowed (R28)	H301 Toxic if swallowed (R25)
H310 Fatal in contact with skin (R27)	H311 Toxic in contact with skin (R24)
H330 Fatal if inhaled (R23/26)	H331 Toxic if inhaled (R23)
H304 May be fatal if swallowed and enters airways (R65)	EUH070 Toxic by eye contact (R39/41)
Specific target organ toxicity	
Category 1	**Category 2**
H370 Causes damage to organs (R39/23, R39/24, R39/25, R39/26, R39/27, R39/28)	H371 May cause damage to organs (R68/20, R68/21, R68/22)
H372 Causes damage to organs (R48/25, R48/24, R48/23)	H373 May cause damage to organs (R48/20, R48/21, R48/22)
Respiratory and skin sensitisation	
Category 1a	**Category 1b**
H317: May cause allergic skin reaction (R43)	H317: May cause allergic skin reaction (R43)
H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled (R42)	H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled (R42)
Carcinogenic, mutagenic or toxic for reproduction	

Category 1a and 1b	Category 2
H340 May cause genetic defects (R46)	H341 Suspected of causing genetic defects (R68)
H350 May cause cancer (R45)	H351 Suspected of causing cancer (R49)
H350i May cause cancer by inhalation (R49)	
H360F May damage fertility (R60)	H361f Suspected of damaging fertility (R62)
H360D May damage the unborn child (R61)	H361d Suspected of damaging the unborn child (R63)
H360FD May damage fertility. May damage the unborn child (R60, R60/61)	H361fd Suspected of damaging fertility. Suspected of damaging the unborn child (R62/63)
H360Fd May damage fertility. Suspected of damaging the unborn child (R60/63)	H362 May cause harm to breast fed children (R64)
H360Df May damage the unborn child. Suspected of damaging fertility (R61/62)	
Hazardous to the aquatic environment	
Category 1 and 2	**Category 3 and 4**
H400 Very toxic to aquatic life (R50)	H412 Harmful to aquatic life with long-lasting effects (R52/53)
H410 Very toxic to aquatic life with long-lasting effects (R50/53)	H413 May cause long-lasting effects to aquatic life (R53)
H411 Toxic to aquatic life with long-lasting effects (R51/53)	
Hazardous to the ozone layer	
EUH059 Hazardous to the ozone layer (R59)	

Assessment and verification

Assessment and verification procedures would then need to be specified. It is proposed that these should reflect the supply chain management practices of front runner manufacturers and selected ecolabels with experience in this area (see 0). Initial findings from industry and ecolabel case studies suggest that this could include declarations for specific sub-components obtained from tier 1 suppliers and random analytical testing for specific substances or chemistries.

Present criteria, Decisions 2011/337 and 2011/330
"Hazardous substances and mixtures" In accordance with Article 6(6) of Regulation (EC) No 66/2010 the product or any part of it shall not contain substances referred to in Article 57 of Regulation (EC) No 1907/2006 nor substances or mixtures meeting the criteria for classification in the following hazard classes or categories in accordance with Regulation (EC) No 1272/2008 of the European Parliament and of the Council. List of hazard statements and risk phrases: *see equivalent listing above* The use of substances or mixtures which change their properties upon processing (e.g. become no

longer bioavailable, undergo chemical modification) so that the identified hazard no longer applies is exempted from the above requirement.
Concentration limits for substances or mixtures meeting the criteria for classification in the hazard classes or categories listed in the table above, and for substances meeting the criteria of Article 57(a), (b) or (c) of Regulation (EC) No 1907/2006, shall not exceed the generic or specific concentration limits determined in accordance with Article 10 of Regulation (EC) No 1272/2008. Where specific concentration limits are determined, they should prevail over the generic ones. Concentration limits for substances meeting criteria of Article 57(d), (e) or (f) of Regulation (EC) No 1907/2006 shall not exceed 0,1 % weight by weight.

The following substances/uses of substances are specifically derogated from this requirement: Homogenous parts with weight below 10 g: Nickel in stainless steel

Assessment and verification: for each part above 10 g the applicant shall provide a declaration of compliance with this criterion, together with related documentation, such as declarations of compliance signed by the suppliers of substances and copies of relevant Safety Data Sheets in accordance with Annex II to Regulation (EC) No 1907/2006 for substances or mixtures. Concentration limits shall be specified in the Safety Data Sheets in accordance with Article 31 of Regulation (EC) No 1907/2006 for substances and mixtures.

"Substances listed in accordance with Article 59(1) of Regulation (EC) No 1907/2006"
No derogation from the exclusion in Article 6(6) may be given concerning substances identified as substances of very high concern and included in the list foreseen in Article 59 of Regulation (EC) No 1907/2006, present in mixtures, in an article or in any homogenous part of a complex article in concentrations higher than 0,1 %. Specific concentration limits determined in accordance with Article 10 of Regulation (EC) No 1272/2008 shall apply in case it is lower than 0,1 %.

Assessment and verification: the list of substances identified as substances of very high concern and included in the candidate list in accordance with Article 59 of Regulation (EC) No 1907/2006 can be found here:
http://echa.europa.eu/chem_data/authorisation_process/candidate_list_table_en.asp
Reference to the list shall be made on the date of application.
The applicant shall provide a declaration of compliance with this criterion, together with related documentation, such as declarations of compliance signed by the suppliers of substances and copies of relevant Safety Data Sheets in accordance with Annex II to Regulation (EC) No 1907/2006 for substances or mixtures. Concentration limits shall be specified in the Safety Data Sheets in accordance with Article 31 of Regulation (EC) No 1907/2006 for substances and mixtures.

Proposed structure for the revised criteria (first proposal)

"Substitution of hazardous substances and mixtures in computers"

The following structure is proposed for the criteria, which will also need to include the standard hazard listing and a legal reference to the requirements in the Ecolabel Regulation 66/2010:

(a) Restricted substances in computers: A list would be compiled based on best practice by manufacturers and, as far as possible,
   - Article 57 substances that have already been/are in the process of being substituted by leading manufacturers.
   - The listing would be appended as an appendix of the Ecolabel Decision. The listing would include the Article 6(6)/6(7) requirement to exclude Candidate List SVHC's and Article 57 substances.

(b) Derogation framework: If the need for derogations is identified then these will, as far as possible, be structured according to the function of the substance and/or the relationship of the substance to a specific sub-component within a computer.
   - Derogations will only be permitted for specific hazards if, after a screening of substance

Proposed structure for the revised criteria (first proposal)

group substitutions, they are required.

- The hazards derogated would be defined by the hazard profile and market status of substitution options.
- Derogation conditions would be set that would be related to the point in the life cycle of the product where the hazard is most relevant.

(c) Assessment and verification: This would be specified for the restricted substance listing and for the derogation framework (if required).

- It is to be discussed if a restriction list could be verified by random analytical testing and if so the frequency of this testing.
- It is to be discussed the level at which verification of the classification/non-classification of substance groups within products could be workable. One possibility is for declarations to be obtained from tier 1 component suppliers.

Consultation questions

- Could the overall approach, combining a substance list and a substance group approach to hazard screening and substitution/derogation, be workable for this product group?
- Are there other screening studies and/or examples of (implemented) substitution projects that we have not covered in the background report?
- What can be learnt from the experience of applicants/competent bodies for other ecolabels which have similar criteria? e.g. EPEAT, TCO
- Based on the experience of industry and existing ecolabels could the approach to assessment and verification be workable? Are there other examples of how this can work in a way that provides a high level of assurance?

3.2.1 Stakeholder feedback and further evidence

The main points arising from the 1st AHWG meetings for Computers and Televisions were as follows:

- Stakeholders understood that the criteria has to be ambitious, but the level of ambition has to stay within the limits of possibility. Even the present, less ambitious Television criteria, are difficult to realise.
- A critical point was the transparency of the supply chain. A computer or a TV is a complex article. Manufacturers are not used to verifying based on hazards but on specific substances.
- Care needs to be taken in looking to other Ecolabels' criteria as they have copied each other 'bad' criteria which are not necessarily implementable or scientific. Verification was also highlighted as an important area to strengthen. Third party verification of the hazardous substance criteria for the US EPA DFE programme and for Green Screen assessments were cited as good models.
- An approach focused on a prioritisation of the main components and functions related to the product was generally supported. Flame retardants and plasticisers, for example, should not be treated in a group but should be studied separately. Safety standards which include the use of FR, such as those for TV housings, have to be considered. Clear guidance would be needed for Competent Bodies on which components they would need to verify.
- Concern was expressed that the Ecolabel Regulation's Article 6(6) and 6(7) has a very broad scope and the scope for flexibility was questioned. For example, there could be over 700 pigments used to colour plastic. DG ENV highlighted the need to consult during the revision process on what is legally possible. Early feedback from Member States indicates a willingness to adopt a more flexible approach for electrical products.
- Substitution is expensive. Leading manufacturers therefore seek to anticipate future regulatory restrictions so as to minimise costs. However, substitutes should have a better hazard profile than those they substitute. The US Design for the Environment (DFE) programme, for example, has evaluated 32 flame

retardants, including halogenated and non-halogenated. Other studies and evaluations could also be referred to.

- Stakeholders highlighted the need to cover not only a black list of restricted substances but also a white list of substances which are substituting black substances, which could be a living dynamic list.

The main points arising from written stakeholder feedback received between September and November 2013 were as follows:

- There was concern that fundamentally the approach would not work because manufacturers have not implemented hazard-based restrictions. Concern was raised that Ecolabels have led manufacturers to make 'regrettable substitutions' for which there are major data gaps in their hazard profile.
- From 2011 onwards a major TV manufacturer could not apply for the Ecolabel because it was not possible to use main the flame retardant used in the plastic housings based on hazard restrictions.
- The industry manages well the absence of regulated substances and those of concern but has limited information on all substances in parts e.g. plastics additives and colorants. The scope of the criteria therefore needs to be limited in order to make progress.
- Restricting the use of SVHC in Ecolabel products makes sense. The SVHC restriction should be applicable to component level rather than homogeneous material level. To make the SVHC criteria workable, it is necessary to limit the scope of the 'homogenous' part to a manageable range (e.g. plastic parts over 25 grams, metal parts, etc.). A clear distinction is required between substances in mixtures, and substances in articles/complex articles.
- More information is needed on the inventory of hazardous substances included in TVs/computers. This information is the basis for any debate about substitution possibilities and barriers and respective needs for derogations. Sources such as ENFIRO, Green Screen, SubSport and the US DfE project were highlighted as being important references.

- Green Screen in particular was highlighted as a means of evaluating, benchmarking and comparing the hazard profile of potential substitutes. Verification should be strengthened, moving away from self-declarations by OEM's to third party verified hazard evaluations and test reports for defined hazard end-points.
- There is the need to avoid the use of substances that will case health and environmental impacts during the End of Life phase of these products e.g. in third world countries where the goods may be processed in dangerous conditions, harming the health of local people and damaging the environment. An EEA report on the issue was highlighted.

One formal derogation has been received to date - nickel in stainless steel, submitted by Eurofer - together with supporting technical information relating to the use of Antimony, Beryllium and non-halogenated flame retardants. A compilation of information and assessments relating to the Green Screen assessment tool was also provided.

Further research and evidence:

In order to analyse and gather further evidence related to hazards that may be present within the product, as well as substitutions and restrictions made by the industry, a sub-group was established as mandated at the first AHWG and two matrices were established as a means of compiling and structuring the information that will underpin the criteria proposal.

Establishment of the sub-group

An invitation to take part in the sub-group was sent out to registered stakeholders and EUEB members in November. The aim of the hazardous sub-group was defined as being to:

- Steer the overall approach to be taken with regards to the Ecolabel Regulation and the substitution potential of the best performing products on the market;
- Assist in developing a better understanding of the substitution potential for the product group;

- Review substitution information and derogation requests;
- Advise on how verification could work.

Based on the responses to the invitation the sub-group was structured to ensure a balanced representation from product manufacturers, industry specialists, EU member states and NGO's. The sub-group members are listed in Table 7. A first telephone meeting of the sub-group took place on the 26th February 2014 with full attendance and a further meeting is anticipated following the second AHWG. *For transparency the minutes have been made available to stakeholders.*

Table 7: Computers and Display hazardous substance sub-group members

Markus Stutz	Dell
Hans Wendschlag	Hewlett Packard
Claudia Albuquerque	LG
Steven Clayton	Samsung
Lein Tange	ICL-IP
Claus Ruediger	Bayer
Dr. Johanna Wurbs	UBA (Germany)
Søren Mørch Andersen	Danish EPA
Dirk Jepsen	Oekopol
Lauren Heine	Clean Production Action (USA)

Participation as observers:

Blanca Morales	EEB/BEUC
Bernd Kappenberg	CEFIC
Susanne Stark	VKI (Austria)

Screening and evaluation of the comments and evidence base

In order to screen and evaluate the existing evidence compiled in the September 2013 background document on hazardous substances and new evidence submitted by stakeholders subsequent to this two matrices have been setup:

1. Candidate List and RoHS screening matrix: The IEC 62474 Declarable substance list for electrotechnical products [15] was used as the starting point for identifying substances from the most current ECHA Candidate List that may be relevant to computers and displays. The list is frequently updated by a dedicated team and is therefore understood to be accurate as well as assisting in screening the list. Substances of potential relevance were flagged and colour coded before being circulated to sub-group members to obtain further feedback on their use/non-use in products. The codings were as follows:

    i. Substances that are already understood to have been eliminated from production;
    ii. RoHS exemptions that may be relevant to the product group but their current/post-sunset date relevance is to be confirmed;
    iii. Substances on which little is known about their potential relevance to the product group
    iv. Substances not deemed relevant to the product group based on the available information.

2. Bill of materials and hazardous substance screening matrix: The evidence gathered to date was structured, firstly, according to substance groups, which can generally be seen to related to functions associated with components of the product, and secondly according to the components/sub-components where hazardous substances are/may be found. A summary of the evidence used to compile the matrix can be found in Table 8. This evidence is supplemented by feedback from product group stakeholders and sub-group members, including OEM's. An overview of how the matrix is structured and how it works is summarised in Table 8.

[15] International Electrotechnical Commission, *IEC 62474 - Material Declaration for Products of and for the Electrotechnical Industry,* http://std.iec.ch/iec62474

Table 8: Main evidence base used to compile the screening matrix

Screening	Evidence base
RoHS (recast) Directive	• Relevance of exemptions identified from OEM restriction lists
RoHS ATP	• Oeko-Institut and Austrian EPA reports with recommendations on extended RoHS scope
ECHA Candidate List	• Substances of relevance to the product group using IEC 62474 Declaration List (see colour coded version appended) • ECHA and Member State risk assessments and dossiers (e.g. German BFR - PAHs)
Substitution analysis	• EU ENFIRO study of environment-compatible flame retardants • US EPA Printed Circuit Board and decaBDE evaluations • Green Screen assessments for TV enclosures and plasticisers • COWI and the Danish Technological Institute compilation for plastics
Industry substitutions and restrictions	• OEM chemical restriction lists (with a focus on SG members HP, Samsung, Dell, LG) • International Electronics Manufacturing Initiative (iNEMI) • EFRA and PINFA guides to flame retardant applications in electronic equipment • SubSport Case Story substitution database • OEM product and component specifications

The analysis carried out using the matrix was used to derive the following outputs which form the basis for the scope and ambition level of first criteria proposal:

- Current hazard benchmarks: *Substances that are currently used or were used until recently in mainstream products*. For each substance the CAS number and, as far as possible, their hazard profile have been identified for comparative purposes.
- Proposed substitution benchmarks: *Substitutes for hazardous substances currently used in mainstream products that have been implemented, or are proposed for implementation, by leading manufacturers*. For each substance the CAS number and, as far as possible, hazard profile have been identified for comparative purposes.
- Proposed restrictions: *Substance or substance group restrictions that have been identified from OEM restriction lists or from risk assessment exercises by the European Commission, Member State or Intergovernmental bodies*. Where a restriction is proposed:

- The specific substances, how they relate to the product and, where appropriate, a concentration limit are identified.
- The potential to specify analytical testing of component parts to strengthen verification is flagged for follow-up and, if agreed to be appropriate in terms of the available test methods and burden for applicants, specification.
- For some special cases possible derogation conditions are briefly flagged.

These outputs from the screening can be found in *'Functional need and substances currently used'* and *'best practices identified'* columns in the main screening matrix.

Table 9: Indicative schema for the hazardous substance screening matrix

Component or sub-component	Functional need and substances currently used	Best practice identified	Summary evaluation of evidence to support substitution or restrictions	Questions and information gaps
Substance group x				
Generally supply chain tier 2 or 3 components	Description of the function and its need as well as identification of the substances typically used. Substances are also identified which may be used as the hazard profile benchmarks for current practices against which the improvement potential of substitutes may be compared.	Substitutions made by industry and/or mandatory and voluntary restrictions that have been implemented in leading products available on the market. Substances are also identified which may be used as the substitution hazard profile benchmarks to set 'white list' derogations, as well as possible restrictions on specific hazardous substances.	Discussion of background evidence relating to different options for achieving the same function. Comparative evidence relating to substances and substance groups is summarised, in some cases with reference to US EPA and Green Screen assessments.. This evidence may be used to support criteria proposals to derogate the use of substances (*the hazard white list*) and/or restrict the use of substances (*the hazard black list)*.	For follow-up with stakeholders in order to address information gaps

Grouping of the EU Ecolabel hazard list

At the March meeting of the EU Ecolabel Board a final version of the Chemicals Horizontal Task Force approach to implementation of the hazardous substance

criteria was tabled[16]. The approach was informally mandated for use in product groups.

Importantly the approach included a grouping of the hazard list which forms a reference for the criteria. This grouping is intended to better reflect the different levels of hazard as defined in the CLP classification rules. The Groups have also been designed to facilitate a better read across from the results of US EPA and Green Screen hazard assessments, which form part of the evidence base in the screening matrix.

The Groups are accompanied by a set of rules for the derogation of hazards, with Group 1 being the strictest and Group 3 being the most flexible. These rules can be found in the Horizontal Task Force approach paper. In all cases the emphasis is on the need to demonstrate the functional need for the use of a substance and the availability of substitutes.

For reference the three groups are listed below:

Group 1: Hazards subject to complete restriction

Substances present in mixtures, in an article or in any homogeneous part of a complex article that meet the criteria of Article 57 of Regulation (EC) No 1907/2006 or that are identified according to the procedure described in Article 59(1) of that Regulation. This shall include the hazards listed below, as well as endocrine disruptors, neurotoxins and sensitisers of equivalent concern.

Carcinogenic, mutagenic or toxic for reproduction	
CLP Category 1A and 1B	
H340 May cause genetic defects (R46)	
H350 May cause cancer (R45)	
H350i May cause cancer by inhalation (R49)	
H360F May damage fertility (R60)	
H360D May damage the unborn child (R61)	

[16] JRC-IPTS, *Findings of the EU Ecolabel Chemicals Horizontal Task Force – Proposed approach to hazardous substance criteria development*, 24th February 2014

H360FD May damage fertility. May damage the unborn child (R60, R60/61)	
H360Fd May damage fertility. Suspected of damaging the unborn child (R60/63)	
H360Df May damage the unborn child. Suspected of damaging fertility (R61/62)	

Group 2: Priority hazards for restriction to which strict conditions shall apply

Combinations of these hazards that also result in the substance being PBT (Persistent, Bioaccumulative and Toxic), or persistent or bioaccumulative, according to the definitions provided in Annex XIII of the REACH Regulation, shall be treated as Group 1 substances.

Carcinogenic, mutagenic or toxic for reproduction	
	CLP Category 2
	H341 Suspected of causing genetic defects (R68)
	H351 Suspected of causing cancer (R49)
	H361f Suspected of damaging fertility (R62)
	H361d Suspected of damaging the unborn child (R63)
	H361fd Suspected of damaging fertility. Suspected of damaging the unborn child (R62/63)
	H362 May cause harm to breast fed children (R64)

Acute toxicity	
CLP Category 1 and 2	
H300 Fatal if swallowed (R28)	
H310 Fatal in contact with skin (R27)	
H330 Fatal if inhaled (R23/26)	
H304 May be fatal if swallowed and enters airways (R65)	

Specific target organ toxicity (STOT)	
CLP Category 1	
H370 Causes damage to organs (R39/23, R39/24, R39/25, R39/26, R39/27, R39/28)	
H372 Causes damage to organs (R48/25, R48/24, R48/23)	

Hazardous to the aquatic environment	
CLP Category 1 and 2	
H400 Very toxic to aquatic life (R50)	
H410 Very toxic to aquatic life with long-lasting effects (R50/53)	
H411 Toxic to aquatic life with long-lasting effects (R51/53)	
Hazardous to the ozone layer	
H420 Hazardous to the ozone layer (R59)	

Respiratory and skin sensitisation (*not proposed for general application to this product group, with limited exceptions*)	
CLP Category 1	
H317: May cause allergic skin reaction (R43)	
H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled (R42)	

Group 3: Hazards to which greater flexibility may be applied in derogations

Acute toxicity	
	CLP Category 3
	H301 Toxic if swallowed (R25)
	H311 Toxic in contact with skin (R24)
	H331 Toxic if inhaled (R23)
	EUH070 Toxic by eye contact (R39/41)
Specific target organ toxicity (STOT)	
	CLP Category 2
	H371 May cause damage to organs (R68/20, R68/21, R68/22)
	H373 May cause damage to organs (R48/20, R48/21, R48/22)

Hazardous to the aquatic environment *	
	CLP Category 3 and 4
	H412 Harmful to aquatic life with long-lasting effects (R52/53)
	H413 May cause long-lasting effects to aquatic life (R53)

** flexibility may be applied only if the fate of the product is not in the aquatic environment*

3.2.2 First proposal for hazardous substances criteria

First criteria proposal

"Substitution of hazardous substances used in the main computer components"

2(a) Substances of Very High Concern (SVHC's)

The product shall not, unless specifically derogated, contain substances that:

(i) Meet the criteria in Article 57 of Regulation (EC) No 1907/2006,

(ii) Have been identified according to the procedure described in Article 59(1) of Regulation (EC) No 1907/2006 which establishes the candidate list for substances of very high concern.

These conditions apply to substances that carry out a function to the final product and to substances that may be present as impurities or contaminants. No derogation shall be given concerning substances that meet either of these two conditions, and which are present in an article or in any homogeneous part of a complex article in concentrations greater than 0,1 % (weight by weight).

Assessment and verification: Substances that are present in the final product shall be screened against the latest version of the candidate list published by ECHA. The applicant shall compile declarations of compliance from, as a minimum, tier 2 suppliers. Where a derogation has been granted then the applicant shall show that use of the substance is in compliance with the relevant concentration limits and derogation conditions.

2(b) Restrictions based on hazard classifications

Hazardous substances that may be present in main components of the computer that, in accordance with Regulation (EC) No 1272/2008 of the European Parliament and of the Council or Council Directive 67/548/EC, meet the criteria for classification with the hazard classes or risk phrases listed in table 2.1 shall not be used unless they have been specifically derogated. The main components of a computer are defined as comprising:

- Printed Circuit Boards
- Central Processing Units and Graphics Processing Units (including cooling units)
- Electrical solder and metal contacts
- Electrical and data connections (internal and external)
- Data storage drives
- External cables and power packs
- External housing and enclosure materials
- External casing and surfaces of peripheral devices
- Notebook or tablet batteries
- Display screen glass
- Liquid Crystal Display unit
- Screen LED backlights

Homogeneous parts with a weight of below 25 g and the metal chassis of the product are excluded from the scope of this criterion.

The hazard classifications in Table 2.1 generally refer to substances. However, if information on substances cannot be obtained, the classification rules for mixtures apply. The most recent classification rules adopted by the European Union shall take precedence over the listed hazard classifications or risk phrases.

The use of substances or mixtures which change their properties upon processing (e.g., become no longer bioavailable, undergo chemical modification) so that the identified hazard no longer applies are exempted from the above requirements. This shall include polymers that have been modified to incorporate a function and additives which become covalently bonded with polymers.

Table 2.1: Restricted hazard classifications and risk phrases and their CLP categorisation

Acute toxicity	
Category 1 and 2	**Category 3**
H300 Fatal if swallowed (R28)	H301 Toxic if swallowed (R25)
H310 Fatal in contact with skin (R27)	H311 Toxic in contact with skin (R24)
H330 Fatal if inhaled (R23/26)	H331 Toxic if inhaled (R23)
H304 May be fatal if swallowed and enters airways (R65)	EUH070 Toxic by eye contact (R39/41)
Specific target organ toxicity	
Category 1	**Category 2**
H370 Causes damage to organs (R39/23, R39/24, R39/25, R39/26, R39/27, R39/28)	H371 May cause damage to organs (R68/20, R68/21, R68/22)
H372 Causes damage to organs (R48/25, R48/24, R48/23)	H373 May cause damage to organs (R48/20, R48/21, R48/22)
Carcinogenic, mutagenic or toxic for reproduction	
Category 1A and 1B	**Category 2**
H340 May cause genetic defects (R46)	H341 Suspected of causing genetic defects (R68)
H350 May cause cancer (R45)	H351 Suspected of causing cancer (R40)
H350i May cause cancer by inhalation (R49)	
H360F May damage fertility (R60)	H361f Suspected of damaging fertility (R62)
H360D May damage the unborn child (R61)	H361d Suspected of damaging the unborn child (R63)
H360FD May damage fertility. May damage the unborn child (R60, R60/61)	H361fd Suspected of damaging fertility. Suspected of damaging the unborn child (R62/63)
H360Fd May damage fertility. Suspected of damaging the unborn child (R60/63)	H362 May cause harm to breast fed children (R64)
H360Df May damage the unborn child. Suspected of damaging fertility (R61/62)	
Hazardous to the aquatic environment	
Category 1 and 2	**Category 3 and 4**
H400 Very toxic to aquatic life (R50)	H412 Harmful to aquatic life with long-lasting effects (R52/53)
H410 Very toxic to aquatic life with long-lasting effects (R50/53)	H413 May cause long-lasting effects to aquatic life (R53)

H411 Toxic to aquatic life with long-lasting effects (R51/53)	
Hazardous to the ozone layer	
EUH059 Hazardous to the ozone layer (R59)	

Assessment and verification: The applicant shall obtain declarations of compliance from, as a minimum tier 2 suppliers. This shall declare that, where used in the listed components, the following substancesdo not meet the criteria for classification with one or more of the hazard classifications or risk phrases listed in table 2.1:

- Flame retardants
- Plasticisers
- Plastic stabilisers
- Plastic colorants
- Biocides in plastic and rubber
- Plastic contaminants
- Solders and metal contacts
- Thermal conductors
- Coolants
- Battery electrolytes
- External metals and coatings
- Screen glass fining agents
- Liquid crystals in displays
- LED doping and luminescence

Where substances are derogated in 2(c) or 2(d) then the declaration shall specifically identify those derogated substances and provide supporting evidence showing how the derogation conditions are to be met. The following technical information shall be provided to support the declaration of classification or non-classification for each substance:

(i) For substances that have not been registered under Regulation (EC) No 1907/2006 or which do not yet have a harmonised CLP classification: Information meeting the requirements listed in Annex VII to that Regulation;

(ii) For substances that have been registered under Regulation (EC) No 1907/2006 and which do not meet the requirements for CLP classification: Information based on the REACH registration dossier confirming the non-classified status of the substance;

(iii) For substances that have a harmonised classification or are self-classified: SDS where available. If these are not available or the substance is self-classified then information shall be provided relevant to the substances hazard classification according to Annex II to Regulation (EC) No 1907/2006;

(iv) In the case of mixtures: safety data sheets where available. If these are not available then calculation of the mixture classification shall be provided according to the rules under Regulation (EC) No 1272/2008 together with information relevant to the mixtures hazard classification according to Annex II to Regulation (EC) No 1907/2006.

SDS shall be completed in accordance with the guidance in Section 2,3,9,10, 11 and 12 of Annex II to Regulation (EC) 1907/2006 (requirements for the compilation of SDS).

2(c) Derogation of substances with an improved hazard profile

In accordance with Article 6(7) of Regulation (EC) No 66/2010 the substance groups in table 2.2 are specifically derogated from the requirements set out in Article 2(b) and in accordance with the associated derogation conditions.

Table 2.2. Derogation of substitutes with an improved hazard profile

Substance group	Sub-components	Hazard derogations	Derogation conditions
Flame retardants	Printed Circuit Boards	*Not required*	Control of associated hazardous reaction products.
	Internal connectors and switches	H413	-
	External power cables	*Not required*	-
	Plastic enclosures and casings	H412, H413	Control of PFOA emissions from PTFE production
	Recycled plastic in enclosures and casings	FR's and their synergists that are not restricted or identified as SVHC's	Declaration of FR and synergist present obtained from the component supplier.
Plasticisers	External cables	H411	-
	Recycled content (all components)	Substances present in recyclate that are not SVHC's.	-

2(d) Restriction of substances in specified components

The final product and, where stipulated, specified components shall not contain the hazardous substances listed in table 2.3 at or above the specified concentration limits or according to the specified restrictions. The restrictions in the RSL take precedence over any derogations listed in Criterion 2(C).

Verification and testing requirements are specified in table 2.3. Laboratory testing, where required, shall be carried out for each production model. Testing shall be carried out annually during the license period in order to demonstrate ongoing compliance.

Table 2.3. Restriction of substances within components

Substance group	Restriction	Concentration limit
Plasticisers	DEHP, BBP, DBP, DIBP, DMEP, DIPP, DPP, DnPP and DnHP shall not be present in external cables and power packs.	A sum total concentration limit of 0.1% is proposed.
	Medium Chained Chlorinated Paraffins (MCCP's) Alkanes C14-17 shall not be present in external cables and power packs.	A sum total concentration limit of 0.1% is proposed.

Plastic stabilisers	Lead shall not be present in external cables, wires and connecting cords.	Concentrations at or greater than 300 ppm. *A test method is proposed to be specified.*	
Plastic colourants	Colourants containing lead, chromium VI and cadmium, including those included in the Candidate List, shall not be used.	*The potential to specify testing is to be discussed.*	
	Pigments and dyes used to colour ABS shall be colour fast.	*A migration test is to be identified.*	
Biocides	Biocides intended to provide a hygiene (anti-bacterial) function shall not be added to keyboards and peripherals.	Self-declaration obtained from component suppliers.	
Plastic contaminants	The 18 listed Polycyclic Aromatic Hydrocarbons (PAHs) shall not be present above individual and sum total concentration limits in the external surfaces of notebooks and tablets; peripheral keyboards, mice, stylus and trackpads; external power cables.	The following concentrations shall apply: - Individual concentrations for the eight REACH restricted PAHs shall be 1 ppm - The sum total concentration of the 18 listed PAHs shall not be greater than 18 ppm	
Metal solder	RoHS exemption 7b for solder in small-scale servers shall not be granted to ecolabelled computers	Declaration by the manufacture detailing the alternative solder specified.	
	The following RoHS exemptions shall be granted for ecolabelled computers: - 6a-c: An alloying agent in steel, aluminium and copper (expires July 2016); - 7cii: In dielectric ceramic materials in capacitors (expires July 2016).	-	
Electrical contacts	RoHS exemption 8b shall not be granted to ecolabelled computers	Declaration by the manufacture detailing the alternative solder specified.	

Ceramic heat conductors	Beryllium and its compounds shall not be used in parts at concentrations greater than 0.1%	Self-declaration obtained from component suppliers.
Coolants	Refrigerants in cooling systems shall not be classified as Ozone Depleting Substances (H420) or Controlled substances under the Montreal Protocol.	-
External metal parts	Nickel in stainless steel shall be restricted in-line with REACH where any external part will be in close and prolonged contact with the skin.	*Verification shall be by analytical testing for migration.*
External metallic coatings	Hexavalent chromium shall not be present in metallic coatings applied to parts of a computer.	*Verification shall be by analytical testing of coated parts.*
Screen glass	Arsenic and its compounds shall not be used in the manufacturing of screen glass and shall not be present at a concentration greater than 10 ppm.	*It is proposed that verification is obtained from the glass manufacturer.*

Assessment and verification: The applicant shall provide a declaration of compliance with the restriction list in table x supported by evidence as applicable to the substances used to manufacture components within the final product. Testing, where required, shall be carried out upon application for each production model licensed and once a year thereafter, with results then communicated to the relevant competent body.

Failure of a test result during a license period shall result in retesting for the specific product line. If the second test fails then the license shall be suspended for the specific product line. Remedial action will then be required in order to re-instate the license.

Summary of the how the proposal is formulated:

- The scope of the criteria has been set in order to ensure that it can be complied with the best products on the market, reflects the practical potential for the substitution of hazards and can be verified with a high level of assurance.
- The scope is proposed to be narrowed to specific named components and substance groups that have been identified as being of high concern and which have been addressed by substitution initiatives.

- A lower cut-off limit of 0.1% is set for the consideration of CLP hazards in *component parts*. In-line with the practice within all other ecolabelling and reporting schemes for computer products a general weight-based cut-off for the scope of the criterion is proposed at 25g. Additionally it is proposed to exclude steel or aluminium chassis material that form the structure of a product.
  - The defined components – mainly understood to be manufactured by Tier 2 or 3 suppliers - are proposed to be recognised as *homogenous parts* for the purpose of applying the 0.1% cut-off limit for hazardous substances, such that verification shall be required for the part as whole in the case that specific restrictions or concentration limits are defined.
- In-line with Articles 6(6) and 6(7) of the Ecolabel Regulation (EC) 66/2010 a restriction is placed on the presence of substances placed on ECHA's Candidate List for authorisation (Substances of Very High Concern) being present in any component of the final product.
  - Provision is only made for the derogation of SVHC's under strict conditions and where a substance is present at concentrations less than 0.1%. It is understood that some OEM's intend to submit derogations. A strict deadline for derogations to be submitted shall be set at the AHWG2.
- A set of substance restrictions – *a black list* - have been identified from the hazard restriction lists of the leading OEM's that seek to limit or avoid the presence of substances of concern. The aim is to create a clear and visible control of these substances presented in a form that is familiar to OEM's and their suppliers. Functions that are not essential are also excluded where possible e.g. biocidal treatment of keyboards.
  - These restrictions are proposed to be verified for specific identified components. In some cases the restriction relates to possible exposure of the consumer to hazards. Where limit values are proposed then verification shall be according to laboratory testing using standardised IEC, EN or ISO test methods.

- Reflecting the practices of leading OEM's random laboratory testing is proposed for selected Candidate List substances (to be identified from the IEC 62474 Declaration List) and/or the Ecolabel's restriction list. This shall take place once a year during the license period.

- The initial findings from an analysis of substitutions made by leading manufacturers in order to minimise hazards present in their products has been used to establish a *'white list' hazard derogation framework*. The aim of the framework is to identify from the EU Ecolabel hazard list those hazards that should be derogated in order to permit the hazard profile of the best products on the market to comply with the criterion.
- The framework is structured according to common substance groups that carry out specific and required functions in the product.

3.2.3 Stakeholder feedback and further evidence

Summary of stakeholder feedback
A Member State queried the implied definition of an article – could it be flexibly applied to specific components or the whole product? Their understanding was that it was a case of 'once an article, always an article'. Moreover, a definition of 'homogenous parts' was requested and it was clarified by JRC-IPTS that this had no legal definition in EU legislation and that 'component parts' had the same intended meaning for the purpose of this proposal. *Defining the main components* In general the linking of 2(a) and 2(b) to a defined list of main components was supported by stakeholders who commented. It was requested that the list be repeated in 2(a) for clarity and it was also queried why the 25g threshold was needed if the components were already defined. For some stakeholders this would not be acceptable because it was not clear what would be covered by such an exemption. The scientific argument for 25g was also felt to be lacking. A Member State requested to know what would be the proportion of the product that would be covered by the components defined in 2(b)? This would then define the coverage and the acceptability of the criterion.

Screening for SVHCS's

In the criterion text it is unclear whether the intention is to screen SVHC meeting the criteria of article 57 or REACH (i) and/or SVHC in the candidate list (ii). This requires clarification. Candidate List substances should be screened not only in the main components listed but also for the entire article. With this proposed solution it would be ensured that the level of ambition remains high for listed components while at the same time the entire final product as sold is addressed as a safety net. For clarity the component list should be included within 2(a).

Verification of hazard profiles

The proposal for third party verification of hazard profiles was the subject of many comments. In other products there is an almost complete reliance on self-declarations – why should this product group be different? What value would this add, how would it work and in what situation? Good arguments would be needed to introduce this additional new step.

Asking for verification or documentation for the classification is going further that CLP and will add an extra burden on manufacturers, but only for those applying for the Ecolabel. A Member State felt that this was neither fair to applicants nor increased the environmental benefit.

Clarification was additionally requested that a parallel system to REACH and CLP was not being created. A proposal was made that joint submission dossiers in the ECHA C&L Inventory be taken as being more authoritative than single notifications or aggregated notifications. An industry stakeholder highlighted the need for decisions to be made based on the best available scientific data. It was commented that Green Screen assessments could be used to fill gaps.

Exemption of substances which changes their properties

Concern was raised by one stakeholder regarding that criterion text which exempts substances where they change their properties so as to no longer be bioavailable. It was queried what evidence this would need to be based on (e.g. EU risk assessment reports) and it was felt that the burden of proof should be on the manufacturer to demonstrate that it would not be bioavailable along the products lifecycle.

This exemption was felt to preclude addressing the lifecycle of the product and certain substances and, moreover, would give a freedom to use any substances bonded to

polymers. On this basis brominated flame retardants and PVC may not be addressed, whereas at the very least consumers should be informed if they are used. One stakeholder proposed that instead all additives (e.g. FRs, plasticisers) should be treated as bioavailable unless proven stable over time.

A related concern was expressed for the need for a stronger focus on breakdown products which may arise. Assumptions are currently being made about the stability of substances over time which require reviewing.

Substance-specific issues raised

A Member State was opposed to there being a restriction and declaration for mercury backlights. With LED's understood to be mercury free anyway and Ecodesign proposals for mandatory labelling of displays this could cause confustion for consumers. Another stakeholder disagreed, citing the potential for mercury backlit LCD's to still be on the market. The requirement would therefore serve as a safety net.

A specific point was raised in relation to testing for nickel in stainless steel. This will require reviewing because the approach to migration testing is under review. It was also considered that stainless steel casings are specialised so may not be relevant to the product group. For chrome coatings the same approach should be considered as for solders under RoHS where self-declarations are used.

Another specific point was raised in relation to power cables. Can the restriction proposed for plasticisers actually be verified? It was cited by a Member State that problems had arisen with this before.

With regard to the use of beryllium in computer products it was stated that it was not used in connectors and that the use of beryllium oxide as a heat sink was too expensive for the applications covered by the product group.

An industry representative highlighted the different ways in which substances such as flame retardants may be incorporated into components. In some cases they are reacted and so should be exempted. It was queried whether the evidence base was being put together to reflect what industry wanted or what the scientific evidence showed.

Addressing improper WEEE disposal

Substandard and improper treatment technologies were of concern to one stakeholder. A report by the European Environmental Agency was cited as evidence that considerable

amounts of electronic products end up outside the EU. The report estimates this trade to be at least 250 000 tonnes every year, possibly much more. '*These goods may subsequently be processed in dangerous and inefficient conditions, harming the health of local people and damaging the environment*'.

The main concerns related to brominated flame retardants and PVC cables. Whether or not the EU Ecolabel excludes use of PVC and halogenated FRs, it should allow manufacturers who succeed in making halogen-free substances to make such claims in association with the label.

Approach to testing

With regards to the proposal for product testing during the license period a Member State felt that this went too far towards market surveillance rather than compliance and wasn't necessary.

Follow-up research to finalise the criteria proposal for hazardous substances were steered by the comments from the AHWG2 and a second meeting of the sub-group (SG), which took place on the 11th July 2014.

Should declarations for Candidate List substances be required at product, component or material level?

In further discussions within the SG there was a general agreement on setting a threshold of 0.10% the non-presence of Candidate List substances. This is the threshold for notification under the REACH Regulation and, moreover, manufacturers and their suppliers are familiar with having to provide declarations at or above this threshold. Manufacturer's experience was that there are very limited substances on the Candidate List that may be present above 0.1% at the article level (usually only plasticisers).

Further investigation of how this threshold works in practice highlighted that if a declaration was to be requested without a threshold (i.e. below 0.10%) then this would go beyond current practices, with the exception of where manufacturers have implemented very specific restrictions that can be verified with laboratory testing. For example, those required under RoHS.

A more significant issue raised by manufacturers was whether the threshold should be applied at 'complex article' (the whole product), sub-assembly, component or material level. The first criterion proposal was worded to be verified at a component level. This is stricter than current practice because many products are imported as a finished article. Some manufacturers do not assemble their final products, having decided to outsource their design and assembly.

However, a key distinction was identified that could be used to introduce selectivity into the criterion. *Some manufacturers request declarations of compliance at what is termed 'sub-assembly' level* e.g. populated motherboard or HDD unit as supplied for final assembly. A stakeholder highlighted that a sub-assembly such as a HDD may be sold in the EU as an article itself, so it seems reasonable to ask for verification at a level equivalent to a sub-assembly that a consumer might be able to obtain themselves as a spare/replacement part.

A comparison was made between the sub-assemblies declarations of the two major manufacturers participating in the SG. This was on the basis of Candidate List declarations requested from suppliers. The results are presented in Table 10. Similarities can be seen for the major sub-assemblies, although some variations can also be seen, for example, with the inclusion of internal cables by Dell. It is also notable that the casing of a computer is not included, with references only to the chassis by Dell and to the bezel (front cover) by both Dell and HP.

Table 10. Comparison of the sub-assembly lists of two major computer manufacturers

Dell [1]	**Hewlett Packard** [2]
- Populated motherboard (includes RAM, graphics, CPU etc.) - Data storage device (HDD, SSD) - Optical Drive (if installed) - Internal *or* external Power Supply Unit - Chassis and bezel - Mechanical assemblies (fans, heatsinks) - Internal cables/cords/connectors - Power cord *Desktop-specific* - Wired or wireless keyboard	- Printed Circuit-board Assembly - Graphics card - Memory module(s) - Hard Disk Drive - Solid State Drive - Optical Disk Drive - Internal or external Power Supply Unit - Fan assembly and heat sink - Power cord - Keyboard Desktop-specific - Front bezel - Wired or wireless keyboard

- Wired or wireless mouse *Notebook-specific* - LCD display - Battery - Fingerprint reader	- Wired or wireless mouse Notebook-specific - Display panel - Port replicator/docking station - Power adapter - Battery - Touchpad
Notes: 1. Dell (2010) *EU REACH SVHC disclosure on the Candidate List*. Sample disclosure listing 2. HP, *EU Regulation 1907/2006 (REACH) Compliance*, HP Substance report.	

Pre-screening of the Candidate List for relevance to computer products

It was noted in SG discussions that there are Candidate List substances that are not relevant for electronics. Use of the IEC 62474 substance declaration list [17] was highlighted as a tool to pre-screen the Candidate List for relevance. This is then provided to suppliers who must then provide declarations down to concentration limit of 0.1%.

The IEC 62474 declaration list includes notes on what functions substances serve and in which products and/or components they may be present. In general it was felt by SG members to be relevant and reasonable to carry out such a pre-screen. It was highlighted that the use of pre-screening can be seen in the published restriction lists of manufacturers, where SVHC's of relevance are listed alongside substances restricted by, for example, RoHS.

Defining the scope of substances and components addressed by the hazard element of the criterion

The background research by IPTS has highlighted that a complete picture of hazards that may be present in a computer product is not available. Instead information must be pieced together from different sources, as summarised in Table 8. In the April 2014 (v1) criteria proposal a substance group and components list was defined

[17] See footnote 15

based on the evidence of progress made by leading manufacturers to address hazardous substances in computers.

This evidence has been brought together into a Computer evidence matrix (see Annex 1) that identifies the following activities by industry that in turn form the basis for the criterion proposal:

- Restriction of hazards by communicating to suppliers *substances that shall not be used* e.g. PAHs in plastic and man-made rubber;
- Substitution of hazards by *benchmarking and assessment of alternatives* e.g. flame retardants, plasticisers;
- Precautionary substitution of substances that cause exposure to hazards either at *manufacturing sites* or during the *improper disposal of waste electrical equipment* e.g. brominated flame retardants in motherboards, PVC in power cables;
- Early compliance with *RoHS derogations that may sunset* e.g. lead solder in servers, cadmium in metal contacts;

Based on further analysis and stakeholder feedback the v1 proposal for criterion 2(b) was too open in its scope to be implementable. This is because currently only some of the substance groups can be verified for the hazard classifications under 2b (i.e. flame retardants and plasticisers) whereas most are currently verified for substance restrictions of the kind in 2c (e.g. colourants, screen glass).

Flame retardants and plasticisers have been the main focus for planned substitutions of hazardous substances by leading manufacturers. These substance groups are also notable for being the first examples of substitutions by computer manufacturers where hazard classifications have been a consideration. This process has been supported by research programmes of the US EPA and assessments using Green Screen.

Further discussions within the SG emphasised that for certain substance groups identified in the Computer evidence matrix, industry has not been able to obtain further information or influence suppliers. A cited example was colourants in plastics,

which it was claimed had received attention but that no progress had been made because of confidentiality in the supply chain. Suppliers are also often given flexibility as to how they meet certain specifications e.g. plastic colour.

The most common approach is, instead, to use CAS numbers to identify specific substances that should not be present in the product or sub-assemblies. For example, several colourants of concern are identified in the IEC 62474 declaration list. Whilst the CAS numbers of colourants that may be used in different types of plastic can be identified from the catalogues of, for example, Clariant [18] and BASF [19] an overview of the hazard profile of different colourants and their comparative improvement potential is not currently available.

How much of the product is addressed by the criterion proposal?

The proposed approach is based on a narrowing of the scope to focus instead on specific groups of substances and the 'sub-assemblies' (or components) in which they may be found. In order to answer the question, which was posed by a number of Member States, A bill of materials for an example notebook computer from a study by Teehan and Kandlikar (2013) was analysed. The sub-assemblies and components were colour coded according to which are addressed by the different elements of the draft criteria:

- Restriction on Substances of Very High Concern (2a);
- Hazard derogations that reflect substitute flame retardants and plasticisers (Criteria Appendix 1a)
- Hazard restrictions applying to substances that may be present in sub-assemblies or components (Criteria Appendix 1b)
- Restrictions applying to substances that may be present in the final product (Criteria Appendix 1c)

[18] Clariant (2007) *The coloration of plastics and rubber*, Pigments & Additives Division.
[19] BASF, *Housing applications*, Accessed 2014, http://www.plasticadditives.basf.com/ev/internet/plastic-additives/en_GB/content/plastic-additives/Industries/Electrical_Electronics/electrical_electronics_applications

- Derogations applying to specific substances or groups of substances (Criteria Appendix 1d)

The indicative results for a notebook are presented in Table 11, supported by the full analysis in Annex 2, demonstrate that a large proportion of each product is addressed, in some cases by several elements of the criterion proposal. Large parts of each product are accounted for by homogenous metal components, for example the steel chassis and capacitor coils in a desktop, which are derogated by the proposed approach.

Table 11. Indicative coverage of a notebook BOM (Bill of Materials)

Criteria coverage sub-totals	***% of total product mass***
C2(a) SVHC	96.3%
A1(a) Substitute derogations	43.8%
A1(b) Hazard-based restrictions	1.3%
A1(c) Substance-based restrictions	59.4%
A1(d) Specific derogations	37.6%

Determining the hazard classification of substitutes

Background research and dialogue with stakeholders has enabled a range of substitute flame retardants and plasticisers to be identified that are used in different components. However, in seeking to decide which should be derogated for use in the EU Ecolabel, and what form this derogation should take, a problem emerges in that a complete picture of a substances hazard classification may not be readily available.

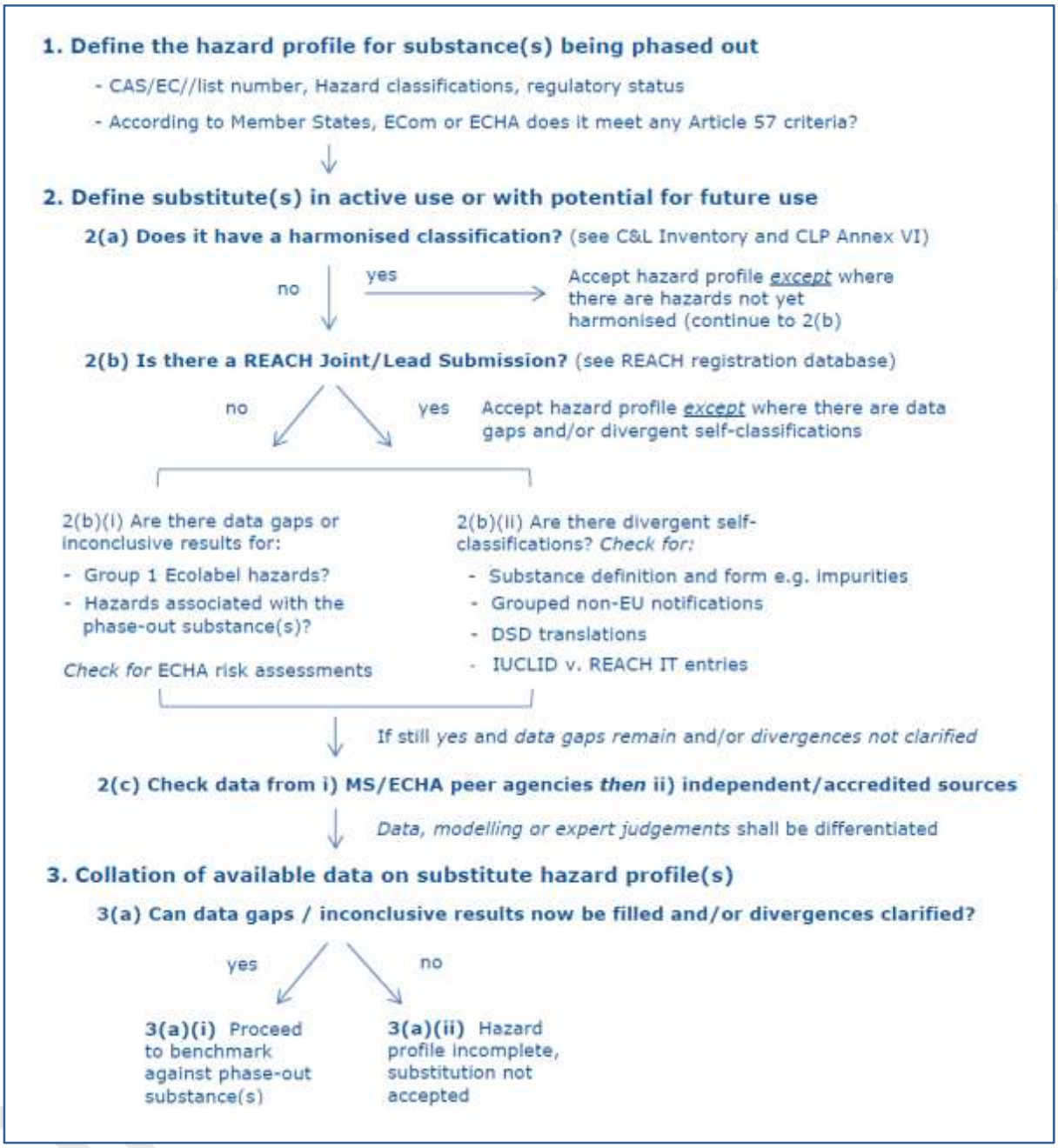
Based on follow-up discussions with ECHA it has been identified that this may be the case because of a number of factors:

- Substances are progressively being registered under REACH and so a substance may not be registered yet;
- Data gaps may exist in the hazard classifications for a substance and these may only be filled once testing proposals have been evaluated and agreed by ECHA;

- Where a substance has not been registered there may only be self-classifications to use as a reference point. These can be divergent depending on the state/form of the substance and, moreover, depending on the knowledge/expertise of the notifier they may not correspond to the final EU classification;
- Joint submissions and entries in the REACH registration database tend to provide greater confidence in the hazard classification because, as is encouraged by the REACH system, test data is shared by manufacturers;
- Harmonised classifications are only made where Member States or stakeholders make a proposal, as a result harmonisation may only focus on specific hazards associated with a substance.
- Adaptations to Technical Progress (ATPs) have resulted in changes to the classification rules, which may mean that self-classifications are incorrect.
- Data for low tonnage bands may more limited so, for example, there is the potential for gaps for hazards such as CMR which require longer term test data.

Because of these factors it may not therefore be possible to make a clear decision on a substances classification. It was therefore decided that, with input from ECHA, a decision making tool should be developed in order support the process. The resulting decision tree is presented in Figure 3.7. This tool was then used to determine hazard classifications for the substitute flame retardants and plasticisers identified. The results are compiled in Annex 3.

Figure 3.7 JRC-IPTS decision tree used to determine hazard classifications



An example of application of the decision tree to a flame retardant substitute is provided in Box 1. This example highlights a situation in which there are data gaps for a major substitute. Whilst the option exists to accept the self-classifications made, cross checking a hazard assessment by an ECHA peer agency provides a

potential means of filling the classification gaps and also highlights potential discrepancies in the self-classification for certain end-points.

Box 1. Application of the decision tree to a substitute flame retardant

Dihydrooxaphosphaphenanthrene (DOPO) CAS No 35948-25-5

Description: DOPO is a reactive flame retardant used in Printed Circuit Boards. It is the main substitute for TBBPA used by industry (CAS No 35948-25-5).

EU status: 74 notifications in C&L Inventory, including one REACH Joint Entry, which suggests that it is not classified but upon checking the REACH registration database it can be seen that data gaps exist for Acute Toxicity and CMR hazards.

Peer agency and independent data check: Cross checking with a US EPA study on PCB's we find that it is generally classify as a 'low' hazard (EU Ecolabel = no hazard) with the exception of 'medium' aquatic toxicity (EU Ecolabel = Group 3). It may therefore be classified with H412 and H413.

Options:

1. Accept that it is not classified according to the C&L Inventory if this is the finding for the Joint Entry for its use as a Flame Retardant.
2. Require further evidence that it is not classified as an acute toxin or CMR hazard, but this raises the issue of verification.
3. Use the US EPA's assessment to fill the gaps and cross-check the hazard profile, which suggests low acute toxicity and carcinogenicity but suggests medium aquatic toxicity (H412 and H413).

Using other hazard assessment tools and methodologies to fill classification gaps

Tools have been developed in the USA to address similar challenges when seeking to make decisions on the hazard profile of substances. The US EPA developed a hazard classification matrix for its design for the environment programme which it has applied to a range of different flame retardants. The matrix consists of a series of hazard end-points that mainly correspond to the EU Ecolabel hazard list. When the matrix is completed data gaps in GHS hazard classifications are clearly identified and can be filled based on expert judgement using evidence from computer modelling, read across and scientific literature.

The US Green Screen assessment tool has been developed by an NGO and broadly follows the approach of the US EPA [20]. At least one major computer manufacturer is now using Green Screen assessment tool to make decisions on investment in substitutions. A substances hazard profile is benchmarked based on combinations of GHS classifications and clearly defined characteristics, such as persistence or bioaccumulation, for which there is ready equivalence in REACH and CLP.

Discussions and feedback from the AHWG2 and the SG supported the use of information from governmental sources such as the US EPA (a peer agency for ECHA) or independent schemes such as Green Screen. Concern was, however, expressed that Green Screen as a system should not be used as the verification route for the EU Ecolabel. Instead it should be used alongside other sources of information in order to determine hazard profiles. This concern is reflected in the design of the decision tree in Figure 3.7, which emphasises the need to check data from ECHA peer agencies before resorting to independent schemes.

How shall substitutes be derogated?

The v1 proposal for substitute derogation made in April 2014 was considered to require further justification. Moreover, comparison with proposals for hazard benchmark levels in the TCO label suggested that important substitutes would not be permitted.

Three options for how substitutes could be derogated were discussed further within the Sub-group. The options were as follows:

1. *Derogate the white list based on hazards*: A white list of likely substitutes is finalised their associated hazards shall then be derogated.
   Background to the option: Whilst this option reflects the current approach in EU Ecolabel product groups it might be inflexible if other substitutes are introduced with different hazard profiles or if the classifications for important substitutes change in the future.

[20] Clean Production Action (2013) *Green Screen chemical hazard assessment procedure v1.2*

2. *Derogate/restrict based on hazard groups or benchmarks*: The electronic product ecolabel TCO will permit substances that are Green Screen benchmark level 2,3 or 4.
   Background to the option: Equivalence between the Green Screen benchmark levels and the EU Ecolabel hazard list can be established using the hazard groups 1-3. This option would give more flexibility for other substitutes to be brought forward. It would also allow for equivalence to be established with Green Screen and TCO.

3. *Provide a white list of substances that are accepted*: This option was proposed at the first AHWG but concern was raised in written comments about maintenance of such a list.
   Background to the option: This option relies on the white list substances having an acceptable/improved hazard profile, which is not clear in all cases. If a new substance is brought forward an applicant would need to proof that it has the same/improved hazard profile. This would reflect current practice in the EU Ecolabel, but verification of hazard classifications is considered to require strengthening.

Sub group members had divided views on the options. From the manufacturers side, one suggested either to derogate the hazard (Option 1) or describe a benchmark level from Green Screen in terms of hazards (Option 2). Another manufacturer showed a preference for Option 3 because they restrict using CAS No's and it would be clearer upon publication of the criteria. However, if needed they would be able to verify on the basis of hazards, with a preference: for Option 2. A third manufacturer wanted to target/exclude substances instead of hazards (Option 3). They considered the scope too open ended with hazards. From the NGO and MS side 1 *or* 2 were supported.

An industry stakeholder highlighted the need to take a broader view that just the hazard classifications. Referring to the example in Box 1 some FR's such as TBBPA are reactive. A life cycle perspective is required as DOPO has a worse carbon footprint. From the NGO and MS side the need was highlighted to consider

degradation products - as is done within Green Screen – as well as emissions from improper WEEE disposal were highlighted by another stakeholder.

No objections were raised when Option 2 was then proposed as a preferred option, being based on hazards but also allowing for flexibility and equivalence. It was agreed that degradation products and end-of-life environmental impacts would be explored, but only for targeted components of concern, given the need to minimise the complexity of the proposal.

Proposed decisions on derogation requests

Following consideration of the derogation requests received from stakeholders the proposed decisions are summarised in Table 12.

Table 12. Proposed decisions on derogation requests received

Substance(s)	Function within the product	Hazard profile and concentrations	Proposed decision
Diantimony trioxide CAS No 1309-64-4	Synergist for flame retardants used in casings and cables.	H351 (harmonised) *Typical concentration:* PVC 3.5 – 20% Non-PVC 1 – 10%	Derogation not granted *Reasoning:* Analysis of substitutes suggests that the flame retardants used in combination with ATO would not be derogated for use in EU Ecolabelled computers.
Lithium Cobalt oxide CAS No 235-362-0	Cathode in rechargeable lithium batteries.	H412, H361f, *data lacking for* acute toxicity, C, M and STOT hazards. *Typical concentration:* 20-40% battery weight	Derogation granted *Reasoning:* The substance is a key component in high performance batteries, which are required by the proposed EU Ecolabel criteria. Controls on workforce exposure are proposed as a derogation condition

Substance(s)	Function within the product	Hazard profile and concentrations	Proposed decision
Lithium Cobalt Nickel Manganese Oxide CAS No 480-390-0.	Cathode in rechargeable lithium batteries.	H330, H372, H412, *data lacking for* carcinogenicity. *Typical concentration:* 20-40% battery weight	Derogation granted *Reasoning:* The substance is a key component in high performance batteries, which are required by the proposed EU Ecolabel criteria. Controls on workforce exposure are proposed as a derogation condition
Lithium hexafluorophosphate CAS No 21324-40-3	Salt forming part of a rechargeable lithium battery electrolyte [1].	H301, H311, H372, *data lacking for* acute toxicity, C and R. *Typical concentration:* 1-5% battery weight	Derogation granted *Reasoning:* The substance is a key component of high performance batteries, which are required by the proposed EU Ecolabel criteria.
Nickel in stainless steel CAS No 7440-02-0	Nickel is used in stainless steel alloys in order to provide corrosion resistance Stainless steel casings may be required in locations where hygiene is a consideration e.g. hospitals, food production facilities.	H351, H373 and H412 *Typical concentration:* 8-13%	Derogation granted. *Reasoning:* Steel is a standard material used in casings, bolts, nuts, screws and brackets. Evidence submitted demonstrated the limited potential for migration where used in locations without frequent skin contact.
Beryllium oxide CAS No 1304-56-9	Beryllium oxide is used as a thermal conductor in high reliability electronic circuits e.g.	H301, H330, H350i, H372 (harmonised classifications) *Typical*	Derogation not granted. *Reasoning:* Beryllium oxide ceramic is rarely used in consumer electrical and

Substance(s)	Function within the product	Hazard profile and concentrations	Proposed decision
	military or space applications.	*concentration:* <0.1% in an article.	electronic equipment due to its higher relative cost. It is not therefore considered necessary to grant a derogation given the existing use of safer alternatives.
Beryllium alloys CAS No 7440-41-7	Beryllium alloys are used to increase electrical and thermal conductivity, enhance the reliability of connectors and facilitate miniaturisation of components. It enables resistance to be minimised whilst retaining strength at higher temperatures.	H301, H330, H350i, H372 (harmonised classifications) *Typical concentration:* <0.0050% in connectors and springs	Derogation not granted. *Reasoning:* No current use could be identified in desktop, notebook or server computers. Given the concentrations would be below the 0.1% threshold and the existing use of safer alternatives it is not therefore considered necessary to grant a derogation.
Notes: 1. Other salts and solvents required for high performance batteries have been identified and added to the overall hazard derogation for battery electrolytes. Details of these substances are entered in the hazardous substance evidence matrix.			

Addressing toxic emissions from improper WEEE disposal routes

The environmental impacts associated with the improper disposal of WEEE were highlighted by LCA work package of the ENFIRO project [21] and are well documented. Informal recycling and treatment of, amongst other components, printed circuit

[21] ENFIRO *Life Cycle Assessment of Environment-Compatible Flame Retardants (Prototypical Case Study),* WP8: D8.5 LCA report, January 2013

boards and cables to recover precious metals and copper [22] has been analysed and shown to result in a range of toxic emissions, including species of dioxins and furans, at much higher concentrations than those generated by modern controlled forms of incineration [23]. These have led to the exposure of communities and the pollution of local environments [24].

In a recent report the European Environment Agency quantify the scale of illegal WEEE export to less developed countries where improper disposal and informal recycling may take place [25]. The EEA estimate that 16-38% of the EU 's WEEE waste (between 550,000 and 1,300,000 tonnes) was exported in 2008. However, whilst illegal WEEE shipments are classified as hazardous waste under the Basel Convention and are the subject of new controls under the recast WEEE Directive, the EEA highlights that there are no restrictions on the export of goods for re-use, potentially accounting for a significant proportion of WEEE waste collected in Europe.

The ENFIRO projects' LCA work package identified from literature the following scenarios and modelled the related emissions to the environment from the informal treatment of an exported notebook computer in China:

- Open burning of cables to retrieve copper wires (lead and cadmium, chlorinated dioxins)
- Open burning of circuit boards to retrieve precious metals (brominated dioxins from Brominated Flame Retardants)

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[22] Oeko-Institut, *Recycling critical raw materials from waste electronic equipment*, Commissioned by the North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection, 24th February 2012 *and* Oeko-Institut, *Informal e-waste management in Lagos, Nigeria – socio-economic impacts and feasibility of international recycling operations*, UNEP SBC project, June 2011

[23] Sepúlveda, A., Schluep, M., Renaud, F.G., Streicher, M., Kuehr, M., Hagelüken, C. and Gerecke, A.C., (2010) *A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipments during recycling: Examples from China and India,* Environmental Impact Assessment Review 30, 28–41

[24] Gullett, B.K.; Linak, W.P.; Touati, A.; Wasson, S.J.; Gatica, S.; King, C.J *Characterisation of air emissions and residual ash from open burning of electronic wastes during simulated rudimentary recycling operations*, Journal of Material Cycles & Waste Management 9: 69-79, 2007

[25] European Environment Agency, *Movements of waste across the EU's internal and external borders*, Report No 7/2012

- Desoldering of printed wiring boards by heating them on a stove (lead/tin emissions)
- Acid leaching of printed wiring boards to retrieve precious metals (acid emissions to air and water, cyanide emissions)
- Manual dismantling of flat panel display with mercury-containing lamps (mercury emissions)

Concern relating to the end-of-life phase of electrical products has driven action by computer manufacturers to phase-out those materials and flame retardants for which evidence exists of the potential for toxic emissions [26].

The ENFIRO LCA modelling and comparison of the potential emissions from improper disposal of WEEE (see Figure 3.8) illustrates the significance of dioxin and furan emissions to human toxicity mid and end-points for WEEE incorporating brominated and chlorinated flame retardants. Notably in the low dioxin scenario the contribution of non-halogenated flame retardants to human toxicity is of comparative significance to the halogenated flame retardants. This is understood to be the result of toxic emissions such as carcinogenic Polyaromatic Carbons (PAHs).

[26] Chem Sec, *Leading Electronics companies and Environmental organisations urge EU to restrict more hazardous substances in electronic products in 2015 to avoid more global dioxin formation*, 19th May 2010, http://www.chemsec.org/images/stories/publications/ChemSec_publications/RoHS_restrictions_Company__NGO_alliance.pdf

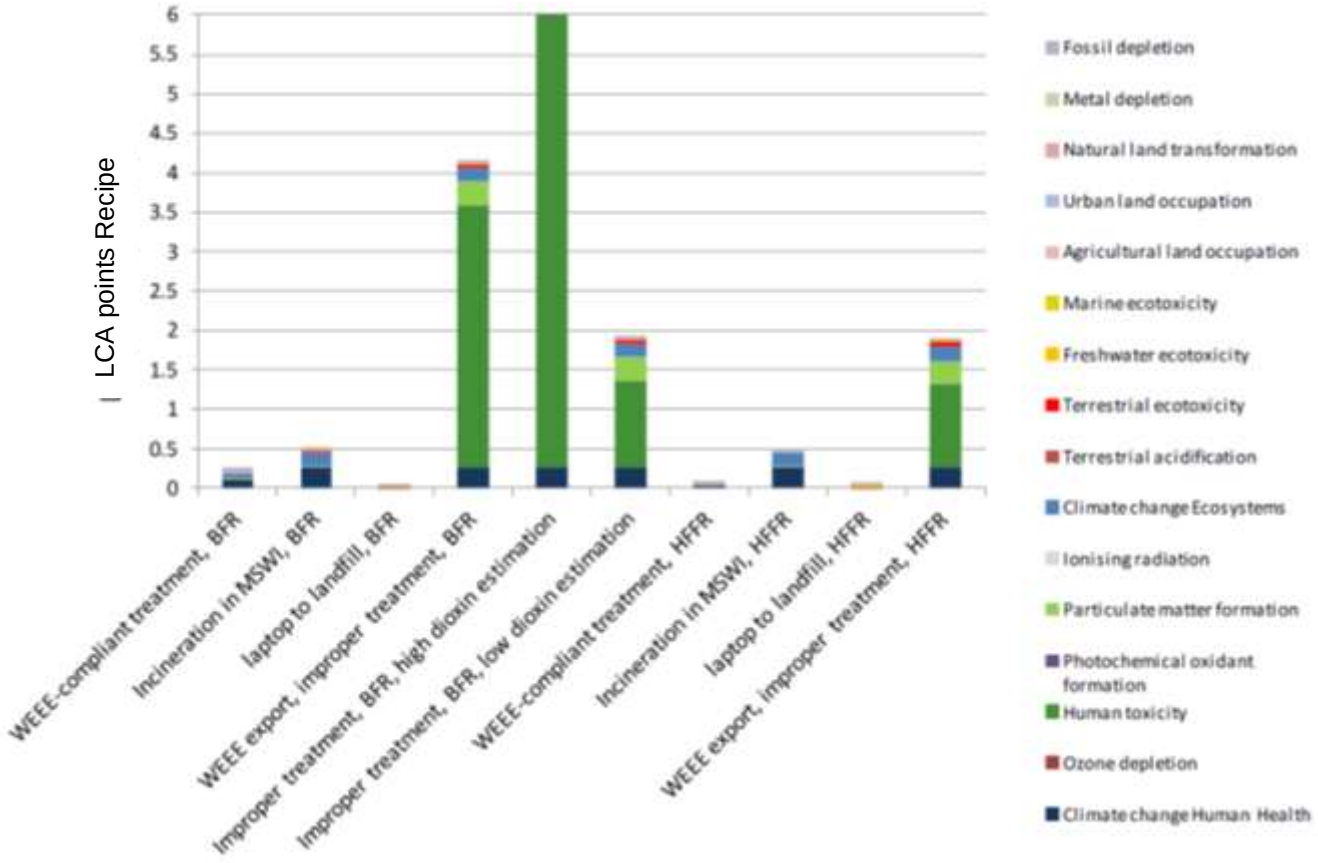

Figure 3.8. influence of dioxin formation during improper WEEE treatment on the total environmental impact of the waste treatment of one laptop.

Source: ENFIRO project (2013)

The testing of toxic emissions from the burning of printed circuit boards and cables has been carried out as part of the US EPA's Design for the Environment programme and ENFIRO work package 8, as well as studies by, amongst others Gullett et al (2007), Hull et al (2008) and Li et al (2009).

Simulation of the improper thermal treatment of WEEE waste can be approximated based on evidence of how this is carried out in different locations and by then using fire performance test methods and scenarios such as those described in ISO 19700 or IEC 60695-7-50, for which Hull et al (2008) suggests that the results are comparable with those from a large-scale fire model.

Simulation of the potential conditions for the formation of dioxins and furans, as well as their subsequent quantification, is understood to be more complex than for emissions such as chlorinated gases and PAHs. The US EPA and University of Dayton study characterised both dioxin and carcinogenic PAHs emissions from a range of flame retardant options [27]. The results, which are illustrated in Figure 3.9, show a variation in emissions based on the flame retardant chemistry. The emissions results are significantly higher than the 0.2 mg/kg sum total proposed by the German UBA for the control of PAHs.

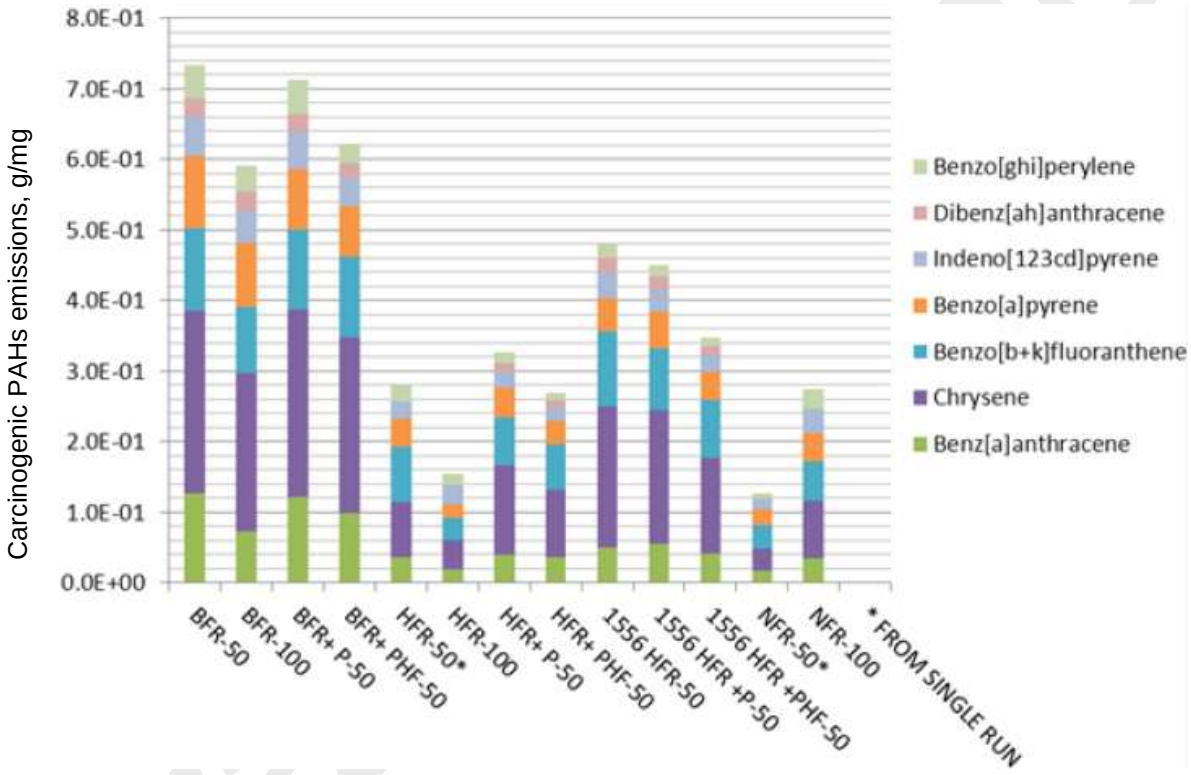

Figure 3.9. Carcinogenic PAHs emissions for three flame retardant resin chemistries

Source: US EPA (2013)

[27] US EPA and the University of Dayton, *Phase II of Circuit Board Emissions Project: Cone Calorimeter Testing and Emissions Analysis*, Presentation of findings 19th September 2013

3.2.4 Second proposal for hazardous substances criteria

Second criteria proposal

Criterion 2. Restriction and substitution of hazardous substances in the product and its sub-assemblies and component parts

2(a) Restriction on Substances of Very High Concern (SVHC's)

The product and its associated sub-assemblies and components as defined below shall not contain substances that have been identified according to the procedure described in Article 59(1) of Regulation (EC) No 1907/2006 (the 'REACH Regulation') which establishes the candidate list for substances of very high concern in concentrations of greater than 0.10% (weight by weight).

The absence of the above referred to substances shall be declared for the product and, as a minimum, the following sub-assemblies:

All products

- Populated motherboard (including CPU, RAM and graphics units)
- Internal or external Power Supply Units
- External power cable
- Internal cables, cords and connectors
- Data storage devices (HDD or SSD)
- Optical Drive (if installed)
- Chassis, casing and bezel

Integrated desktops, portable all-in-one computers and notebooks

- Display unit (including backlighting)

Desktops and integrated desktops

- Wired or wireless keyboard
- Wired or wireless mouse

Notebooks and portable all-in-one computers

- Battery

In communicating this requirement to suppliers of the listed sub-assemblies applicants may pre-screen the candidate list based on the relevance of substances to the product using the IEC 62474 declarable substance list.

No derogation shall be given to the above referred to substances if they are present in an article ('the product') or in any homogeneous part of a complex article ('associated sub-assemblies') in concentrations greater than 0,10 % (weight by weight).

Assessment and verification: The applicant shall compile declarations of the non-presence of candidate list substances for the product and, as a minimum, the listed sub-assemblies. Where declarations are made based on a pre-screening of the candidate list using IEC 62474 the screened list given to sub-assembly suppliers shall also be provided by the applicant. Where a derogation has been granted then the applicant shall show that use of the substance is in compliance with the stated derogation conditions and verification requirements.

2(b) Restriction of CLP hazard classifications and Article 57 criteria

Hazard classifications and criteria that shall apply

The product and its associated sub-assemblies and components shall not contain substances that meet the criteria for classification as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction (CMR), in accordance with Regulation (EC) No 1272/2008 ('the CLP Regulation') and Council Directive 67/548/EC ('the DSD Directive').

Substances that meet the aforementioned criteria shall not be present in the product and its associated sub-assemblies and components at concentrations greater than 0.10%. Specific concentration limits identified in Annex VI of the CLP Regulation or in sub-criterion 2(b)(ii) shall take precedence over this generic concentration limit.

The CLP hazard classifications and REACH Regulation Article 57 criteria that shall apply are listed in Table 2 . For the purpose of this product group the hazard classifications and Article 57 criteria are grouped based on their hazardous properties. Derogations shall be granted for individual hazard classifications or groups of hazards according to the requirements in Appendix 1.

Table 2 CLP hazard classifications and REACH Article 57 criteria that apply to the product

Please see the draft criteria document

The hazard classifications in Table 2 generally refer to substances. However, if information on substances cannot be obtained, the classification rules for mixtures apply. The most recent classification rules adopted by the European Union as Adaptations to Technical Progress (ATPs) shall take precedence when determining hazard classifications.

2(b)(i) The scope of restrictions that shall apply to the product

In accordance with the provision within Article 6(7) of Regulation (EC) No 66/2010 application of 2(b)(i) to the product as a whole shall be derogated and instead the scope of substance groups to which 2(b)(ii) shall apply, and the associated sub-assemblies and components for which verification shall be provided, shall be defined as those in Table 3.

The restrictions and derogations applying to the sub-assemblies and components identified in Table 3 are listed in Appendix 1. The sub-assemblies and components of product shall not contain the hazardous substances listed in Appendix 1 at or above the specified concentration limits or according to the restrictions stipulated.

The restrictions contained in Appendix 1 shall be communicated to suppliers and agents responsible for the manufacturing of the specified sub-assemblies and components. Verification and testing requirements are specified for sub-assemblies, components and production stages.

Table 3. Substance groups to which hazard restrictions shall apply

Substance group	Sub-assemblies or components for which verification shall be provided
Flame retardants	- Printed Wiring Boards >10 cm2 including the populated motherboard, - Central Processing Units (CPU's) - Data storage drives, - Internal and external power supplies - Internal connectors and sockets - Plastic casings and bezels

Plasticisers	- External power cables - Internal wiring - Plastic casings
Coolants	- CPU and GPU heat transfer systems
Polymer stabilisers	- External power cables
Polymer colourants	- Plastic casings and bezels
Polymer contaminants	- External plastic and man-made rubber
Biocides	- Plastic and rubber parts of peripheral devices and external cables
Metal solder and contacts	- Printed Wiring Boards - Contacts between internal components
Metallic coatings	- Metal casings and bezels
Vapour discharge	- LCD screen backlight units
Fining agents	- Screen glass
Cleaning agents and degreasers	- All internal components subject to treatment in the final assembly plant
Electrolytes	- Batteries in portable devices
Doping and luminescence	- LED backlighting

Assessment and verification: The applicant shall provide declarations of compliance with the requirements in Appendix 1. These shall be supported, where stipulated, by valid test reports and toxicological data confirming the hazard classification or the concentration of substances that are present.in the specified sub-assemblies or component parts of the product.

Test reports, where required, shall be valid at the time of application for a production model. Applicants shall additionally identify where derogated substances are present in the product and provide supporting evidence showing how the derogation conditions have been met.

The following information shall be provided to support declarations of the hazard classification or non-classification for each substance identified as being used:

(i) The substance's CAS, EC or list number;
(ii) Harmonised CLP hazard classifications;
(iii) Self-classification entries in ECHA's REACH register.

Where a classification is recorded as 'data lacking' or 'inconclusive' according to ECHA's REACH register database, or where the substance has not yet been registered under the REACH system, toxicological data shall be provided that is sufficient to support conclusive self-classifications in accordance with Annex II of the CLP Regulation and ECHA's supporting guidance. In the above mentioned cases self-classifications shall be verified, with the following information sources being accepted:

(i) A Safety Data Sheet fully completed in accordance with Sections 2,3,9,10, 11 and 12 of Annex II of the CLP Regulation;
(ii) Toxicological studies by ECHA Peer Agencies, Governmental regulatory bodies or Intergovernmental bodies;
(iii) An expert review of scientific literature and existing testing data, where necessary supported by results from new testing carried out by independent laboratories using methods approved by ECHA;
(iv) A report prepared by a toxicologist accredited to an independent hazard assessment scheme in accordance with the guidelines in Annexes I and II of ISO 17065. Schemes shall be based on the GHS or CLP hazard classification system.

Information on the hazardous properties of substances may be generated by means other than tests, for instance through the use of alternative methods such as in vitro methods, by quantitative structure activity models or by the use of grouping or read-across in accordance with Annex XI to the REACH Regulation.

2(b)(ii) Substance declarations for sub-assemblies and components

Applicants shall request substance declarations for the associated sub-assemblies and components identified in Table 4. For each identified substance group the supplier, or suppliers, shall declare the CAS numbers for the substances used to fulfil the function.

Table 4. Substance groups for which CAS number declarations are required

Substance group	Sub-assemblies or components requiring declarations
Colourants	Plastic casing and bezel, keyboard, mouse
Stabilisers	External cables Internal electrical wiring

Assessment and verification: The applicant shall compile supplier declarations listing the CAS numbers of the substances used in the specified sub-assemblies and components.

Summary rationale for the proposed changes

Sub-criterion 2(a): SVHCs

- Manufacturers obtain declarations for the presence/non-presence of Candidate List substances to meet the legal obligation for notification at concentrations >0.1% under the REACH system. This is generally obtained for the whole imported article as most computers are assembled outside of the EU. However, some manufacturers additionally seek notifications for sub-assemblies and components.
- It is therefore proposed that in sub-criterion 2(a) SVHC declarations are required for the product as a whole and a defined set of 'sub-assemblies'. The additional declaration for sub-assemblies would introduce an additional level of strictness, differentiating those manufacturers who require more information from their suppliers,
- It is additionally proposed in sub-criterion 2(a) that, reflecting current practices, the process of screening the Candidate List for relevant substances is made

easier for applicants by allowing use of the IEC 62474 declarable substance list.

Sub-criterion 2(b)(i): Hazard-based restrictions

- Leading manufacturers have started to identify, screen and request the substitution of hazardous flame retardants and plasticisers based on their hazard classifications. This is not yet the case for other types of hazardous substances that may be present in a computer product, with manufacturers communicating to their suppliers restrictions for specified substances instead.
- It is therefore proposed that, based on the evidence gathered to date, the scope of 2(b) is defined based on the extent of leading manufacturers' activity to control hazardous substances in parts of a computer. Moreover, to ensure that the approach is workable for the electronics sector, very specific restrictions shall be defined relating to substance groups and sub-assemblies where they are present.
- The evidence collected to date has been used to compile a list of hazard and substance based restrictions, together with derogations. Each restriction related to a specific sub-assembly or component. The list reflects best practice within the sector.
- Hazards have been restricted for flame retardants and plasticisers in a way that reflects substitutions of hazardous made by leading manufacturers. Safer substances have been identified and their hazard profile determined.

Sub-criterion 2(b)(ii): Substance declarations

- Some substances found within a product – for example, plastic colourants – have not yet been comprehensively addressed by even leading manufacturers. It is therefore proposed that a number of substance groups are identified for which manufacturers shall request basic information (in the form of CAS numbers). This would encourage further understanding and provide further information for the next criteria revision.

- The hazards addressed by the criterion have been grouped and combinations of additional hazards such as PBT and vPvB have been added. This approach provides the benefit of allowing a read across to the Green Screen scheme, which is now being used by leading manufacturers, and the new hazardous substance criterion to be adopted by successful electronics ecolabel TCO.

Revision of the approach to assessment and verification

- Reflecting discussions with ECHA it is proposed to revise the assessment and verification in order to better reflect the uncertainty associated with identifying hazard classifications, including gaps in data and classifications.
- In the absence of harmonised classifications or joint entry self-classifications in the REACH register, 'data lacking' or 'inconclusive' classifications could be filled using a number of verified sources, including approved testing, ECHA peer agencies (e.g. US EPA) and third party schemes (e.g. Green Screen).

3.3 Cluster 3 – Lifetime extension

The research results of Task 3 and Task 4 revealed that attention should be paid to the extension of the lifetime of computers in order to reduce the overall environmental impacts caused by ever shorter lifecycles, primary extraction and manufacturing processes.

In the current criteria documents, requirements that influence the lifetime of computers are spread across different discontiguous criteria (“lifetime extension”, “repairability”). To illustrate the importance of lifetime extension for computers, for the revision it is proposed to cluster the associated criteria, rearrange some of the sub-criteria and overall complementing them by some new proposals.

3.3.1 Criterion 3.1 – Expansion facilities

Present criteria, Decisions 2011/337 and 2011/330
"Lifetime extension": Personal computers shall have facilities that enable the following: (i) Exchangeable and upgradeable memory and graphic cards; (ii) Expansion capability: presence of at least four USB interfaces Notebook computers shall have facilities that enable the following: (i) Exchangeable and upgradeable memory (ii) Expansion capability: presence of at least three USB interfaces as well as a connection for an external monitor. The computer shall also be designed so that major components (including memory drives, CPUs and cards) can be exchanged and/or upgraded easily by the end-user. For example using snap, slide in/slide out or cartridge-style housing for components. *Assessment and verification*: The applicant shall declare the product's compliance with these requirements to the competent body.

Major proposed changes (first proposal)

Proposed revised criteria (first proposal)
Capability enhancement / upgradeability Computers shall have the following facilities to enable easy exchange to upgrade major components without the use of special tools by the end-user: (i) Desktop PCs: • Presence of at least 4 USB interfaces. • Installation and/or exchange of memory (for thin clients only applicable if equipped with a processor), storage capacity (not applicable to thin clients) and optical drives (not applicable to thin clients). (ii) Notebook PCs: • Presence of at least 3 USB interfaces as well as a connection for an external monitor • The memory shall be exchangeable or upgradeable. • Presence of a modular bay for an extra battery. (iii) Tablet PCs: • Presence of at least 1 USB interface. • Support for external monitor, keyboard and mouse. • The memory shall be exchangeable or upgradeable. *Assessment and verification*: The applicant shall declare the compliance of the product with these requirements to the competent body.

- The components required to be upgradeable shall be defined more clearly to take into account major technical developments (to-date, certain components are not separately exchangeable any more).
- New: Inclusion of specific requirements for tablet computers.

- New: Notebooks shall provide a modular bay for an extra battery as this provides potential advantages in terms of lifetime extension and material efficiency (additional battery capacity, availability of battery spare parts, modular bay also usable for other applications, e.g. optical drives).

For more details cf. Task 4 report “Improvement Potential”, section 4.2.3.1 “expansion capability” and section 4.2.3.2 “upgradeability”.

Consultation questions
• Expansion capability: Are there any other technical solutions (USB host, hub, thunderbolt etc.) instead of a certain number of standard USB interfaces fulfilling the same requirement and therefore justifying a different formulation of the criterion? • Is there any possibility for upgrading graphic cards, CPUs or other significant components? Are there differences between Desktop and Notebook PCs?

3.3.1.1 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, the proposals were felt to be too strict for ultrabooks (very light notebooks). There are some potential applicants that may encounter problems. It was questioned whether with 'the cloud' and external drives capability enhancements were still needed.
One of the manufacturers stated that they had provided an additional battery bay but that this had not been successful. It was felt to be more important to provide a higher-quality battery. Tablet batteries were identified as being an issue. They cannot be easily removed to replace them. A view was expressed that tablet manufacturers should be forced to ensure this. Finally, for business users it must be possible to update and adapt to new software. This issue is particularly relevant to GPP.
Written feedback of stakeholders following the AHWG meeting suggested

- to not restricting the criterion for an external physical interface to USB to avoid discriminating between brands or connection techniques. It should be analysed if there are any other technical solutions (USB host, hub, thunderbolt etc.) instead of a certain number of standard USB interfaces fulfilling the same requirement and therefore justifying a different formulation of the criterion.
- Further, the requirement for a notebook for a “modular bay for extra battery” is asked to be clarified as “modular bay to permit battery change-over, e.g. to

enable use of an additional or spare battery". On the other hand, it is noted that the request that Notebook PCs must have an exchangeable and upgradeable memory and a modular bay for extra battery would not allow Ultrabooks to be certified and thus cutting off an important / widespread subgroup of notebooks.

- "Installation and/or exchange of storage capacity" is additionally proposed.
- The exchangeability and upgradeability of internal memory and batteries is asked to be included in the criteria set as these requirements are very important e.g. for the professional use of IT devices, i.e. GPP.
- The possibility for upgrading graphic cards, CPUs or other significant components should be further analysed, as well as possible differences between Desktop and Notebook PCs.
- It is informed that the Nordic Ecolabel include the following criteria for Tablet PCs (actually one licensee fulfilling the criteria):
  - A demand requiring that it must be possible to swap the battery (a swap by the supplier is OK). A replacement battery must be available as an option or a spare part. The battery replacement can be done at a repair shop.
  - A minimum requirement for storage capacity together with a demand for a storage expansion slot: For tablet computers the following is required:
    - Working memory (RAM) capacity shall be minimum 1 GB.
    - Storage capacity shall be minimum 16 GB
    - Storage expansion slot (example a SDHC slot)
    - Minimum 1 expansion port following industry standard for accessories.
    - Support for external monitor, keyboard and mouse.
- It is proposed to provide clear communicable criteria for this product group:
  - Easy replaceable battery (lifetime-extending feature)
  - Easy upgrade of memory (lifetime-extending feature)
  - Easy upgrade of storage by micro-SD card (lifetime-extending feature)

Further research and evidence:

- According to PCMag[28], generally, **USB is the most widely used standard hardware interface for attaching peripherals (e.g. monitor, mouse, hard drives, keyboard, printer, camera, etc. …) to a computer.** There are different types and formats of sockets depending of the devices being host or peripheral. Sockets of hosts (e.g. computers, hubs or chargers) are called "**Type A**", and sockets of peripherals are "Type B" (e.g. printer, scanner), "Mini-B" (e.g. digital camera, hub) or **Type "Micro-B"** (e.g. tablet PCs, smartphones)[29].
- **Number of USB interfaces**: Experiences show that USB interfaces are susceptible to defects; if this happens at the mainboard, it is impossible to repair[30]. Thus, computers generally should have more than one USB port in order to provide substitutes for defect interfaces. For convenience, a larger number of USB ports should be available to connect the different necessary peripherals.
  - For **Desktop PCs**, a rough analysis of devices at the market showed that four to six USB ports are common; conventional notebooks usually provide three USB ports.
  - **Ultrabooks** being classified as notebooks as well, generally have less physical interfaces due to their slim and lightweight form factor. However, there are several ultrabooks from different brands on the market providing 3 USB interfaces (e.g. Samsung ATIV Book 7, Lenovo IdeaPads U-series, Asus Zenbook UX302, or Fujitsu Lifebook UH572 Ultrabook)[31]; the Gigabyte U2142 model (combined tablet/ultrabook) provides 4 USB ports.

[28] Cf. http://www.pcmag.com/encyclopedia/term/53531/usb

[29] For illustration of different types of sockets and plugs see for example http://www.conrad.de/ce/de/content/steckertypen_im_ueberblick/Steckertypen-alle-Abbildungen-im-Ueberblick-Conrad-

[30] Source: personal communication to editorial staff of computer magazine c't.

[31] Further models with 3 USB interfaces, see e.g.: www.onlinekosten.de/computer/ultrabook

- **Tablet PCs** commonly have Micro-B interfaces, i.e. the devices are used as peripheral, not as host (see previous point above). Some Micro-USB ports are host-capable, meaning that USB devices like sticks, digital cameras or external hard drives can directly being connected to the tablet PC; however, for this functionality there is an additional adapter needed ("on-the-go (OTG) USB adapter"). Further, some peripherals need more power than provided by the micro-USB port so that they do not work steadily. An additional self-powered USB hub (see next point below) might solve that problem, but meaning the end of mobility of the tablet PC. Finally, USB OTG often lacks of a comprehensive driver support so that external devices are not recognized by the tablet[32]. For this reason, Micro-B interfaces are not recommended as expansion capabilities for tablet PCs.
  The larger USB Type A interfaces are more difficult to realize[33] in Tablet PCs due to the small and flat devices with commonly rounded off edges. However, there are some Tablet PCs with USB Type A interfaces on the market; examples are Microsoft Surface, Samsung Galaxy Tab 3 7.0, or Sony Vaio SVT1121B2EW; the Fujitsu Stylistic Q702 hybrid tablet and notebook PC provides 2 USB ports[34]. Especially for business consumers using tablet PCs in their working environment, USB interfaces for accessories and the support for an external display, keyboard and mouse seems to be of importance.

- **USB hubs** are typically used to extend the number of USB sockets (common e.g. four-port hub). Hubs can be self-powered, deriving their power from a wall outlet (providing up to 500 mA at each port) or bus-powered, plugging into the computer's USB bus and obtaining all their power from the bus (splitting the total 500 mA among all the ports and the hub itself, e.g. to only 100 mA at each

[32] Source: http://www.pcwelt.de/ratgeber/News-Tablet-PC-USB-Anschluss-am-Tablet-PC-7345291.html

[33] Further note, that tablet PCs only benefit from the faster transmission rate of USB Type A if the performance of the tablet processor is adequate; most tablets still have smartphone processors resulting in lower transmission rates at all.

[34] Further examples can be found at www.onlinekosten.de/computer/tablet-pc-slate/2

port).[35] For the EU ecolabel criteria, USB hubs are not recommended as expansion facility due to the following reasons: They require an additional device / cable; there might be problems with the compatibility; some peripheral devices, e.g. external 2.5'' hard drives, need more than the provided 100 mA (self-powered USB hub, i.e. additional power supply unit necessary).

- **USB 2.0 ⇔ USB 3.0**: USB 3.0 is the most current version adopted in 2008. Compared to USB 2.0, USB 3.0 has larger data transfer rates (4.8 GBit/s instead of 480 Mbit/s). The power supply of external devices is 900 mA instead of 500 mA, so that peripherals with higher power demand can be connected without additional power supply (e.g. external hard drives). This would be especially useful for Tablet PCs due to their limited memory capacity. The energy demand of USB 3.0 is lower, as for example connected peripherals are only awakened from virtual sleep mode when being active. Generally, USB 3.0 is downstream compatible to USB 2.0 with exception of Type-B interfaces, as the design of the plugs is different. According to Computerwoche (2013)[36], citing the market research company IDC, it is forecasted that in 2016 all PCs and Notebooks will be equipped with USB 3.0 interfaces. However, today USB 2.0 is still widespread. For the EU ecolabel criteria, it is recommended to require at least one USB 3.0 port as upcoming standard technology with major advantages. A rough analysis of devices at the market showed that many Desktop and Notebook PCs already apply at least one USB 3.0 interface.
- **Thunderbolt**, developed and mainly[37] used by Intel / Apple, is an interface for high-speed transfer of data and audio/video information with 10 GBit/s (for comparison: USB 2.0 has 480 MBit/s, USB 3.0 has 4.8 GBit/s). The next

[35] Source: http://www.pcmag.com/encyclopedia/term/53534/usb-hub
[36] Source: http://www.computerwoche.de/a/print/was-ist-usb-3-0,2518972
[37] For example, HP uses Thunderbolt technology in some of its professional workstations and display products as well as in an ultrabook workstation; cf. http://www8.hp.com/us/en/hp-news/press-release.html?id=1473065; Dell plans to introduce Thunderbolt in its workstation segment in 2014; cf. http://news.cnet.com/8301-1001_3-57618779-92/dell-workstations-could-embrace-thunderbolt-later-this-year/; a list of further Thunderbolt-compatible devices can be found at http://en.wikipedia.org/wiki/List_of_Thunderbolt-compatible_devices

generation, Thunderbolt 2, is an update to the original Thunderbolt specification and takes the original's two 10 Gbps bi-directional channels and combines them into a single 20 Gbps bi-directional channel. The amount of data able to go through a Thunderbolt connection hasn't increased, but the throughput of a single channel has been doubled, allowing e.g. to stream a 4K video and write it to disk at the same time[38]. A disadvantage is the higher component cost for chips and cables (e.g. two meter of Thunderbolt cable 49 Euro) compared to USB (ten times lower)[36]. To connect USB peripherals to Thunderbolt interfaces, an additional USB adapter is needed.

According to Computerwoche (2013) [36], citing the market research company IDC, it is forecasted that in 2016 around 16 percent of mobile computers and 13 percent of Desktop PCs will be equipped with Thunderbolt interfaces.

For the EU Ecolabel, Thunderbolt interfaces should not be discriminated or excluded as their high data rate is an important feature, especially for the connection of high resolution displays such as full HD, or 4k monitors. However, due to the high market relevance of peripherals with USB interfaces, computers should not use Thunderbolt as the only solution, but additionally to USB, e.g. as interface for an external monitor (see also next point).

- **Additional interfaces**:
  - Due to ergonomic reasons, especially for mobile devices like Notebook or Tablet PCs with comparably small displays and keyboards or touch-sensitive control, and especially in business environments the support for connecting an external monitor, keyboard and mouse should be given. For displays, this could be realized by different interfaces, e.g. VGA, HDMI, DVI, DisplayPort, Thunderbolt etc. Interfaces for keyboard and mouse could still be PS/2, but today, they are increasingly connected by USB. For the EU Ecolabel, the additional interfaces for an external display, keyboard and mouse should not be further specified regarding their technology.

[38] Source: http://www.macworld.com/article/2083257/what-you-need-to-know-about-thunderbolt-2.html

- For Tablet PCs, e.g. the Nordic Ecolabel additionally requires a storage expansion slot (e.g. a SDHC slot) in addition to the built-in storage. According to Computerworld (2013)[39], some manufacturers per se do not include an expansion slot in their devices referring to the increasing usage of online storage capacities via cloud. An IDC market analyst cited in that article indicates that most people are not that interested in using these expansion slots and they can negatively impact design, cost and usability.

- **Workstations and Small Scale Server** are designed for extensive and high-performance business solutions which already includes a high number of interfaces for peripherals per se (USB 2.0, USB 3.0, or Thunderbolt etc.)[40].

3.3.1.2 Second proposal for expansion facilities criteria

Proposed revised criteria (second proposal)
Expansion facilities (i) Desktop PCs and Thin Clients: • Presence of at least 4 USB interfaces, of which at least one USB 3.0. (ii) Notebook PCs and Mobile Thin Clients: • Presence of at least 3 USB interfaces, of which at least one USB 3.0. • One additional interface for an external monitor (iii) Tablet PCs: • Presence of at least 1 USB interface. • Support for external monitor, keyboard and mouse. *Assessment and verification*: The applicant shall declare the compliance of the product with these requirements to the competent body.

Major proposed changes

- The title of this criterion has been changed to “expansion facilities” and by shifting the sub-criteria on upgradeability (memory etc.) to section 0 ‘repairability and upgradeability’ the focus has been clearly set on the presence of standardized interfaces to easily expand devices by external peripherals.

[39] See http://www.computerworld.com/s/article/9241181/Tablet_storage_Do_you_really_need_an_expansion_slot_?pageNumber=1

[40] For an overview of mobile workstations and their equipment, see for example http://www.notebookcheck.com/Top-10-Workstation-Notebooks.65535.0.html

- USB has been proven to be the most widely used standard interface for attaching peripherals. Hubs and thunderbolt interfaces are not recommended as Ecolabel criteria per se as they demand additional devices / adapter, cables, might have problems with compatibility and, in terms of thunderbolt, have considerably higher component costs. On the other hand, thunderbolt can act as monitor connection and thus is not generally discriminated by the criteria.
- For desktop and notebook PCs, at least one USB 3.0 interface is required enabling larger data transfer rates and energy demand being lower.
- The required number of interfaces has not been changed compared to the first criteria proposal. For ultrabooks, a sub-category of notebooks, market analysis indicated several products with 3 USB-interfaces. For tablet PCs, the presence of a USB Type A interface seems more challenging due to the small form factor of the devices; however, the common Type Micro-B interface does not allow tablets to be used as host connecting other peripherals; market research shows that there are tablets on the market providing a USB Type A interface.
- The proposal to require for notebooks the presence of a modular bay for an extra battery has been deleted.
- A requirement on an additional storage expansion slot for Tablet PCs has not been added due to the increasing usage of online storage via 'cloud'.

3.3.1.3 Stakeholder feedback and further evidence

Summary of stakeholder feedback
It was questioned by a Member State what the purpose of the criteria was. Is it to provide added functionality? Another stakeholder asked whether the USB requirement for a tablet included mini and micro port specifications. Would this support a mouse and other peripherals? A USB 3.0 interface allows for a faster data transfer and also gives the possibility to provide more electrical power than a USB2.0 interface. For example, USB2.0 devices provide power of 2.5W per device whereas a USB 3.0 can provide power of

4.5W and USB 3.1 can provide power of 10W. For laptops the only issue which is under consideration is the speed of data transfer and not the capacity of electrical power. The expected functionality therefore requires clarification.

A manufacturer did not see expansion ports as a significant issue. It was highlighted that there may be other technical aspects to focus on. For example, the nature of circuitry may mean that one internal failure may result in all USB ports failing.

It was queried as to whether a wireless solution would be permitted. This would, for example, support next generation display and keyboard connectivity.

A stakeholder supported the proposal if it is clear that early failure may be an issue and that it would support a longer product lifetime.

3.3.1.4 Third proposal for expansion facilities criterion

Third criteria proposal
Criterion proposal withdrawn

Summary rationale for proposed changes

- Battery replacement is now to be fully addressed by a combination of criteria 3(b) and 3(e)
- There does not appear to be significant evidence that expansion facilities, or faults relating to them, are a significant influence on the lifespan or reliability of computers.
- The rapid uptake of improved expansion ports such as USB 3.0, the development of new forms of storage accessible via wi-fi connections, together with the use of wireless peripherals also suggests that expansion is less significant an issue than the fundamental durability, reliability and repairability of the product as a whole or key hardware components.
- On this basis a sub-criterion addressing expansion facilities is withdrawn in order to focus attention on sub-criterion that are considered to be more important.

3.3.2 Criterion 3.2 – Lifetime of batteries

For notebook computers and tablet computers, the lifetime of the rechargeable batteries is a crucial and limiting factor to the overall lifetime of the whole product. Thus, the following new criteria are proposed for inclusion in the revised criteria documents for computers (user instructions on factors influencing the lifetime of batteries; application of a test method to ensure a minimum battery capacity for ecolabelled computer products). For more details cf. Task 4 report "Improvement Potential", section 4.2.3.4 "Life-time of individual components".

3.3.2.1 First proposal for lifetime of batteries criteria

Proposed new criteria (first proposal)

Lifetime of batteries

Notebook computers and tablet computers shall have the following facilities to enable lifetime extension of rechargeable batteries: Information should be included in the user instructions and the manufacturer's website to let the user know the factors influencing the lifetime of batteries as well as instructions for the user facilitating its prolongation.

Assessment and verification: The applicant shall declare the compliance of the product with these requirements and shall provide a copy of the instruction manual to the competent body. These user instructions should then be preloaded onto the notebook or tablet computer for the user to read and available for access on the manufacturer's website.

Consultation questions

A test method to ensure a minimum battery capacity

In Germany, as part of revising the Blue Angel ecolabel criteria for mobile phones, the following test procedure has been applied in order to derive minimum requirements regarding the lifetime of rechargeable lithium batteries: Four different batteries per size and type shall be tested. All four tested batteries shall meet the requirements of the following test method.

Test Method:

C is the rated capacity given on the battery in ampere hours (Ah) as maximum capacity. The test starts (quasi the 'zeroth' cycle) with a discharge at 0.2 C until the cut-off voltage is reached (according to IEC/EN 61960: specified voltage under load where the discharge of one cell or battery is completed). The subsequent repeated charge and discharge shall be done in accordance with the specifications listed in the following tables. Different requirements are set for different applications.

Test Specifications for Rechargeable Lithium Batteries:

Cycle No.	Charge	Rest period after charge	Discharge	Rest period after discharge
1-399	Manufacturer specification	30 minutes	1.0 C to cut-off voltage	30 minutes
400	Manufacturer specification	1 hour	0.2 C to cut-off voltage	

The minimum discharge time for cycle 400 shall be 3.5 hours and the capacity delivered during cycle 400 shall be equal to 70 % of the rated capacity.

Applied Test Specification for Rechargeable Lithium Batteries in Blue Angel ecolabel requirements for Mobile Phones:

Cycle No.	Charge	Rest period after charge	Discharge	Rest period after discharge
1-149	Manufacturer specification	30 minutes	1.0 C to cut-off voltage	30 minutes
150	Manufacturer specification	1 hour	0.2 C to cut-off voltage	

The minimum discharge time for cycle 150 shall be 3.5 hours and the capacity delivered during cycle 150 shall be equal to 90 % of the rated capacity.

Consultation question: Discussion if one of the above introduced test specifications for rechargeable Lithium Batteries can also be required by the EU Ecolabel for notebook PCs and tablet PCs.

3.3.2.2 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, the high cost of the 400 cycle test presented (based on IEC/EN 61960) was highlighted, with up to 20,000 Euro quoted. Only large brands would be able to comply on this basis.

The value of the shorter 150 cycle test was questioned as this would not necessarily be representative enough. Even this test is still long. Moreover, the applicability of the second (Blue Angel) approach to notebook and/or tablet batteries was questioned and will need to be checked.

It was asked if the test methods consider user behaviour. Intelligent charging was identified as an important issue to address. If a notebook is plugged into the mains power a long time the battery cycles then this will deteriorate the battery. A view was expressed that this may equally be a question of education (cf. section 3.7.1 on user instructions). A manufacturer highlighted the potential for green wash with battery claims. It was asked if there are international standards that manufacturers are using as the basis for their claims.

High capacity, long life batteries can be provided but they cost a lot more. Finally, the potential to provide consumers with information on solar charging equipment should be explored, as addressed as an option in EPEAT criteria.

Written stakeholder feedback following the first AHWG meeting:

- From an environmental perspective, durability of the batteries is seen as one of the most important quality aspects for notebooks and other portable devices. Therefore, the inclusion of meaningful criteria regarding the “long-life” battery quality is a key issue for the revision of the criteria. Based on this consideration, any effort possible should be made to come up with a robust and, at least, indicative testing method for battery lifetime. An additional issue of similar importance is the need for technical solutions to avoid deterioration of the battery while the device is connected to the grid for long periods (e.g. while using a notebook with a clocking station).
- A battery lifetime declaration has already been discussed in relation to the non-energy related requirements under ErP, Lot3. Information to be provided by manufacturers would be the minimum number of loading cycles that the batteries can withstand (applying only to notebook computers); however, concern is that at present, there are no agreed international technical standards that deliver reproducible results allowing customers to make informed purchase decisions. Therefore this requirement is seen as neither suitable for the EU Ecolabel nor for GPP.
- The norm IEC/EN 61960 could probably be used only by big brands since it happens to be very expensive and it might request 6 months to 1 year just to test one battery. The option of the test for mobile phones’ batteries could be interesting since it seems quicker but it has to be considered that mobile’s batteries are smaller than notebook’s so maybe the test for notebook’s batteries wouldn’t fit with those reduced cycles and times.
- It is proposed a specification of a minimum number of charge cycles that the battery can deliver at acceptable performance. Extension of life prior to first repair (or replacement of battery) will maximise lifetime of the product. It is recommended that this is based on a minimum of e.g. 1 charge per day for the minimum guarantee length required by the ecolabel criteria. For example if the

guarantee is 2 years, 2 x 365 = 730 charge cycles to a certain high proportion of the original battery performance.

Further research and evidence

Battery life and cycle length within today's market

Battery lifetime declarations are now required to be made for notebooks under the non-energy related requirements of the Ecodesign Implementing Measure Regulation (EU) 207/2013 Annex II Part 7.1 'Information to be provided by manufacturers' (from 1st July 2014):

> *(o) the minimum number of loading cycles that the batteries can withstand (applies only to notebook computers);*

Early declarations provide an indication as to the standard cycles and test methods used by OEM's. For example, Dell declares that all notebook and tablet batteries meet the accelerated endurance in charge/discharge cycles procedure of IEC EN 61960[41] retaining 60% capacity over 300 cycles. Commentators suggest that **300-500 cycles is the de facto standard for lithium ion batteries**[42]. The ITU (International Telecommunication Union) recently published Recommendation L.1010 on Green Batteries which proposes retention of **80% of capacity after 500 cycles as a benchmark for a long lasting battery**[43].

A closer look at the market, however, reveals that longer battery life and cycle claims appear to be increasingly important, particularly for business machines. A review of leading products on the market, together with feedback from OEM's, suggests that battery life claims are the most frequently communicated to consumers. Of the notebook manufacturers that dominate the EU market share Acer, Dell, Asus, HP and Toshiba all offer high end consumer or business models with over 7-8 hour battery life and 800 or 1000 cycle batteries. In some cases this also allows the OEM to provide an extended warranty for the battery itself of up to 3 years.

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[41] Dell (2014) *ErP Lot 3 Technical documentation*, http://www.dell.com/downloads/global/corporate/environ/comply/ErP_Lot_3_Public_Information.pdf

[42] Battery University, *How to prolong lithium based batteries*, http://batteryuniversity.com/learn/article/how_to_prolong_lithium_based_batteries

[43] ITU, *Green batteries solution for mobile phones and other hand-held information and communication technology devices*, Recommendation ITU-T L.1010, February 2014, http://www.itu.int/rec/T-REC-L.1010-201402-P

Publicly available market data to determine the selectivity of these specifications could not be located. Feedback from some OEM's, however, is that it is difficult to communicate longer cycles or battery lifetime to consumers, who are generally more interested in the **number of hours that a battery will give them 'off grid'**. This is therefore an important measure of a quality product for some purchasers. For 15 inch+ screen desktop replacements this can now extend to an estimated 7-8 hours+ (dependant on hardware combinations). For Ultrabooks it can extend from estimated 8-9 hours to up to 16 hours in one example.

Ultrabook models respond to consumer and business demand for longer battery life by combining battery technology with much reduced energy use. As a result most models can operate for a full working day without requiring a charge. This performance is based on battery packs formed from cylindrical or, more usually because of the form factor, prismatic or lithium polymer cells[44]. Prismatic lithium ion cells are more durable because they swell less upon charging, resulting in reduced degradation and a longer life span.

Manufacturers of cylindrical and prismatic batteries with greater capacity and longer cycles include Samsung[45], Boston Power (supplying Asus)[46] and Amperex (supplying Apple)[47]. Boston Power carries the Nordic Swan Ecolabel for batteries, which requires 80% charge retention after 800 cycles[48]. Notable amongst the leading OEM's is Apple who offers 80% retention of charge after 1,000 cycles as standard on new MacBook Pro and Air models[49]. The cost of these batteries is higher, with the costs for design/development/testing passed onto the OEM in the price of the battery, which may be up to 80% more expensive than 300-500 cycle performance. It has been highlighted by a leading lithium ion battery manufacturer that it is more

[44] Hewlett Packard, *Understanding lithium ion and smart battery technology*, www.hp.com
[45] Samsung SDI, *Cells, packs and prismatic battery products*, http://www.samsunglib.com/en/app/laptop.jsp
[46] Boston Power, *Sonata cell*, http://www.boston-power.com/resources/download/sonata-5300-data-sheet
[47] Amperex Technology, http://www.atlbattery.com/technology/en/technology-4.htm
[48] Nordic Ecolabelling of Rechargeable Batteries, Version 4.2, December 2010 – 31 December 2015
[49] Apple, *Determining battery cycle count*, Accessed March 2014, http://support.apple.com/kb/ht1519

important to specify longer cycle endurance for notebooks where the battery cannot be readily changed by the consumer.

Extending battery life using intelligent charging

The battery life cycle can be extended through the use of intelligent charging systems that control how a battery is charged and discharged, as well as power management of the computer. Battery life span degrades more rapidly if there is a deep charge and discharge i.e. if a battery is charged to near 100% capacity and is then subjected to near full discharge. Minimising the 'depth of discharge' will therefore extend the lifespan of the battery, as illustrated in Table 13.

Table 13: Relationship between depth of discharge and number of cycles

Depth of discharge	Discharge cycles
100% DoD	300 – 500
50% DoD	1,200 – 1,500
25% DoD	2,000 – 2,500
10% DoD	3,750 – 4,700

Source: Battery University (2014)

Pre-installed software is now provided with some notebooks, for example with Apple, Asus and Toshiba products, which rewrites the firmware of the battery can be **used to limit charging to approximately 80% of battery capacity**. This has the potential to extend the battery life cycle by >50%, although in practice this reduces battery life, i.e. usage hours during the day, which we have already highlighted as being important for consumers.

Benchmarking and verifying performance

Battery life is verified using a range of **different software packages and test routines**. Consumer magazines and websites use a combination of the two, with some having developed their own bespoke routines, making comparability difficult. Tests include, for example, a wireless web browsing protocol[50] and a HD movie

[50] Laptop Magazine, *Laptops with the longest battery life*, 31st March 2014, http://blog.laptopmag.com/all-day-strong-longest-lasting-notebooks

playback[51]. OEM's tend to make reference to business software such as Power-mark[52] or Mobilemark[53] which simulate real-life scenarios and power demands. Limited information could be found at this stage to judge the relative merits of these benchmark tools.

In terms of **battery cycles** the **industry standard is IEC EN 61960**. IEC 61960 specifies both a standard endurance in cycles test at 0.2 I_t A and an accelerated endurance in cycles test routine based on increased charge of 0.5 I_t A within the tolerance of the battery. The latter was introduced into the last revision by CENELEC technical body CLC/TX 21X in 2011. An accelerated test based on EN 62660-1 is also understood to have potential for adaption to notebook and tablet batteries and is briefly discussed below.

The potential for accelerated testing to reduce time and cost

Accelerated tests are possible for longer life cycle batteries, reflecting the need to reduce the time and cost of bringing new products to market. IEC EN 61960 adopts a higher charge rate for its accelerated option. This would enable, for example, for an 800 cycle claim to reduce the time for testing from 252 days to an estimated 153 days (see Table 14). This is, however, likely to be an underestimate as over many cycles the battery deteriorates and each cycle takes longer. An adjustment factor would therefore need to be applied. The potential for a reduction in costs have been requested from a major battery testing body.

Table 14: Comparison of IEC 61960 endurance in cycle test options

	IEC 61960 cycle specification (400 cycles)	**Extended cycle performance (800 cycles)**
Option 1: 0.2 I^tA (7.6.2)	126 days	252 days
Option 1: 0.5 I^tA (7.6.3)	76 days	153 days

[51] Which? *How we test laptops*, http://www.which.co.uk/technology/computing/guides/how-we-test-laptops/

[52] Futuremark, *Powermark software*, https://www.futuremark.com/benchmarks/powermark

[53] BAPCo, *Mobilemark 2012*, http://bapco.com/products/mobilemark-2012

It is understood that there are only a small number of battery manufacturers globally who supply the major notebook manufacturers, who in turn expect verification of battery cell or pack performance. So whilst the costs may appear high they should be seen in the context of securing volume orders to OEM's, suggesting that the costs are quickly absorbed as a prerequisite to supply the market.

Accelerated tests that combine increased charge rate and temperature can also be carried out[54]. Test specifications combining different variations in these parameters have been developed in the US for electric vehicle batteries, including in support of the 'Freedom Car' programme. Guidance has been developed by Government laboratories and by the vehicle industry[55]. It is understood that this approach can be used to model the projected life cycle performance over 15-years lifespan in 1-2 years.

This form of accelerated testing has been standardised in IEC 62660-1, which specifies a test at 45^{o}C, however, concerns have been raised that these results cannot easily be extrapolated to batteries performance at room temperature and that this would exceed the design limit for many batteries.

A major lithium ion battery manufacturer provided feedback that such tests are used by manufacturers to compare performance between their own product lines, but that they may not be appropriate for comparing the performance of different manufacturer's products because of the potential for variations in the tolerance of different battery designs to accelerated conditions such as higher temperatures. An organisation that carries out battery testing globally highlighted a further problem in that in order to supply to notebook or tablet OEM's a reference is preferred to an international test standard such as IEC 61960.

[54] Thomas.E.V, Bloom.L, Christophersen.J.P and V.S.Battaglia, *Rate-based degradation modelling of lithium ion cells, Journal of power sources*, 206 (2012), p-378-382

[55] Steffke, K., Inguva, S., Van Cleve, D., and Knockeart, J., *Accelerated Life Test Methodology for Li-Ion Batteries in Automotive Applications,* SAE Technical Paper 2013-01-1548

A test variation has been developed by a team from Universities in Belgium which is based on depth of discharge, which we have already highlighted as an important factor in battery lifespan and stability[56]. This may warrant further investigation.

3.3.2.3 Second proposal for battery quality and lifetime criterion

Proposed new criterion (Second proposal)
'Battery quality and lifetime' a) Notebooks shall provide the user with a minimum of 7 hours of battery life after the first full charge. This shall be benchmarked using Mobilemark software or equivalent. b) Notebook and tablet batteries shall meet the following cycle requirements: (i) Models in which batteries can be readily changed by consumers shall maintain 80% of their original capacity after 750 charging cycles; (ii) Models in which batteries cannot be readily changed by consumers shall maintain 80% of their original capacity after 1000 charging cycles. This performance shall be verified according to the IEC EN 61960 'endurance in cycles' test carried out at 25^{o}C and at a rate of either 0.2 I_t A or 0.5 I_t A (accelerated test procedure). c) The cycle performance requirement described in (b) may be achieved using pre-loaded software which partially charges the battery up to 80% of capacity. In this case the applicant shall pre-install the software in such a way that it is the default charging routine and they shall verify the charging cycle performance according to the requirements in (b). The maximum partial charge shall also provide a battery life that complies with sub-criterion (a). d) Information about known factors influencing the lifetime of batteries as well as instructions on how the user can prolong battery life should be included in pre-loaded energy management software, written user instructions and posted on the manufacturer's website. *Assessment and verification:* The applicant shall provide a test method showing that the battery packs or cell types used in the product meet the specified battery life and charging cycles. Partial charging and the accelerated test method specified within IEC 61960 may be used to comply. A demonstration version of the energy management software and text content of user instructions and website articles shall additionally be provided.

Major proposed changes:

- Battery life is an important factor in consumers' choice of a notebook and so it is proposed to establish a minimum threshold for a good quality battery. This would reflect the performance of desktop replacements rather than ultrabooks in order to keep the requirement simple.
- Verification of the battery life is problematic due to the range of different methodologies and aspects used by consumer bodies and OEM's. The most

[56] Omar.N, Daowd.M, Hegazy.O, Mulder.G, Timmermans.J-M, Coosemans.T, Van de Bossche.P and J, Van Mierlo, *Standardisation work for the BEV and HEV applications: Critical appraisal of recent traction battery documents*, Energies, 2012, 5 p-138-156

comprehensive reference point is considered to be professional testing software but further input is required from stakeholders on how to select based on the underlying method used.

- The life span of the battery can be measured by the retention of rated capacity over a number of cycles. Whilst testing for endurance cycles under set conditions may not be fully representative of real life conditions in which a battery will operate, the routines set out in IEC 61960– both standard and accelerated –are considered to represent an international reference point for comparability of a batteries underlying performance potential.
- It is therefore proposed to introduce two benchmarks of excellence. The first 80% retention of capacity after 750 cycles for easily changed batteries, aligning with the recommendation of the ITU for 500 cycles but requiring partial charging to meet the requirement. The second 1,000 cycles for batteries that cannot readily be changed by a consumer, so as to minimise their potential to become a barrier to extended product life.
- Cycle endurance shall be verified according to IEC 61690 using either the standard or accelerated endurance cycle test routine. It shall be allowed for cells to be verified as this is more commonly carried out by the battery manufacturer whereas pack testing may be carried out or commissioned by the OEM.
- Moreover, in recognition of the importance of depth of discharge on battery lifespan it is proposed to specifically encourage partial charging as a means of complying with the ambitious cycle performance requirements. Compliance with partial charging to extend the endurance shall, however, still deliver the same minimum battery life for the consumer.
- Further investigation and feedback is requested on the potential for an additional accelerated test option based on standards from the electric vehicle sector or based on depth of discharge.
- Given the influence of how a notebook is used on battery life the wording relating to user information has been expanded to include a requirement for a

battery management system to be included within pre-installed power management software.

3.3.2.4 Stakeholder feedback and further evidence

Summary of stakeholder feedback
The proposal should differentiate between models where the batteries can be easily changed and those where it is more difficult/not possible. It was asked whether in situations where the batteries cannot be changed these models should not be able to meet the criterion. The term 'readily changed' requires a clearer definition. Are some special tools and knowledge required and would this also apply to business customers? Verification based on the IEC test method was supported. It was queried whether it would need to be verified for battery cells or packs. It was felt that 80% retention was too ambituous and that 70% might be more realistic, although another stakeholder stated that there would need to be a good justification to reduce the ambition level. It could be higher for models where the battery cannot be as readily changed e.g. Ultrabooks. The applicability of the criteria to tablets is to be clarified. A manufacturer asked whether the additional lifespan and performance would have an implication for the weight of the battery and therefore the product. A manufacturer responded that this would depend on the form of battery. There has been a move from larger cylindrical batteries to flatter, lighter prismatic batteries. A manufacturer stated that power consumption may relate to screen size. A Member State asked how the 7 hour battery life shall be measured. With reference to the proposed verification software is what asked what modes and scenarios are used by the Mobilemark software – are they representative? A manufacturer confirmed that Mobilemark and some other similar softwares are industry standard. It can be used to simulate a range of realistic scenarios.

Ensuring that batteries can be easily changed

A definition of how easy it is for a notebook or tablet battery to be changed was raised by a number of stakeholders, and was also understood to have been discussed during the recent revision of the Nordic Swan criteria. It is notable that the Ecodesign Regulation imposes a requirement that from July 2014:

> *'If a notebook computer is operated by battery/ies that cannot be accessed and replaced by a non-professional user….manufacturers shall provide in the technical documentation, and make available on free-access websites and on the external packaging of the notebook computer, the following information 'The battery[ies] in this product cannot be easily replaced by users themselves'.'*

Moreover, The Battery Directive 2013/56/EC requires Member States to ensure that manufacturers design appliances to allow the readily removal of waste batteries by end-user or by qualified professionals that are independent of the manufacturer.

In order to explore this issue further it was decided to analyse a sample of computer products in order to try and define what constitutes an 'easy' or 'readily' extracted battery. Notebook computers with a sub-notebook or 'ultrabook' form factor and tablet computers were analysed by JRC-IES, with the former being chosen because their slim design is understood to necessitate greater integration of the battery into the casing.

The process of battery extraction was codified in each case into the number of steps and the related tools required to extract the battery. The potential and ease of extraction were considered from the point of view of the consumer, a service centre and a recycler.

Analysis and findings for sub-notebook batteries

The first issue is to attempt to define sub-notebooks as a separate sub-product within the family of notebook computers. Subnoteboks are a very thin and light version of traditional notebooks that has emerged with the onset of Apple's Macbook Air product and Intel Corporation's Ultrabook chipsets. They are generally under 18-21

mm thick and 1.8 kg. Most models are characterised by a solid state drive instead of a rotating hard disk drive, low power processors and prismatic battery packs lasting from 5 to up to 16 hours. Optical disk drives are generally omitted due to their limited size.

The analysis of sub-notebooks took as its starting point the 28 models addressed by the Electronics Takeback Coalition in their 2012 briefing [57], The steps required to access and extract the battery packs was studied by analysing audio-visual material available from manufacturers and over the internet.

The steps required were codified into six main groups, defined alphabetically from A to F. For groups C, D and E, subgroups have been further defined using numerical values. The numerical values refer to the number of additional steps required to extract battery packs. For example, code C means that to extract battery packs, first the base cover needs to be opened, and then the battery unplugged and unscrewed. Code 1+C means that a pre-step is required.

Table 15 presents the findings of the analysis for the 28 models. In addition to the number of steps it identifies the tools required to extract the battery and the number of units from the sample found with such features.

Table 15. Steps required to extract batteries in selected sub-notebook models

Code	Embedded battery?	Steps	Number of steps	Tools	Number of units	%
A	No	Spring-loaded release	1	none	1	4
B	No	Unscrew battery pack	1	Screwdriver	1	4
C	Yes	Remove base cover, unscrew and unplug battery pack	3	Screwdriver	13	46
1+C	Yes	Steps described in C plus one pre-step. For example, remove rubber feet and connector cover on the side	4	Screwdriver	2	7
2+C	Yes	Steps described in C plus two pre-step. For example, remove rubber feet, connector shell on the side and remove additional screws	5	Screwdriver	2	7

[57] Electronics Takeback Coalition, *Ultra-inconvenient*, 15th August 2012

1+C+1	Yes	Steps described in C plus one pre-step and one post-step. For example, remove rubber feet, connector shell on the side, remove adhesives and unplug additional cables	5	Screwdriver	2	7
D	Yes	Remove base cover, remove adhesive, unscrew and unplug battery pack	4	Screwdriver	2	7
2+D	Yes	Steps described in D plus two pre-steps. For example, remove rear panel and HDD unit	6	Screwdriver	1	4
E	Yes	Remove base cover, connectors, lift tape, unscrew and unplug battery pack, and pull without disconnecting speakers cables	6	Screwdriver	2	7
F	Yes	Unscrew base cover, turn the computer and press the tab in to loosen the keyboard, unplug the keyboard cable, unplug and remove the palm rest, unscrew battery and lift it out of the laptop	6	Screwdriver	1	4
5+F	Yes	Steps described in E plus 5 pre-steps. For example, remove SD blank, unscrew and remove access door, remove the memory and remove screws	11	Screwdriver	1	4

Source: JRC-IES (2014 draft). *Analysis of material efficiency for EU Ecolabel criteria: the example of two product groups. Environmental Footprint and Material efficiency support for product policy*.

The results show that only 8% of the subnotebooks analysed have battery packs that are externally accessible via a dedicated bay, whereas 92% have battery packs embedded within the main casing. For 46% of the models the battery can be extracted by removing the base cover, unplugging the battery from the main printed circuit board (PCB) and then unscrewing it from the laptop chassis.

Of the remaining models additional steps are required before or/and after removing the base cover, including the removal of adhesives, and in the worst case scenario the keyboard and palm rest requires removal. In general, the results show that the

extraction of battery packs in sub-notebooks is generally not easy for a consumer and could, in most cases, invalidate a warranty.

Analysis and findings for tablet batteries

The analysis of tablets took as its basis a study published by Fraunhofer IZM which disassembled and analysed 21 models [58]. The evidence from this study was supplemented by audio-visual material available from manufacturers and over the internet. For some models, it was not possible to compare evidence from the Fraunhofer IZM study with audiovisual material because the manufacturer could not be identified, as these were anonymised. As was done for sub-notebooks, the steps were codified in order to summarise the diverse types of battery extraction identified.

Table 16 presents the findings of the analysis for the 21 models. In addition to the number of steps it identifies the tools required to extract the battery and the number of units from the sample found with such features.

Table 16. Steps required to extract batteries in selected tablet models

Code	Embedded battery?	Steps	Tools	Number of units	%
A	No	Spring-loaded release	none	1	5
B	Yes	Remove screws	Screwdriver	1	5
B+1	Yes	Remove screws plus up to three connectors	Screwdriver, spudger	2	10
C	Yes	Remove adhesive/s	Heat gun or heat pad, spudger	2	10
C+1	Yes	Remove adhesive/s plus up to three connectors	Spudger	5	24
D	Yes	Remove adhesive/s plus unscrew	Screwdriver, spudger	1	5
D+1	Yes	Remove adhesive and unscrew, plus up to three connectors	Screwdriver, spudger	6	29
D+2	Yes	Remove adhesive/s and unscrew, plus remove more than three connectors	Screwdriver, spudger	3	14

[58] Fraunhofer IZM, *Disassembly analysis of slates: Design for repair and recycling evaluation*, Final report, August 2013.

Source: JRC-IES (2014 draft). *Analysis of material efficiency for EU Ecolabel criteria: the example of two product groups. Environmental Footprint and Material efficiency support for product policy*.

The results show that 95% of the units were designed with battery packs embedded in the casing and only 5% (one unit) was designed to be externally accessible via a dedicated bay. Among the models studied, 20% could be opened by using a spudger and screwdriver to open the casing, followed by unscrewing up to three connectors.

Models identified under codes C and D require the additional removal of adhesives to open the case and/or to remove the battery. About 10% of the models required the use of a heat gun the remove the adhesive fixing the base cover to the display. Often small components such as a camera, cable, tape or electromagnetic interference (EMI) shield need also to be removed.

In the case of both sub-notebooks and tablets knowledge about the disassembly or extraction procedure in advance facilitates less destructive disassembly in less time and also enables easier location of specific parts (i.e. battery packs) (Schischke, Stobbe et al. 2013). This suggests that providing simple instructions for opening the back cover of the notebook or tablet could facilitate easier repair or disassembly.

Benchmarking and verifying battery life

Two of the most commonly used software packages used to benchmark battery life are understood to be Powermark by Futuremark [59] and Mobilemark by BAPCo [60]. Futuremark is a private enterprise with a community of developers that includes Apple, Asus, Dell, HP, Lenovo and Microsoft. BAPCo is a non-profit enterprise established to develop benchmarking tools for its members who include Asus, Dell, HP, Lenovo, Microsoft, Samsung and Toshiba – although its origins with Intel raise concerns with some commentators that it has/continues to favour products with Intel

[59] Futuremark, *Powermark*, Accessed 2014, http://www.futuremark.com/benchmarks/powermark
[60] BAPCo, *Mobilemark 2012*, Accessed 2014, http://bapco.com/products/mobilemark-2012

processors [61]. BAPCo has a 'government network' and claims its software is used in public procurement by 24 EU states.

Both Powermark and Mobilemark are professional benchmarking programmes which can be used to simulate combinations of different tasks on a portable computer until the battery power is run down. The softwares consist of the following scenarios:

- Powermark includes three scenarios – balanced, productivity and entertainment. The first two are similar but differ in that web and word processing activities are supplemented in the balanced scenario by video and gaming. The entertainment scenario consists of video and gaming.
- Mobilemark has two scenarios which are more diverse. Office productivity features word processors, spreadsheet, email, web browsing and wireless activity. Media creation and consumption features photo manipulation, video encoding, video playback and audio playback.

The new Mobilemark 2012 scenarios appear to respond to criticism that it was too optimistic [62], with factors cited including screen brightness being set too low, assumptions relating to idle periods and background energy use relating to wireless use and music players. A battery life comparison for the previously criticised Mobile Mark 2007 with the 2012 version can be seen in Figure 3.10.

[61] Bright Side News, *Are benchmarks worthless?* 19th April 2012, http://www.brightsideofnews.com/2012/04/19/opinion-are-benchmarks-worthless/
[62] PC World, *Laptop battery benchmarks are out of juice*, 23rd July 2009, http://www.pcworld.com/article/168907/laptop_battery_life.html

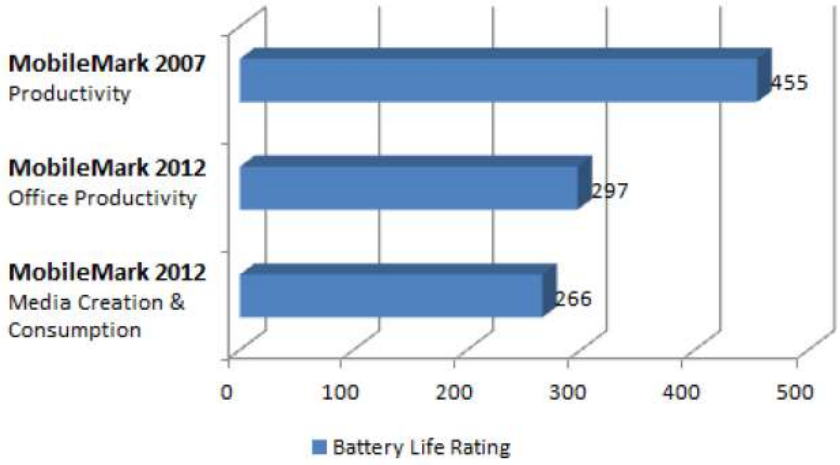

Figure 3.10. Comparison of battery life ratings for scenarios under Mobile Mark 2007 and 2012

Source: BAPCo (2012)

Futuremark have recently introduced an update of their performance benchmarking software, PCMark 8, which includes a similar 'office' scenario to that of Mobile Mark 2012 and a 'home' scenario which has the potential to more realistically simulate a consumer pattern of usage.

For Powermark, Mobilemark and PCMark the scenarios and rules underlying each tool appear too complex to describe the underlying criterion. Reference must therefore be made to a specific software packages and associated scenarios.

3.3.2.5 Second proposal for battery quality and lifetime criterion

Second criteria proposal
3(b) Battery quality and lifetime a) Notebooks, tablets and two-in-one computers shall provide the user with a minimum of 7 hours of battery life after the first full charge. This shall be benchmarked using either: (i) For home and consumer products the Futuremark PCMark 'home' scenario. (ii) For business or enterprise products the BAPCo Mobilemark 'office productivity' scenario. For models which qualify for Energy Star $TEC_{graphics}$ allowances, the 'Media creation & consumption' scenario shall be used instead. b) Notebook, tablet batteries and two-in-one computer batteries shall meet the following performance requirements, dependant on whether the battery can be changed without tools: (i) Models in which batteries can be changed without tools shall maintain 80% of their declared initial capacity after 750 charging cycles; (ii) Models in which batteries cannot be changed without tools shall maintain 80% of their declared initial capacity after 1000 charging cycles.

This performance shall be verified for battery packs or their individual cells according to the IEC EN 61960 'endurance in cycles' test, to be carried out at 25oC and at a rate of either 0.2 It A or 0.5 It A (accelerated test procedure). Partial charging may be used to comply with this requirement (see sub-criterion 3(c))

c) The performance requirements described in 3(b) may be achieved using factory installed software which partially charges the battery up to 80% of its capacity. In this case partial charging shall be set as the default charging routine and the battery performance shall then be verified according to the requirements in 3(b). The maximum partial charge shall provide a battery life that complies with sub-criterion 3(a).

d) The longer charging cycles required by this criterion shall be reflected in a longer guarantee period for the battery provided with the product. A minimum of a one year guarantee shall be provided.

e) Information about known factors influencing the lifetime of batteries as well as instructions on how the user can prolong battery life shall be included in factory installed energy management software, written user instructions and posted on the manufacturer's website.

***Assessment and verification**:* The applicant shall provide a third party test report showing that the battery packs or cell types used in the product meet the specified battery life and charging cycles. Partial charging and the accelerated test method specified by IEC EN 61960 may be used to comply. A demonstration version of the energy management software and the text content of user instructions and website postings shall additionally be provided.

Summary rationale for proposed changes

- Evidence from the analysis of a sample of sub-notebook and tablet models enables the relative ease of extraction of a battery to be defined based on the number of steps and tools required.
- The extent to which a battery can be readily extracted by a consumer or service centre is therefore proposed as being defined by a minimal number of steps either manually or using a conventional screwdriver, with the benchmark set at a level that is indicative of half of the models sampled and which excludes models in which batteries are glued or soldered into the casing.
- It is considered that a stricter benchmark would be too selective and should be considered in combination with criterion 3(a) which already imposes a stricter requirement for battery cycles where they are not as readily extracted.
- *The new requirements relating to battery extraction are proposed as being included within criterion 3(e) as these relate to upgradeability and repairability.*
- The v1 proposal already addressed a number of points raised by stakeholders. This included:
    - the form in which the battery can be verified, with packs or cells being possible to verify, and;

- differentiation between those batteries which can be manually extracted without tools and those requiring tools, as defined now by criterion 3(e), for which the sub-criterion is stricter.

- Moreover, it is considered that retention of 80% of charge reflects a specific level of performance available in the market and is supported by ITU recommendations for 'green batteries'. This level of performance is currently specified by manufacturers including Apple, Asus and HP.
- It is therefore proposed to retain the 80% retention requirement, for which performance can be evidenced from the data sheets of products by manufacturers such as Boston Power, Amparex and Samsung.
- It is also important to note that by using part charging an 80% level of charge retention can be achieved by a battery with a lower verified level of charge retention (e.g. 60/70%). There is therefore a level of flexibility in the criterion.
- The two major brands of battery life benchmarking software, Powermark and Mobilemark, run scenarios that are representative of typical patterns of professional useage.
- Whilst the scenarios provided by Mobilemark appear to provide suitably demanding professional benchmarks, Futuremark's new PCMark 8 'home' scenario may also be appropriate for general consumer use.
- It is therefore proposed that Mobilemark's 'Office productivity' and 'media creation & consumption' scenarios are, dependant on the graphics capabilities installed, used as benchmarks for computers marketed for business/enterprise and that Futuremark's 'home' scenario is used as a benchmark for computers marketed to consumers.
- Direct reference to these two products is considered appropriate given the complexity of referring to underlying test criteria and rules. The proposed benchmark softwares are also well known to manufacturers.

3.3.3 Criterion 3.3 – HDD reliability

Hard disk drives (HDD) are one of the computer components where according to WRAP (2011) [63] the most common faults are reported by several studies and product surveys. It is also understood that there can be significant variations in the reliability of HDD products. Several HDD products reviewed, as well as examples of OEM procurement procedures for HDD[64], specify the reliability of HDD using metrics such as 'Mean Time Between Failures' and 'Operating Shock'. For more details cf. Task 4 report "Improvement Potential", section 4.2.3.4 "Life-time of individual components".

Consultation questions
Besides criteria regarding easy access for repairability (see section 3.3.5) it should be discussed the feasibility of an Ecolabel criterion requiring a standardised test method being applied comparably indicating the reliability of HDD, for example using the indicators "Mean time between failures (MTBF)", "Annualised Failure Rate (AFR)" or others relating to simulated environmental stresses such as 'operating shock'.

3.3.3.1 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, the ease of verification needs to be checked further if there is a metric or system that will suit all manufacturers and components. A specialist manufacturer commented that the same drives were used by small and large manufacturers. The issue was raised as to what would happen if the HDD failed despite a claim relating to failure rate being made and how this would be communicated to the consumer. A guarantee may be needed. In response it was noted that this will always be the case even with servers – a certain risk of failure is always present.

A manufacturer stated that there were standards for drives. These depend on market demands. The use of Solid State Drives, which have no moving parts and are therefore potentially more reliable and energy efficient, is a question of price versus capacity.

Written stakeholder feedback following the first AHWG meeting indicated that the above mentioned indicators "Mean time between failures (MTBF)", "Annualised

[63] See http://www.wrap.org.uk/sites/files/wrap/Laptop%20case%20study%20AG.pdf

[64] Hewlett Packard, *Hard Disc Drive quality system – the driving force for reliability*, November 2006

Failure Rate (AFR) etc. are statistical numbers, which are of limited value for the individual product user.

Published HDD MTBF figures are an extrapolation of wear and tear on the physical components of many HDDs over a relatively short time. It is a statistical figure and MTBF on HDDs are often in excess of 1 million hours. The MBTF system is often unrealistic as MTBF may be quoted on new ranges of drives that could not have actually been tested at length in the field yet and it does not actually take into account the many reasons why a drive may fail, e.g. shock.

More usefully, some mobile computers have a feature which detects the possibility of an imminent shock using a built-in accelerometer and protects the mechanism of the hard drive. If HDD reliability is an issue that needs to be addressed, shock protection may be a better way of specifying it than MTBF. From a verification viewpoint, it is not seen how MTBF or AFR could be verified apart from auditing the method and data used to produce the figures. Shock protection might be better verified (e.g. drop tests) although it may be destructive.

It is agreed with the principle of specifying minimum reliability for key components such as HDD, as outputs from WRAP consumer research indicates that UK consumers welcome the "upgrade opportunity" presented by early failure in consumer electronic products. Finally, for the HDD the durability/reliability is very important from an environmental perspective (certainly as well from a user perspective). In this respect, the attempt to include meaningful quality criteria for HDDs is strongly supported.

Further research and evidence

Follow-up OEM enquiry

As a starting point a follow-up enquiry was made to OEM's with a view to gathering information in the following areas identified from stakeholder interaction:

- HDD quality and physical specifications:
  - Reliability and durability specifications

- Physical design features including shock resistance in portable models
- Evidence for the improvement potential of specifications and features
- Verification of the improvement potential

- SSD quality specifications:
  - Whether SSD should be exempted from such a criterion
  - Reliability and durability specifications

Responses were received from four major OEM's who either manufacture HDD/SSD or outsource HDD/SSD manufacture. The main points are summarised in Table 17..

Table 17: Summary of OEM feedback on HDD and SSD specifications

Hard Disc Drives (HDD)	
Reliability and durability specifications	Responses confirmed a set of standard OEM requirements for quality control including: • Error rate • Mean Time Between Failure • Annual Failure Rate • Load/unload endurance Operating shock, vibration and temperature range were particularly highlighted for mobile applications. Most defects are related to shock and vibration.
Physical design features	For notebooks free-fall sensors (accelerometers) are used in some drives for business models. Shock absorption is also specified, in some cases instead of free-fall sensors.
Improvement potential of features	No information was provided to verify the improvement potential of the quality control parameters.
Verification	Standard quality control and supplier qualifications processes are used, with all HDD required meeting the same requirements for each OEM. In the case of portable HDD protection by shock absorption this is verified by notebook drop and vibration tests.
Solid State Drives (SSD)	
Exemption from the criterion?	In general SSD should be exempted from general quality requirements. Most HDD failures are related to moving parts, which SSD do not have.
Reliability and durability specifications	General reliability and durability parameters are still required as part of quality control for SSD e.g. error rate, MTBF, AFR.

Although a limited response was received this was from leading manufacturers in the market. The feedback suggests that similar quality parameters are applied across all HDD purchases for specific form factors, suggesting that comparisons would instead

need to be made between HDD models or OEM requirements. However, no additional information was provided to facilitate this.

For notebooks, however, two physical design features were highlighted – free-fall sensors and shock absorption – which can be related based on field data to common stresses on a drive. SSD is an alternative solution because it has no moving parts.

Stationary drive durability and reliability

The enquiry provided limited further information to inform criteria development. Whilst OEM's specify and procure drives based on a range of parameters there is not a clear picture as to their relative significance in terms of HDD reliability and durability.

'Mean Time Between Failure' (MTBF) was discussed at the first stakeholder meeting. It was highlighted that this was based on statistical calculation for specific HDD lines. This means that it cannot accurately be related to the performance of an individual HDD – for example, the potential for a failure during its operating life. It also raises an issue for new HDD lines which have an unproven track record.

A leading HDD manufacturer highlights that new HDD models tend to be designed and specified based on detailed analysis of previous models followed by accelerated life testing[65]. Parameters such as MTBF are therefore extrapolated from design and prototype testing and modelling. This issue is highlighted by Seagate in a commentary in which they suggest the use of Annual Failure Rate as a clearer indication of the probability of a HDD failing during its lifespan[66]. The AFR is calculated as follows:

AFR = 1 – exp(– Annual Operating Hours / MTBF)

So a MTBF of 1,600,000 hours represents an AFR of 0.55% for any one server HDD within the production line for that model.

[65] HGST, *HGST and hard disk drive reliability*, Whitepaper, November 2007.

[66] Seagate, *Diving into MTBF and AFR: Storage reliability specs explained*, 26th April 2010, http://enterprise.media.seagate.com/2010/04/inside-it-storage/diving-into-mtbf-and-afr-storage-reliability-specs-explained/

A recently published study by US Company Backblaze, an on-line storage provider, is at a first sight a potentially useful benchmark of HDD performance[67].

The study analysed a sample set of 27,000 HDD from Seagate, Hitachi and Western Digital. In total fifteen different models were analysed. Western Digital and Hitachi gave the best performance in terms of AFR ranging between 0.9% and 3.2% depending on HDD capacity. Their total proportion of the fleet was 47%. The best 20% of the HDD gave a performance of 0.9%.

The survey results have, however, been subject to criticism by industry specialists[68]. For example, the results represent 24 hour operation at servers, so features such as power up and power down, which may be of value to a consumer, may have exerted greater wear on the HDD used by Backblaze. The results also combine enterprise drives and consumer drives (the majority of the sample), and are heavily skewed by a number of Seagate HDD models that have acknowledged problems. MTBF and bit error rates are highlighted in a follow-up to a critique of the Backblaze survey which explores how to choose HDD, with a clear distinction required between performance for consumer and enterprise (server) applications[69].

A study by Google in 2007 of server HDD of a sample of over 100,000 server drives[70] also refers also to Annualised Failure Rate (AFR) as a headline parameter but goes on to highlight the significance of how early scan errors start to appear. After the first scan error a drive was 39 times more likely to fail within 60 days. First failures in reallocations and probational counts were similarly highlighted. However, these are not identified by Google as the main reasons for HDD failure. The study quotes a

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[67] Backblaze, *What hard drive should I buy?,* January 21st 2014 http://blog.backblaze.com/2014/01/21/what-hard-drive-should-i-buy/

[68] Newman, H, *Selecting disc drive: How not to do research*, Enterprise Storage Forum, 29th January 2014, http://www.enterprisestorageforum.com/storage-hardware/selecting-a-disk-drive-how-not-to-do-research-1.html

[69] Newman, H, *How to choose a hard drive*, 27th February 2014, http://www.enterprisestorageforum.com/storage-management/how-to-choose-a-hard-drive-1.html

[70] Pinheiro.P,Weber.W-D and L,Barroso. *Failure trends in a large disk drive population*, Proceedings of the 5th USENIX Conference on File and Storage Technologies, February 2007.

number of other studies with significant HDD samples sets in which AFR ranged from 1.9% to 6.0%.

Notebook drive protection features

The two features highlighted by stakeholder feedback were investigated further. **Free-fall sensors** are either fitted externally or internally to a HDD and detect a sudden motion associated with a fall. This then sends a signal to retract the magnetic head of the HDD so that it cannot physically damage the media's surface, thereby protecting the data.

Sensors can have a varying degree of response time, which will give different levels of protection depending on the height of the fall. A white paper by Dell from 2008 suggests that this can vary between 500 milliseconds and 150 milliseconds[71]. This represents the difference between protection from a fall of 122 cm and 12.5 cm, with the latter protecting against a notebook being dropped whilst being carried or from a desk.

A cross-check of specifications for free-fall sensor response in the portable HDD of four major manufacturers – Seagate, Western Digital, HGST and Toshiba – suggests a performance range of 150 – 300 milliseconds. In the worst case this would still protect against a drop whilst being carried by hand.

The use of **physical damping to protect against vibration and shock** was also highlighted by stakeholders, and has also been identified as a design feature of 'rugged' and 'semi-rugged' notebooks (see section 3.3.4). It is understood from commentators on semi-rugged specifications that HDD are generally placed near the base of a notebook but to protect them better it is required to mount them on dampers or for the HDD housing itself to be insulated[72]. The effectiveness of the former would need to be checked by a drop test of the notebook itself (see section

[71] Dell, *Dell raises the bar in shock-resistant hard drives*, February 2008. www.dell.com/innovation
[72] Notebook review, *Rugged laptops: Essential to business and home?* http://www.notebookreview.com/news/rugged-laptops-essential-to-business-and-home/

3.3.4) whilst the latter may be reflected in the tolerance of the HDD quoted in the manufacturers specifications.

A cross-check of specifications for operational and non-operational shock tolerance of notebook HDD of four major manufacturers – Seagate, Western Digital, HGST and Toshiba – suggests a performance range of 300-400 (operational) to 900-1,000 (non-operational) G force. The extent to which this reflects additional damping that may be applied to the drive unit was not possible to discern. Also, the verification procedure was not detailed by each manufacturer. The IEC 60068 series is understood to provide a test method for vibration and shock applied to electro technical equipment, but its application by the HDD industry is to be confirmed.

A further feature identified from Western Digital is termed 'no touch ramp load' technology[73]. This is designed to ensure that magnetic head never touches the disc platter itself, with the potential to reduce wear and damage. More information is required in order to determine the potential benefit of this feature.

[73] Western Digital, *WD Green desktop hard drives*, http://www.wdc.com/wdproducts/library/AAG/hires/ENG/a4/2178-771157.pdf

3.3.3.2 First proposal for HDD durability and reliability criteria

Proposed new criteria (first proposal)
'Data storage drive reliability and protection' **Stationary computers** The data storage drive or drives used in desktops, workstations and thin clients shall have an Annual Failure Rate (AFR) of less than 0.9%. For small-scale servers the Annual Failure Rate shall be less than 0.6% and a Bit Error Rate of >1 in 10^{16} bits. **Portable computers** The primary data storage drive used in notebooks shall be designed to protect the drive and data from shock and vibration. The drive shall comply with one of the following: (i) The HDD drive head should retract within a maximum of 300 milliseconds upon detection of the notebook having been dropped. (ii) The HDD drive shall be designed to withstand a shock of 400 G (operating) and 900 G (non-operating) (iii) A Solid State Drive is installed. *Assessment and verification*: The applicant shall provide a specification for the drive or drives integrated into the product. This shall be obtained from the drive manufacturer and shall be supported by a technical report verifying that the drive complies with the specified performance requirements.

Key aspects of the proposal:

- The title of the proposal has been changed to reflect coverage of both HDD and SSD as well the concepts of reliability and protection of data.
- It is proposed to introduce criteria for notebook drives based on the applicant choosing from a number of options. These options reflect choices that can be made to provide increased protection to the drive itself or the data in the event of an incident.
- Performance parameters have been described for a free-fall sensor and drive unit shock resistance. The former is a physical feature the presence of which would need to be verified. **The latter requires further input from industry in order to ensure the parameters adequately reflect an improved performance and to specify a verification method.**
- A third notebook option of an SSD reflects the potential to eliminate moving parts, but comes at a higher cost than HDD technology, hence its optional status.

- Setting a criterion for stationary computers is a more difficult task as it is difficult to distinguish between different performance parameters because of a general lack of data, particularly for consumer applications. Studies and commentary of HDD selection do, however, suggest that MTBF or AFR, as well as error rates, are valid performance metrics.
- Based on studies with large sample sets and expert commentary it is proposed to set a criteria in which consumer products are required to meet an AFR benchmark and that servers meet an AFR benchmark and an error rate.
- The AFR benchmarks have been set based on real performance data and what is understood to be the best performing HDD products, however, **further input is requested from OEM's based on their qualification requirements.**
- Expert commentary suggests that because of their extended operating times error rates are only relevant, and at a higher benchmark, for servers. Again, **further input is requested from OEM's**.

3.3.3.3 Stakeholder feedback and further evidence

Summary of stakeholder feedback
From the point of view of verification a product, model or line can contain drives from various different manufacturers, all of which would have to be verified. On this basis it could therefore be difficult practicality. A manufacturer highlighted the need to consider EMMC, which is a specific form of lower cost solid state storage used in tablets and in some notebooks. Feedback received was inconclusive as to whether the proposed performance benchmarks reflected a good/better performing drive. A manufacturer highlighted that drive failure tended to be reflected in warranty claims. An industry stakeholder asked whether a high error rate was an indicator of better or worse performance. Would this be experienced from a consumer's point of view? A manufacturer responded that, yes, it could result in a loss of data.

Fundamental research on improving HDD reliability

Technical literature by drive manufacturer Western Digital and research by Strom et al (2007) for Samsung and Seagate highlights that head clearance – the air gap (or 'headspace') between the magnetic read/write head and the surface of the rotating disk – is now the most significant physical reliability issue for HDD. This is because this air gap has reduced in two decades from 300nm to 2.5nm.

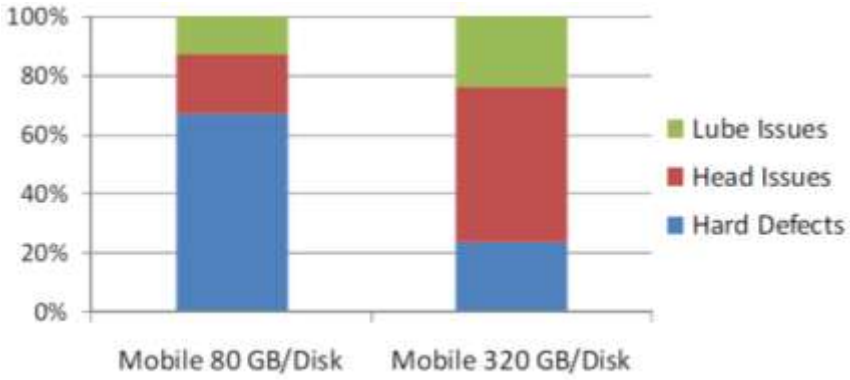


Figure 3.11. Reasons for field failures in notebook HDD

Source: Western Digital (2013)

The fundamental research reviewed suggests that beyond the technical advancements that manufacturers are focussing on as part of their Research & Development programmes, physical protection of the HDD from external shocks that could damage the disk surface should remain a priority if an EU Ecolabel criterion is retained.

Differentiating between consumer, business and 'enterprise' drives

In seeking to further refine the proposed performance benchmarks for stationary computers commentary and literature clearly highlights the importance of distinguishing between drives intended for consumers and businesses [74] [75]. Important variations include the operational time and the Input/Output flow of data,

[74] Intel Corporation, *Enterprise-class versus Desktop class Hard Drives*, April 2008

[75] Newman, H, *How to choose a hard drive*, Enterprise Storage Forum, 27th February 2014, http://www.enterprisestorageforum.com/storage-management/how-to-choose-a-hard-drive-1.html

but many other physical stresses can also be identified that relate to how they operate.

For business the operational time will be between 40-50/hrs per week (an office workstation) and for an enterprise drive (server) 168 hours per week. This variation places very different stresses on a drive and related variations can be seen in the speed a drive rotates and the nature of the activities it is required to carry out e.g. local software tasks, client requests over a network, disk maintenance tasks, A consumer drive would likely operate less hours and have a lower I/O threshold (data flow) unless intensive applications are used such as photo editing or gaming.

It is understood that bit errors (unrecoverable data) are symptomatic of head and writing problems. Expert commentary suggests that a bit error rate of 1 in 10^{14} bits would not impact on a consumer or business desktop user but would not be suitable for enterprise (server) use. Instead bit error rates in the range of 1 in 10^{15} to 1 in 10^{16} bits are highlighted for enterprise grade drives.

A Mean Time Between Failure (MTBF) for enterprise (server) drives of between 1,600,000 and 2,000,000 are highlighted as representing good performing drives, translating into Annualised Failure Rates (AFR) of between 0.44% and 0.55%. For business or consumer desktops it is more difficult to determine a good performance based on available information, primarily because manufacturers do not tend to report MTBF for consumer or business drives. Intel suggest a MTBF of 700,000 which, assuming a duty cycle of 20% (1,752 hours) would equate to an AFR of 0.25%.

3.3.3.4 Second proposal for HDD durability and reliability criteria

Second criteria proposal
3(c) Data storage drive reliability and protection *i. Stationary computers* The data storage drive or drives used in desktops, workstations and thin clients marketed for business use shall have a projected Annualised Failure Rate (AFR) of less than 0.25%. Small-scale servers shall have a projected AFR of less than 0.44% and a Bit Error Rate for non-recoverable data of >1 in 10^{16} bits. The AFR shall be determined based on Bellcore TR-NWT-000332, issue 6, 12/97 or field collected data.

ii. Portable computers

The primary data storage drive used in notebooks shall be specified to protect the drive and data from shock and vibration. The drive shall comply with one of the following:

(i) The HDD drive shall be designed to withstand a half sine wave shock of 400 G (operating) and 900 G (non-operating) for 2 ms without damage to data or operation of the drive.

(ii) The HDD drive head should retract from the disc surface in less than or equal to 300 milliseconds upon detection of the notebook having been dropped.

(iii) A solid state storage drive technology such as SSD or eMMC is used.

Assessment and verification: The applicant shall provide a specification for the drive or drives integrated into the product. This shall be obtained from the drive manufacturer and shall be supported by an independently certified technical report verifying that the drive complies with the specified performance requirements.

Summary rationale for proposed changes

- Further investigation of expert commentary and technical literature highlight the significance of headspace – the air gap between the magnetic reader head and the drive surface - as being critical to HDD reliability.
- It is important to distinguish between HDD's used for consumer, business desktop and enterprise (server) application.
- A Mean Time Between Failure of 2,000,000, Annualised Failure Rate of 0.44% and a bit error rate of >1 in 10^{16} represents a high performance enterprise HDD.
- A high performance for consumer and business desktops is more difficult to determine as there is limited evidence and disclosure in the specifications by manufacturers.
- A Mean Time Between Failure of 700,000, equating to an Annualised Failure Rate of 0.25% for a 1,752 hour duty cycle, is suggested as a benchmark for business desktops.
- The shock resistance requirements have retained and adjusted based on a proposal by an industry stakeholder, together with reference to the form of shock to be applied and the duration.
- Standardised test methods could not be identified/confirmed for portable drive options (i) and (ii). Whilst the sub-criterion are considered to be important and

have therefore been retained, independent certification has been requested to provide assurance and transparency.

- The emergence of new forms of solid state drive such as eMMC is now reflected in the criterion for portable computers.

3.3.4 Criterion 3.4 – Notebook durability testing

The preliminary technical reports for revision of the Ecolabel criteria summarised research by WRAP which identified common components that may fail in computers. Accordingly proposals have been made for disk drives and batteries. A key factor to consider beyond the resilience of individual components is, however, the real-life conditions and stresses that a product may be subjected to.

With notebooks computers set to shortly become the most common form factor for computers in the market the conditions to which computers are exposed to have changed significantly. Notebooks may be exposed to a range of stresses and environmental conditions depending on whether they are used by students, business travellers or out in the field on, for example, industrial sites.

An initial scoping of initiatives and design specifications by major OEM's intended to bring more durable notebook models to the market revealed a range of possible test routines and design features.

A more detailed investigation was therefore carried out with the intention of identifying:

1) The most common accidents and environmental stresses that notebooks are exposed to;
2) Which aspects of a notebook are most likely to be at risk or tend to fail due to exposure to accidents and environmental stress;
3) Test methods and routines that are used by OEM's to benchmark performance aspects for more durable models;

4) The prevalence of more durable models within product ranges and any distinctive design features they may incorporate.

The findings have been used to inform a first criteria proposal which would enable the Ecolabel to be awarded to notebook models that are physically more robust, are more likely to last a minimum 2-3 warranty period without major failures and which have a lower Total Cost of Ownership (TCO).

3.3.4.1 Background research and evidence

Failure and repairs required as a result of common accidents and stresses

Literature on notebook durability mainly relates to 'rugged' and 'semi-rugged' laptop specifications in the US market. 'Rugged' and 'semi-rugged' notebooks are mainly defined with reference to the US Department of Defence's MIL-STD-810G test standards[76]. Two relevant market research studies were identified:

A study by warranty providers Squaretrade of 30,000 new laptops over their first three years of ownership was referenced in the Preliminary report in October 2013[77]. The study highlighted a hardware failure rate of 20.4% and accidental damage of 10.6%. It was also highlighted a significant variation in reliability between leading brands, ranging from 15.6% to 25.6%.

The most directly relevant study was carried out by market analysts IDC and sponsored by Panasonic, who manufacture the leading 'Rugged' notebook[78]. The study was based on a survey of 300 businesses in the USA. The study found that on average each year:

- 14.2% of notebooks required repair or replacement due to physical failure,
- 9.5% of notebooks required repair or replacement due to an accident.

[76] Endpoint Technologies Associated, *Redefining rugged: Assessing the spectrum of durability in the notebook market*, USA, 2008 and 2011

[77] Squaretrade Inc, *1 in 3 laptops fail over 3 years*, USA, November 16th 2009 http://www.squaretrade.com/htm/pdf/SquareTrade_laptop_reliability_1109.pdf

[78] IDC, *The Business case for ruggedized PC's*, USA, June 2012

The **most commonly damaged component** was the **keyboard** (72%) followed by the **screen** (66%), **battery** (58%) and **hard disk drive** (51%). Damage could therefore encompass multiple components. Where the damage was the result of an accident the most common causes where being dropped whilst being carried (72%), followed by some kind of liquid spillage (66%) and a fall from a desk or table (55%).

Of most significance from the IDC study is the claimed extension of lifespan for a semi-rugged notebook, on average from 2 years 5 months to 3 years 6 months. However, a direct correlation between this lifespan extension and the relative importance of specific design features is not possible to identify.

A range of consumer surveys of notebook reliability are also carried out by, amongst others, Which? (UK), Consumer Report (USA) and PC World (UK and USA). Despite surveying very large samples of consumers they are of limited value in identifying physical cause and effect of failure as they tend to focus on headline reliability rates and quality of customer service.

Test methods and benchmarks of durability

The terms 'rugged' and 'semi rugged' can be seen as the first attempt to define durability benchmarks for notebooks. Endpoint Technologies (2011) define them with reference to the US Department of Defence's MIL-STD-810G test standards[79] and the IP65 (Ingress Protection) standards[80].

The study defines a five point numeric scale which it uses to grade notebook durability. The scale relates to the level of compliance with MIL-STD-810G and the International Protection standards for dust and water ingress, as well as whether compliance has been third party verified. The lower tiers of the range encompassing 'semi-rugged' and 'business rugged' are likely to be of most relevance to the Ecolabel, whilst 'rugged' and 'ultra-rugged' can be seen to reflect high cost products

[79] US Department of Defence, *Test method standard MIL-STD 810G*, 31st October 2008

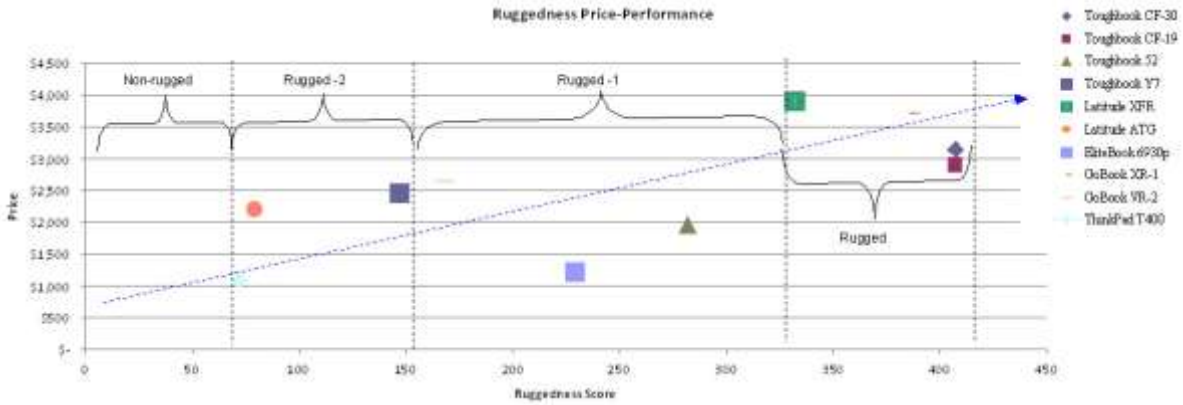
[80] UL, *Environmental ratings for enclosures based on Ingress Protection (IP) Code designations*, http://www.ul.com/global/eng/pages/offerings/services/hazardouslocations/ref/ingress/

specially designed for military and field applications, such as Panasonic's Toughbook, which is the only product to achieve the 'ultra-rugged' category.

The tests and their associated performance benchmarks for 'semi-rugged' relate to:

- Drop
- Vibration
- Shock
- Pressure at varying altitudes
- Temperature over a range between –29^{o}C to +60^{o}C
- Temperature shock
- Humidity

The price:performance of products by Panasonic, GD-Itronix, HP, Dell and Lenovo can be seen in Figure 3.12.



Source: Endpoint Technology Associates (2011)

Figure 3.12: Price versus performance of products assessed on the rugged scale

The Endpoint study defines high end specifications for notebooks with a focus on environmental stress. A scoping of test routines applied to mainstream business and consumer notebooks products by the most significant notebooks manufacturers by EU market share reveals a similar set of tests related to specific design improvements.

Some additional tests related to everyday functionality are also added, such as the durability of the keyboard and screen lid hinge. The tests applied by each manufacturer are summarised in Table 18. Information in the public domain on test routines applied by Apple could not be found.

It is understood that a number of the manufacturers listed have the tests carried out by testing bodies, thereby ensuring that performance is third party verified. TUV is an example of a test body carrying out durability and so-called HALT (Highly Accelerated Life Tests) tests. In other cases such as Asus the tests are carried out in-house.

Table 18: Indicative sample of manufacturers' durability tests

Manufacturer	Durability tests and methods	Models to which they are applied
HP[81]	MIL-STD-810G standards: • Drop, shock, vibration, dust, humidity, altitude, temperature range, temperature shock Additional internal test specifications: • Keyboard strokes (7 year simulation) • Screen/lid open-close (6 year simulation)	HP Elitebook All business models
Asus[82]	Internal test specifications: • Drop, shock and vibration tests • Temperature range • Keyboard strokes simulation • Screen pressure test	All models. Commercial models achieve higher performance
Toshiba[83]	Internal test specifications: • Drop, shock and vibration tests • Temperature range • Screen pressure test	Portege and Tecra models
Lenovo[84]	MIL-STD-810G standards: Drop, shock, vibration, dust, humidity, altitude, temperature range, temperature shock	x131e/140e (student models)
Dell[85]	MIL-STD-810G standards: • Drop, shock, vibration, dust, humidity, altitude,	Selected Latitude models

[81] Hewlett Packard (2012) *Testing the business ruggedness and reliability of HP Elitebook notebook PC's*, Technical white paper

[82] Asus, *Product guide: August – September 2013*

[83] Toshiba, *Easyguard protection*, Accessed March 2014, https://www.toshiba.co.uk/innovation/generic/easyguard_protection/

[84] Lenovo, *Thinkpad laptops and ultrabooks*, http://shop.lenovo.com/us/en/laptops/thinkpad/

[85] Dell, *Latitude 6420u ultrabook summary of environmental testing*, October 2012, http://partnerdirect.dell.com/sites/channel/Documents/Dell-Latitude-6430u-Ultrabook-Environmental-Testing-Product-Guide.pdf

Manufacturer	Durability tests and methods	Models to which they are applied
	temperature range, temperature shock Additional test specifications: • IEC 60529 dust ingress • Keyboard spill	Selected Latitude models
Acer[86]	Unspecified internal standards: • Drop, shock, vibration, dust, humidity, altitude, temperature range, temperature shock • Screen/lid open-close	Business models

Durable models and design features

It is understood that test routines are used to improve the design of notebooks so as to make them more durable. This can include more robust single components but it can also focus on the layout and junctions between components in order to, for example, better absorb impacts[87]. In the process of identifying the test routines of the EU's leading manufacturers a series of common design features were also identified. These, together with the products ranges or models in which they are incorporated, are summarised in Table 19. They have been grouped as they relate to the common accidents and reasons for failure identified by IDC (2011).

Based on feedback from selected manufacturers it is understood that a combination of durability tests and improved design specifications provides the confidence to give 2 or 3 year warranties with new products.

Table 19: Sample of product design features specified for improved durability

Durability factor	Design feature	Product ranges
Accidental drop	• Strengthened case, e.g. magnesium alloy, carbon fibre • Shock and vibration absorbent internal enclosure lining	• Lenovo T series • Dell Inspiron • HP Elitebook • Toshiba Portege and Tecra
	• HDD redesign of location and incorporation of shock protection dampers • HDD accelerometer to retract magnetic head in the case of a sudden fall	• Acer business models • Toshiba Portege and Tecra • Asus B-Series • Lenovo X131/140e
	• Solid State Drive (SSD) instead of HDD to	• Toshiba Portege and Tecra

[86] Acer, *Built to last:ready for business*, Accessed March 2014, http://www.acer.com/professional-products/en_GB/index_legacy.html

[87] Notebook Review, *Rugged laptops: Essential to business and home?* 25th May 2010, http://www.notebookreview.com/news/rugged-laptops-essential-to-business-and-home/

Durability factor	Design feature	Product ranges
	eliminate moving parts	• Apple Macbook Pro and Air • Dell Latitude models
Liquid spillage	• Spill resistant keyboard with elimination of possible drainage points	• HP Elitebook • Toshiba Portege and Tecra • Asus B-Series • Lenovo Thinkpads and X131/140e
Screen breakage	• Pressure absorbent casing • Screen reinforcement, e.g, glass fibre, toughened glass	• Acer (glass screens) • Asus all models • HP Elitebook • Dell Latitude
Keyboard lifespan	• Durable keyboard specifications	• Apple Macbook Pro • HP Elitebook • Asus all models • Dell Inspiron

3.3.4.2 First proposal for notebook durability criteria

Proposed new criteria (first proposal)

'Durability testing for notebook computers'

The applicant shall submit the notebook model for durability testing. The notebook shall be verified to pass the performance benchmarks and function accordingly during and after each test as specified below.

Durability test	Test conditions and performance benchmark	Reference for test method
Drop	122 cm drop height onto a 5.0 cm of plywood surface on concrete, 4-6 drops per sample to a total of 26 drops covering each face, edge and corner. The notebook is non-operational during the test but shall function following the test.	MIL-STD-810G, 516.6, Procedure IV
Shock	40g for 18 tests each applied to Bottom, Left and Back side. The notebook is non-operational during the test but shall function following the test	MIL-STD-810G, 516.5, Procedure I For further review of equivalence: IEC 60068
Vibration	20-2000 Hz, 1.04 Grms, 1 hour applied to Bottom, Left and Back side. The notebook is to be operational during and after the test.	MIL-STD-810G, 514.6, Category 24 For further review of equivalence: IEC 60068
Temperature	Three 24 hour exposure cycles for each extreme in a test chamber -29^{o}C and 63^{o}C The test to be repeated for an operational and non-operational notebook. The notebook shall be checked that it functions following each routine.	MIL-STD-810G, 501.5, Procedure II For further review of equivalence: IEC 60068

Water ingress	0.2 litres of water is to be poured evenly over the main body of the open keyboard face of the notebook, drained after 3 seconds, inverted on its side for 45 seconds and then tested after 2 minutes. The notebook is to be operational during and after the test.	MIL-STD-810G, 506.5, Procedure III For further review of equivalence: IEC 60529
Screen pressure	25kg loading to be applied to the centre of the screen lid with the notebook placed on a flat surface. The screen to then be inspected for lines, spots and cracks.	*No formal reference: stakeholder input required.* *Potential to refer to panel pressure test methods.*
Keyboard accelerated life	10 million random keystrokes simulation for *(to be specified)* product samples. The keys to then be inspected for their integrity.	*No formal reference: stakeholder input required.*

Assessment and verification: The applicant shall provide test reports showing that the model has been tested and has met the benchmarks for durability. Testing and verification shall be carried out by a third party.

Key aspects of the proposal:

- It is proposed that initial basic set of durability tests are specified, reflecting those commonly commissioned by the leading OEM's with products in the EU market.
- These tests are proposed to be specified to reflect the most common accidents and environmental stresses as identified by the IDC (2011) study and as specified by OEM's. The test routine is proposed to encompass: Drop, Shock, Vibration, Temperature extremes, Water ingress protection (to protect from spillages). In addition a screen pressure test to guarantee screen robustness and an accelerated life test for keyboards are proposed to be specified.
- The starting references for the test methods are the US MIL-STD-810G and the IP (International Protection)/IEC 60529 standards for ingress protection (water and dust). EN 60068 contains a series of environmental test methods that require further review for possible substitution of the reference to the US MIL standard and Ingress Protection standards in order to provide a more definitive and comparative reference.
- For each test a routine has been described, adapted as a starting point mainly from MIL-STD-810G and OEM interpretations of these procedures, together with a performance benchmark or duration for the test. The number of samples

of models to be tested and the inspection routines for integrity of the product following testing are to be detailed further.

- However, in cross referencing the MIL standard, the Endpoint Technology 'rugged' definitions and examples of OEM test routines there is not a consistent read across. The related IEC standards 60529 and the 60068 series therefore require further review.
- The screen pressure test and accelerated life test for keyboards will require bespoke testing routines and benchmarks to be established based on further input and discussions with OEM's and testing bodies.
- The tests and resulting performance are proposed as being carried out and verified by a third party in order to provide comparability and assurance.

3.3.4.3 Stakeholder feedback and further evidence

Summary of stakeholder feedback
A manufacturer highlighted that the US Military standards proposed as a reference for the criterion are well known but mainly only used for products used by businesses or for government tenders. Some of the test specifications force certain forms of design and chassis construction which are more costly e.g. to withstand a drop test. This would affect the market selectivity of the criterion and the Ecolabel. The aim of the criterion should be clarified – is it that the computer still works following each test or only that the data is protected? A Member State highlighted that the cost implications for assemblers should be considered further. The Ecolabel is primarily addressing the consumer market, by using a military test we would be addressing a different market. Are all OEM's applying such tests to models and what are the additional costs? A manufacturer recommended to establish a compromise between durability and price. There needs to be a distinction made between business and consumer needs. The former can be quite specialised i.e. laptops for use outdoors (e.g. on construction sites) and very different from a domestic situation.

Some stakeholders requested further information on toughened screen glass for tablets. Corning and Schott were highlighted as manufacturers of glass that is pressure and scratch resistance. Pressure is applied in testing to each side of the product.

Review of the tests to be applied and the associated test methods

The aim of the proposed EU Ecolabel tests is proposed as being to ensure that a notebook can continue to function under environmental stresses that it may experience during use. In addition, that they are specified to address common component failures and provide additional protection from common accidents that may occur, as suggested by US survey results in Figure 3.13 and Figure 3.14.

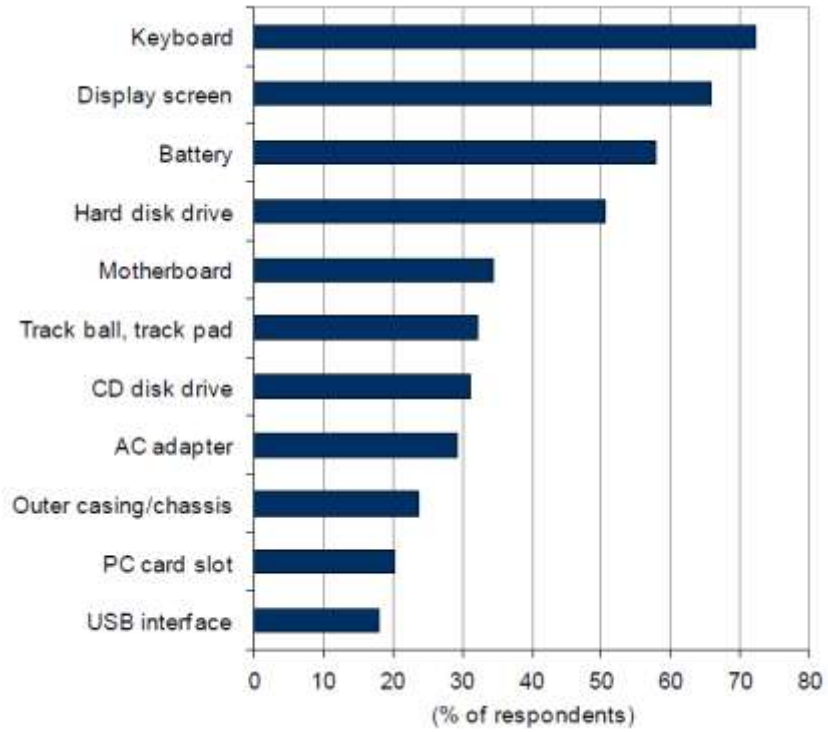


Figure 3.13 Survey results for the most common notebook components that suffered damage

Source: IDC (2011)

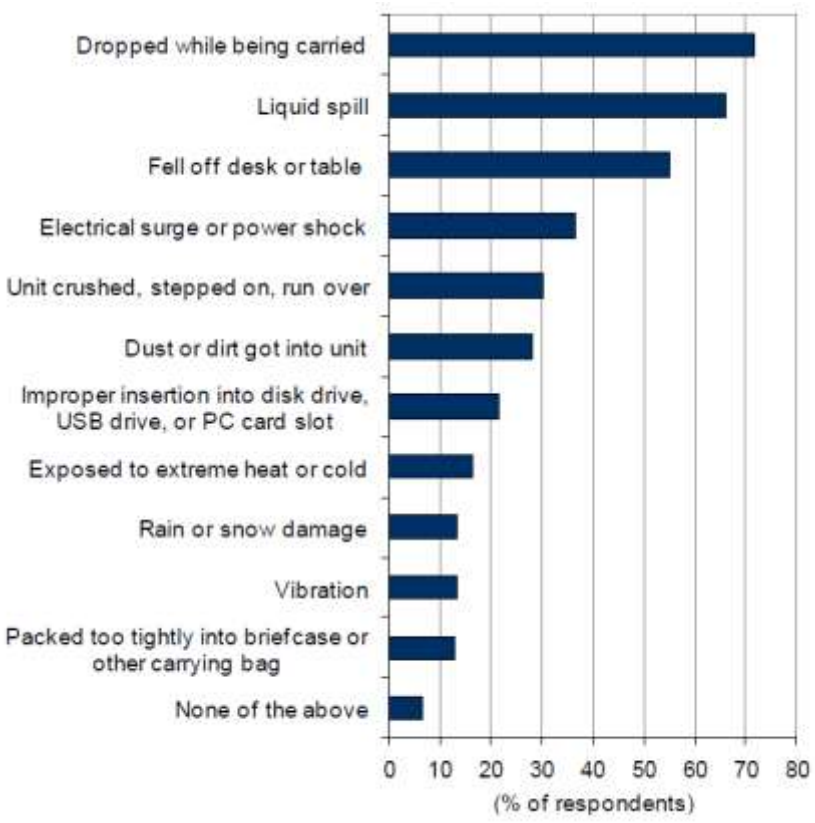


Figure 3.14 Survey results for the most common accidents that notebooks suffer

Source: IDC (2011)

At the AHWG2 stakeholders expressed concern about the extent of the testing and the implications for cost and selectivity of the EU Ecolabel. Further discussions with a leading notebook manufacturer experienced with this form of testing highlighted the importance of a focus on vibration, shock and temperature to ensure in day to day use that a product is more durable.

Drop testing is different in that reflects an accident. The original drop test proposal of 122 cm was considered too strict and could be reduced to 70-80 cm in order to reflect an accidental fall from a desk or whilst carrying a notebook. The application of such a test to all models of Taiwanese manufacturer Asus suggests that a robust chassis and shell can be achieved without an unacceptable price premium.

Moreover, this form of drop testing is now applied to well-known tablet brands such as Microsoft's Surface series [88].

The benefits of such as tests are reflected in the findings of Squaretrade (2009) which highlighted the reliability of Asus and Toshiba models. Sample failure rates for Toshiba are illustrated in Figure 3.15.

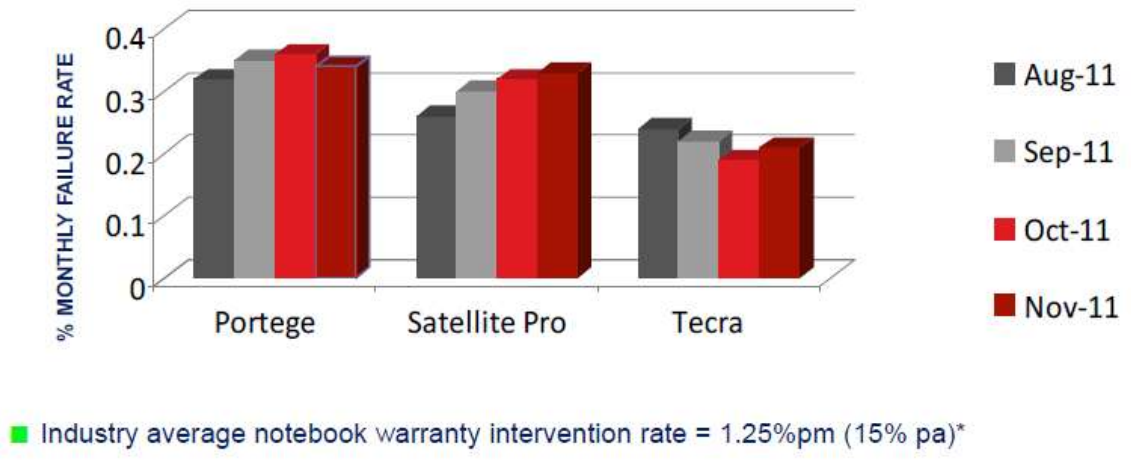


Figure 3.15 Sample monthly failure rates for durability tested notebook models

Source: Toshiba (2012)

The reference to the US Department of Defence's MIL 810-G and the International Protection (IP) ingress protection standards was highlighted by Endpoint Technologies 2011 report which sought to define benchmarks for rugged notebook computers.

The tests described by MIL 810-G and IP are for the most part reflected by similar test procedures in the IEC 60068 'environmental testing' series and the IEC 60529 'Degrees of protection provided by enclosures' standard. Where possible the proposed test methods have therefore been updated based on an approximation to the equivalent IEC standard. An exact equivalence could not be identified for the water spillage test, so instead reference has been made to the IEC definition of 'acceptable conditions for water ingress'.

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[88] Information Week, *Microsoft surface drop tests*, Accessed 2012, http://www.informationweek.com/mobile/mobile-devices/video-microsoft-surface-drop-tests/d/d-id/1106957?

For a number of tests – namely screen resilience, keyboard lifespan and hinge resilience - standardised methods could not be identified:

- Screen resilience, which has been updated to also address possible bending of a screen, is further specified by referring to LCD quality tests for Apple and LG [89]. Reference to ASTM C158-02 'four point bend test' was considered [90], but was not considered to reflect tests currently carried out by OEM's on the finished product. The inspection requirements could be further elaborated on in the User Manual based on manufacturer guidelines for LCD units.
- Keyboard lifespan is further specified to ensure that testing is weighted to reflect the most commonly used keys.
- Hinge failure was highlighted by a manufacturer as being a breakage that is particularly costly to repair. This because electrical connections for the screen LCD unit pass through the hinges. A test based on a set number of openings and closures of the screen is therefore proposed, allowing a minimum lifespan for the product to be defined.

Equipment suppliers for such tests can be readily identified [91], so the verification has been updated to require that the equipment and setup used for the test is reported. In all cases tests must be carried out by a third party.

For tablets a combination of the proposed screen resilience tests with a drop test is, based on the practices of leading manufacturers such as Microsoft and Fujitsu, as well as warranty providers such as Square Trade [92], considered to be essential to ensure a durable tablet product. The majority of manufacturers are already understood to use toughened glass such as Corning's Gorilla glass and Schott's

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[89] AUO B133EW07 V0 *display specification for LED backlight with high color gamut* (Apple specification) *and* LG Display, *HD TFT specification for approval*, September 2012

[90] ASTM C158 - 02(2012) *Standard Test Methods for Strength of Glass by Flexure (Determination of Modulus of Rupture)* http://www.astm.org/Standards/C158.htm

[91] *See for example* Design & Assembly Concepts, http://www.dac-us.com/testandreliability.html

[92] Squaretrade, *New Research Rates Google's New Nexus 7 Tablet a "Medium Risk" 5 Breakability Score, Outscoring the iPad Mini*, August 2013 http://www.squaretrade.com/press/new-research-rates-googles-new-nexus-7-tablet-a-medium%20risk-5-breakability-score-outscoring-the-ipad-mini

Xensation glass, so there would be limited scope for market differentiation by having a specific performance requirement for the screen glass.

Further review of the market availability and pricing of durable notebooks

In order to respond to questions raised by stakeholders at the AHWG2 the availability of durability tested models, the tests applied and their pricing was indicatively reviewed. This was compiled using information from manufacturers websites in either the UK or Spain, supplemented where necessary by pricing taken from DABS Direct (UK, list prices) or Amazon EU (direct sales, list prices). Pricing was obtained for 15.6 inch screen models. The results are summarised in Table 20.

The findings indicate that comprehensive durability testing, including drop, shock and vibration tests, tend to be carried out for business models, for which there appears to be a wide range of choice of tested models on the market. Asus is, however, notable for applying more rigorous tests to its consumer and business models.

Whilst a price premium tends to exist between home and business models, it does not appear possible to clearly attribute this to durability testing. The wide range of models, specifications and price points available also mean it is possible obtain a compehensively tested 'ruggedised' business notebook at a lower price than some consumer notebooks.

Moreover, whilst manufacturers' websites make a clear distinction between home and business models this is not always reflected in how models are sold to consumers by retailers. A mix of home and business models can be found on sale by high street and internet retailers. The consumer may therefore not know they are buying a 'business' model.

Table 20. Updated review of notebook durability testing applied by leading manufacturers

Manufacturer	Market segment (% with testing applied)	Models to which testing is applied	Scope of testing
HP	Consumer range (no models)	*No testing claims made for consumer models.* *Price range, 15.6 inch screen: €399 - €1099*	n/a
	Business range (88% models)	250-i2/3/5, 350-i2/3/5, 350-G1,355-G2 series *Price range, 15.6 inch screen: €446.49 - €603.79*	Internal test specifications: • Water spill resistant keyboard
		Probook series 455-G1, 640-G1, 645-G1, 840-G1, 430-G2, 450-G2, 455-G2, 470-G2 *Price range, 15.6 inch screen: €688.49 - €859.10* Elitebook series 820-G1, 840-G1, 1040-G1, 725-G2, 745-G2, Folio 4010-G1, 8470p *Price range, 15.6 inch screen: from €1,148.29*	Ínternal 'total test process' based on MIL-STD-810G standards: • Drop, shock, vibration, dust, humidity, altitude, temperature range, temperature shock Additional test specifications: • Keyboard strokes (7 year simulation) • Screen/lid open-close (6 year simulation)
Acer	Consumer range (no models)	*No testing claims made for consumer models.* *Price range, 15.6 inch screen: €259.90 - €1,133.77*	n/a
	Business range (14% models)	Travelmate P2, P4, B, Aspire S7 *Price range, 15.6 inch screen: €345.91 - €1,414.44*	Internal test specifications: • Water spill resistant keyboard
		Travelmate P6 *Price range, 15.6 inch screen: €1,109.31 (indicative)*	Internal test specifications: • Drop, shock, vibration, dust, temperature range • Screen/lid open-close • Dust ingress

Manufacturer	Market segment (% with testing applied)	Models to which testing is applied	Scope of testing
Lenovo	Lenovo range (no models)	*No testing claims made for consumer models.* *Price range, 15.6 inch screen:: €275-99 - €1,173.65*	n/a
	Thinkpad range (56% of models)	11E/T/X/L/W/G series *Price range, 15.6 inch screen: €718.00 €1,705.21*	MIL-STD-810G standards: • Drop, shock, vibration, dust, humidity, altitude, temperature range, temperature shock Additional internal test specifications: • Screen pressure test • Water spill resistant keyboard • Hinge durability
Dell	Consumer range (32% of models)	XPS *Price range, 15.6 inch screen: €1,499*	n/a
		Inspiron 3000,5000,7000 models *Price range, 15.6 inch screen: €269 - €799*	Internal test specification: • Temperature range • Screen lid open/close (25,000 times) • Keyboard (10 million key strokes) • Trackpad (1 million presses)
	Business range (46% of models)	Latitude series 3000, 5000 models, *Price range, 15.6 inch screen: €699 - €964*	MIL-STD-810G standards: • Shock, vibration, temperature range, temperature shock
		Inspiron series 3000,7000 models *Price range, 15.6 inch screen: €369 - €799*	Internal test specification: • Temperature range • Screen lid open/close (25,000 times) • Screen lid torsion (25,000 times) • Keyboard (10 million key strokes) • Trackpad (1 million presses)
Asus	All notebooks (100% of models)	All notebook series *Price range, 15.6 inch screen: €315.50 - €973.62*	Internal test specifications: • Drop, shock and vibration tests • Temperature range • Keyboard strokes simulation • Screen pressure test

Manufacturer	Market segment (% with testing applied)	Models to which testing is applied	Scope of testing
			• Screen lid open/close (20,000 times)
	Business range (100% of models)	ProB and ProP series *Price range, 15.6 inch screen: €467.27 - €1,143.38*	Internal test specification with higher performance for: • Drop test (+100% increase in drop height) • Screen pressure test (+20%) • keyboard strokes (+100%)
Toshiba	Consumer range (no models)	*No testing claims made for consumer models.* *Price range, 15.6 inch screen: €419.10 - €662.38*	n/a
	Business range (58% models)	Tecra series Portege series *Price range, 15.6 inch screen:* €974.38 – €2,696.16	Highly Accelerated Lifetime Test simulating 3 years of use: • Drop, shock and vibration tests • Temperature range • Screen pressure test • Water spill resistant keyboard

3.3.4.4 Second proposal for notebook durability criteria

Second criteria proposal

3(a) Durability testing of portable computers

3(a)(i) Tests that shall apply to notebook computers

The notebook computer model shall pass durability tests. Each model shall be verified to function as specified and meet the stipulated performance benchmarks after performing the mandatory tests in Table 5 and a minimum of one additional test selected from Appendix 2.

Table 5 Mandatory durability test specification for notebook computers

Test	Test conditions and performance benchmark	Test method
Resistance to shock	Specification: A40g half-sine pulse shall be applied for duration of 6 ms three times each to the bottom, left, right and back side. Functional requirement: The notebook shall be switched on and running a software application during the test. It shall continue to function following the test.	IEC 60068 Part 2: Ea

Resistance to vibration	Specification: Randomised vibrations in the frequency 20-2000 Hz, 1.04 Grms, shall be applied for 1 hour each to the bottom, left, right and back side. Functional requirement: The notebook shall be switched on and running a software application during the test. It shall continue to function following the test.	IEC 60068 Part 2: Fh (Random test)
Accidential drop	Specification: The notebook shall be dropped from 76 cm of height onto a surface consisting of 5.0 cm of plywood upon concrete. 4 drops shall be made per face, edge and corner. Functional requirement: The notebook shall be switched off during the test but shall successfully boot up following each test. The casing shall remain integral and the screen undamaged following each test.	IEC 60068 Part 2: Ec (Freefall, procedure 1)

3(a)(ii) Tests that shall apply to tablet and two-in-one computers

The tablet computer model or the tablet component of a two-in-one computer model shall pass durability tests. Each model shall be verified to function as specified and meet the stipulated performance benchmarks for each test as specified in Table 6.

Table 6. Mandatory durability test specification for tablet and two-in-one notebook computers

Test	**Test conditions and performance benchmark**	**Test method**
Accidential drop	Specification: The tablet shall be dropped from 76 cm of height onto a surface consisting of 5.0 cm of plywood upon concrete. 4 drops shall be made per back face, edge and corner. Functional requirement: The tablet shall be switched off during the test but shall successfully boot up following each test. The casing shall remain integral and the screen undamaged following each test.	IEC 60068 Part 2: Ec (Freefall, procedure 1)
Screen resilience	Specification: A 60kg/cm2 static load shall be applied to the centre of the screen with the tablet placed on a flat surface. The test shall be repeated x times. The screen shall be flexed by pushing and pulling each top corner with a force of 20 N applied 2,500 times in each direction. Functional requirement: The screen surface and pixels shall be inspected for the	The test equipment and setup used shall be confirmed by the applicant.

	absence of lines, spots and cracks after each application of a loading.	

Assessment and verification: The applicant shall provide test reports showing that the model has been tested and has met the functional performance requirements for durability. Testing and verification shall be carried out and certified by a third party.

Summary rationale for the proposed changes

- Further analysis of the notebook ranges of HP, Acer, Lenovo, Dell, Asus and Toshiba provides an indicative overview of the extent to which durability testing is carried out and the aspects that are tested.
- Comprehensive durability testing, including drop, shock and vibration tests, tend to be carried out for business models, with the notable exception of Asus, and there appears to be a wide range of choice of tested models on the market.
- Whilst a price premium tends to exist between home and business models, it does not appear possible to clearly attribute this to durability testing, or to assume that there a durable business model will be more expensive than an untested consumer model.
- Moreover, whilst manufacturers' websites make a clear distinction between home and business models this is not always reflected in how models are sold to consumers by retailers. The consumer may not therefore know they are buying a 'business' model.
- Based on the further market analysis, together with feedback from stakeholders, a reduced number of mandatory notebook tests have therefore been defined – shock, vibration and accidental drop.
- Shock and vibration tests are understood from discussions with a leading manufacturer, and on the basis of warranty returns, to be fundamental in ensuring that a notebook is robust in day to day usage. Moreover, the most common accident identified by surveys is an accidential drop.

- In addition, it is proposed that applicants choose at least one supplementary test from a list of common notebook tests reflecting potential accidents or environmental conditions – temperature stress, screen resilience, water ingress, keyboard lifespan and screen hinge resilience. This would give manufacturers flexibility to choose based on priorities for the model and its target market, as well findings from their own warranty returns,
- Tablets are proposed as being addressed by a mandatory combination of a drop test and screen resilience test.
- The US Department of Defence MIL standards have been replaced throughout with references to electrotechnical standards from the IEC 60068 environmental testing series and IEC 60529 for ingress protection
- Where a standardised test procedure could not be identified then a test specification, benchmark and functional requirement are briefly described. Applicants would then need to verify the equipment and setup used.

3.3.5 Criterion 3.5 – Upgradeability and Repairability

To avoid an early replacement of the whole computer in the case of worn out or defective single components, the upgradeability and repairability of products are major factors that can facilitate a lifetime extension. Thus it is proposed to place a focus on the revision of these criteria.

Present criteria, Decisions 2011/337 and 2011/330
"User repairability": The applicant shall provide clear instructions to the end-user in the form of a manual (in hard or soft copy) to enable basic repairs to be undertaken. The applicant shall also ensure that spare parts are available for at least five years from the end of production of the personal computer and/or computer monitor / notebook computer. *Assessment and verification*: The applicant shall declare the product's compliance with these requirements to the competent body together with a copy of the repair manual.

3.3.5.1 Major proposed changes (first proposal)

Proposed revised criteria (first proposal)
Repairability: For the purpose of undertaking repairs and replacements of worn out parts, or to upgrade older parts

and components, the following criteria shall be fulfilled:

(a) Design for repair: All major repairable/replaceable components of computers, if applicable, such as hard drive, CD/DVD and Blue-ray drive, printed circuit board, memory, screen assembly, LCD backlight, keyboard, mouse pad, rechargeable battery, cooling fan, catches and hinges shall be easily accessible and exchangeable by the use of universal tools (i.e. widely used commercially available tools).
As a minimum the following should be used: simple access panels provided for key components and screw numbers minimised (e.g. by lugs and slots). Screw heads standardised with no more than three head sizes. Removable electrical connectors (e.g. clip, screw) should be used rather than soldered or crimped joints where access is required. The following should not be used: self-tapping screws, irreversible snap-fits or adhesives where access is required. Tamper-proofing (such as plastic covers or labels) should only be used to ensure authorised repair under warranty and should not inhibit other repairs outside of the warranty period.

(b) Repair manual: The applicant shall provide clear instructions in form of a repair manual (in hard or soft copy) to enable replacing of these key components.

(c) Availability of spare parts: The applicant shall ensure that spare parts, including rechargeable batteries (if applicable), are available for at least five years following the end of the computer model production.

(d) Reasonable repair costs: The applicant shall ensure that the cost of individual spare parts is less than 20% (LCD assembly: less than 60%) of the cost of a new machine.

(e) Repair Service / Information: Information should be included in the user instructions or the manufacturer's website to let the user know where to go to obtain professional repairs and servicing of the computer, including contact details as appropriate.

Assessment and verification: The applicant shall declare the compliance of the product with these requirements to the competent body. Additionally, the applicant shall provide a copy of the repair manual, a copy of the user instructions, and a list with prices of available spare parts.

- The link to the end-user has been removed; today's products become increasingly complex and often the right to claim under guarantee becomes invalid when repairs are executed by persons who are not authorised.
- Design for repair: Detailed requirements for major components that shall be easily exchangeable have been included. The focus is instead on those components that appear to have a high failure rate. The term "easily accessible and exchangeable" has been illustrated with clear examples.
- A new criterion on reasonable repair costs has been proposed in order to avoid costs of single spare parts being more expensive than the purchase of a whole new computer product.

For more details cf. Task 4 report "Improvement Potential", section 4.2.3.3 "Repairability / Warranty / Service".

Consultation questions
• In general: does a commercial guarantee in case of products' defects facilitate the repair, i.e. lifetime prolongation, or are the defect devices simply being exchanged for new products? • Should an additional commercial guarantee by the brand owner be required (e.g. TCO: 1 year, EPEAT: 3 years)?

3.3.5.2 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, there was a general feeling that the proposal can be supported but the original reference promoting basic repairs by the consumer should be retained where they are possible and do not invalidate the warranty. Safety should also be addressed, so that only those repairs that can be carried out safely and with no risk should be highlighted.

A distinction should be made between components that can be repaired and those that can be replaced. Moreover, a distinction shall also be made between those that can be carried out by consumers and those by professional services.

The issue of competition in professional repairs was highlighted. If it is only permitted for the manufacturer to provide the repair service then this will limit competition and may not help to reduce costs. Franchising and/or agreements with manufacturers might be something to support. The criteria should be non-discriminatory.

There was a general feeling that a limit on repair costs for components would be very difficult to make work.

Longer guarantees for certain components were highlighted as being important but may be problematic for batteries. EPEAT exempts batteries from such a requirement. In the case of some computers they are simply replaced – this must be possible to do by the consumer. The cost of extra guarantees will require consideration.

It was asked whether the study team has access to information on why computers breakdown. This should directly inform the lifetime extension criteria. A study by WRAP in the UK looked specifically at why computers breakdown. The study team confirmed that this reference has been taken into account when drafting the proposal for revised criteria. It was further suggested that cables and chargers may be an area to look at.

Written stakeholder feedback following the first AHWG meeting suggested permitting that spare parts do not have to be those originally designed for the product but that **"backwardly compatible" parts** are also acceptable.

For product safety and liability reasons, there is required the need to make a clear **distinction between user and professional repair actions**. It is seen that for end-users the availability of professional repair options to fix day-to-day problems with the devices by reasonable costs is an important fact for a substantial prolongation of the use time. To stimulate such costly services, in addition to the requirements proposed in the current criteria document, a requirement to guarantee easy access to the necessary repair information, diagnostic tools and spare parts to third party reuse or repair shops or organisations.

Regarding **reasonable repair costs** it was stated that it is difficult to dictate prices to the market. Given that after only a few years the whole product value is 20% of the original purchase price there may be other more effective ways to prolong life[93]. After the warranty period has expired, replacement parts are likely to be sourced from aftermarket or 2nd-hand sources (e.g. eBay). Providing a list with the price of available spare parts would be very difficult to have from applicants, as these prices also depend on who is the final purchaser: GPP or private buyer request different prices for the same products. Further, prices are very dynamic, they vary within countries, between countries and over time for the same product, typically lower prices at the end of a specific product model lifetime. Also, the proposed criterion is stated to be impossible for the Competent Bodies to assess and control. Instead of the proposed requirement on the price of spare parts, it is proposed to have **information about the manufacturing year** on the computer thus the user would have some idea when the availability of spare parts will run out. Regarding the **availability of spare parts**, one of the stakeholders recommended 3 instead of the proposed 5 years. **Longer product guarantees** are preferred as a better indicator of

[93] Source: WRAP Report "The value of consumer electronics for trade-in and re-sale"; March 2013; http://www.wrap.org.uk/sites/files/wrap/Value%20of%20consumer%20electronics_trade%20in%20_resale%2013%2008%2020.pdf

intended minimum first life. For example, WRAP research (HWP200-301)[94] indicated that UK consumers welcome longer guarantees from manufacturers, as this indicates confidence that their products have a long lifetime.

Batteries need to be easily removed without the risk of damaging the product during the action, by the end user or service provider alike facilitating this e.g. by restricting glued in critical components.

Further research and evidence

The **upgradeability** of computer products differs significantly;

- Desktop computers, desktop workstations and small scale server: still certain components can be more or less be easily upgraded (HDD, SSD, memory) or expanded by additional slots (graphics),
- Notebooks:
  - HDD/SSD, memory, CD/DVD/Blu-ray drive, rechargeable battery: some are easily be upgradeable, some are already glued in
  - Videocards for notebooks are not exchangeable separately, as mainly on-board graphic processing unit (GPU), i.e. integrated on motherboard
- Ultrabooks as sub-category of notebooks: The thinner and smaller the form factor, the more complicated is an exchange and upgradability of components; for the reason of saving space, most components are fixed by being glued in.
  - Mostly, neither HDD/SSD nor RAM is exchangeable against new components; either ultrabooks are secured with special screws or the RAM is soldered up with the motherboard[95]. Example for good upgradeability of HDD and RAM: ASUS Zenbook UX32DV[96] (onboard *plus* removable RAM).

[94] Source: WRAP GB Report "Electrical and electronic product design: product lifetime"; January 2013; http://www.wrap.org.uk/sites/files/wrap/WRAP%20longer%20product%20lifetimes.pdf

[95] Sources: www.com-magazin.de/praxis/hardware/20-fakten-zu-ultrabooks-7388.html; www.heise.de/newsticker/meldung/Oeko-Logo-EPEAT-winkt-Ultrabooks-durch-1729666.html 15.10.2012

[96] Source: www.ifixit.com/Teardown/Asus+Zenbook+UX32VD+Teardown/10120

  - Rechargeable batteries are mostly fixed and only replaceable by manufacturers. Examples for best practice: ASUS Zenbook UX32DV[96], Dell Latitude 6430u and Sony Vaio T13[97]

- In general: Motherboard and CPU are rather more difficult to exchange for upgrades; the exchange of the CPU is theoretically possible, however, meanwhile it is often soldered up with the motherboard for the reason of better heat dissipation.[98]

Regarding longer product **guarantees**,

- WRAP research (HWP200-301)[94] conducted six qualitative focus groups and a nationally representative survey of 1,104 consumers of household electrical appliances in England and Wales; based on that, the study concluded that the provision of longer standard guarantees or warranties is likely to be central to maximising consumer pull for longer lifetimes. They are seen by consumers as a show of faith by the manufacturer in the lifetime of their product. However, participants in the qualitative focus groups of the study also expressed a strong preference for longer guarantees or warranties that would enable them to have the product in question replaced rather than repaired if it did break down.
- The website www.onlinekosten.de/computer/computer-defekt gives an overview of standard warranties provided by different manufacturers, see following table. The information provided indicates that the defect devices are generally taken back from the manufacturer for doing repairs in the first instance, thus facilitating the prolongation of lifetime.

Table 21: Overview of standard warranties provided by different manufacturers

Manu-facturer	Standard warranty				Opening of hardware allowed?
	PCs	Notebooks/ Netbooks	Notebook battery	Monitors	
Acer	• Consumer PCs: 1-2 years • Business PCs:	• Notebooks: 1-2 years • Netbooks:	6 months	• Consumer LCDs: 2 years	Upgrade of hardware not generally forbidden, but defects caused by

[97] Source: www.onlinekosten.de/news/artikel/50054/2/Ultrabook-Beratung-Vor-und-Nachteile-der-duennen-Dauerlaeufer

[98] www.gamestar.de/hardware/praxis/notebooks/2323984/notebook_tuning_teil_1.html

Manu-facturer	Standard warranty				Opening of hardware allowed?
	PCs	Notebooks/ Netbooks	Notebook battery	Monitors	
	1-3 years	1 year		• Professio-nal LCDs: 3 years	improper repairs or incorrect components not covered by warranty
Apple	Generally 1 year				Allowed, when in handbook the exchange of components like RAM or HDD are described explicitly; if not in the manual, hardware may only be opened by Authorized Apple Service Provider (AASP)
Asus	2 years	2 years	1 year	3 years	Exchange of RAM and HDD allowed
Dell	Service against payment of a fee: 1 year				Components like RAM, HDD or cards are allowed to exchange
Fujitsu	2 years	2 years	1 year	3 years	Yes, e.g. RAM; generally warranty covers only original configurations
HP	2 years for certain product series	2 years for certain product series	Excluded from standard warranty	n.a.	Upgrade of hardware not generally forbidden, e.g. RAM, but defects caused by improper repairs or incorrect components not covered by warranty
Lenovo	1-3 years depen-ding on model	1-3 years depending on model	1 year	n.a.	Yes, e.g. RAM
LG	2 years	2 years	6 months	3 years	No, only by authorized / specialized dealers
Toshiba	n.a.	1-3 years depending on model	1 year	n.a.	Upgrade of hardware not generally forbidden, e.g. RAM, but defects caused by improper repairs or incorrect components are not covered by warranty

Regarding **repairability**,

- Market analysts of IDC carried out a study sponsored by Panasonic based on a survey of 300 businesses in the USA. The study found that on average each

year 14.2% of notebooks required repair or replacement due to physical failure, and 9.5% of notebooks required repair or replacement due to an accident. The most commonly damaged component was the keyboard (72%) followed by the screen (66%), battery (58%) and hard disk drive (51%).[99]

- WRAP research (HWP200-401)[93] especially for Tablet PCs analysed that there are many different standards from device to device as the market is evolving fast for this product type. This currently makes repair difficult as parts are not easily available or interchangeable. This may improve as the market matures and only a few product types become the norm. Repair costs are high, relative to residual value, because of the high volume of screen damage that is incurred over all the model types.
- The study 'Disassembly analysis of slates: Design for repair and recycling evaluation' by Fraunhofer IZM (2013)[100] aimed to assess the ease of dismantling slates by experimental teardowns of in total 21 different devices under test, including disassembly processes, difficulty and need for special tools, identification of good D4R examples (design for repair, refurbishment, reuse and recycling) and reflection on suitable product information from manufacturers that would be of value to repairers, refurbishers and recyclers.
  - As **regular tools**, Fraunhofer IZM defined in their study screwdrivers, metal and plastic spatula, pliers and tweezers. **Special tools** are: screwdrivers with special heads (e.g. torx), heat gun, thermal pad, soldering iron etc.
  - With respect to a repair scenario, the study identified **robust clips and screws as feasible design solution supporting damage-free opening** and closing of a slate. The use of adhesive was found to be suboptimal but possible, requiring cleaning and applying new adhesive when closing the device again.

[99] IDC, *The Business case for ruggedized PC's*, USA, June 2012
[100] Cf. http://www.izm.fraunhofer.de/content/dam/izm/de/documents/News-Events/News/2013/urn_nbn_de_0011-n-255111-18-1.pdf

- For battery removal, two design options were found: a battery housing (type of tray) made out of plastics or metal being attached with an average of four **screws** to the device; and on the other hand the battery being directly glued mostly with two strips of adhesives into the device. Whereas the glued option required a very delicate approach to lifting the battery and requiring a cleaning process, the screws were found to have a slight advantage in terms of reversibility and safety. A practicable solution for adhesives was found to be a small non-adhesive strip at the end of the adhesive tape attached to the backside of the battery which allowed the adhesive tape to be easily pulled off to remove the battery. Further, batteries with a **connector cable** to the mainboard were easier to replace than those with soldered wires.
- For the dismantling of the mainboard and the display unit, Fraunhofer IZM indicated connectors and screws as favourable design options facilitating the reversibility of the process. However, the report states that the front glass touch panel and the display panel are always glued together, sometimes additionally enveloped in metallic tape. The display module is furthermore attached (e.g. with glue, screws) to an outer frame or an inner frame. To separate the front glass from the display panel one option is to use heat to dissolve the glue that connects the two panels. If double side tape is used (thicker foam material), the material more likely gets ripped and comes off unevenly, with a replacement needed in a repair scenario. Further, a simple separation of both parts with a spatula in various cases ended up in breaking the thin front glass.
- **For independent repair shops**, but partly also for independent recyclers Fraunhofer IZM stated it would be of high interest to get hold of **information about the opening mechanism in advance** to save time and more important in case of repair to avoid damage to the surface and parts.

3.3.5.3 Second proposal for upgradeability and repairability criteria

Proposed revised criteria (second proposal)

Upgradeability and Repairability:

For the purpose of upgrading older components or undertaking repairs and replacements of worn out components or parts, the following criteria shall be fulfilled:

(a) Design for upgrades and repair: The following components of computers, if applicable, shall be easily accessible and exchangeable by the use of universal tools (i.e. widely used commercially available tools as screwdriver, spatula, plier, or tweezers):

(i) HDD/SSD,
(ii) Memory,
(iii) Rechargeable battery,
(iv) Screen assembly and LCD backlight,
(v) Keyboard and mouse pad, and
(vi) Cooling fan.

Indicatively, the following should be used: simple access panels provided for key components and screw numbers minimised (e.g. by lugs and slots). Screw heads standardised with no more than three head sizes. Detachable electrical connectors (e.g. clip or screw) should be used rather than soldered or crimped joints where access is required. The following should not be used: self-tapping screws, irreversible snap-fits or adhesives where access is required. Tamper-proofing (such as plastic covers or labels) should only be used to ensure authorised repair under warranty and should not inhibit other repairs outside of the warranty period. Special tools include e.g. screwdrivers with special heads (e.g. torx), heat gun, thermal pad, soldering iron.

(b) Repair manual: The applicant shall provide clear disassembly and repair instructions (e.g. hard or soft copy, video) being publicly available, to enable a non-destructive disassembly of products for the purpose of replacing key components or parts for upgrades or repairs.

(c) Repair Service / Information: Information should be included in the user instructions or the manufacturer's website to let the user know where to go to obtain professional repairs and servicing of the computer, including contact details as appropriate. Service should not be limited exclusively to applicant's Authorized Service Providers.

(d) Availability of spare parts: The applicant shall ensure that original or backwardly compatible spare parts, including rechargeable batteries (if applicable), are publicly available for at least five years following the end of the computer model production.

(e) Warranty: The applicant shall provide an additional three year warranty or service agreement for the computer product; for rechargeable batteries, if applicable, the period should be at least one year.

Assessment and verification: The applicant shall declare the compliance of the product with these requirements to the competent body. Additionally, the applicant shall provide

- A copy of the warranty or service agreement.
- A copy of the repair manual
- A copy of the user instructions

Major proposed changes

- The proposed criteria for reasonable repair costs have been deleted.

- The components that have to be exchangeable have been further detailed based on further research and evidence; for repairs, keyboards, screen, battery and HDD are of relevance, for upgrades HDD/SSD, memory and battery.
- The listed joining techniques and connections have been changed from being a 'minimum requirement' in the first criteria proposal to be proposed as 'indicatively'. Further research[101] revealed no verifiable proof that certain joining techniques such as adhesives are destructive to the products or components per se.
- An explicit distinction between repairs that might be undertaken by end-users and others only by professional repair services has not been made. Clarification is often provided in the product manual which repairs might be done by the consumer without affecting the manufacturers' guarantee/warranty (cf. Table 21).
- However, feedback from stakeholders proposed to support customer's choice for third party reuse or repair shops or organisations. In order to facilitate them easy access to the necessary repair information, diagnostic tools and spare parts, the criteria on spare parts and repair manual have been specified by having to be "publicly available"; the criterion on repair service includes a requirement that it must not be limited exclusively to applicant's Authorized Service Providers.
- Repair manual: video demonstration of disassembly has been added as possibility.
- The criteria on availability of spare parts have been further detailed regarding the possibility of being "original or backwardly compatible". The number of five years, however, has not been shortened as partly being required. For computer products, it seems that the type of models changes every year; in order to facilitate a real lifetime *prolongation*, the availability of spare parts for 3 years would only address the average lifetime of computers.

[101] For example the study 'Disassembly analysis of slates: Design for repair and recycling evaluation' by Fraunhofer IZM (2013), or iFixit (www.ifixit.com/Teardown/Asus+Zenbook+UX32VD+Teardown/10120)

- A new sub-criterion regarding a manufacturer's warranty additionally to the legal guarantee is proposed aligning it to the current EPEAT criteria for product longevity of computers, however specifying it to explicitly cover rechargeable batteries. Further research indicated that most manufacturers already offer such service taking back defect devices for repairing them, thus facilitating the prolongation of lifetime of computer products.

3.3.5.4 Stakeholder feedback and further evidence

Summary of stakeholder feedback
The ability to replace a battery was highlighted by one stakeholder as being particularly important, particularly if it is glued or welded into the casing, as may be the case for certain tablets. The public availability of repair information to consumers and service centres was welcomed. It should be specified in the criteria that diagnostic tools should be made available. There were different perspectives on the proposal for parts to remain available for 5 years. Would this relate to a model and the availability of parts from the time the model ceased production? Also, what would happen if the model number changed? It was felt by one stakeholder to be preferable to ensure the availability of spare parts for at least five years following end of the computer model production instead of the purchase date. Clarity was requested by a Member State on the meaning of the 3 year warranty proposal. Does it provide the same rights that the legal guarantee period or does it refer to the commercial guarantee? Reference should be made to the Consumer Goods Directive 99/44. It should be clarified what it is additional to (e.g. minimum 2 year legal guarantee period) and that it should be free. It was highlighted that the interpretation of the legal guarantee period varies by Member State. Clarification was requested as to why for rechargeable batteries the period would be only one year when the legal guarantee in Directive 99/44 is two years.

3.3.5.5 Second proposal for notebook durability criteria

Second criteria proposal

3(e) Upgradeability and Repairability

For the purpose of upgrading older components or undertaking repairs and replacements of worn out components or parts, the following criteria shall be fulfilled:

(a) Design for upgrades and repair: The following components of computers shall be easily accessible and exchangeable by the use of universal tools (i.e. widely used commercially available tools as screwdriver, spatula, plier, or tweezers):
   a. HDD/SSD,
   b. Memory,
   c. Screen assembly and LCD backlight (where integrated),
   d. Keyboard and mouse pad (where used), and
   e. Cooling fan.

(b) Battery replacement: The battery shall be easy to extract by one person (either the user or repair service provider). The following specific requirements apply:
   a. For all products batteries shall not be glued or soldered into a product;
   b. For notebooks and portable all-in-one computers it shall be possible for the user to extract the battery without tools;
   c. For sub-notebooks and ultrabooks it shall be possible to extract the battery in a maximum of three steps using a screwdriver;
   d. For tablets and two-in-one notebooks it shall be possible to extract the battery in a maximum of four steps using a screwdriver and spudger;
   e. For sub-notebooks, ultrabooks, tablets and two-in-one computers simple instructions about how the battery packs are to be removed shall be marked on the base cover of the product.

(c) Repair manual: The applicant shall provide clear disassembly and repair instructions (e.g. hard or electronic copy, video) and make them publicly available, to enable a non-destructive disassembly of products for the purpose of replacing key components or parts for upgrades or repairs. Additionally, a diagram shall be provided on the inside of the casing of stationary computers showing the location of the components listed in (a) can be accessed and exchanged. For mobile computers a diagram showing the location of the battery, data storage drives and memory shall be made available in pre-installed user instructions and via the manufacturers website.

(d) Repair Service / Information: Information should be included in the user instructions or the manufacturer's website to let the user know where to go to obtain professional repairs and servicing of the computer, including contact details as appropriate. During the guarantee period referred to in (f) this may be limited to the applicant's Authorised Service Providers.

(e) Availability of spare parts: The applicant shall ensure that original or backwardly compatible spare parts, including rechargeable batteries (if applicable), are publicly available for at least five years following the end of production for the model.

(f) Guarantee: The applicant shall provide at no additional cost a minimum of a three year guarantee during which time they shall ensure the goods are in conformity with the contract of sale. This guarantee shall include a service agreement with pick-up and return.

Assessment and verification: The applicant shall declare the compliance of the product with these requirements to the competent body. Additionally, the applicant shall provide:

(i) A copy of the guarantee or service agreement

(ii) A copy of the repair manual and supporting diagrams
(iii) A copy of the user instructions
(iv) A description supported by photographs showing compliance for battery extraction
(v) A picture of the battery replacement instructions on the base of the product

Summary rationale for proposed changes

- The proposal has been updated with the insertion of a new sub-criterion addressing the ease of battery replacement. The evidence and rationale for this proposal can be found in Section 3.3.2.4
- The reference to an extended warranty has been updated to reflect the language used in Directive 99/44/EC on the sale of consumer goods and associated guarantees.
- It has also been clarified that the three year period referred to is inclusive of the minimum two year period of conformity, and that the same service shall be provided as a commercial guarantee, including pick-up and return, at no cost to the consumer.
- A new reference has been made in part (c) to the inclusion of a diagram inside the computer casing showing where the main component parts can be accessed. This is understood to reflect best practice for desktops and servers.
- Reference to guarantees for rechargeable batteries has been moved to Criterion 3(b).

3.3.6 Criterion 3.5 – Data deletion

Second hand usage can prolong the overall usage and lifetime of computers. However, a barrier to IT devices being given for second hand usage could be the end-users' concern on possible misuse of private data still stored in the devices. Thus, a new criterion on data deletion is proposed.

For more details cf. Task 4 report "Improvement Potential", section 4.2.3.5 "Second hand usage / secure data wiping".

3.3.6.1 First proposal for data deletion criteria

Proposed new criteria (first proposal)
Data deletion: • To allow a second use of the computer, the device shall be designed so as to allow the user to completely and safely delete all personal data by himself without the help of fee-required software or special tools. This can be achieved by either physically removing the data storage (e.g. memory card, Hard Disk Drive) or with the help of software provided by the manufacturer or a third party free of charge. When using software, the deletion process shall at least include an overwriting of all the data stored with a random pattern. Software solutions from the manufacturer or a third party must be available free of charge for at least five years following the end of the computer model production. • The applicant shall provide clear instructions to the end-user in form of a manual (in hard or soft copy) to enable personal data deletion. *Assessment and verification*: The applicant shall declare compliance of the product with these requirements and additionally provide a copy of the user instructions to the competent body.

3.3.6.2 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, there is a wide variety of methods for data resetting allowing a user to restore the computer to factory settings. The criteria will need to be more specific and is particularly relevant to GPP. This is because in some cases data can still be recovered. Some Government departments such as Defence have strict technical requirements to ensure that this cannot occur. Freeware exists but it is doesn't wipe the data as many times. Advanced software exists which writes random patterns to the HDD but is costly. Even if the HDD is damaged or removed this may not prevent the computer from being re-used.

Written stakeholder feedback following the first AHWG meeting:

- The proposal is agreed by one of the stakeholders. Justification: New computers are more frequently configured/partitioned to have a start-up disc (C:) and a data disc (D:). A mechanism to "Restore to factory settings" is not uncommon and will often present the user with a choice of a full reset or only the start-up disc. Software solutions to erase data are freely available and some provide solutions considered to be very secure. A link to several examples is provided[102].
- It is recommended that this section is expanded to specifically include solid state memory in addition to mechanical units such as HDD. To prolong lifetime all memory in the product must be able to be erased and reset in accordance with international data security standards. It is accepted that this may be through a proprietary or licensed software platform. It is suggested that any software is made available through the internet or online store to ensure that any user, anywhere, can carry out the data deletion. However, it has to be taken into account how this compares with security requirements of public sector and corporate organisations e.g. for multiple wipes/re-writes of random data to prevent subsequent access or reconstruction of data. Anecdotal information that inability to securely wipe whole memory of certain tablets and smartphones prevents UK asset management companies from guaranteeing data removal to CESG standards & therefore meeting their obligation in data removal. Such design leads to excess shredding/recycling of products that are inherently re-usable. Further example is the decision by Google to publish the hack codes for Google devices to enable developers to identify novel approaches to device use (and re-use).
- Reliable software granting that all data are completely cancelled is very expensive. This would eventually result into higher price of the final PC for a feature that the consumer might not need to use

[102] http://pcsupport.about.com/od/toolsofthetrade/tp/free-data-destruction-software.htm

- It is suggested to delete this criterion as it not seems to be under the control of ecolabels.
- There are many responsible initiatives for 2nd hand use, to erase data and refurbish for certain social projects. It is proposed as criteria that the brand should be involved in an initiative as part of their take back policy within the country of the original sale.

Further research and evidence

Complete deletion of data without allowing any data recovery, is only possible by multiple overwriting algorithms of the drive with different bit patterns. Several standards have been defined for those software based approaches, for example[103]:

- 5220.22-M-Standard by the US Ministry of Defence, AFSSI-5020 by the US Air Force (3-times overwriting; first: zero; second: one value; third: random character);
- AR 380-19 by the US Army (3-times overwriting; first: random character, 2nd: specified character, e.g. zero; 3rd: complement of the specified character, e.g. one);
- RCMP TSSIT OPS-II by the Royal Canadian Mounted Police (7-times overwriting; first: zero; second: one; third: zero; 4th: one; 5th: zero; 6th: one; 7th: random character);
- VSITR-Standard of the German Federal Office for Information Security (BSI) (7-times overwriting; first: random bit pattern; 2nd to 6th: reversed bit pattern, i.e. zero is replaced by one and one is replaced by zero; 7th: overwriting by fixed '01010101' pattern)
- Bruce-Schneier algorithm (7-times overwriting; first: zero; second: one; 3rd to 7th: random character);
- Peter-Gutmann algorithm (35-times overwriting, random character).

[103] Sources: BITKOM (2008): "Leitfaden zum sicheren Datenlöschen"; Version 2.0; www.bitkom.org/files/documents/Leitfaden_Sicheres_Datenloeschen_Version_2-0_vom_300508.pdf; http://pcsupport.about.com/od/toolsofthetrade/tp/free-data-destruction-software.htm

Software for effectively wiping data from the Hard Disk Drive might be approved. This seems to be done nationally; e.g. in UK, software can be approved by CESG (Communications-Electronics Security Group). For media sanitisation, the certification follows so called "Security characteristics for data sanitisation"[104], e.g.

- "Overwriting tools for magnetic media v1.6" from May 2012 which overwrites information from a piece of magnetic media prior to reuse.[105]
- "Degaussers v2.5" from May 2012 which sanitises data on magnetic media forms such as hard disk drives and tapes such that confidentiality is maintained[106].
- "Flash based Media v0.3" from August 2011 which sanitises all flash-based storage media such as solid-state hard drives, USB 'Thumb' drives and SD cards.[107]

On the other hand, irretrievable data sanitization can be done by physically destroying storage media using one of the following methods:

- Shredding;
- Degausser (demagnetization);
- Thermally destruction.

BITKOM (2008) provides the following recommendations:

- If Hard Disk Drives should be re-used, e.g. in another department, return to a leasing company or re-sale, they should be overwritten with an applicable software tool, at least three times, or seven times for highly sensitive data.
- For highly sensitive data, generally physical destruction should be preferred.
- The data deletion should be completely documented in a tamper-proof report.

[104] Cf. http://www.cesg.gov.uk/servicecatalogue/CPA/Pages/Security-Characteristics.aspx
[105] Cf. http://www.cesg.gov.uk/publications/Documents/overwriting_tools_for_magnetic_media_sc.pdf
[106] Cf. http://www.cesg.gov.uk/Publications/Documents/data_sanitisation-degaussers.pdf
[107] Cf. http://www.cesg.gov.uk/Publications/Documents/data_sanitisation_flash_based_storage.pdf

According to the German Federal Office for Information Security, however, modern Solid State Disks (SSD), Hard Disk Drives (HDD) or combinations (SSHD) use highly complicated mechanisms in order to handle failures; they deny the access of software applications, including data sanitization software, to the defect memory areas; further, hard disks allow the application of protected hard disk segments (host protected areas, HPA), i.e. normally being not visible to an operating system.[108]

3.3.6.3 Second proposal for data deletion criteria

Against the background of further evidence provided in the section above, a criterion for a *software based* data sanitization seems not applicable as irretrievable data deletion cannot be absolutely guaranteed.

Instead, for a complete and safe deletion of data to allow a second use of the computer, the device shall be designed so that the HDD or SSD can be easily removed without causing defects to the overall computer device; this requirement is already covered by criterion 3.5, ‘upgradeability and repairability’.

[108] https://www.bsi-fuer-buerger.de/BSIFB/DE/MeinPC/RichtigLoeschen/richtigloeschen_node.html

3.4 Cluster 4 – End-of-life management: Design and material selection

Similar to the cluster lifetime extension, the research results of Task 3 and Task 4 revealed that high attention should also be paid to the end-of-life (EoL) management of computers to reduce the overall environmental impacts since secondary resources from recycling can substitute primary production. In the current criteria documents, requirements affecting the EoL-management of computers are spread across different discontiguous criteria ("Recycled content", "Design for disassembly"). To illustrate the importance of EoL for computers, for the revision it is proposed to cluster and rearrange the associated criteria.

Present criteria, Decisions 2011/337 and 2011/330
"Recycled content": The external plastic case of the system unit, monitor and keyboard shall have a post-consumer recycled content of not less than 10% by mass. *Assessment and verification*: The applicant shall provide the competent body with a declaration stating the percentage post-consumer recycled content.

Present criteria, Decisions 2011/337 and 2011/330
"Design for disassembly": The manufacturer shall demonstrate that the personal computer/monitor can be easily dismantled by professionally trained personnel using the tools usually available to them, for the purpose of undertaking repairs and replacements of worn out parts, upgrading older or obsolete parts, and separating parts and materials, ultimately for recycling or reuse. To facilitate dismantling: (a) Fixtures within the personal computer shall allow for its disassembly, e.g. screws, snap-fixes, especially for parts containing hazardous substances; (b) Circuit boards, and/or other precious metal-containing components, shall be easily removable using manual separation methods both from the product as a whole and from specific components (such as drives) that contain such boards to enhance recovery of high value material; (c) All plastic materials in covers/housing shall have no surface coatings incompatible with recycling or reuse; (d) Plastic parts shall be of one polymer or be of compatible polymers for recycling and have the relevant ISO 11469 marking if greater than 25 g in mass; (e) Metal inlays that cannot be separated shall not be used; (f) Data on the nature and amount of hazardous substances in the personal computer shall be gathered in accordance with Council Directive 2006/121/EC and the Globally Harmonised System of Classification and Labelling of Chemicals (GHS). *Assessment and verification*: A test report shall be submitted with the application detailing the dismantling of the personal computer. It shall include an exploded diagram of the personal computer labelling the main components as well as identifying any hazardous substances in components. It can be in written or audio-visual format. Information regarding hazardous substances shall be provided to the competent body in the form of a list of materials identifying material type, quantity used and location.

3.4.1 Criterion 4.1 – Material selection and information

3.4.1.1 Major proposed changes (first proposal)

Proposed revised criteria (first proposal)
"Material selection and information" (a) Variety of plastics: Plastic parts with a mass greater than 25 grams shall consist of a single polymer or a polymer blend compatible with recycling. A maximum of 4 types of plastic may be used for these parts. Plastic cases may consist of two separable polymers or polymer blends at the most. (b) Surface coating / metal inlays: (i) Personal computers: All plastic materials used for covers/housing shall have no surface coatings / metal inlays incompatible with recycling or reuse; (ii) Notebook computers: It shall be allowed to apply a metal coating to plastic case parts if such a coating is technically required. However, no electroplating shall be allowed. (c) Content of recyclates: The external plastic case of the system unit, monitor and keyboard shall have a content of post-consumer recyclates material of not less than 10% by mass. (d) Material information facilitating recycling: (i) Plastic parts with a mass greater than 25 grams shall be marked in accordance with ISO 11469 and ISO 1043, sections 1-4. For plastic parts > 200 grams, the marking should be large enough and located in a visible position in order to be easily identified by workers of specialised recycling firms. (ii) Data on the nature and amount of hazardous substances in the computer shall be gathered and provided in accordance with Council Directive 2006/121/EC and the Globally Harmonised System of Classification and Labelling of Chemicals (GHS). *Assessment and verification*: The applicant shall declare compliance of the product with these requirements to the competent body. The applicant shall provide the competent body with an exploded diagram of the computer in written or audio-visual format, labelling the main components, especially plastic parts greater than 25 grams in mass, as well as identifying any hazardous substances in components. The information shall include documentation to prove the conformity to the above mentioned ISO standards and additional specifications of the marking (dimension and position). Information regarding hazardous substances shall be provided to the competent body in the form of a list of materials identifying material type, quantity used and location. The applicant shall provide the competent body with a declaration stating the percentage post-consumer recycled content. In case of surface coating / metal inlays, the applicant shall provide the competent body with a declaration proving the technical demand.

Major proposed changes

- The different sub-requirements under the current criteria 'recycled content' and 'design for disassembly' have been rearranged and renamed 'material selection and information' and 'design for recycling' (see section 3.4.2).
- The criterion 'variety of plastics' has been detailed, taking the current Blue Angel criteria for Personal Computers and Notebook Computers as basis.

- The criterion ‘surface coating’ has been specified for notebook computers with derogation, where legal requirements technically necessitate surface coating in relation to electromagnetic compatibility (EMC).
- The criterion ‘Material information facilitating recycling’ specifies marking requirements.
- The assessment and verification requirements have been specified according to the new criteria structure.

For more details cf. Task 4 report “Improvement Potential”, section 4.2.4.2 “End-of-life management of computer products”.

3.4.1.2 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, a number of practical issues were identified.

- The first was suitability for recycling. This would ideally avoid the use of black plastic as it cannot be picked up by spectroscopic equipment.
- Plastics with **recycled content** are a problem for GPP. This is because there is not an analytical method to verify that the product contains recycled material. The verification assumes 100% control of the raw material. A project in Belgium called QA-CER was referred to as a possible model for verification. The availability of post-consumer recycled content was also highlighted as well as potential hazardous substances in recyclates. In this respect the polymer must be treated the same as virgin material. It was questioned just how beneficial a 10% recycling requirement was.
- End-of-life criteria should also be identified for metals but it is easier to specify criteria for plastics.
- It was highlighted that in line with the Waste Framework Directive the criteria on material selection should equally promote re-use.
- Different opinions were given on the value of **marking**. Some concerns were raised as to whether marking of plastics was really of value if shredding was to be used for recovery. On the other hand feedback from re-processors and

dismantlers suggested that it was of value. Reference was made to an analysis of 600 televisions which showed that 13% of plastics CE markings were incorrect. This provoked different opinions but in general this was felt to represent a high level of assurance for re-processors.

- The **reference to ISO 1043** does not make a specific reference to substances added to the polymer; it only refers to flame retardant classes. What is needed are the CAS numbers.
- The value of reducing the **number of plastics** used was questioned. This is because composites can be used which mean that less material can be used for the same function. The criterion only makes sense if it results in fewer raw materials being used.

Overall it was felt that the criteria on easily dismantling were more important in combination with a focus on recovery of critical metals. However, from a political point of view to not address recycled plastics content is something that would need to be explained. A practical solution would be to allow for high recycled content claims to be made using 'Box 2' of the Ecolabel, allowing content claims to be written next to the flower.

Written stakeholder feedback following the first AHWG meeting…

- The proposed criteria (a), (b) and (d (i)) are explicitly supported by one of the manufacturers. On the other hand, the proposed criteria under (d (ii)) are not supported as 2006/121/EC applies to substances and preparations (mixtures) and NOT to substances in articles. It should clearly be separated between substance/ mixtures and substances in articles/ complex articles.
- **Variety of plastics**:
  - Plastic composition should be easy and cost-effective through currently available industry techniques. Many recyclers shred plastics; some then carry out automated separation. WRAP research[109] on separation techniques showed that factors such as pigment selection can interfere with

[109] Cf. http://www.wrap.org.uk/content/separation-mixed-weee-plastics-0

automated separation processes (e.g. use of certain black pigments prevents recognition by NIR sorters). Equally, if the parts are to be separated manually, the speed with which the plastic can be removed and separated is vital.

- Beyond a reduction of polymer types to be used, also limitation of functional additives is a key prerequisite for any closed loop recycling attempt.
- Plastic parts of one polymer may facilitate recycling – if they are recycled, what is often not the case for plastic parts coming from computers – but will not facilitate dismantling. Reducing the number of plastics to favour recycling, can result in a higher consumption of raw materials and the generation of more waste. It can indeed impede the use of more performing materials in more demanding parts. This is contrary to the priority given to prevention. Limiting the number of plastics makes only sense when it doesn't result in an increase of material use. It should also be taken into consideration that progress is continuously made in sorting technology for mixed plastics waste, so that attention should be better focused on the separation of these plastics (design for recycling). This is seen as another example of a very unscientific criterion that excludes whole families of materials not taking into account improved performance. Laminates and composite plastics may also be much more resource efficient than single polymer plastics. They are seen to be discriminated without any proof based on life cycle analysis showing that their use results in a higher environmental impact than non-laminated and single polymer plastics. An example is provided: Co-extruded films (HYTEC and HYBRIDEX films) are based on new grades of virgin materials (thin-gauge film grades). The thickness could be reduced by 40% while keeping the required properties. This film is 20% cheaper, uses less non-renewable resources and makes on average 20 % of the turn-over of the company (Klerk’s Plastic Industrie B.V.) in the Netherlands. Discriminating laminates and composite plastics will prevent innovation; slow down technical progress; be contradictory to the aim to minimize non-renewable material use.

- **Surface coating**:
  - Neither desktops nor notebooks cases/housings shall have surface coatings (or even electroplated layers) nor have metal inlays. According to stakeholder feedback, the opening clauses “incompatible with recycling” and “technically required” should be skipped. The first one being not meaningful with respect to the variety of current recycling processes and the second being too imprecise.
  - It is not seen how the absence of surface coating of plastics could facilitate a mechanical action like dismantling. It shall be explained what about coatings of non-plastic materials is.
  - It should be specified in more detail what is considered a proof that certain plastic with surface coating is recyclable.
- **Content of recyclates**:
  - The proposed criteria for recycled content, sub-criteria (c), is not supported by one of the manufacturers as it neither can be verified, nor controlled. In GPP, these arguments are extremely important, see European Court of Justice, ECJ case Wienstrom, case C-448/01.
  - The imposed minimum recycled content of the external plastic case of the system unit does not address a main environmental impact, is not feasible for performance reasons and should therefore be removed. There is no justification for placing such criteria on the casing material.
  - There is not enough recyclable plastic material available. Since sourcing such material in the required volume and quality could prove difficult for manufacturers, such criteria would effectively deter uptake of the label. Besides availability, there may also be other technical obstacles. If plastics constitute the outside layer of a computer or other product (laminated or not), stringent appearance requirements may require highly consistent raw materials, which exclude recycled materials.
  - Further, fixed targets for recycled content have not proven to be a measure for minimizing environmental impact. There are cases where nearly 100%

recycled content is easily possible and is the state of the art and others where 5% recycled content leads to poor performing products and additional waste and environmental burdens. Recycling and specified recycled content is not always better from the environmental point of view. A life-cycle benefit from used recycled materials cannot automatically be assumed, but would be dependent on the plastics type and the impacts of the collection/recycling process.

- In an iPad tablet computer only 10 grams of plastic are present on 662 grams total weight. This means that less than 2 % of the total weight is plastic. For tablet computers in general about 10 % w/w or less are plastics (data from the presentation at the ad hoc working group on 10/10/2013). It is believed by one of the responding stakeholders that imposing a minimum of 10 % recycled content for a material that only accounts for 2 to 10 % of the total weight (which means that, at the end, only 0.2 % to 1 % of a computer is recycled plastic material) clearly fails to address a main environmental impact, as EU Ecolabel criteria are meant to do.
- TCO Development informed about their current Optional demands: TCO Certified Edge demands a PCC of 65% for displays and 50% for All-in-one PCs. According to their impression, more vendors are becoming committed to deliver post recycled plastic meeting performance requirements which have been considered a major obstacle in the past. TCO Certified to date has three display brands that achieve +65% PCC and three All-in-One PC brands that achieve +50%.
- One MS stakeholder is in favour in keeping this criterion; maybe lowering to 5% could be an improvement; they are not sure that the focus should be shifted to the recycling of metals, because the recycling rate of metals is already very high (for example printed circuit boards can be taken out before shredding). It is proposed to involve the recycling sector in this discussion.

- Public Waste Agency of Flanders (OVAM) confirmed that recyclates are available on the market, not enough if it would be mandatory for all computers but the EU Ecolabel only aims at 20% of the market and could be a good instrument to drive the market towards the use of recyclates.
- Regarding the verification of recycled content a certification scheme QA-CER started in Belgium. The certification distinguishes 3 levels of certification. Recyclates could also be screened for the presence of certain hazardous substances.
- Another MS stakeholder asked if the minimum amount (10%) is based on empirical findings that manufacturers can meet this criterion and is justified although the technical report states that "generally, however, using PCC in IT products presents significant challenges due to the unique structural, performance, and cosmetic requirements associated with these applications"? The criterion has appeared to be an obstacle even for past licence holders to keep the EU Ecolabel.
- While is it important to encourage the use of recycled plastics, it is suggested that enforcing 10% inclusion in external parts is unreasonable. It is recommended changing the requirement to include internal parts. WRAP trials have shown that often recycled plastics are most suited to internal components where colour, gloss levels, etc. are less stringent. The only ecolabelled computer to date, iameco v3, does not use external plastic parts - an indication that 10% recycled content and acceptable aesthetics are not yet practical.
- From an environmental perspective a much higher recycled content than the current 10% should be stimulated. Environmental stakeholders welcome any proposal allowing real front running companies to communicate in a meaningful way real recycling solutions (e.g. recycled contend > 80%).

- **Material information**:
  - WEEE Directive Article 15 clearly requires information on re-use, recycling and nature & location of hazardous components. It is suggested that this scheme requires best practice in providing this information.
  - Additional to the proposed criteria, the inclusion of critical raw materials in the components of the products shall be identified with type and amount of such materials in respective documentations (recycling pass) in order to support more target recalling activities in the future.
  - In contrast to what is written sometimes, labelling of plastic parts will NOT ease the dismantling of computers. Marking of plastic parts: does not facilitate the dismantling; does not help automatic identification and automatic separation of the plastic parts; does not help recycling. In this application, marking of plastic parts, whatever the weight, does not make any sense and should not be a criterion. The same criterion was removed from the EU ecolabel criteria for fridges in October 2009 and the recently developed Blue Angel criteria for refrigerating, does not include this requirement. The indication was that the markings do not particularly aid the recycling of the plastics in modern recycling facilities. In reality, at the end of life of computers, the LCD screen is separated for mercury recovery; the printed circuit board and the battery are separated (WEEE Directive requirement). The remaining metals and plastics go to a shredder and hence marking of plastic parts makes no sense. The proposal also fails to take into account the fact that there are very few – if any – plastic parts of more than 200 grams.

Further research and evidence

- The study 'Disassembly analysis of slates: Design for repair and recycling evaluation' by Fraunhofer IZM (2013)[110] indicates on the basis of an interview with a recycler that plastics are separated in white (including light grey) plastics which are of significantly higher recycling value, and black plastics. Metal foils attached to plastic parts reduce the value of the plastics fraction, and might be given to an additional shredding process for separation. Coating and plastics parts attached to bulk plastics parts reduce the value of the plastics fractions PC/ABS, white mixed plastics and black mixed plastics from the perspective of the dismantler. Meaning that mono material plastic housing parts without coatings, inserted metal windings, metal shields attached are better to recycle than composite materials.
- On the other hand, according to Köhnlechner (2014)[111], plastic sorting technologies can increasingly cope with black coloured plastics. Amongst others, sorting based on density separation as well as electrostatic properties of different polymer types can achieve high quality output for ABS and HIPS[112] – independent from the plastic colour.
- The Label TCO certified edge (version 1.2 for displays) requires a minimum content for post-consumer plastics of 65 % with exemptions for panels, electronic components, cables, connectors, PWBs, insulating mylar sheets and labels due to insufficient replacement. This also means that the weight of these items is not included when calculating the total weight of the plastic in the product in this requirement. The TCO database currently contains 89 products with 45 certifications compliant with this specification (date: 27.03.2014). This is further to the high level of recycled post-consumer plastic content being claimed by manufacturers such as Lenovo in the Task 4 report.

[110] Cf. http://www.izm.fraunhofer.de/content/dam/izm/de/documents/News-Events/News/2013/urn_nbn_de_0011-n-255111-18-1.pdf

[111] Source: Köhnlechner, R.: Erzeugung sauberer PS- und ABS-Fraktionen aus gemischtem Elektronikschrott. In: Thome-Kozmiensky, K.T.; Goldmann, D.: Recycling und Rohstoffe, Volume 7. Munich, 2014.

[112] HIPS: High Impact Polystyrene; ABS: Acrylnitril-Butadien-Styrol

- Concerns were raised at the first AHWG about the verification of recycled content. An example of a traceability system was provided by the Belgian Competent Body. The QA-CER system is a third party verified quality management system developed by a Belgian certification body and the Flemish Plastics Centre[113]. The system is based on ISO 9001, as well the EN standards EN 15347 relating to the characterisation of waste polymers[114] and EN 15343 relating to the traceability of waste polymers[115]. The standard EN 15343 is of particular interest as an underlying reference for QA-CER as it described a system for tracing polymer waste flows recognising that a system for analytical testing to verify recycled content does not exist.
- Research by Peeters et al.[116] has highlighted the importance of considering the flame retardants incorporated into plastic components, particularly casings and enclosures, as these are added to the polymer to provide fire protection. The study looked at PC/ABS, which is understood to be commonly used in computer casings (where plastics are used). Problems with the stability of the polycarbonate component arise because of the need to use water-based density separation techniques for shredded black plastics. In the scenario examined an 82% pure PC/ABS could be obtained post shredding, density and optical separation. However, in reality the plastic recovered is required to achieve a V1 fire rating and to achieve a so-called 'yellow card' for the recyclate, certifying its fire rating. The result is a recommended upper limit of recycled content of 10%.
- Manufacturers may instead choose a metal casing, for the purposes of ensuring toughness and durability of the product (e.g. cast aluminium, magnesium oxide)

[113] QA-CER, *QA-CER certification of the quality management system for recycling and production companies*, Version 1, January 2013

[114] CEN, *Recycled plastics – characterisation of plastics wastes*, EN 15347, December 2007.

[115] CEN, *Plastics recycling traceability and assessment of conformity and recycled content*, EN 15343, December 2007.

[116] Peeters.J.R, Vanegas.P, Tange.L, Van Houwelingen.J and J.R.Duflou, *Closed loop recycling of plastics containing Flame Retardants*, Journal of Resources, Conservation and Recycling, 84 (2014) p-35-43

and avoiding the need for treatments or additives to provide fire protection. Metal casings may not necessarily be readily recyclable. The alloy used may present problems for smelting.

3.4.1.3 Second proposal for material selection criteria

Proposed revised criteria (second proposal)
"Material selection and information to improve recyclability" (a) Variety of plastics: (i) Plastic parts with a mass greater than 25 grams may consist of a single polymer or a polymer blend compatible for the recycling.The compatibility for recycling shall be verified. (ii) Overall in the product there shall be a maximum of 4 types of plastic used of plastic parts with a mass greater than 25 grams. (iii) Plastic used for housings and enclosures shall consist of a maximum of two polymers in a form that is compatible with recycling. The compatibility for recycling shall be verified. (b) Surface coating / metal inlays: Plastic materials used for housings and enclosures shall have no surface coatings or metal inlays. (c) Material information to facilitate recycling: Plastic parts with a mass greater than 25 grams shall be marked in accordance with ISO 11469 and ISO 1043, sections 1-4. The CAS number of flame retardants shall additionally be marked FR (ISO 1043-4 code)-CAS. For plastic parts > 200 grams, the marking should be large enough and located in a visible position in order to be easily identified by workers of specialised recycling firms. Exemptions are made in the following cases: (i) Where the marking would impact on performance or functionality of the plastic part including screen light guides; (ii) Where parts cannot be marked because there is not enough available appropriate surface area for the marking to be of a legible size to be identified by a recycling operator; (iii) Where marking is technically not possible due to the moulding method; or (iv) Where the addition or location of marking causes unacceptable defect rates under quality inspection, leading to unnecessary wastage of materials (d) Recycled content: Plastic parts of the housings and enclosures as well as of structural elements with a mass > 25 grams shall have a total content of post-consumer recyclates material of not less than 10% by mass. Where the post-consumer recyclate content is higher than 25% a declaration may be made in the text box accompanying the Ecolabel (see Criterion 7.2). Recycled content shall be demonstrated according to the requirements of ISO 15343. Recyclates may contain flame retardants that are specifically derogated in Criterion 2(c). Printed circuit boards as well as transparent plastics that form part of display units are exempted from this requirement. (e) Closed loop recyclability rate of plastic containing flame retardants: The potential for closed loop recycling in a new electronic product of plastic required to meet fire protection standards shall be greater than 10%.

(f) Recyclability of metal enclosures: The recyclability of metals and alloys used for casings shall be verified.

Assessment and verification:

The applicant shall provide the Competent Body with an exploded diagram of the computer in written or audio-visual format. This shall identify the plastic parts greater than 25 grams in mass, their polymer composition and compatibility for the recycling, as well as associated markings and identifications of flame retardants.

The information shall be supplemented by documentation to showing conformity to the above mentioned ISO standards, specifications of the marking (dimension and position) and, where applicable, exemptions. A technical justification shall be provided where an exemption applies.

The applicant shall provide the Competent Body with documentation verifying traceability for the post-consumer recycled content according to the above mentioned ISO standard.

The recyclability of the housing and enclosures shall be verified by a declaration from a permitted treatment operation in accordance with Article 23 of Directive 2008/98/EC (the WEEE Directive) that there is an end-market for the materials.

Major proposed changes

- The heading has been changed from “Material selection and information” to “Material selection and information to improve recyclability”.
- **Surface coating / metal inlays:** The requirement has been tightened and there are no exemptions considered for the use of coatings for metal inlays.
- **Recycled content**: The requirement is not limited to external plastics any more but now applies to all plastic parts and structural elements > 25 grams. To avoid misunderstandings, transparent plastic parts of display units such as PMMA light guides and printed circuit boards are exempted from this requirement. The threshold of 10 % remains unchanged because although the example of TCO Certified Edge Displays shows that there are a certain number of products being able to fulfil this criterion although there are still practical problems faced by even front runner manufacturers in consistently meeting a higher requirement. Instead it is proposed that – following the example of cotton content claims in the textile product group, where a higher content can be demonstrated – there is an option to display this in Box 2 next to the Ecolabel. This would provide a benefit to manufacturers wishing to work towards a high recycled content, without placing an overall burden which could reduce the selectivity of the Ecolabel.

- **Verification of recyclate content:** Concerns were raised at the first AHWG about the verification of recycled content. Given the existence of EN 15343 which provides a system for tracing the original and flows of waste polymers it is proposed that this is introduced as a third party verification required for recycled polymer content. It is to be discussed further with manufacturers whether the information currently collected to verify recycled content claims is sufficient to enable verification according to EN 15343.
- **Material information facilitating recycling**: Although some stakeholder comments claimed that plastic marking has little influence on recycling practices, other stakeholders reported that recyclers do use this information for their sorting activities. As the marking is widely established in practice, it is suggested to retain this requirement. In the new proposal, exemptions are made for cases where technical limitations or restrictions result in marking not being feasible. For example, transparent plastic parts of display units such as PMMA light guides, which are understood to be easy to identify, and printed circuit boards are exempted from this requirement. A technical justification shall be provided where an exemption applies. In addition it is proposed that the CAS number of any flame retardant incorporated into the plastic is marked according to the suggested notation.
- **Recyclability of plastic containing flame retardant:** There is the potential for a contradiction between the incentive within the criteria to increase the recycled content of plastics and a predicted future increase in the WEEE derived recyclate on the market containing flame retardants. Depending on the final ambition level of the hazardous substance Criterion 2.x this may restrict the use of certain recyclate. However, if a flame retardant is restricted in the Ecolabel because of concerns relating to, for example, incineration in end of life phase then it would seem beneficial to permit continued functional use within recyclate. It is therefore proposed that, subject to the FR not being restricted under REACH, identified as an SVHC on the ECHA Candidate List or restricted under EU End of Waste criteria, they shall be permitted within recyclate.

- **Metal used for enclosures:** It is understood that certain alloys and associated coatings which may be used instead of plastic for enclosures may present recycling problems. It is proposed that the applicants verify the recyclability of their material choice. Further information is, however, required from stakeholders in this area.

3.4.1.4 Stakeholder feedback and further evidence

Summary of stakeholder feedback
In criteria 4(a) how will it be decided when polymers are compatible? Shall a list of compatible polymers and problematic flame retardants, additives, thermal properties be provided to the CB's? Recyclers consulted were not sure if they could provide a more practical interpretation of "compatible for recycling". A Member State questioned the value of asking for flame retardant CAS numbers as an additional plastics marking. This may be difficult to request and, in their experience, may be a trade secret. A stakeholder welcomed the proposal to limit the variety of plastics used and they wanted to avoid the potential for downcycling of plastic waste. It was additionally highlighted that TCO is stricter on recycled content and the proposed approach was therefore supported, although it was felt that it could be more ambitious. The viability of their being a stable supply of recyclate was highlighted as a consideration in relation to the minimum recycled content proposal. It was commented by an industry stakeholder that the recycled content criteria should be possible for televisions/displays but is more challenging for computers. Is there any data to support the proposal? It was questioned whether notebook plastic casings actually contained flame retardants given that there are no legal fire protection requirements driving their use. Concerning the the marking of plastics, some recyclers consulted were in favour of this criterion. They stated that it is very important that the marking is clear and in an immediately visible place. Marking is easy to find, provides information quickly and is

a sign of confidence.

The proposals (e) and (f) addressing close loop recycling require clarification. What are they trying to achieve? The recyclability criteria were seen as being vague. How can the 'potential' be defined? How will the recyclability be verified. The presence of certain chemicals also has an influence on the transportation restrictions of the recycled products. Smelters could comment on which contaminants are most problematic.

Feedback from some recyclers indicated that it should be explicitly forbidden that batteries are glued or soldered into the products. Especially for tablets and notebooks this is an issue. This increases detoxification time a lot or increases the risk of accidents because products have to smashed up.

The definition of casing and housing requires clarification.

The 'recyclability' of plastics

The sub-criterion in 4(a) were re-reviewed against the underlying criterion of successful US ecolabel EPEAT - the IEEE 1680.1 standard for the environmental assessment of computer products [117]. The IEEE 1680.1 criteria of relevance include:

- A requirement relating to the avoidance of paints of coatings that are incompatible with recycling;
- An option criterion that plastic enclosures shall not contain molded-in or glue-on metal unless the metal inserts can be easily removed;
- Only one plastic material shall be used in each plastic enclosure part greater than 100g.

Whilst the relevance of the first two points has already been highlighted by research and feedback on design for recycling, the definition of what constitutes compatibility

[117] IEEE Computer Society, *Standard for Environmental Assessment of personal computer products*, IEEE Std 1680.1-2009, 5th March 2010.

with recycling has previously raised concerns with stakeholders. 'Compatible' is defined as being when:

> *'Paints and coatings on plastic parts are proven to be compatible with recycling processes if they do not significantly impact the physical/mechanical properties of the recycled resin. Significant impact is defined as >25g reduction in notched Izod impact at room temperature as measured using ASTM D256-05.'*

Alternatively the term 'recyclable' is also used in relation to materials and components and is defined as:

> 'Materials or components that can be removed or recovered from the whole product or package and put back into productive use as a material, not including energy recovery, using standard technologies, or as otherwise demonstrated.'

A further definition is provided by IEC 62635 which defines recyclability as *'[the] ability of waste product parts or waste materials to be reused or recycled'.*

'Easily removed' is not specifically defined by IEEE 1680.1 but the verification options include listing of commonly available tools that can be used to remove a metal insert and a statement from a recycling company with electronics recycling expertise confirming that product design meets the requirements.

The third point is considered to be more problematic given that casing plastics are generally manufacturer from combinations of different polymers such as PC/ABS or HIPS/PPS. The potential for problems to occur with combinations of plastic that are not miscible has been highlighted by Peeters et al (2014) with their findings suggesting that the miscibility of PC/ABS and HIPS/PPE combinations, together or separately, is poor, as well as all combinations of these polymers with PMMA (a plastic from LCD units).

Of relevance, however, is the potential to recycle polymer:flame retardant combinations, which should be compatible with recycling. Feedback from a major computer OEM confirmed that FR's are incorporated into plastic computer casings,

even though this is not a regulatory requirement. The ENFIRO WP8 LCA findings recommended expanding the recycling of plastics in such as way as to retain the functional value of FR's.

A further issue highlighted by the US EPA's study of flame retardants in Printed Circuit Boards [118] relates to aluminium oxide arising from aluminium FR additives. Their high loading in PCB materials together with insolubility in furnace slag means that if they arose in larger quantities in waste PCBs smelters would need to use more energy. The potential for this trade-off to occur was confirmed from discussions with an FR specialist involved with the ENFIRO project.

3.4.1.5 Third proposal for the material selection criterion

Third criteria proposal
4(a) Material selection and compatibility with recycling a) Recyclability of plastics: (i) Parts with a weight greater than 25 grams shall consist of a single polymer or a polymer blend or alloy that are recyclable; (ii) Parts with a weight greater than 25 grams shall not be painted or coated in such a form that it means they are not recyclable; (iii) Casings, enclosures and bezels shall not contain molded-in or glued on metal unless they are easy to remove with commonly available tools; (iv) Casings, enclosures and bezels incorporating flame retardants shall be recyclable. (v) Printed Wiring Boards greater than 10 cm2 shall not contain aluminium based flame retardants or additives. b) Material information to facilitate recycling: Plastic parts with a mass greater than 25 grams shall be marked in accordance with ISO 11469 and ISO 1043, sections 1-4. Plastic parts incorporating flame retardants may additionally be marked with the CAS number. For plastic parts > 100 grams, the markings should be large enough and located in a visible position in order to be easily identified. *Exemptions are made in the following cases:* (i) Where the marking would impact on performance or functionality of the plastic part including optical plastics; (ii) Where parts cannot be marked because there is not enough available appropriate surface area for the marking to be of a legible size to be identified by a recycling operator; (iii) Where marking is technically not possible due to the moulding method; or (iv) Where the addition or location of marking causes unacceptable defect rates under quality inspection, leading to unnecessary wastage of materials.

[118] See footnote 27

c) Recycled content: The product shall contain on average a minimum 10% content post-consumer recycled plastic measured as a percentage of the total plastic (by weight) in the product excluding Printed Wiring Boards. Where the recycled content is greater than 25% a declaration may be made in the text box accompanying the Ecolabel (see Criterion 7(a)). Products with a metal casing are exempt from this sub-criterion.

Assessment and verification: The applicant shall provide the Competent Body with an exploded diagram of the computer in written or audio-visual format. This shall identify the plastic parts greater than 25 grams by their weight, their polymer composition, and their ISO 11469 and 1043 markings. The dimensions and positions of the marking shall be illustrated and, where exemptions apply, technical justifications provided.

The applicant shall verify recyclability by providing evidence that the plastics either individually or combined do not impact the technical properties of the resulting recycled plastics in such a way that they cannot be used again in electronic products. This could include:

(i) A declaration from an experienced plastics recycler or permitted treatment operation in accordance with Article 23 of Directive 2008/98/EC ('the Waste Framework Directive');
(ii) Test results from an independent laboratory or an experienced plastics recycler;
(iii) Peer and industry reviewed technical literature applicable to Europe.

The applicant shall provide third party verification and traceability for post-consumer recycled content.

Summary rationale for the proposed changes

- It is proposed to reflect EPEAT criterion that address the compatibility for recycling of plastics with coatings/paints and the ease of removal of molded-in or glued-on metal inserts.
- The recyclability of casings, enclosures and bezels that incorporate flame retardants shall be verified and, furthermore, the use of aluminium-based FR's with a high loading in PCB base materials shall not be permitted because they require more energy to smelt in the end-of-life phase.
- In order to address concerns relating to the definitions of 'compatibility with recycling' or 'recyclable' greater flexibility is proposed in the assessment and verification, again reflecting EPEAT, with three different options based on (i) declarations from recyclers, (ii) test results and/or (iii) technical literature relevant to the EU market.
- The sub-criterion 4(b) requiring plastic marking is proposed to be retained, with the provision of additional information about FR's (e.g. CAS No)

encouraged instead of mandatory. The set of technical exemptions remain and were not commented on further by stakeholders.

- The sub-criterion 4(c) requiring a minimum 10% post-consumer recycled plastic content is proposed to be retained, but has been reworded to allow for an average recycled content for each model and to exclude Printed Wiring Boards.
- Products with metal casings are excluded from the recycled content requirement because the quantity of plastic remaining would be too low for the sub-criterion to be practical.

3.4.2 Criterion 4.2 – Design for dismantling and recycling

3.4.2.1 Major proposed changes (first proposal)

As laid out in the Task 4 report, manual dismantling is an important means to improve material recovery of, in particular, precious and critical metals, thus reducing the overall impacts of computer products. This can be facilitated by appropriate design. Nevertheless, the current requirements are not very specific regarding the dismantling process and the key components affected. Here, proposals developed by JRC-IES in support of implementation of the Ecodesign Directive (Ardente & Mathieux 2012) and approaches taken by other ecolabels (in particular Blue Angel RAL-UZ 78a) are more specific. Thus, it is suggested to introduce more specific requirements for the most relevant components of computers in terms of material recovery of precious and critical metals, which are

- Printed circuit boards > 100 cm^2
- Displays > 100 cm^2
- Rechargeable batteries.

This selection is based on the WEEE-Directive, which requires recyclers to separate these components during end-of-life management[119].

[119] Although the WEEE-Directive also requires separate treatment of other components (e.g. external electrical cables, plastic containing brominated flame retardants, mercury containing backlights), these

Additional components identified as hot spots by the LCA analysis could also be added to the criteria. The following revised formulation is proposed:

Proposed revised criteria (first proposal)

"Design for disassembly and recycling"

For recycling purposes computers shall be designed so that

(a) They shall facilitate easy (manual) disassembly in order to separate rechargeable batteries (if applicable), display units >100 cm² (if applicable) and printed circuit boards >100 cm².

(b) An efficient (manual) disassembly of display units >100 cm² (if applicable), rechargeable batteries (if applicable) and printed circuit boards >100 cm² by a specialised firm can be carried out using widely used commercially available tools (i.e. pliers, screw-drivers, cutters).

(c) One person alone shall be able to disassemble display units >100 cm² (if applicable), rechargeable batteries (if applicable) and printed circuit boards >100 cm².

(d) Electrical modules shall be easily removed from the case.

Assessment and verification:

The applicant shall declare compliance with the requirements to the competent body.

The applicant shall provide a 'test disassembly report' to the competent body including disassembly procedures and tools needed for the disassembly supported by either:

- Test results verifying the time (in seconds) required for the different steps to disassemble the components during the testing. The timing shall be verified by a third party, which can include specialised recycling firms or testing bodies.
- Verification by a specialised recycling firm that the requirements of the criteria can be fulfilled. Firms shall be a permitted treatment operation in accordance with Article 23 of Directive 2008/98/EC.

The report may be submitted either in writing or by photo, drawing or in video format.

Major proposed changes

- The criterion 'design for disassembly' has been renamed 'design for disassembly and recycling'; the focus of this criterion is now clearly set on recycling by removing the introduction "…for the purpose of undertaking repairs and replacements of worn out parts, upgrading older or obsolete parts…". Typically dismantling for repair or upgrade purposes is carried out significantly different from dismantling for recycling: While the first one requires caution to avoid any damage, the latter can widely accept damage to parts as it solely aims at recycling. Thus, the structure of the requirements should clearly distinguish between both purposes. For this reason, requirements for the access and exchange of components for repair and/or upgrade are specified

fractions are of less relevance for the European Ecolabel as some constitutes are excluded from labelled products (e.g. plastic containing brominated flame retardants, mercury containing backlights) or do not represent any challenge in dismantling processes (e.g. external electric cables).

under ‘upgradeability and repairability’ (cf. section 3.3.5). In that sense, Peeters et al. (2012)[120] provides a very helpful structure of different demanufacturing processes, distinguishing between non-destructive, semi-destructive and destructive demanufacturing, depending on the purpose (repair, reuse, recycling), see Figure 3.16.

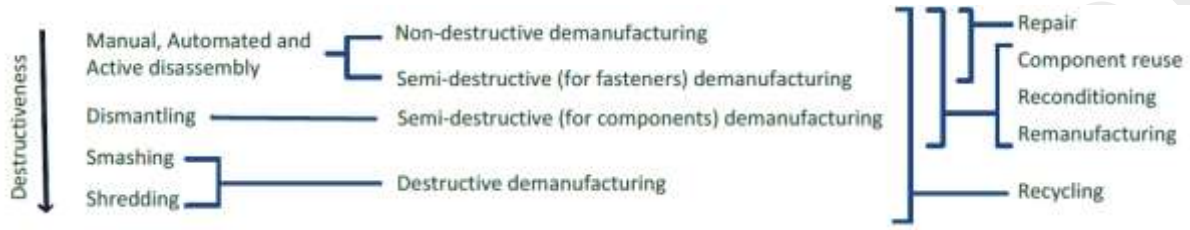

Figure 3.16: Overview of different demanufacturing processes and their level of destructiveness (Source: Peeters et al. 2012)

- Some of the sub-requirements under the current criterion ‘design for recycling’ have been moved to the new proposed criterion ‘material selection and information’ (cf. section 3.4.1).
- The components being relevant in terms of LCA hot spots and material recovery of precious and critical metals have been specified.
- The disassembly process has been specified (specialised firm, one person alone, use of universal tools).
- For the assessment and verification, the provision of a ‘test disassembly report’ has been proposed with two options for third party verification.

Ideally, as proposed by JRC-IES (Ardente & Mathieux 2012) for televisions and LCD displays[121], the above listed requirement would also incorporate a threshold for the disassembly time in seconds for the different specified parts and components. However, according to Ardente & Mathieux (2012), the testing and verification of such a dismantling-time benchmark would require a detailed standardised test and measurement procedure as the manual dismantling time depends on various factors:

[120] See https://lirias.kuleuven.be/bitstream/123456789/348771/1/i-sup2012

[121] Ardente, F.; Mathieux, F.: Integration of resource efficiency and waste management criteria in European product policies – Second phase. Report no 2, Application of the project’s method to three product groups. Joint Research Centre – Institute for Environment and Sustainability, Ispra, 2012

- Minimum working experience of disassembler or operators (e.g. number of years working in the sector);
- Pre-conditions for the measurement (e.g. knowledge of the product's structure and location of the part to be disassembled, including access to relevant information from manufacturers as videos and exploded diagrams of the product);
- The sequence of the steps in the disassembly;
- Tools or machine / equipment to be used for the disassembly (e.g. common tools and machines in use in recycling plants for dismantling);
- Typology and precision of instruments used for measurement of the time;
- Uncertainty of the measurement and tolerance of the results.

As such a test and measurement procedure is not currently available, and pending further guidance in support of the Ecodesign process, the above listed criteria would either have to be specified in the User Manual for the product group or other means for verification would need to be specified. An alternative proposal for verification by registered specialised firms is therefore proposed.
For more details cf. Task 4 report "Improvement Potential", section 4.2.4.2 "End-of-life management of computer products".

Consultation questions
• Have similar testing procedures based on timed dismantling or verification by dismantlers been developed in other countries or regions? • Could the alternative proposal for verification by specialised dismantlers be workable and if so, would any supporting requirements or procedures need to be introduced into the criteria or the User Manual? • Are there other examples of verification procedures for this type of criteria that may be relevant?

3.4.2.2 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, timing for dismantling was felt to be challenging. The timing could simply be a tick box or figure to record for verification purposes. This approach could work where there is closer connection between manufacturers and the end-of-life phase for products. The product will only be dismantled in 3-4 years time ahead.

Not only manual dismantling should be considered but also the detoxification of the key components such as printed circuit boards.

It was noted that a similar criteria is to be incorporated into Ecodesign for Televisions and that this may inform a new ISO standard for dismantling.

Clarification was requested on the size of circuit boards for dismantling which was indicating a 100 cm^2 threshold. The main board contains the majority of the precious metals. The threshold should be clarified as to whether it refers to the total area of boards or individual board sizes.

An alternative proposal was made to set a requirement to recover a high proportion of the metal content. This would require consideration of where the metal parts are within the computer. It was noted that metal scrap with a 30% residual polymer content is acceptable for smelters.

Finally, it was proposed that the potential for a reduction in the amount of critical metals could also be considered.

Written stakeholder feedback following the first AHWG meeting

- It is suggested to clarify that this is disassembly for recycling only.
- A maximum time limit to indicate "cost-effective separation of components and materials" based on testing with existing manual recycling processes is recommended. It is essential that this requirement includes a maximum time limit, or else it does not provide adequate indication of how easy "easy" really is. Different targets would be required for laptop and tablet computers. It is accepted that specific methodologies for time can be elusive. However, if a manufacturer is able to demonstrate that a disassembly expert can separate the key components within e.g. 60 seconds, this improves the chance of a high-quality manual recycling process being implemented (even if in reality it takes a typical recycling operative twice as long.)
- There exists a stockpiling of panels due to what recycling firms consider the uneconomical extraction of the mercury due to intricate dismantling and risk for

spill. If CCFL are continued to be permitted, then an easy extraction of the lamps and mercury shall be demanded.

- Missing: A restriction on halogens as part of the polymer facilitates separation and reuse. Glued in or in-moulded are for example also demanded in TCO Certified Displays.
- The proposed criteria should be checked carefully as WEEE has some 'pre-treatment' requirements which are legally required. If the suggested ecolabel requirement is identical with WEEE it can be removed as ecolabel criteria should only address non-legal requirements.
- The criteria proposed for (easy) disassembly is generally supported because separate treatment of the respective components allows a much higher efficiency of the following material recycling steps. But the proposed requirement (d) "Electrical modules shall be easily removed from the case." needs to be phrased more clearly and possibly a more differentiated way regarding the various kind of products covered (desktops, notebooks, tablets). E.g. beside circuit boards, HDD contain relevant shares of critical raw materials and should be treated separately. For notebooks and (even more) for tablets, it might be appropriate to consider ongoing developments for their targeted treatment (focussing on a quantitative recovering of the included critical raw materials). This would contribute to the formulation of more precise requirements on design for recycling supporting such treatments in further revisions of the Ecolabel.
- Another publication was recommended as providing more information on design for disassembly[122]

Further research and further evidence

Based on the feedback from stakeholders, follow-up research focused on the potential to support the recovery of critical raw materials and other relevant materials. The research aimed at identifying materials and components that should be

[122] See https://lirias.kuleuven.be/bitstream/123456789/348771/1/i-sup2012

prioritised for the EoL treatments, reflecting the approach taken by JRC-IES in support of the draft revision of the Ecodesign Implementing Measure for Televisions (and Displays) EC/642/2009[123].

Identifying Critical Raw Materials from an EU perspective

A first step is to define and identify Critical Raw Materials (CRM). The availability of Critical Raw materials has been highlighted as a strategic policy issue by the European Commission. Under the EU Raw Materials Initiative a working group has identified and listed the Critical Raw Materials from a geo-political and economic point of view[124]. The list is based on a time horizon of ten years, so geological scarcity was not a central consideration, with the increasing demand for products containing CRM's cited instead as an important factor. Recyclability and the potential for substitution were also factors considered in the creating the initial list.

Table 22: Initial list of critical raw materials at EU level

Antimony	Indium
Beryllium	Magnesium
Cobalt	Niobium
Fluorspar	PGMs (Platinum Group Metals)[a]
Gallium	Rare earths[b]
Germanium	Tantalum
Graphite	Tungsten

Notes:

a) Platinum, palladium, iridium, rhodium, ruthenium and osmium

b) Yttrium, scandium, and the 'lanthanides' - lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium

[123] European Commission, Integration of resource efficiency and waste management criteria in European product policies: Application of the project's methods to three product groups, JRC-IES, November 2012

[124] European Commission, *Critical raw materials for the EU*, Report of the Ad Hoc Working Group on defining critical raw materials, DG Enterprise and Industry, 30th July 2010

Lithium and chromium were at the time on the borderline of being identified as CRM. However, the list is currently being revised by the Commission and it is understood their economic importance and supply risk have shifted, bringing them within the definition of 'criticality' [125].

Of direct relevance to development of this EU Ecolabel criterion is the recommendation made within the 2010 report that policy actions are undertaken to *'make recycling of raw materials-containing products more efficient'* including *'mobilising end of life products with critical raw materials for proper collection*'. A specific recommendation is also made that:

> *'…overall material efficiency of critical raw materials should be achieved by…minimising raw material losses into residues from where they cannot be economically-recovered.'*

Identifying metal, CRM and plastic components of life cycle significance

The preliminary background reports for the revision of the EU Ecolabel and GPP criteria for computer products published in October 2013 contained a screening of LCA (Life Cycle Assessment) studies for desktop, notebook and tablet computers[126]. The aim of this screening was to identify comprehensive, quality studies that would support the identification of 'hot spots' of environmental impact in the life cycle of these products.

These studies have been screened further in order to identify hot spots relating to specific metals, CRM's or plastics. The results are summarised in Table 23 below. Whilst many of the studies did not provide sufficiently detailed analysis to identify hot spots in greater detail than main components, it was in some cases possible to identify additional hot spots because these were presented within the analysis (for

[125] Mattia Pellegrini, *DG Enterprise & Industry: Raw Materials Initiative – Criticality Study*, Presentation to EU-U.S. Expert Workshop on Raw Material Flows & Data, 6-7 November 2013

[126] Cf. http://susproc.jrc.ec.europa.eu/computers/stakeholders.html, Task 3 report

example, Maga et al 2012) or through interrogation of the system networks arising from the LCA modelling (for example, Ciroth and Franze 2011).

Table 23: Screening of LCA evidence for relevant metals or plastics

Study	Component hot spots	Sub-component hot spots	Metals (including CRM's), and other relevant materials
Notebook computers			
Ciroth, A and J,Franze (2011)	The normalised results for climate change, human health, human toxicity and fossil depletion highlighted the: • Motherboard • LCD module	Identified from one or more of the normalised mid-points are: • LED backlight (all three midpoints)	• Gold in PCB's • Copper in Integrated Circuits and LCD modules • Tin in LED lamps
Siddarth.P, Liu.R, Schischke, K and L,Stobbe (2012)	Aluminium, copper and iron are assumed to be recovered. 'Business as usual' and 'high recovery rate' scenarios are used to examine the sensitivity based on variations in the recovery of: • Gold (40-93%), • Silver (40-87%) • Palladium (40-91%) A variance in Greenhouse Gas Emissions of 0.5 – 0.9% was estimated.	It is not possible to identify sub-component hot spots from the published study.	• Aluminium and steel in the chassis and housing • Gold, silver and palladium in PCB's
Desktop computers			
Song.Q, Wang.Z, Li.J, and W.Yuan (2013)	The normalised results for a desktop unit, represented by ten LCIA indicators using the CML method highlighted, in descending order of importance, the: • Motherboard • Power Supply Unit • Optical drive • HDD • Steel and aluminium in the housing The motherboard and LCD unit are significant in terms of the separate LCD screen unit.	*It is not possible to identify sub-component hot spots from the published study.*	• Tin, nickel and copper are identified as being significant in terms of resource depletion • Extraction of arsenic and cadmium were identified as the most significant contributors to water pollution.
Duan.H, Eugster.M, Hischier.R,	The normalised results for the end-points resources, ecosystem quality and	*It was not possible to identify sub-component hot spots from the*	*It was not possible to identified specific materials from the*

Study	Component hot spots	Sub-component hot spots	Metals (including CRM's), and other relevant materials
Streicher-Porte.M and J,Li (2008)	human health highlighted, in descending order of importance, the: • Motherboard • Power Supply Unit • Optical drive • HDD • Cables The LCD unit and electronics are significant in the separate LCD screen unit.	*published study.*	*published study.*
Maga.D, Hiebel.M and C,Knerman (2012)	Based on characterised results for Global Warming Potential, human toxicity and aquatic ecotoxicity: • Motherboard (desktop and LCD) • Power Supply Unit • Optical drive • LCD module	The analysis of a thin client identified the following sub-components as significant based on their contribution to GWP: • Integrated Circuits: The silicon wafer and gold • Capacitors and coils: Aluminium, copper and iron, • Panel plating: Copper, nickel and chromium (specific to the housing) • Casing: Steel sheet • Backlighting: LED's • Controller board (DIMM memory module)	• Gold, copper, aluminium and iron are identified in relation to circuitry and capacitors; • Steel, copper, nickel and chromium are identified in relation to the casing and plating • Cross referencing to Ciroth and Franze (2012) may suggest tin in relation to LED's

Critical metals and raw materials inventory

A number of bills of materials (BOM) for computer products were identified and presented in the background report on Hazardous Substance published in September 2013[127]. Aside from metal and plastic associated with enclosures and the chassis these did not identify CRM occurrence within product sub-components. Literature was therefore reviewed in order to identify a bill of materials for CRM's.

[127] Cf. http://susproc.jrc.ec.europa.eu/computers/stakeholders.html, Hazardous substance report

Indicative BOM's for a notebook computer and a desktop computer have been identified based on analysis by Oeko-Institut[128].

It can be seen from the BOM that CRM's are concentrated in a small number of main components, primarily the motherboard, batteries, HDD, optical drives and LED backlights. Sub-components can then be identified that would then require extraction in order to recover the CRM's – for example, capacitors containing tantalum, magnets containing neodymium, LED cells containing gallium.

Table 24: Indicative occurrence of high value metals and CRM's in an indicative notebook computer

Metal	Content per notebook (mg)	LCA hot spot	EU CRM	Occurrence in the notebook
Cobalt	65,000		✓	Lithium ion batteries
Neodymium	2,100		✓	HDD motors and accelerators (70%) Loudspeakers (30%)
Tantalum	1,700		✓	Motherboards capacitors (90%) Other PCB capacitors (10%)
Silver	440	✓		Motherboard (57%) Other PCB's (43%)
Praseodymium	270		✓	HDD accelerators (53%) Loudspeakers (47%)
Gold	100	✓		Motherboard (54%) Other PCB's (46%)
Dysprosium	60		✓	HDD accelerators
Indium	40		✓	Display and LED Backlights
Palladium	40		✓	Motherboard (64%) Other PCB's (36%)
Platinum	4		✓	HDD platters
Rare Earths [a]	2.48		✓	LED backlights
Gallium	1.6		✓	LED backlights

Notes:

[128] Oeko-Institut, *Recycling critical raw materials from waste electronic equipment*, Commissioned by the North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection, 24th February 2012 *and* Oeko-Institut, *Informal e-waste management in Lagos, Nigeria – socio-economic impacts and feasibility of international recycling operations*, UNEP SBC project, June 2011

a) Yttrium, gadolinium, cerium, europium

Table 25: Indicative occurrence of high value metals and CRM's in an indicative desktop computer (without display)

Metal	Content per desktop (mg)	LCA hot spot	EU CRM	Occurrence in the notebook
Steel	6,737.50	✓		Chassis and enclosure
Plastics	1,579.55			Enclosure, cables, peripherals
Aluminium	550.21	✓		Chassis, capacitors, HDD platters
Copper	413.225	✓		Circuitry, cables,capacitors
Zinc	25.94			-
Tin	19.57	✓		Solder
Antimony	18.58		✓	Solder, flame retardants
Nickel	12.70	✓		Metal plating
Neodymium	5.87		✓	HDD motors and accelerators Loudspeakers
Silver	1.70			Motherboard and other PCB's
Gold	0.26	✓		Motherboard and other PCB's
Palladium	0.12		✓	Motherboard and other PCB's
Chromium	0.02			Coatings
Ceramics & others	366.04			Heat sinks, power supply units and capacitors

Market potential for dismantling and CRM recovery

Whilst it is possible to identify components and sub-components for selective extraction it does not follow that their extraction is currently economically or technically feasible. Relevant market commentary on the potential for their recovery and recycling has therefore been briefly reviewed summarised in order to inform the identification of components and sub-components for which recycling is a realistic prospect either now or within the validity period for the Ecolabel criteria. The three

main sources are Oeko-Institut[129], JRC-IES[130] and WRAP[131]. Other sources are referenced where relevant.

The collection of WEEE in Europe has grown rapidly since the introduction of the WEEE Directive in 2003 and this is set to increase further as the recast WEEE Directive is transposed at a European level. Treatment centres tend to be a mixture of large processing centres handling a wide range of different types of WEEE and niche operators concentrating on a few or even single streams. Centres may consist of a combination of manual dismantling and sorting of components with bulk shredding and detoxification (e.g. mercury removal from LCD screens)[132]. Selected components may then be sent to specialist smelters (e.g. PCB's) or be subject to automatic or manual separation (e.g. plastics).

The main plastics fraction (e.g. PC/ABS casing), steel and aluminium chassis, alloy casings (painted or unpainted), rechargeable lithium ion batteries, capacitors with a diameter larger than 2.5 cm, external power cables and Printed Circuit Board's larger than 10 cm^2 are generally extracted and passed on to the relevant markets for materials recycling.

From a resource point of view, leading actors in the specialist metals and CRM market claim that some manual pre-treatment, including complete removal of PCBs and other components such as HDD's, followed by subsequent recovery of the precious metals would enable a significantly more efficient recovery of various

[129] Oeko-Institut, Recycling critical raw materials from waste electronic equipment, Commissioned by the North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection, 24th February 2012

[130] European Commission, *Report n° 2. Application of the project's methods to three product groups (final)*, JRC-IES, November 2 01 2

[131] WRAP, *Strategic raw materials, recovery capacity and technologies*, Final report, 26th March 2012, UK.

[132] Meskers.C.E.M and C.Hageluken, *The impact of different pre-processing routes on the metal recovery from PC's*, Conference paper *Resource management and technology for material and energy efficiency*, EMPA Materials Science and Technology, September 2009.

metals, CRM's and REE's[133]. Taking silver, gold and palladium as examples the recovery rate could be increased in selected scenarios from 12-26% to 90%.

A recent industry survey conducted by WRAP suggested that to a great extent removal by manual treatment of HDD (82%), circuit boards (88-94%), plastics incorporating brominated flame retardants (82%), capacitors (79%), speakers (75%) and LCD displays (88%) already takes place, although it is not clear the extent to which this can be taken to be representative of the picture across the EU.

Plastic casings

While there is no legal requirement in the EU for computer enclosures to meet a specific level of fire protection it is understood that plastic casings are specified to meet a V1 (FR4) standard. The market value of a plastic casing containing flame retardants that meets a specified fire protection standard is not currently clear. JRC-IES states in their Ecodesign case study that plastics containing flame retardants are generally not recyclable after shredding, as evidenced by IEC 62635. A recent study on industry trials suggested that a purity rate up to 82% can be achieved for the separation of some plastics, as PC/ABS containing phosphorus FR's[134]. This result is based on optical and density-based sorting treatments of plastics after shredding.

Technically there is not understood to be a barrier to use of this recyclate, although the plastic and the incorporated FR must first be identified, and such separation for recycling is not yet commonplace. Despite the prevalence of shredding the recent REWARD/EFRA pilot study highlights the importance of plastics marking and the provision of information about the FR's used as being important to facilitate recovery and recycling[135].

[133] C. Hagelüken and C. E. M. Meskers, *Complex life cycles of precious and special metals*, Chapter 10 from *Linkages of Sustainability* (2010) Strüngmann Forum Report, Edited by Thomas E. Graedel and Ester van der Voet.
[134] Peeters et al. (2013)
[135] EFRA (2013) *Recycling of plastics from LCD television sets*

Printed Circuit Boards (PCB's)

The main economic aim of recovering PCB's is to recover the copper, gold, silver and palladium. Currently, CRMs are primarily recovered from circuit boards at large metal refining facilities designed to handle complex streams of metal containing wastes[136]. They can then be refined from copper alloys. Although a range of additional metals are obtained by this route other critical metals such as tantalum in capacitors are lost in this process – so-called 'dissipative losses'. Successful recovery of CRM's such as tantalum would require the prior separation and removal of related sub-components, such as tantalum capacitors. This type of sub-component extraction is only carried out on a pilot scale. It is understood that the economics of separation are marginal and that some pilots may have been discontinued.

LCD/LED display units

Displays are usually recycled thermally in waste incineration plants or in the Waelz kiln process for steel mill dust. The organic components (liquid crystals, polarisation filters, resins) are generally shredded and may then be incinerated, and the glass along with the oxidized metals remains bound in an inert slag The indium contained in the displays is generally lost through dissipation[137].

Several pilot and laboratory technologies have been already developed for Indium[138] and rare earths[139] recovery. However there are currently no large scale recycling facilities for the separation and refining of indium from the display units and the rare earths from the background illumination. The very low indium content and lack of another significant metal to recover in each LCD unit makes the economics of recovery very challenging. However, with indium supplies being dependant on lead

[136] Van Kamp.M and A, Vasseur, *Raw materials sustainability: Collaborating towards a better world*, Presentation to the Future Circular Materials Expo, Sweden, 2013

[137] See Oeko Institut (2012)

[138] Kye-Sung Park, Wakao Sato, Guido Grause, Tomohito Kameda, Toshiaki Yoshioka. *Recovery of indium from In_2O_3 and liquid crystal display powder via a chloride volatilization process using polyvinyl chloride.* Thermochimica Acta 2009

[139] See HydroWEEE projects

or tin extraction there is the potential for exposure of the electronics sector to price volatility.

In view of the need to protect future supplies of indium, Germany is understood to be considering storage of dismantled display units for recycling at a later date. It has been postulated that some form of chemical leaching process might in the future be more promising than a smelting process.

The rare earth elements contained in the luminescent materials are currently not recycled. Up until now the luminescent materials and rare earth elements contained in display units e.g. yttrium, europium, terbium, were sent to landfill following shredding. However, several mobile pilot plants are being developed to recover metals like copper, manganese, zinc, yttrium, indium from WEEE by hydrometallurgical processes.

LED backlights

The CRM's and rare earth metals used in the manufacture of LED backlight units are related to doping and luminescence. They can include indium, gallium, cerium, europium, yttrium and gadolinium. The weight per substance typically amounts to only μg's per LED. There is no current reliable information on the potential to recycle LED chips.

PMMA display light guide

The plastic light guides within an LCD display constitute a large proportion of the plastic used in a TFT display. In particular the PMMA light guide has been identified as a sub-component that is readily identified and which is readily recyclable according to IEC 62635. However, JRC-IES identified that without prior manual separation the PMMA light guide, together with other large technical plastic layers from within the display unit, may be dispersed among other shredded fractions as it is difficult to then separate by density. On the other hand, PMMA sorted from other fractions before shredding can be recycled for the production of new boards of the same quality.

Hard Disk Drives (HDD's)

Attention is increasing on the potential to recover REE's from HDD's. Whilst the physical quantity per HDD is relatively low the large volume of drives manufactured is understood to make them a potentially attractive recovery stream. The larger 3.5 inch HDD format used in desktop computers, servers and datacentres are of potentially greater interest in terms of the quantity of materials for recovery.

Their physical design can, however, hamper recovery of Rare Earth Metals such as neodymium from magnets. Amongst the problems cited include their compact design, the type/range of screws used and the use of glues to attached plastic enclosures to metal housings. The loss of REE content can therefore be high because HDD's may enter mechanical shredding routes.

Industry initiatives to recover REE's from HDD's can be identified. A rapid recovery process is, for example, being developed by Hitachi, a major HDD manufacturer, which would enable eight times faster recovery than a manual route. It is also noteworthy that Solid State Drives (SSD) typically contain only 0.001% w/w REE compared to 0.2% w/w for HDD.

Lithium ion batteries

Lithium ion batteries are addressed by the collection requirements under the Batteries Directive 2006/66/EC but it is understood that their recovery rate is currently low, with a recent report claiming as low as 5%[140]. This is understood to largely be the result of a significant stock held by consumers. The Batteries Directive specifically highlights the importance of ease of recovery for batteries stating in Article 11 that:

> *'Member States shall ensure that manufacturers design appliances in such a way that waste batteries and accumulators can be readily removed.*
> *Appliances into which batteries and accumulators are incorporated shall be accompanied by instructions showing how they can be removed safely…'*

As this issue is of high significance to both product lifespan and resource recovery it is therefore proposed to be addressed within the frame of the EU Ecolabel. The

[140] ENDS Europe, *Low recycling rates for lithium batteries criticised*, 14th February 2013

potential for OEM take back routes that ensure that batteries are smelted to recover cobalt is to be discussed further.

Establishing a comparable test method for timed dismantling

Reference is proposed to analysis and discussion led by JRC-IES to develop a standardised method for the measurement of the timing of dismantling. The timing for this process is likely to extend beyond the programme for adoption of the new EU Ecolabel criteria for computers. In the interim an extraction method to ensure comparability would therefore need to be outlined in the User Manual based on the work to date by JRC-IES[141]. Outline steps for the method are for example described in Box .

Box 2: Outline steps for the measurement of the time for the extraction of certain target parts in electronic displays

Terms and definitions

- *Target parts:* Parts and/or components that are targeted for the extraction process.

Operating conditions for the extraction

- *Extraction sequence to be followed:* The Extraction sequence to be followed has to be set out prior to the measurement. The sequence shall be documented and provided to the third party carrying out the extraction.
- *Tools for extraction:* The extraction operations should be performed using manual or power-driven standard tools.

Extraction time measurement

- *Measurement sample:* The sample of EEE to be used for the measurement shall be undamaged.
- *Measurement:* The extraction time measurement consists of the measurement with an instrument of the time elapsed between the starting of the first operation listed in the extraction sequence documentation and the end of the last one.

[141] Joint Research Centre – Institute for Environment and Sustainability - "Analysis of dismantleability" - draft 2014

3.4.2.3 Second proposal for dismantling and recycling criteria

Proposed revised criteria (second proposal)

"Design for dismantling and recycling"

For recycling purposes computers shall be designed so that:

(a) For the following components an efficient manual disassembly by one person in a specialised company shall be possible to carry out using widely used commercially available tools (i.e. pliers, screw-drivers, cutters and hammers as defined by ISO 5742, ISO 1174, ISO 15601):

All products

(i) Printed Circuit Boards relating to computing functions >10 cm²

Stationary computer products

(i) Internal Power Supply Unit
(ii) HDD drives

Portable computer products

(i) Rechargeable battery

Displays (where a display is integrated into the product enclosure)

(i) Printed Circuit Boards >10 cm²
(ii) Thin Film Transistor unit and film conductors in display unit >100 cm^2
(iii) LED backlight units

The applicant shall measure and specify the required manual dismantling time for those components relevant to the product.

(b) At least two of the following components shall also be efficiently manually disassembled with reporting of the additional time requirement based on the fastest identified sequence following on from (b):

(i) Printed circuit boards ≤ 10 cm^2 and > 5 cm^2
(ii) Tantalum-capacitors ≥ 2 mm x 2mm x 3 mm from printed circuit boards in (a) and (b)
(iii) HDD drive (portable products)
(iv) Speaker units (notebooks and integrated desktops)
(v) Optical drives (where applicable)
(vi) Polymethyl Methacrylate (PMMA) film light guide (where the screen size is >15 inches)

Assessment and verification:

The applicant shall provide a 'test disassembly report' to the competent body including the adopted disassembly sequence (steps and procedures), identification of the optional components selected, the reported timings and the tools needed for the disassembly. Reference shall be made to the extraction timing method outlined in the user manual.

The reported timings for disassembly and the related disassembly sequence shall be provided for verification by either:

(i) A third party, testing body.
(ii) A specialised recycling firm that is a permitted treatment operation in accordance with Article 23 of Directive 2008/98/EC.

The report may be submitted either in writing or in digital format, supported by photos, drawings and/or videos.

Major proposed changes:

- The heading has been changed from “design for disassembly and recycling” to “design for dismantling and recycling”.
- The threshold for the extraction of printed circuit boards has been lowered from 100 cm^2 to 10 cm^2 as this is in line with the relevant threshold of the current WEEE-Directive. A lower threshold is also introduced in order to reflect the potential for smaller PCB’s in devices such as tablets.
- The identification of components has been expanded and made more specific in order to reflect the LCA hot spots, CRM/REE occurrence and market potential identified by the follow-up research. It is proposed that a core set of components are set as requirements for all products and are subject to a timed extraction according to the specified sequence, with variation between stationary and portable products, as well as those with integrated displays.
- A separate list of components and, where relevant, sub-components that are more challenging to extract are also identified. It is proposed that in order to draw attention to their importance applicants shall demonstrate a timed extraction for a minimum number of these components or sub-components, which in some cases are specific to certain product form factors.
- A requirement on measuring the dismantling time is retained throughout. This approach is proposed by the Commission for introduction into Ecodesign requirements for electronic products, being an important proxy for economic first stage manual dismantling.
- Verification for the timed extraction of components is proposed to be flexible with two alternative options presented - a third party option and a ‘real-life’ option in a WEEE treatment facility. The latter option mirrors a similar verification option for dismantling criteria 4.1.1.3, 4.3.1.5, 4.3.1.7 and 4.3.2.1 in the EPEAT standard for computers (IEEE 1680.1).
- It is proposed that the manufacturer establishes a suitable dismantling sequence for its product, and then uses this as the basis for commissioning the testing/measurement of the timing (to verify compliance to the criteria). The

testing would therefore be carried out by a third party knowing in advance the sequence suggested by the manufacturer.

- The potential for a manufacturer to self-verify in their own labs is not felt to be appropriate because it would represent optimised conditions whereas in real-life a dismantler may have to deal with a wide variety of models without the benefit of an OEM's familiarity with their own product.
- The proposal does not contain any time-related benchmarks. Instead the applicant shall report on the timing achieved by the third party following the extraction time measurement methodology to be provided in the User Manual.

3.4.2.4 Stakeholder feedback and further evidence

Summary of stakeholder feedback
An industry representative questioned whether the criteria were realistic given that notebooks are at the moment not pre-processed by manual dismantlers. Moreover, shredding with some selective metal and plastic recovery followed by incineration is currently the most common treatment for handling computer waste. This position was also supported by a manufacturer. A Member State also voiced concern as to whether the criteria was right for the product group. Although separation can be very manual, the market is driven by the value of the components and materials and industry is developing many different innovative ways of extracting parts that are of value. This is very difficult to reflect in a criterion. Another Member State supported this position, stating that the proposal was too idealistic and questioning the environmental benefit. A Member State proposed a focus on reparability criteria only. It is not clear whether the criterion is assessing the efficiency of the techniques employed by specialised recyclers or whether we are trying to influence better design for disassembly by the manufacturer. It may be better to emphasise repairability and reuse. Another stakeholder supported the proposals stating that even if equipment is not

being recycled now it would encourage the process.

A Member State had consulted with electronic waste recyclers. Although, they don't manually dismantle the products the proposed criteria would help them with the detoxification of the products. They saw the criteria as a tool to raise awareness of producers about the recyclability of their products, even though it is unclear what the future will bring concerning the level of manual dismantling.

Sometimes a large batch of a certain product has to be dismantled. In these cases more information on the product becomes more relevant. Easy dismantling or detoxification also reduces the number of working accidents in dismantling plant.

The current market for end-of-life computers

Based on recent work in the WEEE sector JRC-IES are able to confirm that few notebooks are currently reaching recycling facilities. Various possible reasons can be cited - second-hand market and repairing, storage at the consumer's home/work, shipment outside EU - and therefore recycling by manual dismantling is not well-established yet. On the other hand, the manual dismantling of desktop computers, with the selective extraction of some key components, is already commonplace.

It is important to note, however, that the criterion is directed at products that will be placed on the market from 2015 onwards and may not enter the waste stream until 2018-2019 at the ealiest.

Design for recycling v. design for dismantling

The proposed criterion design for recycling criteria are considered an improvement on the previous criterion because although a product may be easy disassembled for repair it may not be suitable for easy disassembly. It is economically viable to spend tens of minutes to repair a computer, but not more than few minutes for dismantling.

The time and complexity of disassembly are a proxy for the cost effectiveness of dismantling to extract components that are valuable from both a life cycle and

resource efficiency perspective. This will remain the case even if dismantling is, in the future, carried out robotically [142].

Moreover, strategic concerns about Critical Raw Materials are also becoming more significant in policy making. As was highlighted in Section 3.4.2.2 in general CRMs can only be efficiently recovered by early stage manual dismantling and separation of components e.g. PWBs, capacitors, HDDs. .

A further issue to highlight is battery removal. This is a legal requirement for detoxification before shredding under the WEEE Directive. This may have implications for some designs and models, as was analysed in Section 3.4.2.2.

Revising the proposed approach

DG ENV and JRC consider there to be a sufficient evidence base to support a criterion based on manual dismantling. For computers the evidence base does not yet exist to place a requirement on the time taken for dismantling. It is therefore proposed to modify the criterion to focus on applicants carrying out a disassembly test in order to measure:

- how many steps are required,
- their complexity, and
- the associated tools required.

The benefit of this knowledge was demonstrated by the analysis of battery extraction in Section 3.3.2.4 and the study by Fraunhofer IZM (2013) used as evidence for tablet computers. By carrying out the test knowledge would be gained on potential problems relating to the extraction of valuable sub-assemblies and components.

The proposed test procedure has been revised accordingly and is presented in Box 3. In-line with comments from stakeholders the forms of verification accepted have

[142] R. Knoth, M. Hoffmann, B. Kopacek, P. Kopacek, and C. Lembacher, *Intelligent disassembly of electronic equipment with a flexible semi-automatic disassembly cell*, Austrian Society for Systems Engineering and Automation.

been expanded to include disassembly by the manufacturer (or their designer/fabricator) in their own laboratory.

Box 3. Revised outline procedure for a product disassembly test

Terms and definitions

- Target parts and components: Parts and/or components that are targeted for the extraction process.
- Disassembly step: An operation that finishes with the removal of a part or with a change of tool.

Operating conditions for the extraction

- Personnel: The test shall be carried out by one person.
- Test sample: The sample product to be used for the test shall be undamaged.
- Tools for extraction: The extraction operations shall be performed using manual or power-driven standard commercially available tools (i.e. pliers, screw-drivers, cutters and hammers as defined by ISO 5742, ISO 1174, ISO 15601).
- Extraction sequence: The extraction sequence shall be documented and, where the test is to be carried out by a third party, information provided to those carrying out the extraction.

Recording of the test conditions and steps

- Documentation of steps: The individual steps in the extraction sequence shall be documented and the tools associated with each step shall be specified.
- Recording media: Photos shall be taken and a video recorded of the extraction of the components. The video and photos shall enable clear identification of the steps in the extraction sequence.

3.4.2.5 Third proposal for design for dismantling and recycling criterion

Third criteria proposal

4(b) Design for dismantling and recycling

For recycling purposes computers shall be designed so that target components and parts can be easily extracted from the product. A disassembly test shall be carried out according to the test procedure in Appendix 3. The test shall record the number of steps required and the associated tools and actions required to extract the target components and parts identified in (a) and (b).

(a) The following target components and parts, selected as relevant to the product, shall be extracted during the disassembly test:

All products

(i) Printed Wiring Boards relating to computing functions >10 cm^2

Stationary computer products

(i) Internal Power Supply Unit

(ii) HDD drives

Portable computer products

(i) Rechargeable battery

Displays (where integrated into the product enclosure)
(i) Printed Circuit Boards >10 cm2
(ii) Thin Film Transistor unit and film conductors in display units >100 cm2
(iii) LED backlight units

(b) At least two of the following target components and parts, selected as relevant to the product, shall also be extracted during the test, following-on in the test from those in (a):

(i) HDD drive (portable products)
(ii) Optical drives (where included)
(iii) Printed circuit boards ≤ 10 cm2 and > 5 cm2
(iv) Speaker units (notebooks, integrated desktops and portable all-in-one computers)
(v) Polymethyl Methacrylate (PMMA) film light guide (where the screen size is >100 cm2)

Assessment and verification: The applicant shall provide a 'disassembly test report' to the competent body detailing the adopted disassembly sequence, including a detailed description of the specific steps and procedures, for the target parts and components listed in (a) and (b),

The disassembly test may be carried out by:
(i) The applicant, or a nominated supplier, in their own laboratory, or;
(ii) An independent third party testing body, or;
(iii) A specialised recycling firm that is a permitted treatment operation in accordance with Article 23 of the Waste Framework Directive.

Summary rationale for the proposed changes

- Design for efficient dismantling is considered by DG ENV and JRC to be an important proxy for cost effective dismantling/recycling and should be an important factor in product design.
- The criterion is therefore proposed to be retained with its focus on the dismantling of specific components of life cycle and resource efficiency significance for different types of computers.
- The proposal has been modified to focus on dismantling steps and tools rather than timing. This will improve the value of the disassembly test requirement to computer designers – as illustrated by Fraunhofer IZM's recent analysis of tablets.
- An outline test procedure has been drafted, to be provided in the Appendix to the criteria.

Criterion 4.3 – Packaging

Present criteria, Decisions 2011/337 and 2011/330
Where cardboard boxes are used, they shall be made of at least 80 % recycled material. Where plastic bags are used for the final packaging, they shall be made of, at least, 75 % recycled material or they shall be biodegradable or compostable, in agreement with the definitions provided by the EN 13432 or equivalent. *Assessment and verification*: a sample of the product packaging shall be provided on application, together with a corresponding declaration of compliance with this criterion. Only primary packaging, as defined in European Parliament and Council Directive 94/62/EC, is subject to the criterion.

Consultation questions
• The technical analysis and literature review of LCA studies (see Task 3) clearly shows that the packaging of computers and displays is of negligible relevance with regard to environmental impacts. Against this background it shall be discussed if this criterion should be retained?

3.4.2.6 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, it was felt that this is an environmental policy issue and that cardboard with a high recycled content is not difficult to achieve – although the practical % threshold varied between 60% and 80% depending on the availability of the recycled feedstock.

Written stakeholder feedback following the first AHWG meeting

- If it is decided to include packaging, a complete harmonization with EPEAT, the IEEE1680.2 standard is recommended.
- One of the MS stakeholders proposed to keep the criterion if it is feasible for the applicants. Given the amount of packaging from all computers sold the impact is not negligible (however insignificant). In order to ensure consistency with other EU policies, the requirements set out should remain unchanged.
- The requirements on plastic packaging in the different EU Ecolabel product groups are confusing, both quantitatively and qualitatively. The percentages vary from zero to 100 % of a variety of materials such as recycled material, recyclable material, renewable material, biodegradable material, compostable material, etc.
- It should be proven that packaging has a major influence on the sustainability impact of the whole system (content + packaging) if criteria should be set. For

computers, as for many other energy using products, the impact of the packaging over the full life cycle is usually marginal. The technical analysis and literature review of LCA studies clearly shows that the packaging of computers is of negligible relevance with regard to environmental impacts. If this is true and the EU Ecolabel criteria should address main environmental impacts, then there should not be criteria on packaging.

- There are strong doubts on the feasibility of this requirement regarding a minimum percentage of recycled material for packaging. The proposed percentage is definitely too high for plastics and for many other packaging materials. A fixed minimum percentage of recycled material for the different plastics used in packaging is neither feasible nor acceptable for the industry, because it does not allow guaranteeing the required level of quality and performance. A lower performance of the packaging will result in increased likelihood of damaging the packed product, and hence will increase the amount of waste. Such a criterion would discriminate/exclude most plastics from being used as packaging materials for this product group.
- The use of recycled material is environmentally beneficial only if: material losses in the recycling loop are limited; the substitution ratio is higher than about 0.7 (i.e. 1 part of recycled material replacing about 0.7 parts of virgin material). When the virgin material performance is improved in such a way that the thickness can be reduced, then the use of recycled material may become environmentally more damaging. We are very sceptical about using recycled content as a criterion for plastic packaging in EU Ecolabel criteria. Also for packaging, a life-cycle benefit from used recycled materials cannot automatically be assumed, but would be dependent on the plastics type and the impacts of the collection/recycling process. Besides, computers are not packaged on ‘plastic bags”. They may be protected by a plastic film which must ensure effective protection from humidity, dust, etc. Using recycled material in such relatively thin, but very protective, films may not be possible. Since we do not see any comparative life cycle analysis showing that the requirement of “at

least, 75% recycled material “, is beneficial for the environment, we ask to remove this requirement.

- Comments on “biodegradable or compostable” plastic bags for packaging: Biodegradability or compostability, according to EN 13432, is not a guarantee of superior environmental performance. It only guarantees that the material, if discarded in the right waste fraction, collected and adequately managed, will disappear as water and CO_2, which means no resource saving. The inadequately managed fraction that will end in landfill will generate methane. Methane is a greenhouse gas more than 20 times more powerful than CO_2. We advise using for packaging the most sustainable packaging material as proven by a life-cycle analysis for the respective application. Recycling content or biodegradability can be part of a life-cycle analysis, but per se they are no indicators for a more sustainable or "greener" packaging. It is questionable whether biodegradable packaging for computers brings any environmental advantage. We wonder where the life cycle assessments are, guaranteeing that these two criteria will reduce the impact on the environment. Again, by lack of scientific proof, we ask to remove the requirements for biodegradable and compostable material.

Further research and evidence

Compostable plastics

The term “biodegradable” is not equivalent to “compostable”. Whereas biodegradability is an inherent property that is independent of time and space, compostability is specifically related to the conditions in a composting plant. Compostability is the apability of biological degradation in a defined time under controlled conditions in a composting plant. The European standard (EN 13432 standard for bioplastic packagings and EN 14995 for plastic waste) requires 90% degradation within 90 days.

According to UBA (2012) there was criticism because typical rotting times in reality are often shorter than 12 weeks, the period for which biodegradability was tested. In these cases it was possible that packaging components were not fully degraded thus

decreasing the value of the compost. Even if biodegradable plastics are fully degraded they do not have an added value from ecological perspective as they disintegrate into water and CO_2 and do not provide any nutrients to the compost[143].

Relating to the energy balance composting is not effective as no energy is recovered as long as it does not go into biogas production systems where energy can partly be recovered. However, according to an interview with an expert from the German Federal Environment Agency (UBA)[144], the separation techniques of composting plants are not so elaborated that they can distinguish between conventional and biodegradable plastics. Plastics are generally disturbing and thus sorted out.

Biodegradable plastics

A current study commissioned by the German Federal Environment Agency "Analysis of the environmental impact of biodegradable plastic packaging" evaluated a total of 85 life cycle assessments, studies and professional articles with a view to all of the environmental pros and cons of every type of packaging (UBA 2012)[145].

The study resulted that biodegradable plastics used in packaging, which are made from renewable biomass sources, do not prove to offer an overall ecological advantage. Whereas their CO_2 emissions and consumption of petroleum of bioplastics are lower, they are negative in a number of other environmental areas particularly through the use of fertilisers: The farming and processing of the plants used in packaging cause more severe acidification of soil and eutrophication of water bodies than the production of common plastic packaging. Moreover, they cause higher levels of particulate emissions.

Further, the study revealed that packaging made of biodegradable plastics was also unsuccessful in retail. During the 2009 period covered in the study, the market share

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[143] Source: Interview with Franziska Krüger, expert for plastic recycling at German Federal Environment Agency (UBA); cf. http://www.planet-wissen.de/alltag_gesundheit/werkstoffe/kunststoff/biokunststoffe.jsp

[144] Source: http://www.deutschlandfunk.de/mogelpackung-bioplastiktuete.697.de.html?dram:article_id=78835

[145] Cf. http://www.umweltbundesamt.de/en/press/pressinformation/bioplastics-not-superior; study: http://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/4446.pdf

of bioplastics packaging was a maximum of 0.5 per cent. Germany consumed a total of 2,645 million tonnes of plastic packaging in 2009.

The study was commissioned to determine whether the special provisions for biodegradable plastic packaging introduced by the German Packaging Ordinance are still defensible from an ecological viewpoint. The overall conclusion of the study was that bioplastic bags have no ecological advantages over common plastic bags. Reusable bags made of fabrics and other durable materials are in fact the real ecological alternative.

3.4.2.7 Second proposal for packaging criteria

Proposed revised criteria (second proposal)
"Packaging" Where cardboard boxes are used, they shall be made of at least 80 % recycled material. Where plastics are used for the final outer packaging, they shall be made of at least 75 % recycled material. Plastics used for protectively covering the product within the outer packaging are exempted from this requirement. *Assessment and verification*: a sample of the product packaging shall be provided on application, together with a corresponding declaration of compliance with this criterion. Only primary packaging, as defined in European Parliament and Council Directive 94/62/EC, is subject to the criterion.

Major proposed changes

- According to stakeholder feedback and further evidence, it is proposed to delete the requirement concerning biodegradable or compostable plastic materials as they did not proof to be of environmental benefit.
- Regarding the requirement of using recycled plastic materials, an exemption has been added for plastic materials that are used for protecting the computer product against damage (e.g. shock absorbance).

3.4.2.8 Stakeholder feedback and further evidence

Summary of stakeholder feedback
80% recycled cardboard would make the packaging too fragile. This would be tolerable if you were only to ship packages together so they behave as a whole, but separate or small numbers of products could get damaged. Producers would only

permit up to 50-60%.

The criterion is written in a confusing way. There is no requirement for plastics, only for cardboard boxes. Why should plastics be exempted? The text from the draft displays criteria stating that plastics should be at least from 75% recycled material could be added.

3.4.2.9 Third proposal for packaging

Third criteria proposal
Criterion proposed for withdrawal

Summary rationale for the proposed changes

- Given the introduction of new criterion that will improve the overall life cycle focus of the criteria on product lifespan it is proposed to omit the packaging criteria.
- This is because packaging, although a visible issue for the consumer, is not associated with significant life cycle environmental impacts. Moreover, cardboard already contains high levels of recycled content.

3.5 Cluster 5 – Corporate production / supply chain management

Within the hotspot analysis for computer products, some additional issues concerning environmental as well as social impacts were identified. Within this context it shall be discussed if the revision of the EU ecolabel for computers shall also introduce new requirements on corporate responsibility, meaning that they cannot be implemented and verified at product level but would need to be implemented at production level, possibly during production stages not carried out by the applicants themselves.

3.5.1 Criterion 5.1 – Labour conditions during manufacturing

3.5.1.1 First proposal for criteria on labour conditions during manufacturing

Proposed options for a new criterion (first proposal)
Option (a): No social criteria at all **Option (b): Labour conditions during manufacturing** The applicant shall have a code of conduct or a comparable policy that requires adherence to the core labour standards of the International Labour Organisation (ILO Core Labour Standards). This code of conduct and/or policy shall also address the assembly-stage of the production even in cases the assembly is not carried out by the applicant. The applicant shall ensure that the code of conduct is communicated to all suppliers / subcontractors (up to the level of product assembly) together with a requirement that these shall also comply with a code of conduct that follows the ILO Core Labour Standards. *Assessment and verification*: The applicant shall declare compliance with these requirements (for example implementation of OECD Guidelines for Multi-National Enterprises "Recommendations on human rights and on employment and industrial relations" or of the United Nations Global Compact: "Principles on Human rights and Labour") and shall provide a copy of the code of conduct and a description of the implementation process at tier 1 suppliers/sub-contractor level (up until assembly). **Option (c): Labour conditions during manufacturing** Fundamental principles and rights with respect to universal human rights, as specified in the applicable core labour standards of the International Labour Organisation (ILO Core Labour Standards) shall be complied with during manufacturing (assembly) of the European eco-labelled products. *Assessment and verification*: Option (1): The applicant shall declare the compliance with these requirements to the competent body. Option (2): The applicant shall declare the compliance with these requirements to the competent body and provide evidence by third-party verified certification of tier 1 production sites (up until assembly), e.g. by SA8000 or other standards that contain the ILO Core Labour Standards. This shall include site visits by auditors for all tier 1 production sites in the supply chain (up until assembly) for the licensed products. Site visits shall take place upon application and subsequently during the license period if new production sites are introduced.

Note: Requirements regarding the social labour conditions during manufacturing are difficult to integrate in ecolabel criteria, especially in terms of assessment and verification.

Recent examples show that the reputation of the overall Ecolabel might be at risk if breaches of social labour conditions of ecolabelled products become known.

For more details cf. Task 4 report “Improvement Potential”, section 4.2.5.1 “General CSR criteria: Challenges for the implementation by ecolabels”.

Consultation questions
• Should a criterion addressing labour conditions be included? • Which further social aspects might be required beyond the ILO *Core* Labour Standards (e.g. wages, working time, occupational health & safety)? • Are there specific hot spots in the supply chain that might provide for a more focused criterion? (see also proposed criteria 5.3) • Which verification mechanisms shall apply in order to best ensure compliance with the required criteria?

3.5.1.2 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, this criteria proposal was generally supported by stakeholders, including by manufacturers who have been developing their own initiatives in this area. A Protocol Code of Conduct signed by 16 manufacturers in 2004 was referred to.

It was felt that the criteria should have strong verification in order to avoid problematic situations. As an example, a recent case relating to TCO certification scheme and Samsung was referred to. Even if a scandal occurs this would serve to highlight the issues. Some criteria are better than no criteria.

It was discussed, however, if these criteria would need to be mandatory? If a strict verification is implemented it may be difficult for all manufacturers to follow.

Written stakeholder feedback following the first AHWG meeting

- The inclusion of a criterion on labour conditions seems to be generally supported by the stakeholders.
- It is asked to have a uniform approach how to write the social criteria in different criteria documents.

- The criterion is welcomed by one of the CBs preferring either option b) or c) with sub-option 1. Also from the outcomes of the “Horizontal Task Force on social and ethical criteria for the EU Ecolabel- March 2013”, it is understood that third-party verification can be way too expensive (“SA 8000: 10,000 € per production site for three years”).
- One of the MS stakeholders is in favour of option (b) as it sets a standard but doesn’t put an excessive burden on the applicant to prove compliance with it. Verification by a third party is proposed to be demanded perhaps in the next revision period.
- According to feedback from a manufacturer it should be further discussed if one incident related to one applicant for the TCO ecolabel should lead to the conclusion not to require social criteria for computers at all. The positive side of the TCO social criteria is that there are now 15 companies that have certified displays for which compliance to these social criteria is a condition (criteria version 6.0). All of these companies have worked hard to demonstrate compliance to these requirements by annually showing an independent external audit report. Thus the inclusion of social criteria into the EU Ecolabel is supported. If included, a complete harmonization with TCO is recommended.
- CSR criteria should at least be in line with public and private procurement demands and for credibility be 3rd party verified. CSR is either a progressive approach such as EICC code of conduct and validated audit process for members or SA8000 certification of factories (not headquarters) where a certain standard is reached before certification is issued. Global compact and GRI do not guarantee a level of implementation at factory level without factory audits. EICC membership does not assure a level of implementation at factory level that is controlled by a 3rd party. If the progressive improvement methodology is chosen then to move forward from adopting principles, an agreement should be entered where the brand follows a code of conduct that is based on labour standards and principles that includes social and ethical production and where also exists a structured CSR policy of control routines for monitoring their

production facilities. CSR demands as these create a tool for brands and facilitate the sharing of information between the supplier, purchaser and a 3rd party (“3 way interest group”). At a stage of setting a minimum level of verified social commitment, progressive improvement is not a proof of good working conditions but it should be seen as a phase of ambitious 3rd party follow-up audits that communicates to stakeholders that social issues are important.

- To not push the industry into CSR for the reason of avoiding criticism is seen as sending the wrong signal to stakeholders.
- TCO Certified is 3rd party verified. If compliance is questioned (as one incident has been at TCO) then it in part is often dependent on a misunderstanding that can lead to a productive dialogue and perhaps future criteria improvements. TCO Development, as part of a watchdog system, is dependent on external information and will open a dialogue with informants and - if there are causes - start an investigation into the claims.
- It is recommended to avoid the phrase ‘guarantee compliance’ as this cannot be done without progressive improvement. It should be worked from the base up to know where to bring about positive change in the facilities where the certified products are manufactured.
- It has to be clearly communicated, to which tier of the supply chain the criteria are addressed to bring progressive improvement and where reasonable efforts are accepted. A network of approved 3rd party expert CSR verifiers will be needed to control the quality of the 3rd party audits are in line with demands and can review corrective action plans (CAPs) for their corrective effectiveness.
- The suggestion of being involved in other initiatives which more target the most relevant social hot spots could be a good approach, however brands may be unwilling to accept yet another initiative involvement, so there is the need to assess those where they are already involved in. Perhaps this is an option that should be included as a complementary option to conducting audits, such as the proposed tier (optional) scheme.

- There is no mention of the advancements created by the new TCO Certified CSR criteria: It is communicated to the stakeholders that social issues are important by setting a minimum level of verifying social commitment. It is communicated that TCO Development is primarily verifying the brand owner's procedures for promoting legal and human labour standards throughout the supply chain as specified in the mandate, but control audits for now are limited to the final production (1st tier). Here a brand shall conduct independent audits and address all findings (violations to the TCO mandate) with a corrective action plan (CAP). To date TCO Development cannot guarantee that violations don't occur but they are verifying a structured CSR policy and control routines toward production facilities. By entering in an agreement with TCO Development the brand agrees to annual 3rd party audits at supply factories and the sharing of audit reports, findings and corrective actions plans between the buyer, supplier and 3rd party (TCO Development and approved assessors) and also spot checks. It has taken some brands over 1.5 years to implement the necessary changes to their Code of Conducts and production control routines to be in-line with TCO Certified (even though brands have been involved with more established CSR initiatives for a long time). To date there are 17 brands TCO Development works with and requires that they annually demonstrate their commitment toward improving working conditions for socially responsible production at supplier level.

Further research and evidence

The international **standard SA8000**[146] is an auditable certification standard. Based on international workplace norms of International Labour Organisation (ILO) conventions, the Universal Declaration of Human Rights and the UN Convention on the Rights of the Child, it entails nine elements to measure social compliance (cf. Table 26). The third party accredited certification scheme foresees audits being conducted by approved SA8000 auditors.

[146] See http://www.sa-intl.org/index.cfm?fuseaction=Page.ViewPage&PageID=937

Table 26: SA8000 standard and their basis of ILO fundamental and further labour conventions

SA8000	8 ILO fundamental labour conventions	Further ILO labour conventions relevant to SA8000 implementation and auditing
Child Labour: No use or support of child labour; policies and written procedures for remediation of children found to be working in situation; provide adequate financial and other support to enable such children to attend school; and employment of young workers conditional.	• **Minimum Age** Convention (No. 138) • Worst Forms of **Child Labour** Convention (No. 182)	
Forced and Compulsory Labour: No use or support for forced or compulsory labour; no required 'deposits' - financial or otherwise; no withholding salary, benefits, property or documents to force personnel to continue work; personnel right to leave premises after workday; personnel free to terminate their employment; and no use nor support for human trafficking.	• **Forced Labour** Convention (No. 29) • Abolition of **Forced Labour** Convention (No. 105)	
Health and Safety: Provide a safe and healthy workplace; prevent potential occupational accidents; appoint senior manager to ensure OSH; instruction on OSH for all personnel; system to detect, avoid, respond to risks; record all accidents; provide personal protection equipment and medical attention in event of work-related injury; remove, reduce risks to new and expectant mothers; hygiene- toilet, potable water, sanitary food storage; decent dormitories- clean, safe, meet basic needs; and worker right to remove from imminent danger.		• Occupational Safety and Health Convention (No. 155) • Occupational Health Services Convention (No. 161) • Safety in the Use of Chemicals at Work Convention (No. 170); Prevention of Major Industrial Accidents Convention (No. 174) • Asbestos Convention (No. 162); White Lead (Painting) Convention (No. 13); Radiation Protection Convention (No. 115); Benzene Convention (No. 136) • Occupational Cancer Conv. (No. 139); Guarding of Machinery Conv. (No. 119); Maximum Weight Conv. (No. 127); Maternity Protection Conv. (No. 183 rev.); Medial Examination of Young Persons (Industry) Conv. (No. 77)

SA8000	8 ILO fundamental labour conventions	Further ILO labour conventions relevant to SA8000 implementation and auditing
Freedom of Association and Right to Collective Bargaining: Respect the right to form and join trade unions and bargain collectively. All personnel are free to: organize trade unions of their choice; and bargain collectively with their employer. A company shall: respect right to organize unions & bargain collectively; not interfere in workers' organizations or collective bargaining; inform personnel of these rights & freedom from retaliation; where law restricts rights, allow workers freely elect representatives; ensure no discrimination against personnel engaged in worker organizations; and ensure representatives access to workers at the workplace.	• **Freedom of Association** and Protection of the Right to Organise Convention (No. 87) • Right to Organise and **Collective Bargaining** Convention (No. 98)	• Workers' Representatives Convention (No. 135) • Collective Bargaining (No. 154)
Discrimination: No discrimination based on race, national or social origin, caste, birth, religion, disability, gender, sexual orientation, union membership, political opinions and age. No discrimination in hiring, remuneration, access to training, promotion, termination, and retirement. No interference with exercise of personnel tenets or practices; prohibition of threatening, abusive, exploitative, coercive behaviour at workplace or company facilities; no pregnancy or virginity tests under any circumstances.	• **Discrimination** (Employment and Occupation) Convention (No. 111) • Equal **Remuneration** Convention (No. 100)	• Workers with Family Responsibilities Conv. (No. 156); Vocational Rehabilitation and Employment (Disabled Persons) Conv. (No. 159); Indigenous and Tribal Peoples Conv. (No. 169); Maternity Protection Conv. (No. 183); Migration for Employment Conv. (No. 97 rev.); Night Work (Women) Convention (Nr. 89 rev.)
Disciplinary Practices: Treat all personnel with dignity and respect; zero tolerance of corporal punishment, mental or physical abuse of personnel; no harsh or inhumane treatment.		
Working Hours: Compliance with laws & industry standards; normal workweek, not including overtime, shall not exceed 48 hours; 1 day off following every 6 consecutive work days, with some exceptions; overtime voluntary, not regular, not > 12 h/w; required overtime only if negotiated in CBA.		• Hours of Work (Industry) Convention (No. 1)
Remuneration: Respect right of personnel to living wage; all workers paid at least legal minimum wage; wages sufficient to meet basic needs & provide discretionary income; deductions not for disciplinary purposes, with some exceptions; wages and benefits clearly communicated to workers; paid in convenient manner – cash or check form; overtime paid at premium rate; prohibited use of labour-only contracting, short-term contracts, false apprenticeship schemes to avoid legal obligations to personnel.		• Minimum Wage Fixing Convention (No. 131)
Management Systems: Facilities seeking to gain&maintain certification must go beyond		

SA8000	8 ILO fundamental labour conventions	Further ILO labour conventions relevant to SA8000 implementation and auditing
simple compliance to integrate the standard into their management systems & practices.		

The SA8000 standard includes the **eight fundamental labour conventions but goes far beyond them** including also principles on health and safety, disciplinary practices, working hours, remuneration (by especially addressing "living wages" and "overtime payment" linking to some major hot spots of the ICT manufacturing industry) and management systems.

Further, the standard strives towards **feasible implementation** of; for example, the Principle on Freedom of Association and Right to Collective Bargaining. In situations where the Right to freedom of association and collective bargaining are restricted under law, SA8000 standard still requires companies to allow workers to freely elect their own representatives. Furthermore, in cases where above mentioned fundamental rights are restricted under law SA8000 still requires that employers, as to the actions of their companies and suppliers, have the responsibility to allow the workplace to be one where workers can fully and without fear of retaliation exercise their right to unimpeded collective representation[147]. No discrimination against personnel being engaged in worker organizations shall be ensured; and representatives' access to workers at the workplace shall be ensured. With these specific additions and amendments to the ILO Core Labour standards, being able to be applied to any company, of any size, anywhere in the world, the SA8000 standard is viewed as the most globally accepted independent workplace standard[148].

According to EICC (2012)[149], the industry initiative Electronic Industry Citizenship Coalition's **(EICC) code of conduct** is applied by 60 manufacturers which voluntarily committed to ensure that working conditions in the electronics industry supply chain are safe, that workers are treated with respect and dignity, and that business operations are environmentally responsible and conducted ethically. However, WSI (2012)[150] identified some significant weaknesses of the EICC code of conduct:

[147] SA8000 ® Consolidated Guidance – Freedom of Association and Right to Collective Bargaining
[148] Cf. www.sgs.com/~/media/Global/Documents/Brochures/SGS_SSC_NG_SA_8000_web_LR.pdf
[149] Cf. http://www.eicc.info/documents/EICCCodeofConductEnglish.pdf
[150] WSI (2012): Wirtschafts- und Sozialwissenschaftliches Institut (WSI) in der Hans-Böckler-Stiftung: Öffentliche Beschaffung von IT-Mitteln (PCs) unter Berücksichtigung sozialer Kriterien; WSI-Diskussionspapier Nr. 183. Düsseldorf, 2012. Cf. http://www.boeckler.de/index_wsi.htm

- The labour standards are not based on the fundamental ILO labour conventions but rather on the national laws which might be weaker in some countries.
  - Especially regarding the Freedom of Association and Right to Collective Bargaining, the EICC codex falls behind the ILO and the SA8000 standards.
  - Further, the codex only implies regional minimum wages and not wages sufficient to meet basic needs (“living wages").
  - The right on employment security is not included at all.
- The monitoring is mainly based on self-evaluation; a systematic independent external audit is not part of the codex. In the monitoring process, no independent trade unions or labour rights organisations are included. Controls of the self-evaluation of suppliers are only taking place on a random basis.

The current **CSR criteria of TCO Development** include ILOs eight core conventions 29, 87, 98, 100, 105, 111, 138, and 182, the UN Convention on the Rights of the Child, Article 32, the health and safety legislation in force in the country of manufacture, and the labour law, including rules on minimum wage and the social security protection in the manufacturing country. In situations where the right to freedom of association and collective bargaining are restricted under law, workers shall be permitted to freely elect their own representatives. The verification mechanism is based on four different options (a) to (d):

(a) The Brand owner is a member of EICC and provides documented proof of third party audits conducted at production facilities of TCO certified products.

(b) The Brand owner is SA8000 certified **or** carrying out the production at SA8000 certified facilities and provides documented proof of third party audits conducted at production facilities of TCO certified products.

(c) The Brand owner shall complete the self-documentation according to a questionnaire provided by TCO Development and provide documented proof of third party audits conducted at production facilities of TCO certified products.

(d) The Brand owner applies for a 12 month grace period by sub-mitting a signed declaration stating which option above (a, b or c) shall be implemented by them and an estimation of when all the necessary documented proof will be available.

According to WSI (2012)[150], the linkage to the eight ILO core conventions, the explicit addressing of options in cases where freedom of association and collective bargaining are restricted under law, as well as the more explicitly regulated monitoring approach go far beyond that of EICC. However, WSI (2013) sees optimization potential with regard to the following aspects:

- In case of weaker national laws, the TCO standards are hardly going beyond the ILO core conventions as for example aspects as living wages or social security are not addressed.
- Option (b) allows the interpretation or possibility that a headquarter of a brand company, situated in a Western developed country, could be SA8000 certified to fulfil the criteria on verification.

From perspective of Germanwatch, an independent development and environmental organization in Germany with focus and deep expertise on CSR activities in the supply chain, which has been interviewed by the study team on 19 March 2014, membership in EICC and self-declaration would not be a sufficient option as verification mechanism.

3.5.1.3 Second proposal for social supply chain criteria

Proposed new criterion (second proposal, Option A)
Labour conditions during manufacturing (<u>required</u>) The applicant shall demonstrate that the product is manufactured under working practices that promote good labour relations and working conditions by proving that more than 90% of the first-tier suppliers (final product assembly) comply with the following ILO Conventions: a) **Child Labour**: i. ILO Core Convention “Minimum Age” (No. 138) ii. ILO Core Convention “Worst Forms of Child Labour“ (No. 182) b) **Forced and Compulsory Labour**: i. ILO Core Convention “Forced Labour” (No. 29) ii. ILO Core Convention “Abolition of Forced Labour” (No. 105) c) **Freedom of Association and Right to Collective Bargaining**: i. ILO Core Convention “Freedom of Association and Protection of the Right to Organise” (No. 87) ii. ILO Core Convention “Right to Organise and Collective Bargaining” (No. 98) d) **Discrimination**: i. ILO Core Convention “Discrimination (Employment and Occupation)” (No. 111) ii. ILO Core Convention “Equal Remuneration” (No. 100) e) **Working Hours**: i. ILO Convention “Hours of Work (Industry)” (No. 1)

f) **Remuneration**:

i. ILO Convention "Minimum Wage Fixing" (No. 131)

ii. **Living wage**: The applicant shall ensure that wages paid for a normal work week shall always meet at least legal or industry minimum standards and shall be sufficient to meet the basic needs of personnel and to provide some discretionary income; with reference to SA8000 Consolidated Guidance "Remuneration" regarding definition, implementation, auditing and evidence of compliance

Assessment and verification:

The applicant shall declare compliance with these requirements to the Competent Body providing the copies of the certificates of Accredited Certification Bodies (CBs) accredited by Social Accountability Accreditation Services (SAAS) showing the compliance with the above requirements in more than 90% of the first-tier suppliers (final product assembly).

Additionally, the applicant shall provide to the Competent Body

- A list of first-tier suppliers representing at least 90% of procurement expenditure for final product assembly of computers.
- The independent social audit reports to verify that he is fulfilling its obligations according to this mandate.

Additionally, the applicant shall publish the independent social audit reports of the first-tier suppliers online to provide evidence to interested consumers.

Major proposed changes

- Despite feedback from manufacturers asking for a "slight" version not putting an excessive burden on the applicant to prove compliance with the criteria (i.e. code of conduct, self-declaration), the study team recommends – when implementing criteria on labour conditions during manufacturing into the EU Ecolabel at all – these should be adequate, effective and verifiable.
- According to expert judgement, a basic linkage to the 8 fundamental ILO labour conventions and the (often weaker) national labour laws would not be sufficient enough to address the social hot spots being specific to computers' manufacturing processes, especially those on working hours and remuneration.
- Thus, as minimum criteria the 8 ILO core conventions are proposed, added by two further ILO conventions on working hours and remuneration, together with an independent third-party auditing scheme.
- In terms of remuneration, ILO's Minimum Wage Fixing Convention 131 (1970) specifies in Article 3 (a) and (b) that the following two elements are taken into consideration in determining the minimum wage:

- The Needs of workers and their families taking into account the general level of wages in the country, the cost of living, social security benefits, and the relative living standards of other social groups;
- Economic factors, including the requirements of economic development, levels of productivity, and the desirability of attaining and maintaining a high level of employment."

According to SA8000[151], they experienced that in most countries these two considerations are odds and may not be weighted equally in the determination of the minimum wage. To attract foreign investment and international buyers, countries may emphasize economic growth and development. Minimum wages are often set to compete with low cost suppliers in other countries and not to promote workers' interests. Therefore, many countries have minimum wage levels that do not meet the basic needs of workers and their families. These wages also frequently do not reflect inflation and other factors that affect actual standards of living. Lack of enforcement of even these minimal rates of pay is common, forcing workers to work excessive overtime just to earn the legal minimum wage. Due to this reason, the proposed EU Ecolabel criteria include an additional requirement on "living wage" being sufficient to meet the basic needs of personnel and to provide some discretionary income. For definition of "living wages", interpretations, implementation, auditing and evidence of compliance, reference is made to the SA8000 Consolidated Guidance on Remuneration[152].

- Regarding assessment and verification, the fulfilment of requirements shall be verified by providing certificates of independent accredited certification bodies.
- The social requirements are proposed not to address the whole supply chain but only first-tier suppliers (final product assembly). This is due to the fact that first-tier suppliers (contract manufacturers) more and more act vertically within the supply chain from purchasing to final assembly (cf. WKI 2012). Further,

[151] Source: http://www.sa-intl.org/_data/n_0001/resources/live/SA8000Remuneration.pdf

[152] See http://www.sa-intl.org/_data/n_0001/resources/live/SA8000Remuneration.pdf

social aspects regarding hotspots of raw materials extraction will be addressed more specifically by criterion 5.2 'Use of conflict-free minerals'.

- For most manufacturers, the final assembly of their ICT products takes place at a limited number of contract manufacturers. Providing a list of first-tier suppliers summing up to at least 90% of procurement expenditure for final assembly (see for example Apple's information on suppliers[153]) would facilitate the Competent Bodies to cross-check with the availability of independent audit reports as also being required for verification. Online publication of audit reports would improve the overall transparency of the ICT supply chain.

Proposed new criterion (second proposal, Option B)

Labour conditions during manufacturing (optional)

The applicant shall demonstrate that the product is manufactured under working practices that promote good labour relations and working conditions by proving that more than 90% of the first-tier suppliers (final product assembly) comply with the following principles (derived from SA8000, including ILO all fundamental as well as further relevant labour conventions):

g) **Child Labour**: No use or support of child labour; policies and written procedures for remediation of children found to be working in situation; provide adequate financial and other support to enable such children to attend school; and employment of young workers conditional.

h) **Forced and Compulsory Labour**: No use or support for forced or compulsory labour; no required 'deposits' - financial or otherwise; no withholding salary, benefits, property or documents to force personnel to continue work; personnel right to leave premises after workday; personnel free to terminate their employment; and no use nor support for human trafficking.

i) **Health and Safety**: Provide a safe and healthy workplace; prevent potential occupational accidents; appoint senior manager to ensure OSH; instruction on OSH for all personnel; system to detect, avoid, respond to risks; record all accidents; provide personal protection equipment and medical attention in event of work-related injury; remove, reduce risks to new and expectant mothers; hygiene- toilet, potable water, sanitary food storage; decent dormitories- clean, safe, meet basic needs; and worker right to remove from imminent danger.

j) **Freedom of Association and Right to Collective Bargaining**: Respect the right to form and join trade unions and bargain collectively. All personnel are free to: organize trade unions of their choice; and bargain collectively with their employer. A company shall: respect right to organize unions & bargain collectively; not interfere in workers' organizations or collective bargaining; inform personnel of these rights & freedom from retaliation; where law restricts rights, allow workers freely elect representatives; ensure no discrimination against personnel engaged in worker organizations; and ensure representatives access to workers at the workplace.

k) **Discrimination**: No discrimination based on race, national or social origin, caste, birth, religion, disability, gender, sexual orientation, union membership, political opinions and age. No discrimination in hiring, remuneration, access to training, promotion, termination, and retirement. No interference with exercise of personnel tenets or practices; prohibition of threatening, abusive, exploitative, coercive behaviour at workplace or company facilities; no pregnancy or virginity tests

[153] Cf. http://www.apple.com/supplier-responsibility/our-suppliers/ and http://images.apple.com/supplier-responsibility/pdf/Apple_Supplier_List_2014.pdf

under any circumstances.

l) **Disciplinary Practices**: Treat all personnel with dignity and respect; zero tolerance of corporal punishment, mental or physical abuse of personnel; no harsh or inhumane treatment.

m) **Working Hours**: Compliance with laws & industry standards; normal work-week, not including overtime, shall not exceed 48 hours; 1 day off following every 6 consecutive work days, with some exceptions; overtime voluntary, not regular, not > 12 h/w; required overtime only if negotiated in CBA.

n) **Remuneration**: Respect right of personnel to living wage; all workers paid at least legal minimum wage; wages sufficient to meet basic needs & provide discretionary income; deductions not for disciplinary purposes, with some exceptions; wages and benefits clearly communicated to workers; paid in convenient manner – cash or check form; overtime paid at premium rate; prohibited use of labour-only contracting, short-term contracts, false apprenticeship schemes to avoid legal obligations to personnel.

o) **Management Systems**: Facilities seeking to gain and maintain certification must go beyond simple compliance to integrate the standard into their management systems & practices.

Assessment and verification:

The applicant shall declare compliance with these requirements to the Competent Body providing the copies of the certificates of Accredited Certification Bodies (CBs) accredited by Social Accountability Accreditation Services (SAAS) showing the compliance with the above requirements in more than 90% of the first-tier suppliers (final product assembly).

Additionally, the applicant shall provide to the Competent Body

- A list of first-tier suppliers representing at least 90% of procurement expenditure for final product assembly of computers.
- The independent social audit reports to verify that he is fulfilling its obligations according to this mandate.

Additionally, the applicant shall publish the independent social audit reports of the first-tier suppliers online to provide evidence to interested consumers.

Major proposed changes

- Despite feedback from manufacturers asking for a “slight” version not putting an excessive burden on the applicant to prove compliance with the criteria (i.e. code of conduct, self-declaration), the study team recommends – when implementing criteria on labour conditions during manufacturing into the EU Ecolabel at all – these should be adequate, effective and verifiable.
- According to expert judgement, a basic linkage to the 8 fundamental ILO labour conventions and the (often weaker) national labour laws would not be sufficient enough to address the social hot spots being specific to computers’ manufacturing processes.
- On the other hand, the nine elements of the SA8000 standard, based on the 8 ILO core conventions but adding further relevant requirements and providing modified options for cases where the national law restricts those rights, together

with an independent third-party auditing scheme, are seen as best practicable option to date. Thus, a general linkage to the nine principles as used by the SA8000 standard builds the basis for this criterion, however not referencing to SA8000 directly.

- Regarding assessment and verification, the fulfilment of requirements shall be verified by providing certificates of independent accredited certification bodies.
- The social requirements are proposed not to address the whole supply chain but only first-tier suppliers (final product assembly). This is due to the fact that first-tier suppliers (contract manufacturers) more and more act vertically within the supply chain from purchasing to final assembly (cf. WKI 2012). Further, social aspects regarding hotspots of raw materials extraction will be addressed more specifically by criterion 5.2 'Use of conflict-free minerals'.
- For most manufacturers, the final assembly of their ICT products takes place at a limited number of contract manufacturers. Providing a list of first-tier suppliers summing up to at least 90% of procurement expenditure for final assembly (see for example Apple's information on suppliers[154]) would facilitate the Competent Bodies to cross-check with the availability of independent audit reports as also being required for verification. Online publication of audit reports would improve the overall transparency of the ICT supply chain.
- Complying with the principles of SA8000 is proposed not to be defined as minimum requirement / exclusion criteria but as option for complying manufacturers to highlight this fact besides the label.

[154] Cf. http://www.apple.com/supplier-responsibility/our-suppliers/ and http://images.apple.com/supplier-responsibility/pdf/Apple_Supplier_List_2014.pdf

3.5.1.4 Stakeholder feedback and further evidence

Summary of stakeholder feedback
There was a general preference for Option A as presented (a strengthened version of the TCO approach). A Member State highlighted the need to be practical and felt that it was difficult to go further than the ILO conventions. Another stakeholder stated that the focus should be on what is implementable today. A Member State questioned the extent to which the proposed additional provision for a living wage would have an impact. Transparency via publication of activities was welcome, however. Concern was raised by another Member State that the Ecolabel was an environmental and not a social label. It could result an additional workload and discourage uptake. They were not in a position to verify and control such a criterion. On one hand it is easy for verification to be faked whilst on the other hand third party verification can be expensive. An industry stakeholder submitted a proposal for the criterion to be based on the EICC Code of Conduct. Other Codes of Conduct could also be accepted, as is the case with the TCO Development criterion. Supplementary to this main proposal it was also suggested that manufacturers should: • Identify how they are engaging with suppliers to building their capacity for social and environmental responsibility; • Publish a list of 1st tier manufacturing sites; • Publish aggregated audit results linked to coverage by expenditure;

Addressing identified perceived weakpoints with EICC processes

Feedback from industry stakeholders requested alignment with the Electronic Industry Citizenship Coalition's (EICC) Code of Conduct. As was previously highlighted, the EICC CoC, although providing a positive framework for action on

social issues by manufacturers, raises a number of concerns relating to 'social hot spots' in the supply chain and the monitoring/audit processes:

- The labour standards are not based on the fundamental ILO labour conventions but rather on the national laws which might be weaker in some countries.
  - The Freedom of Association and Right to Collective Bargaining requirements fall behind the Core ILO and SA8000 standards.
  - Moreover, the CoC only implies regional minimum wages and not wages sufficient to meet basic needs ("living wages").
  - Rights relating to employment security are not addressed.
- Monitoring is mainly based on self-evaluation and in the monitoring process, no independent trade unions or labour rights organisations are included. Controls of the self-evaluation of suppliers only take place on a random basis.

Reviewing further the EICC it can be seen that a 'Validated Audit Process' is also offered alongside monitoring based on self-assessment. Audits are carried out by third party auditors that are trained and accredited by the EICC's appointed audit manager, Vectra [155].

Although the SA8000 audit process focusses in a similar way to the EICC VAP audit process on interviews with the employer and workforce, it also identifies consultation with external stakeholders as being important. The SA8000 audit guidance describes how stakeholders shall be involved prior to the audit process [156]:

> *'The interested stakeholders to be consulted include: workers, trade unions, research institutions, NGOs, community organisations, and labor experts. The groups being consulted may be asked if any facility in the area has particular problems and/or for comments on a list of facilities including the audited facility, but auditors should not identify the applicant facility prior to certification.'*

[155] EICC, *Validate Audit Process*, Accessed 2014, http://www.eiccoalition.org/standards/assessment/validated-audit-process/

[156] Social Accountability International (2004) *Guidance document for Social Accountability 8000*,

This wider engagement is intended to assist auditors to 'build up a picture of working conditions at the enterprises in advance of the verification process'. The guidance specifically refers to the convening of meetings of local groups.

3.5.1.5 Third proposal for labour conditions during manufacturing

Third criteria proposal
5(a) Labour conditions during manufacturing The applicant shall obtain third party certification that the fundamental principles and rights at work as described in the International Labour Organisation's (ILO) Core Labour Standards, the UN Global Compact and the OECD Guidelines for Multi-National Enterprises are respected by final assembly plants for the product. For the purpose of verification the following ILO Core Labour Standards and supplementary provisions shall be referred to: a) Child Labour: (i) ILO Core Convention "Minimum Age" (No. 138) (ii) ILO Core Convention "Worst Forms of Child Labour" (No. 182) b) Forced and Compulsory Labour: (i) ILO Core Convention "Forced Labour" (No. 29) (ii) ILO Core Convention "Abolition of Forced Labour" (No. 105) c) Freedom of Association and Right to Collective Bargaining: (i) ILO Core Convention "Freedom of Association and Protection of the Right to Organise" (No. 87) (ii) ILO Core Convention "Right to Organise and Collective Bargaining" (No. 98) d) Discrimination: (i) ILO Core Convention "Discrimination (Employment and Occupation)" (No. 111) (ii) ILO Core Convention "Equal Remuneration" (No. 100) e) Working Hours: (i) ILO Convention "Hours of Work (Industry)" (No. 1) f) Remuneration: (i) ILO Convention "Minimum Wage Fixing" (No. 131) (ii) Living wage: The applicant shall ensure that wages paid for a normal work week shall always meet at least legal or industry minimum standards, are sufficient to meet the basic needs of personnel and provide some discretionary income; The audit process shall include consultation with external stakeholders in local areas around sites, including trade unions, community organisations, NGO's and labour experts. The applicant shall publish the audit reports online to provide evidence to interested consumers. ***Assessment and verification:*** the applicant shall certify compliance with these requirements by providing copies of certificates of compliance and supporting audit reports for each final product

assembly plant for the model(s) to be ecolabelled.

Certificates shall be issued by certification bodies accredited by Social Accountability Accreditation Services (SAAS) or approved auditors for the Electronics Industry Citizenship Coalition's (EICC) Validated Audit Process. Valid certifications from schemes or processes that audit compliance with the listed Core ILO Conventions, together with the additional provisions on working hours and remuneration, shall be accepted.

Summary rationale for the proposed changes

- The basic safety net of the Core ILO Conventions is to be retained, together with the additional provisions relating to minimum and living wages.
- Additional reference is to be made to the UN Global Compact and the OECD Guidelines for Multi-National Enterprises, reflecting discussions in other product groups with DG Trade.
- Additional reference shall be made in-line with SA8000 to the need to involve 'trade unions, community organisations, NGO's and labour experts' in the local area around sites.
- The potential for third party auditing by EICC accredited VAP auditors is proposed alongside SAAS accredited auditors. This is considered to provide greater scope for applicants who are members of EICC to comply with the criterion, albeit with stricter additional requirements relating to the audit process, ILO coverage and minimum/living wages.
- It is to be discussed by the EUEB whether with the proposed level of assurance the criterion would be too selective for the product group as a whole.

3.5.2 Criterion 5.2 – Use of 'conflict-free minerals' during production

3.5.2.1 First proposal for conflict-free minerals criteria

Proposed new criterion (first proposal)
'Conflict-free minerals' in electronics The applicant shall support the responsible sourcing of "conflict-free minerals" from the African Great Lakes Region for use in their computer products. *Assessment and verification*: The applicant shall declare the compliance with these requirements and shall provide additionally a description of the way he engages in responsible sourcing projects in the African Great Lakes Region (e.g. membership in a voluntary industry initiative, e.g. the Public Private Alliance, the Conflict-Free Tin Initiative or the Solutions for Hope Project) to the competent body.

Computer products contain a wide range of scarce resources which are largely mined in the Democratic Republic of Congo, a conflict region, and according to sources under dangerous conditions, without sufficient maintenance of health and safety standards and in some cases by children. However, instead of a criterion to exclude of the use of conflict minerals, bearing in mind the potential impact of a de facto embargo of minerals from a whole region that is economically and socially dependent on the mining industry, for the EU ecolabel revision a process oriented approach has been proposed to stimulate sustainable sourcing.

For more details cf. Task 4 report “Improvement Potential”, section 4.2.5.2.1 “Minimising the risk of using ‘conflict metals’ in electronics”.

3.5.2.2 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, this criteria proposal was generally supported, including by manufacturers who have been developing their own initiatives in this area. The activity in this area was stimulated by the US Dodd-Frank Act which requires disclosure of the source of metals.
It was seen as important to make the link to specific initiatives on the ground. Examples included the Tin Source Initiative and the Tantalum Initiative.
A request was made for a clear definition of ‘responsible sourcing’ although this was felt to be sufficient to encompass a range of projects in the region.

Written stakeholder feedback following the first AHWG meeting indicates that criteria must be worded carefully and compliance verification is a challenge. Also it should be defined which conflict minerals are covered. In GPP these criteria would be mainly appropriate as a contract performance clause.
Further research and evidence show that the requirement needs to specify the materials in scope, which is mostly defined as tin, tantalum, tungsten and their ores and gold. Responsible sourcing projects can be specified geographically by defining activities carried out within on the fringes of the resource-conflict hot spot (the eastern parts of the Democratic Republic of the Congo) and by their compliance with

the *OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas,* which was specifically tailored to the responsible sourcing of tin, tantalum, tungsten and gold.

3.5.2.3 Second proposal for conflict-free minerals criteria

Proposed new criterion (second proposal)
'Conflict-free minerals' in electronics The applicant shall support the responsible sourcing of "conflict-free minerals" from the African Great Lakes Region. In this context, the material scope encompasses tin, tantalum, tungsten and their ores and gold. *Assessment and verification*: The applicant shall declare the compliance with these requirements and shall provide additionally a description of the way he engages in responsible sourcing projects in the African Great Lakes Region for at least one of the above listed conflict minerals to the Competent Body. As responsible sourcing projects, all activities carried out within the Democratic Republic of the Congo that aim to source minerals in accordance with the *OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas* are eligible (e.g. the Public Private Alliance for Responsible Minerals Trade, the Conflict-Free Tin Initiative, and the Solutions for Hope Project).

Major proposed changes

- The section "[…] for use in their computer products" *has been* removed as this significantly limits the possibilities of companies (e.g. activities in the great Lakes Region that lead to responsible sourcing did not yet yield material output should also be able to qualify for this requirement).
- The scope is further specified (tin, tantalum, tungsten and their ores and gold).
- It is specified that applicants have to engage in activities that address at least one of the above listed materials.
- The definition of 'responsible sourcing projects' was further specified and encompasses projects carried out within the Democratic Republic of the Congo being in accordance with the widely recognised OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.
- The focus on the Democratic Republic of the Congo is justified by the fact that the DR Congo is the primary conflict region and the region where mineral mining and trading are closely linked to conflict. Although the other countries of

the Great Lakes Region are covered by relevant policy instruments (e.g. Dodd-Frank Act Section 1502), this has to do with fact that these countries might act as transit countries for smuggled ores from the DR Congo. Generally, it is widely recognised that a focus on the DR Congo has the highest development priority.

3.5.2.4 Stakeholder feedback and further evidence

Summary of stakeholder feedback
One Member State felt that declarations would be too weak to test this criterion. Moreover, another Member State felt that with the resources they have available they would not be able to verify and control this criterion. An industry stakeholder made a proposal that applicants should report on and publish a list of tantalum, tin, tungsten and gold smelters and refiners in its supply chain.

Towards an integrated EU approach

At the AHWG2 DG Trade outlined work by the Commission to address the Conflict-free sourcing for end-products containing tin, tantalum, tungsten and gold. The proposed approach is outlined in Joint Communication JOIN(2014)8 [157] which includes proposals for public procurement guidance.

Although the Communication highlights the significance of the OECD's Due Diligence guidance as a framework for action it cites fragmented compliance efforts, including a wide range of public and private initiatives, as well as the limited incentives to act as barriers to further progress.

A draft Regulation is proposed which would introduce a requirement for due diligence along the supply chain for EU importers, reflecting the approach promoted by the

[157] Joint Communication to the European Parliament and the Council on *Responsible sourcing of minerals originating in conflict-affected and high-risk areas: Towards an integrated EU approach*, JOIN(2014)8

OECD. It describes a responsible importer due diligence self-certification requirement linked to the establishment of a list of responsible smelters and refiners .

The Commission also proposes to broaden the geographical scope of conflict areas adopted under the Dodd Frank Act to any '*areas in a state of armed conflict, fragile post-conflict as well as areas witnessing weak or non-existing governance and security, such as failed states, and widespread and systematic violations of international law, including human rights abuses*.'

3.5.2.5 Third proposal for conflict-free minerals criterion

Third criteria proposal
5(b) Sourcing of 'conflict-free' minerals The applicant shall support the responsible sourcing of tin, tantalum, tungsten and their ores and gold from conflict-affected and high-risk areas by: (i) Conducting due diligence in line with the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas, and (ii) by actively supporting at least one on-the-ground-project promoting responsible mineral production and trade in accordance with OECD and EU guidance within conflict-affected and high-risk areas. ***Assessment and verification:*** The applicant shall declare the compliance with these requirements together with the following supporting information: • A report describing their due diligence activities along the supply chain for the four minerals identified, and • Descriptions of the project(s) they are engaged with, which of the four minerals are addressed and how they contribute to responsible sourcing.

Summary rationale for proposed changes

- Reflecting the Commission's proposed approach the criterion has been redrafted with a less geographically specific focus and with reference to the OECD guidance on Due Diligence.

3.6 Cluster 6 – Further criteria

3.6.1 Criterion 6.1 – Noise

Present criteria, Decisions 2011/337 and 2011/330
The 'Declared A weighted Sound Power Level' (re l pW) of the personal computer, in accordance with paragraph 3.2.5 of ISO 9296, shall not exceed (1) 40 dB (A) in the idle operating mode, (2) 45 dB (A) when accessing a hard disk drive. The 'Declared A weighted Sound Power Level' (re l pW) of the notebook computer system unit, in accordance with paragraph 3.2.5 of ISO 9296, shall not exceed (1) 32 dB (A) in the idle operating mode, (2) 36 dB (A) when accessing a hard disk drive. *Assessment and verification*: the applicant shall provide the competent body with a report, certifying that the levels of noise emissions have been measured in accordance with ISO 7779 and declared in accordance with ISO 9296. The report shall state the measured levels of noise emissions in both idle operating mode and when accessing a disk drive, which shall be declared in accordance with paragraph 3.2.5 of ISO 9296.

Table 27 provides an overview how different ecolabel criteria implement noise requirements.

Table 27: Existing noise requirements in ecolabel criteria

	EU Ecolabel	**Blue Angel**	**Nordic Swan**	**TCO**	**EPEAT**
Desktop PCs	• Idle operating mode: 40 dB (A) • HDD enabled: 45 dB (A)	• Idle operating mode: 38 dB (A) • HDD enabled: 42 dB (A) • Optical drive enabled: 50 dB (A)	• Idle mode: 38 dB (A) • Operating: 42 dB (A)	• Idle mode: 39 dB (A) • Operating mode: 44 dB (A) Valid for desktop PCs with integrated moving parts, such as motor driven HDD, fans etc. *If the product does not emit prominent discrete tones a higher declared A-weighted sound power level is accepted but shall not exceed* • Idle mode: 42 dB (A) • Operating mode: 47 dB (A)	No noise criteria at all
Notebook PCs including Tablet	• Idle operating mode: 32 dB (A) • Hard-disk	• Idle operating mode: 35 dB (A) • Hard-disk	• Idle mode: 35 dB (A) • Operating:	• Idle mode: 35 dB (A) • Operating mode: 39 dB (A)	No noise criteria at all

	EU Ecolabel	Blue Angel	Nordic Swan	TCO	EPEAT
PCs	drive enabled: 36 dB (A)	drive enabled: 40 dB (A) • Optical drive enabled: 48 dB (A) • Netbooks: The sound power levels of the netbook shall be reported for statistical purposes in accordance with ISO 7779.	40 dB (A) *Valid for Notebook PCs + Thin clients*	*Valid for notebook PCs with integrated moving parts, such as motor driven HDD, fans etc.* *If the product does not emit prominent discrete tones a higher declared A-weighted sound power level is accepted but shall not exceed* • Idle mode: 38 dB (A) • Operating mode: 42 dB (A)	

3.6.1.1 Major proposed changes (first proposal)

Proposed revised criteria (first proposal)

The 'Declared A weighted Sound Power Level' (re l pW) of the computer, in accordance with paragraph 3.2.5 of ISO 9296, shall not exceed

(1) in the idle operating mode (the measurement can be dropped if no fans are installed, e.g. CPU fans, power supply fans, computer system fans):
   a. 38 dB (A) for desktop computers,
   b. 32 dB (A) for notebook computers;

(2) when accessing a hard disk drive (the measurement can be dropped if no mechanical hard disk drive is installed):
   a. 42 dB (A) for desktop computers,
   b. 36 dB (A) for notebook computers;

(3) when optical drive enabled (the measurement can be dropped if no optical drive is installed):
   a. 50 dB (A) for desktop computers,
   b. 48 dB (A) for notebook computers.

Assessment and verification: the applicant shall provide the competent body with a report, certifying that the levels of noise emissions have been measured in accordance with ISO 7779 and declared in accordance with ISO 9296. The report shall state the measured levels of noise emissions in idle operating mode, when accessing a disk drive and when optical drive enabled (if applicable), which shall be declared in accordance with paragraph 3.2.5 of ISO 9296. In case of different configurations of identically constructed units the measurements have to be performed on the loudest individual components.

- Based on the most current Blue Angel ecolabel criteria for personal computers and notebook computers,
  - For personal computers the slightly stricter limit values have been taken;
  - For personal and notebook computers limit values for when an optical drive is enabled have been included.

- Exemptions have been included for the measurements in cases where fans, mechanical hard disk drives or optical drives are not installed.
- Regarding assessment and verification, in case of different configurations of identically constructed units the measurements shall be allowed to be performed on the loudest individual components to avoid measurements for each individual configuration.

3.6.1.2 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, the extra tests should not be a problem. There was concern that the lowering of some of the limit values could have very high costs, thus more market information was requested to support the case for stricter criteria.
Sound power should be expressed in sound power and measured in bells and not decibels. This causes confusion in the market (check ISO 9296 where the noise should be measured).

Written stakeholder feedback following the first AHWG meeting

- The proposal is supported by one of the stakeholders.
- Another stakeholder remarks that a lowering of the sound power level of 2 dB like from 40 to 38 is something that the human ear cannot detect but that requires more expensive components to be used in the PC. If deciding to go for stricter values this economic factor should be kept in mind.
- The proposed partly stronger limit values for noise are not supported by one of the stakeholders because: a) not too many products comply b) the lower levels are not appreciated in relation to the increased cost. Also, the desktops limits have been copied from the German Blue Angel, who currently only have one license. For Notebooks these limits are from the EU Ecolabel, at present no certified products. For the optical drive measurements: copied from Blue Angel, currently only one license. Not required according to applicable ECMA and ISO standards. Results in extra test cost, not justified for a rare operational mode. Suggest skipping (very few persons use the optical disk today). Finally,

according to applicable ISO and ECMA standards, sound power shall be expressed in Bel not Decibel.

- It is asked to check the 2010 version of ISO 7779 address that the noise level of an optical drive might be very dependent on the type of disc.
- One of the answering stakeholders disagrees with the argumentation of a certain stakeholder during the first AHWG meeting that lowering the A-Weighted Sound Power Level by 2 dB is not meaningful due to the following reasoning: Based on the document written by Professor Steven Errede, Department of Physics, University of Illinois at Urbana-Champaign, Illinois (The Human Ear Hearing, Sound Intensity and Loudness Levels) it is believed that "The Just Noticeable Difference (JND, in dB) in our human hearing is JND is on average - 0.5 dB. It varies between 1.4 and less than 0.4 (see graph on page 22). It changes depending on the frequency. An example of the noise spectrum of a cooling fan is provided[158]. Assuming that most of the noise is produced by the cooling fan and taking the exemplary noise spectrum into account, the Just Noticeable difference would be between 0.8 and 1 dB at 40dB. Against this background the stakeholder asked that it should be investigated if the existing criteria are strict enough. A Dutch study[159] is provided as further evidence which is proposed to give a good indication which levels are preferable in a work environment. It should be considered if it is necessary to set different levels for different types of computers. For example small scale servers (new in the scope), if not placed in the workspace, can produce more sound. Tablets generally don't make much noise so more strict criteria would be preferable. Workstations on the other hand are larger than small laptops. This means they can use a larger fan that can spin at a lower speed than small fans in small laptops.

[158] See http://en.wikibooks.org/wiki/Engineering_Acoustics/Noise_from_cooling_fans
[159] See http://www.nen.nl/pdfpreview/preview_126140.pdf

- The website Notebookcheck.net[160] is provided by one of the answering stakeholders as further evidence indicating noise emissions of different products. Next to the measurements there is always an appreciation given, which is proposed to be used as indication which noise levels are good. The table below gives an overview of the noise emissions of the tablets that have been reviewed in the above database.

Table 28: Further evidence provided by stakeholder feedback: Noise emissions of different Tablet computers (Source used: www.notebookcheck.net)

Model	Type	Noise Emission
Prestigio MultiPad PMP5080B	Tablet	Idle med: 0 dB(A)
Dell Streak 7	Tablet	Idle med: 0 dB(A)
Archos 101	Tablet	Idle med: 0 dB(A)
Viewsonic ViewPad 10s	Tablet	Idle med: 0 dB(A)
Apple iPAD	Tablet	Idle med: 0 dB(A)
Microsoft Surface Pro 2	Tablet	Idle med: 27 dB(A)
Samsung Galaxy Tab 10.1v	Tablet	Idle med: 27 dB(A)
Fujitsu Stylistic Q550	Tablet	Idle med: 27 dB(A)
Acer Iconia Tab A200	Tablet	Idle med: 27 dB(A)
Acer Iconia Tab W500 Keydock	Tablet	Idle med: 29.3 dB(A)
Fujitsu Stylistic Q572	Tablet	Idle med: 30.4 dB(A)
Samsung Series 7 XE700T1A-H01DE	Tablet	Idle med: 30.8 dB(A)
Asus Eee Slate EP121-1A013M	Tablet	Idle med: 31.4 dB(A)
Gigabyte S1080	Tablet	Idle med: 37.3 dB(A)
AVERAGE	***Tablet***	***19, 1dB (A)***

Table 29: Further evidence provided by stakeholder feedback: Noise emissions of different Workstations (Source used: www.notebookcheck.net)

Model	Type	Noise Emission
Dell Precision M4500 Core i7-940XM	Workstation	Idle med: 28.2 dB(A
Dell Precision M4600	Workstation	Idle med: 28.6 dB(A)
Dell Precision M4700	Workstation	Idle med: 30.7 dB(A)
Dell Precision M4800	Workstation	Idle med: 28.2 dB(A)
Dell Precision M6600	Workstation	Idle med: 29.6 dB(A)
Dell Precision M6700	Workstation	Idle med: 29.6 dB(A)

[160] See http://www.notebookcheck.net/Laptop-Search.8223.0.html#results

Model	Type	Noise Emission
Dell Precision M6800	Workstation	Idle med: 29.2 dB(A)
MSI GT60 0NG-405DE	Workstation	Idle med: 35.8 dB(A)
HP EliteBook 8470w B5W63AW-ABD	Workstation	Idle med: 32.4 dB(A)
HP Elitebook 8540w	Workstation	Idle med: 32.8 dB(A)
HP EliteBook 8560w-LG660EA	Workstation	Idle med: 33.3 dB(A)
HP EliteBook 8570w LY550EA-ABD	Workstation	Idle med: 32.9 dB(A)
HP EliteBook 8570w B9D05AW-ABD	Workstation	Idle med: 34.7 dB(A)
HP Elitebook 8740w 820QM/FX2800M	Workstation	Idle med: 33.4 dB(A)
HP EliteBook 8770w DreamColor	Workstation	Idle med: 32.7 dB(A)
Schenker XIRIOS W710	Workstation	Idle med: 37.6 dB(A)
Schenker XIRIOS W712	Workstation	Idle med: 36.8 dB(A)
MSI GT60 0NG-294US	Workstation	Idle med: 35.8 dB(A)
Lenovo Thinkpad W510 4319-29G	Workstation	Idle med: 34.1 dB(A)
Lenovo ThinkPad W520	Workstation	Idle med: 32.4 dB(A)
Lenovo ThinkPad W530-N1K43GE	Workstation	Idle med: 33.6 dB(A)
Lenovo Thinkpad W701 2500-2EG	Workstation	Idle med: 31.4 dB(A
Fujitsu Celsius H700	Workstation	Idle med: 35.1 dB(A)
Fujitsu Celsius H710 WXP11DE	Workstation	Idle med: 29.2 dB(A)
Fujitsu Celsius H920	Workstation	Idle med: 33.6 dB(A)
Toshiba Tecra S11-11H	Workstation	Idle med: 33.3 dB(A)
Average	**Workstation**	**32.5 dB(A)**

According to the stakeholder, if tablets were considered to be under the notebook noise emission limit within the EU Ecolabel, all but one would pass (limit 32dB). This is seen as a clear indication that the noise emission levels should be differentiated.

Further research and evidence

Difference between Sound Pressure Level and Sound Power Level

For noise emissions of products, two different indicators have to be distinguished[161]:

- **Sound Pressure Level**: A noise level or sound level is usually a sound pressure level, a measure of the small pressure fluctuations in the air superimposed on the normal atmospheric pressure. Noise levels produced by a machine or a piece of equipment can be easily measured with a sound level meter. The meter shows the sound pressure level at the measurement position. The sound level depends on how far away the meter is from the machine, and on the measuring environment. For example, is the machine outdoors, in a large room or in a small room, and does the room contain soft furnishings or are the walls hard and bare? This sound level is important because it relates to the loudness of the sound and to the potential damaging effect on hearing.
- **Sound Power Level**: A sound power level on the other hand is a measure of the total noise radiated by the machine in all directions. It is a property of the machine and is essentially independent of the measuring environment. Sound power levels are useful to equipment manufacturers, buyers, installers, and users for:
  - Calculating the sound pressure level from a machine, or several machines, at a given distance in a given environment, such as a factory, workshop, office or the home.
  - Comparing the noise output from different machines.
  - Setting specifications for the maximum permitted noise from a machine.
  - Comparing machines before and after modifications to reduce the noise.

These differences have to be carefully taken into account when discussing EU Ecolabel criteria and comparing benchmarks. For example, the examples of noise emissions for Tablets and Workstations provided above by written stakeholder feedback (cf. Table 28 and Table 29) are based on measuring the Sound *Pressure* Level[162] and thus not applicable for comparison with the proposed EU Ecolabel criteria which are based on Sound Power Level (it is not possible to calculate the

[161] Source: http://silent.se/pc/iso-9296.php

[162] Cf. Measurement method at http://www.notebookcheck.net/Our-Test-Criteria.15394.0.html

sound power level from just one sound pressure level value as sound power level is calculated based on many sound pressure level values).

Differences between bels (B) and decibels (dB)

Generally, a decibel is a tenth of a bel: 1 B = 10 dB. The ISO 9296 standard "Acoustics – Declared noise emission values of computer and business equipment" is used for declaration of acoustic noise emissions of information technology. It specifies reporting statistical maximum values of the A-weighted sound power levels in decibel; and to report measurements taken according to ISO 7779[163]. However, although ISO 9296 specifies reporting of A-weighted sound power levels (as well as sound pressure levels) in **decibel**, which most consumers are aware of as unit, the computer industry as only product group decided to declare sound power levels in bel to avoid confusion between decibels for sound power level and decibels for sound pressure level.

Benchmarks for noise emissions

An indicative research has been done if there are any computer products on the market fulfilling the proposed requirements at all. However, data on noise emissions (i.e. sound power level measured in accordance to ISO 7779) are not common information within the technical specifications of computer products. As the manufacturer HP provides a broad range of public available IT Eco declarations[164] for its products (Desktop PCs, Workstations, Notebook and Tablet PCs), the research has been focussed on those products assuming that products of other manufacturers have similar performances. The lists are non-exhaustive but provide a good overview that quite a large number of current models would be able to meet the requirements.

[163] The ISO 7779 standard, "Acoustics -- Measurement of airborne noise emitted by computers and business equipment", is the international accepted one used for measuring noise emissions from personal computer system units, hard disks and other storage media. Source: http://silent.se/pc/iso-9296.php

[164] Cf. http://www.hp.com/hpinfo/globalcitizenship/environment/productdata/iteconotebook-o.html; http://www.hp.com/hpinfo/globalcitizenship/environment/productdata/itecoworkstatio.html; http://www.hp.com/hpinfo/globalcitizenship/environment/productdata/itecodesktop-pc.html

Notebook PCs, Tablet PCs and Mobile Workstations

Especially for Notebook PCs, the existing criteria with 3.2 bel (idle mode) and 3.6 bel (operation mode) are the lowest compared to other ecolabelling schemes.

Table 30: Declared A-weighted sound power levels L_{WAd} (B) of a range of current HP notebook models (Source: HP IT Ecodeclarations)

Notebook (document date)	Idle Mode (benchmark: 3.2 bel)	Operating Mode (benchmark: 3.6 bel)
Compaq 14 Notebook PC (2013)	1.8	4.1
Compaq 14 Touchsmart Notebook PC (2013)	1.8	4.1
Compaq 15 Notebook PC (2014)	3.0	3.1
Compaq Mini CQ10 (2012)	2.6	2.6
Compaq Presario CQ45 (2012)	2.9	3.1
Compaq Presario CQ58 (2012)	2.8	3.3
HP SpectreXT (2012)	3.5	3.5
HP 1000 Notebook PC (2012)	2.9	3.1
HP 14 Notebook PC (2013)	1.8	4.1
HP 15 Notebook PC (2014)	3.0	3.1
HP 2000 Notebook PC (2012)	2.8	3.3
HP 215 G1 Notebook PC (2013)	3.3	3.3
HP 240 G2 Notebook PC (2013)	1.8	4.1
HP 242 G1 Notebook PC (2013)	2.52	2.7
HP 250 G3 Notebook PC (2014)	3.0	3.1
HP 255 G3 Notebook PC (2014)	2.5	2.5
HP 350 G1 Notebook PC (2014)	2.6	3.1
HP Elitebook 820 G1 Notebook PC (2013)	2.96	3.13
HP Elitebook 840 G1 Notebook PC (2013)	3.3	4
HP Elitebook 850 G1 Notebook PC (2013)	3.27	4.03
HP Elitebook 8770w Mobile Workstation (2013)	3.3	3.9
HP Elitebook Folio 1040 G1 Notebook PC (2013)	2.8	2.8
HP Elitebook Revolve 810 G2 Notebook PC (2013)	2.9	2.9
HP ElitePad 1000 G2 (2014)	2.0	2.0
HP ElitePad 900 (2014)	2.6	2.6
HP Envy 14 Sleekbook (2013)	3.4	3.4
HP Envy m6 Notebook PC (2014)	3.4	3.9
HP Pavilion 10 Notebook PC (2014)	3	3.2
HP Pavilion 17 TouchSmart Notebook PC (2014)	2.7	2.7
HP Pavilion Chromebook 14 PC (2013)	3.4	3.4
HP ProBook 450 G1 Notebook PC (2013)	3.2	3.2

Notebook (document date)	Idle Mode (benchmark: 3.2 bel)	Operating Mode (benchmark: 3.6 bel)
HP Split 13x2 Notebook PC (2013)	3.0	3.3
HP ZBook 17 Mobile Workstation (2013)	2.9	2.9

Desktop PCs, Integrated Desktop PCs and Workstations

For Desktop PCs, the first proposal for revised noise criteria has been aligned to the stricter requirements of the ecolabel Blauer Engel (idle mode: 3.8 instead of current 4.0 bel; operation mode: 4.2 instead of current 4.5 bel).

Table 31: Declared A-weighted sound power levels L_{WAd} (B) of a range of current HP desktop models (Source: HP IT Ecodeclarations)

Desktop PC (document date)	Idle Mode (proposed: 3.8 bel)	Operating Mode (proposed: 4.2 bel)
Compaq 18 All-in-One PC (2014)	3.4	3.5
HP 110 Desktop PC / Compaq 100 Desktop PC (2014)	3.82	4.03
HP 18 All-in-One PC (2014)	3.4	3.5
HP 19 All-in-One PC (2014)	3.5	3.5
HP 20 All-in-One PC (2014)	3.5	3.5
HP 200 G1 MT Business PC (2014)	3	4
HP 202 G1 MT Business PC (2014)	3.4	3.5
HP 205 G1 All-in-One Business PC (2014)	3.43	3.45
HP EliteDesk 800 G1 Ultra-slim Desktop Business PC (2013)	3.6	3.6
HP EliteDesk 880 G1 Tower Business PC (2013)	3.6	3.6
HP Envy 700 Desktop PC (2013)	3.92	4.35
HP Envy Phoenix 810 Desktop PC (2014)	4	4.1
HP Pavilion 21 TouchSmart All-in-One PC (2014)	2.8	2.9
HP Pavilion 500 Desktop PC (2014)	3.5	3.9
HP Pavilion Slimline 400 Desktop PC (2013)	3.45	4.24
HP Pavilion23 All-in-One PC (2014)	2.8	2.9
HP ProDesk 400 G1 Microtower Business PC (2013)	3.7	3.6
HP ProDesk 485 G1 Microtower Business PC (2013)	4.0	4.1
HP ProDesk 600 G1 Tower Business PC (2013)	3.6	3.6
HP ProOne 400 G1 AiO Business PC (19.5” Non-Touch) (2014)	3.6	3.6
HP ProOne 400 G1 AiO Business PC (21.5” Touch) (2014)	3.2	3.3
HP Z1 Workstation G2 (2014)	2.96	3.2
HP Z230 SFF Workstation (2014)	3.3	3.3
HP Z230 Tower Workstation (2014)	3.3	3.3
HP Z620 Workstation (2012)	3.3	3.9

3.6.1.3 Second proposal for noise criteria

Proposed revised criteria (second proposal)
The 'Declared A weighted Sound Power Level' (re l pW) of the computer, in accordance with paragraph 3.2.5 of ISO 9296, shall not exceed (a) For desktop computers including integrated desktop computers and workstations i. Idle Mode: 3.8 bel (the measurement can be dropped if no fans are installed, e.g. CPU fans, power supply fans, computer system fans) ii. Operation mode: 4.2 bel (the measurement can be dropped if no mechanical hard disk drive is installed) (b) For notebook computers including tablet computers and mobile workstations i. Idle mode: 3.2 bel (the measurement can be dropped if no fans are installed, e.g. CPU fans, power supply fans, computer system fans) ii. Operating mode: 3.6 bel (the measurement can be dropped if no mechanical hard disk drive is installed) *Assessment and verification*: The applicant shall provide the competent body with a test report, certifying that the levels of noise emissions have been measured in accordance with ISO 7779. The report shall state the measured sound power levels in idle and operating mode, which shall be declared in accordance with paragraph 3.2.5 of ISO 9296. In case of different configurations of identically constructed units the measurements have to be performed on the loudest individual components.

Major proposed changes

- Small scale servers are not covered by this requirement as it is assumed that they will generally be located in a separate room with no permanent workplaces.
- Thin Clients are indirectly excluded from this requirement as they are constructed with no fans or hard disks so that they do not create background noise emissions being typical for PCs.
- It is proposed to declare the measured sound power levels in Bel not Decibel as being common practice in ICT industry to avoid confusion between decibels for sound power level and decibels for sound pressure level.
- The optical drive measurement has been deleted as optical drives today are rarely and/or only for short, definite periods used (e.g. for installation purposes)
- The limit values of the first revised criteria proposals have been kept in the second proposal as indicative market research showed they can be reached by a number of products.

3.6.1.4 Stakeholder feedback and further evidence

Summary of stakeholder feedback
The were differing views of the technical improvement potential of the proposal. A lowering of the sound power level of 2 dB is something that the human ear cannot detect but that requires more expensive components to be used in the PC. If the decision is made to go for stricter values then this economic should be kept in mind. The need to differentiate the performance for products with a wide range of possible noise levels, such as tablets, was again highlighted.

3.6.1.5 Third proposal for noise criteria

Third criteria proposal
6(a) Noise The 'Declared A weighted Sound Power Level' (re l pW) of the computer, in accordance with paragraph 3.2.5 of ISO 9296, shall not exceed: a) For desktop computers including integrated desktop computers and workstations i. Idle Mode: 3.8 bel ii. Operation mode: 4.2 bel b) For notebook computers including tablets, two-in-one computers and mobile workstations i. Idle mode: 3.2 bel ii. Operating mode: 3.6 bel The requirements shall not apply to Idle mode if no fan is installed (e.g. CPU fans, power supply fans, computer system fans) or to Operating mode if no mechanical hard disk drive is installed. ***Assessment and verification:*** The applicant shall provide the competent body with a test report, certifying that the levels of noise emissions have been measured in accordance with ISO 7779. The report shall state the measured sound power levels in idle and operating mode, which shall be declared in accordance with paragraph 3.2.5 of ISO 9296. In case of different configurations of identically constructed units the measurements have to be performed on the loudest individual components.

Summary rationale for proposed changes

- It is proposed to retain the April v2 proposal unchanged as it is considered to require low noise products, as evidenced by data analysed from models of HP who are understood to have invested in noise reduction.

- It is considered that the criterion already contains sufficient differentiation for tablet products given that those products without fans or mechanical (rotating) hard drives are excluded from part (b)
- It is to be discussed by the EUEB whether this criterion should be retained given the introduction of new criterion more directly addressing life cycle impacts of computer products e.g. product durability and reliability.

3.6.2 Criterion 6.2 – Ergonomics

Currently, there are no fitness for use criteria associated with the EU Ecolabel. TCO Certified 2012 for Desktops, Notebooks, All-in-One PCs and Tablet PCs as well as TCO Certified Displays contain criteria regarding visual ergonomics (image detail, luminance, luminance contrast, reflection and screen colour) and work load ergonomics (inter alia vertical tilt and vertical height for AiO-PCs); the Nordic Swan ecolabel aligns to TCO Displays and Notebooks criteria with regard to ergonomics and includes some own requirements for tablet PCs.

Consultation questions
• Should the EU ecolabel for computers include criteria for (visuable and/or workload) ergonomics, e.g. aligning them to the TCO criteria?

3.6.2.1 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting, it was felt that the TCO criteria could form a good starting point and if the criteria proposal is adopted then harmonisation with TCO would be preferable. The cost benefits of certain criteria require careful consideration. This criteria area could be more relevant to GPP, where people are using computers for longer hours.

Written stakeholder feedback following the first AHWG meeting:

- Aligning criteria for ergonomics to TCO Development criteria is recommended as the criteria and test methods are very established, transparent and relevant.
- The proposal is supported under the condition that it should be made 100% identical with TCO 6.0 including a mutual recognition agreement.
- Ergonomics criteria can be introduced but if we want to give impulse to this EU Ecolabel product group it is asked not to align too much to other private labels which are more known and widespread than the EU Ecolabel in this sector and that could, at the end, be preferred by the applicants instead of the Ecolabel just because better known on the market and maybe because they require less number of criteria to comply with.

3.6.2.2 Proposal for ergonomics criteria

Despite stakeholders' feedback generally agreeing to add requirements on ergonomics, aligning them to TCO criteria, the study team decided in the view of a large number of further relevant criteria not to include a new criterion on ergonomics to the product group computers.

3.6.3 Criterion 6.3 – Emission of fluorinated GHG during LCD production

3.6.3.1 First proposal for fluorinated GHG criteria

Proposed new criterion (first proposal)
Fluorinated GHG emission during LCD production Computers with integrated LCD panel must be produced in a way that the fluorinated greenhouse gases NF_3 and SF6, if part of the production process, are abated by a system that is an integrated part of the production process. *Assessment and verification*: The applicant shall declare the compliance with these requirements and shall additionally provide a description of the implementation process at suppliers/sub-contractors (i.e. LCD panel makers) to the competent body.

Fluorinated greenhouse gases (GHG) are among the most potent and persistent GHG contributing to global climate change; they are relevant in the manufacture of semiconductors, light emitting diodes and LCD flat panel displays. As it is currently difficult to set product-related criteria addressing these emissions (difficulties in comparing panel suppliers' F-GHG emissions due to a lack of consistency in estimating emissions, estimating emissions reductions, and in monitoring the efficacy of installed abatement systems), within the EU ecolabel revision a process oriented approach is therefore proposed, based on a proposal in the current revision of the Nordic Ecolabelling criteria for television displays.

For more details cf. Task 4 report “Improvement Potential”, section 4.2.5.2.2 “Minimizing the use of F-gases in the production”.

3.6.3.2 Stakeholder feedback

According to the discussions of stakeholders at the first AHWG meeting, the problem of the availability of data and consistency was briefly discussed. However, the discussion was mainly put on hold for the Televisions and Displays AHWG. Written feedback following the first AHWG meeting of one of the stakeholders indicates support of the inclusion of this criterion.

3.6.3.3 Second proposal for fluorinated GHG criteria

In the view of a large number of further relevant criteria, the study team decided not to include a new criterion on fluorinated greenhouse gases to the product group computers.

3.7 Cluster 7 – Information

3.7.1 Criterion 7.1 – User instructions

Present criteria, Decisions 2011/337 and 2011/330
The [personal computer and computer display] / [notebook computer] shall be sold with relevant user information that provides advice on its proper environmental use. The information shall be located in a single, easy-to-find place in the user instructions as well as on the manufacturer's website. The information shall include in particular: (a) Energy consumption: TEC value in accordance with Energy Star v5.0, as well as the maximum power demand in each operating mode. In addition, instructions must be provided on how to use the devices energy-saving mode; (b) Information that energy efficiency cuts energy consumption and thus saves money by reducing electricity bills and that unplugging your [personal computer or computer display] / [notebook computer] reduces energy consumption to zero; (c) The following indications on how to reduce power consumption when the [personal computer and/or computer display] / [notebook computer] are not being used: (i) Putting the [personal computer and computer display] / [notebook computer] into off mode will reduce energy consumption but will still draw some power; (ii) Reducing the brightness of the screen will reduce energy use; (iii) Running the disk fragmentation on the [computer] / [notebook computer] will reduce energy use and increase the life of your [personal computer] / [notebook computer] (this is not applicable to solid state device machines); (iv) Screen savers can stop [personal computer monitors] / [notebook displays] from powering down into a lower power mode when not in use. Ensuring that screen savers are not activated on [computer monitors] / [notebook computers] can therefore reduce energy use; (d) Information should be included in the user instructions or the manufacturer's website to let the user know where to go to obtain professional repairs and servicing of the [personal computer and/or computer display] / [notebook computer], including contact details as appropriate; (e) End-of-life instructions for the proper disposal of [personal computers and/or computer displays] / [notebook computers] at civic amenity sites or through retailer take-back schemes as applicable, which shall comply with Directive 2002/96/EC of the European Parliament and of the Council. (f) Information that the product has been awarded the EU Ecolabel with a brief explanation as to what this means together with an indication that more information on the Ecolabel can be found at the website address http://www.ecolabel.eu (g) Any instruction/repair manual(s) should contain recycled content and should not contain chlorine bleached paper. *Assessment and verification*: the applicants shall declare the compliance of the product with these requirements to the competent body.

3.7.1.1 Major proposed changes (first proposal)

Proposed revised criteria (first proposal)

The computer shall be sold with relevant user information that provides advice on its proper environmental use. The information shall be located in a single, easy-to-find place in the user instructions as well as on the manufacturer's website. The information shall include in particular:

(a) Energy consumption: TEC value in accordance with Energy Star v6.0, as well as the maximum power demand in each operating mode. In addition, instructions must be provided on how to use the device's energy-saving mode;

(b) Information that energy efficiency cuts energy consumption and thus saves money by reducing electricity bills and that unplugging your computer reduces energy consumption to zero;

(c) The following indications on how to reduce power consumption when the computer is not being used:

  (i) Putting the computer into off mode will reduce energy consumption but will still draw some power;

  (ii) Reducing the brightness of the screen will reduce energy use;

  (iii) Periodically applying the computer's disk defragmentation function will reduce energy use and increase the lifetime of the computer (this is not applicable to solid state device machines);

  (iv) Screen savers can stop computer displays from powering down into a lower power mode when not in use. Ensuring that screen savers are not activated on computer displays can therefore reduce energy use;

  (v) Charging tablet computers via USB-interface by another desktop or notebook computer might increase the energy consumption in case of leaving the desktop or notebook computer in an energy-consuming idle-mode for the sole reason of charging the tablet computer.

(d) Information that extension of the computer's lifetime reduces the overall environmental impacts.

(e) The following indications on how to prolong the lifetime of the computer[165]:

  (i) Information to let the user know the factors influencing the lifetime of batteries as well as instructions for the user facilitating its prolongation (only applicable to mobile computers powered with rechargeable batteries).

  (ii) Clear instructions in form of a repair manual to enable replacing of key components for upgrades or repair.

  (iii) A list of available spare parts with current prices.

  (iv) Information to let the user know where to go to obtain professional repairs and servicing of the computer, including contact details as appropriate;

  (v) Clear instructions to enable a permanent deletion of personal data from the computer to facilitate a possible second hand usage.

(f) End-of-life instructions for the proper disposal of computers, including separate instructions for the proper disposal of rechargeable batteries, at civic amenity sites or through retailer take-back schemes as applicable, which shall comply with Directive 2012/19/EU of the European Parliament and of the Council.

(g) Information that the product has been awarded the EU Ecolabel with a brief explanation as to what this means together with an indication that more information on the Ecolabel can be found at the website address http://www.ecolabel.eu

(h) Any instruction/repair manual(s) should contain recycled content and should not contain chlorine bleached paper.

Assessment and verification: the applicants shall declare the compliance of the product with these requirements to the competent body.

[165] Depending on the final decision on sub-criteria in section 3.3

- Aligning the information on energy consumption with the most current Energy Star version taken as basis for the energy criteria.
- Information that charging tablet computers via the USB-interface of another desktop or notebook computer can increase the energy consumption in case of leaving the desktop or notebook computer in idle-mode for the sole reason of charging the tablet computer.
- Inclusion of information requirements including detailed instructions for the extension of the computer's lifetime.
- Inclusion of information requirements regarding the proper disposal of rechargeable batteries

3.7.1.2 Stakeholder feedback and further evidence

According to the discussions of stakeholders at the first AHWG meeting…
Written stakeholder feedback following the first AHWG meeting ask to check if there is any evidence to indicate that the benefits of periodically running disc fragmentation outweigh the energy use in doing so.
The proposal discussed at the AHWG meeting to include guidance not to charge tablets using a notebook USB port or USB port from desktop computers is supported.
The requirement for recycled content in instruction/repair manuals may have unintended consequences (e.g. prevent the use of an alternative media than paper)

3.7.1.3 Second proposal for user instructions criteria

Proposed revised criteria (second proposal)
"User instructions" The computer shall be sold with relevant user information that provides advice on its proper environmental use. The information shall be located in a single, easy-to-find place in the user instructions as well as on the manufacturer's website. The information shall include in particular: (a) Energy consumption: TEC value in accordance with Energy Star v6.0, as well as the maximum power demand in each operating mode. In addition, instructions must be provided on how to use the device's energy-saving mode; (b) Information that energy efficiency cuts energy consumption and thus saves money by reducing electricity bills and that unplugging your computer reduces energy consumption to zero; (c) The following indications on how to reduce power consumption when the computer is not being used: (i) Putting the computer into off mode will reduce energy consumption but will still draw some power; (ii) Reducing the brightness of the screen will reduce energy use;

(iii) Screen savers can stop computer displays from powering down into a lower power mode when not in use. Ensuring that screen savers are not activated on computer displays can therefore reduce energy use;

(iv) Charging tablet computers via USB-interface by another desktop or notebook computer might increase the energy consumption in case of leaving the desktop or notebook computer in an energy-consuming idle-mode for the sole reason of charging the tablet computer.

(d) Information that extension of the computer's lifetime reduces the overall environmental impacts.

(e) The following indications on how to prolong the lifetime of the computer:

(i) Information to let the user know the factors influencing the lifetime of batteries as well as instructions for the user facilitating its prolongation (only applicable to mobile computers powered with rechargeable batteries).

(ii) Clear disassembly and repair instructions to enable a non-destructive disassembly of products for the purpose of replacing key components or parts for upgrades or repairs.

(iii) Information to let the user know where to go to obtain professional repairs and servicing of the computer, including contact details as appropriate. Service should not be limited exclusively to applicant's Authorized Service Providers.

(f) End-of-life instructions for the proper disposal of computers, including separate instructions for the proper disposal of rechargeable batteries, at civic amenity sites or through retailer take-back schemes as applicable, which shall comply with Directive 2012/19/EU of the European Parliament and of the Council.

(g) Information that the product has been awarded the EU Ecolabel with a brief explanation as to what this means together with an indication that more information on the Ecolabel can be found at the website address http://www.ecolabel.eu

(h) Any print-versions of instruction/repair manual(s) should contain recycled content and should not contain chlorine bleached paper. To save resources, online versions should be preferred.

Assessment and verification: The applicants shall declare the compliance of the product with these requirements to the competent body and shall provide a link to the online-version or a copy of the user instructions / repair manual to the Competent Body.

Major proposed changes

- The criterion on applying the disk defragmentation function has been removed as increasingly the operating system and HDD/SSD are organising the data management by themselves.
- The provision of a list of available spare parts with current prices has been deleted as this has not been seen as practicable by stakeholders (cf. 3.3.5)
- The requirement on clear instructions to enable a permanent deletion of personal data from the computer to facilitate a possible second hand usage has been deleted; cf. section 3.3.6 on data deletion.
- Sub-criterion (h) has been specified regarding print-versions with additional advice to prefer online versions of repair manuals to save resources.

  The assessment / verification have been amended by the provision of a copy and/or link to the user instructions.

3.7.2 Criterion 7.2 – Information appearing on the Ecolabel

Present criteria, Decisions 2011/337 and 2011/330
Optional label with text box shall contain the following text: '- high energy efficiency - designed to facilitate recycling, repair and upgrading - mercury-free backlights (if computer displays)'. *Assessment and verification*: the applicant shall declare the compliance of the product with this requirement, and shall provide a copy of the Ecolabel as it will appear on the packaging and/or product and/or accompanying documentation to the competent body.

3.7.2.1 Major proposed changes (first proposal)

Proposed revised criterion (first proposal)
Optional label with text box shall contain the following text: '- high energy efficiency - mercury-free backlights (if the product contains an LED display) - designed to be more durable and upgradeable - designed to facilitate recycling.' *Assessment and verification*: the applicant shall declare the compliance of the product with this requirement, and shall provide a copy of the Ecolabel as it will appear on the packaging and/or product and/or accompanying documentation to the competent body.

- Explicit focus on extended lifetime (formerly repair and upgrading) with distinguishment between the aspects of lifetime and recycling.

3.7.2.2 Stakeholder feedback and further evidence

Written stakeholder feedback following the first AHWG meeting proposes that responsible sourcing (related to 5.2) and social responsibility (related to 5.1) could also be mentioned in the optional statements.

3.7.2.3 Second proposal for information appearing on the Ecolabel

Proposed revised criterion (second proposal)
Optional label with text box shall contain the following text: - high energy efficiency - mercury-free backlights (if the product has an LED display) - designed to have a longer lifetime - designed to be easy to recycle - *contains xy% post-consumer recycled content (only when being higher than 25%)* *Assessment and verification*: the applicant shall declare the compliance of the product with this requirement, and shall provide a copy of the Ecolabel as it will appear on the packaging and/or product and/or accompanying documentation to the competent body.

3.7.2.4 Third proposal for information appearing on the Ecolabel

Proposed revised criterion (third proposal)
Optional label with text box shall contain the following text: - High energy efficiency - Designed to have a longer lifetime - Avoidance of hazardous chemicals - Designed to be easy to recycle - *Contains xy% post-consumer recycled plastic (only when greater than 25%)* Assessment and verification: the applicant shall declare the compliance of the product with this requirement, and shall provide a copy of the Ecolabel as it will appear on the packaging and/or product and/or accompanying documentation to the competent body.