EU Ecolabel/GPP revision: Computers hazardous substance screening exercise

Draft v2: 28/04/14

1. Summary screening matrix for hazardous substances in computers

Substance group	Where can it be found in the product?		Current hazard benchmarks	Proposed substitution benchmarks	Proposed restrictions
	Component	**Sub-component**			
S1. Flame retardants	Printed Circuit Boards	S1.1 Motherboard S1.2 Memory modules (RAM) S1.3 Graphics card (VD RAM)	○ Tetrabromobisphenol (TBBPA) (H410, P or vP) CAS No. 79-94-7.	○ Dihydrooxaphosphaphenanthrene (DOPO) CAS No 35948-25-5. ○ Aluminium hydroxide (ATH) CAS No 21645-51-2. ○ Fyrol PMP (Aryl Alkylphosphinate) CAS No. *not available*. ○ Aluminium or zinc salts of diethylphosphinic acid (AlPi, ZnPi) with Melamine Polyphosphinate synergist.	*Not identified*
	CPU and GPU's	S1.4 CPU/GPU chip set and cooling system	*Pending stakeholder feedback*	*Pending stakeholder feedback*	*Pending stakeholder feedback*
	Electrical/data connections	S1.5 Internal connectors and switches	○ Ethane bis (pentabromophenyl) (EBP) CAS No 84852-53-9 with Antimony Trioxide synergist CAS No 1309-64-4 ○ Ethylene 1,2 bis(tetrabromophthalimide) (EBTBP) CAS No 32588-76-4	○ Melamine cyanurate + phosphorus synergist: CAS No 15541-60-3. ○ Aluminium or zinc salts of diethylphosphinic acid (AlPi, ZnPi) with Melamine Polyphosphinate synergist. ○ Magnesium hydroxide (MDH) CAS No.1309-42-8.	*Not identified*
		S1.6 Power supply unit and transformer (internal/external) S1.7 External power cables	*Pending stakeholder feedback*	*Pending stakeholder feedback*	*Pending stakeholder feedback*
	Drives	S1.8 Data storage drives (HDD or SSD) and optical drives	*Pending stakeholder feedback*	*Pending stakeholder feedback*	*Pending stakeholder feedback*
	Housing	S1.9 External casing	○ Tetrabromobisphenol (TBBPA) (H410, P or vP) CAS No. 79-94-7. ○ Ethane bis (pentabromophenyl) (EBP) CAS No 84852-53-9 with Antimony Trioxide synergist CAS No 1309-64-4	○ Triphenyl phosphate (CAS 115-86-6). ○ Resorcinol Bis (Diphenyl Phosphate) (CAS 57583-54-7). ○ Bisphenol A Bis (diphenyl Phosphate) (CAS No. 5945-33-5) ○ RDX: Resorcinol bis(2,6-dixylenyl phosphate) CAS No. 139189-30-3.	*Not identified*
S2. Plasticisers	**Cables and power packs**	S2.1 External power cables and power packs	○ DEHP (CAS No. 117-81-7) ○ BBP (CAS No.85-68-7) ○ DBP (84-74-2)	○ DIDP CAS No. 26761-40-0. ○ DINP CAS No. 28553-12-0. ○ Trioctyl trimetallate (TOM/TOTM) CAS No. 3319-31-1 ○ Dioctyl terephthalate (DOTP) CAS No.6422-86-2.	○ DEHP, BBP, DBP, DIBP, DMEP, DIPP, DPP, DnPP and DnHP shall not be present in external cables and power packs. ○ Medium Chained Chlorinated Paraffins (MCCP's) Alkanes C14-17 shall not be present in external cables and power packs.
	Casing material	S2.2 External casing	*Pending stakeholder feedback*	*Pending stakeholder feedback*	*Pending stakeholder feedback*
	Wiring	S2.3 Internal wiring			
S3. Plastic stabilisers	**External cables**	S3.1 External soft plastics	○ Lead stabiliser has now been entered onto the Candidate List.	○ Feedback is requested on relevant stabiliser formulations given the hazard profile of Calcium acetylacetonate, which includes H361 (sub-classification to be confirmed).	○ Lead shall not be present in external cables, wires and connecting cords at or greater than 300 ppm.
S4. Plastic colorants	**External casings**	S4.1 Plastic casings, power packs, cables and peripherals (keyboard and mouse)	○ Information is pending from a major pigment and dye manufacturer.	*No specific initiatives identified*	○ Colourants containing lead, chromium VI and cadmium, including those included in the Candidate List, shall not be used. ○ Pigments and dyes used to colour ABS shall be colour fast. Expert input is required to specify this condition.
S5. Biocides in plastic and rubber	**Peripheral devices**	S5.1 Keyboards, mice, trackpads and external cables	*Pending stakeholder feedback*	*Pending stakeholder feedback*	○ Biocides intended to provide a hygiene (anti-bacterial) function shall not be added to keyboards and peripherals.
	External cables	S5.2 Soft plastics	○ Triclosan (CAS No. 3380-34-5)	*Pending stakeholder feedback*	*Pending stakeholder feedback*
S6. Plastic contaminants	**External casings and rubber**	S6.1 Plastic or rubber that may be in prolonged skin contact	○ The German Federal Institute for Risk Assessment has identified 16 PAHs as Category 1B carcinogens	*No specific initiatives identified*	○ The 18 listed Polycyclic Aromatic Hydrocarbons (PAHs) shall not be present in the external surfaces of notebooks and tablets; peripheral keyboards, mice, stylus and trackpads; external power cables.
S7. Electrical contacts and connectors	**PWB and cable contacts**	S7.1 Soldered joints	○ It is understood from OEM feedback that the standard industry solders are tin, copper and silver.	*No specific initiatives identified*	○ RoHS exemption 7b for solder in small-scale servers shall not be granted to ecolabelled computers ○ 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).

		S7.2 Electrical contacts	*Pending stakeholder feedback*	*Pending stakeholder feedback*	○ RoHS exemption 8b shall not be granted to ecolabelled computers
	External connectors	S7.3 External connectors and sockets	○ Beryllium oxide (CAS No. 1304-56-9)	*Pending stakeholder feedback*	*Pending stakeholder feedback*
S8. Thermal conductors	**CPU and GPU**	S8.1 Ceramic heat conducting elements	○ Beryllium oxide (CAS No. 1304-56-9)	*No specific initiatives identified*	○ Beryllium and its compounds shall not be used in parts at concentrations greater than 0.1%
S9. Coolants	**CPU and GPU fans**	S9.1 Cooling system	*Not identified as being commonly used.*	*No specific initiatives identified*	○ Refrigerants in cooling systems shall not be classified as Ozone Depleting Substances (H420) or Controlled substances under the Montreal Protocol.
S10. Battery electrolytes	**Notebook or tablet batteries**	S10.1 Lithium ion and polymer batteries	○ Ethylene carbonate (CAS No. 96-49-1) ○ Dimethyl carbonate (CAS No.616-38-6), ○ Diethyl carbonate (CAS No.105-58-8).	*No substitution required*	*No restrictions identified*
S11. Metal chassis and enclosures	**Steel structures, casings and parts**	S11.1 Steel chassis, enclosures and external parts	○ Nickel (CAS No. 7440-02-0) ○ Stainless steel is used predominantly in desktop computers for the chassis, but may also be used in the external casing.	*No substitution required*	○ 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. ○ The proposed derogation shall be accepted where nickel is required to provide the necessary workability and corrosion protection for the chassis and enclosures.
	External casings	S11.2 Metallic coatings	*Pending stakeholder feedback*	*Pending stakeholder feedback*	○ Hexavalent chromium shall not be present in metallic coatings applied to parts of a computer.
S12. Screen glass fining agents	**Display screen**	S12.1 Glass screen (where specified)	○ Arsenic trioxide additive (CAS No. 1327-53-3)	○ An alternative process technology avoids the use of arsenic trioxide additives (CAS No. 1327-53-3) in order to fine the 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.
S13. Liquid crystals in displays	**TFT LCD unit**	S13.1 Metal additives in colour filters and other parts of the LCD unit	○ Mo/MoOx is used in thin films Molybdenum trioxide MoO_3 (Cas No. 1313-27-5)	*Pending stakeholder feedback*	*Pending stakeholder feedback*
S14. LED doping and luminescence	**LED backlights in screen**	S14.1 Semi-conductor diode and chip	○ Gallium arsenide *(GaAs)* (CAS. 1303-00-0) ○ Gallium Nitride (GaN) (CAS. 25617-97-4)	○ *Given the importance of LED's to achieving low energy performance and the fundamental role of gallium arsenide and other gallium compounds it is proposed that:* - *subject to confirmation of its % concentration within the LED part, a derogation is considered,* - *that the potential to minimise workforce exposure is explored further, and* - *Potential variations in gallium content based on chip dimensions shall also be explored*	*Substances are essential to function*
		S14.1 Luminescent material	○ Benchmarking of the luminescent substances is to be carried out	*Substances are essential to function*	*Substances are essential to function*
S15. Excluded components	**Throughout product**	S15.1 Screws, clips, fixings, adhesive strips	○ Parts weighing less than 25g are proposed to be exempted from the hazardous substance criteria	n/a	n/a

2. Main screening and evidence collection matrix

Component or sub-component	Functional need and substances currently used	Best practice identified		Summary evaluation of evidence to support hazard substitution options
		Substitutions made by industry	**Mandatory and voluntary restrictions**	
Substance group 1. Flame retardants				
S1.1 Motherboard S1.2 Memory modules (RAM) S1.3 Graphics card (VD RAM)	Epoxy resin PCB's with glass fibre reinforcement are required to meet the FR-4 fire retardant classification (Standard UL 94 V0) *Current hazard benchmark:* ○ Tetrabromobisphenol (TBBPA) (H410, P or vP) CAS No. 79-94-7. Status: Harmonised classification of H400,H410	The restriction of lead solders by RoHS has led to base materials with higher thermal stability to be used. It is understood that manufacturers have used this opportunity to investigate less hazardous flame retardant formulations. Literature suggests that some technical problems still remain to the use of substitutes in desktop, workstation and servers [1] but for notebook product lines in particular leading manufacturers already claim to have moved to 'low halogen' specifications, as defined by iNEMI [2] and IEC 61249-2-21 [3]. However, details of the specific flame retardants now used and their hazard profile compared to the baseline FR-4 compliant chemistry is not readily available. iNEMI claimed that by the end of 2011 *'a list of approved alternative H [Halogen] FR-free PCB materials that are qualified and, thus, available for use in the design and specification of new products'* would be available [4]. The majority of substitute (halogen-free) flame retardants now used by industry are understood to be reactive phosphorus-based or additive combinations of a phosphorus FR with aluminium trioxide or other inorganic fillers. DOPO is understood to be the main substitute used by computer manufacturers, with a 6-7% market share. *Proposed substitution benchmark:* ○ Dihydrooxaphosphaphenanthrene (DOPO) CAS No 35948-25-5. Status: 74 notifications in C&L Inventory suggest that it is not classified but data gaps exist for Acute Toxicity and CMR hazards. The US EPA generally classifies it as a low hazard (EU Ecolabel no hazard) with the exception of aquatic toxicity (EU Ecolabel Group 3) - The US EPA PCB study highlights the hazard profile of unreacted DOPO resin which may therefore require control during production of the laminate.	*Candidate List substances* Hexabromocyclododecane (HBCDD) (CAS No. 25637-99-4 and 3194-55-6) is an ECHA Candidate List substance (28/10/08). HBCDD is an IEC 62474 Declarable Substance and is understood not to be used anymore by the industry. *REACH Article 57 substances* Of the priority list of substances identified in the EU's Strategy for Endocrine Disruptors substances of relevance were identified from stakeholder feedback as being: ○ Tetrabromodiphenyl ether (CAS No. 5436-43-1), a congener of PBDE which is restricted under RoHS, ○ 2,2-bis-(4-(2,3-epoxypropyl)phenyl)propane (CAS No.1675-54-3) is a precursor used in the manufacture of PCB laminates. *Ecolabel restrictions* The successful label TCO restricts FR's according to their hazard classification. FR's classified with the following hazards are restricted: H340, H341, H350, H350i,H351, H360F, H360D, H361d, H361f, H362, H372, H373, H400 and H410, H411 Printed wiring board laminates, certain electronic components and all kinds of cable insulation are exempted.	*US EPA DfE study* The USA EPA established a partnership through their design for the environment programme to evaluate flame retardants in printed circuit boards. Eight FR's were evaluated using x environmental and human health end-points. Reaction products for three of the FR's were also evaluated. Whilst the two alternative phosphorus-based reactive FR's have an improved hazard profile compared to TBBPA their reaction products have more significant human health effects for a number of end-points and are persistent in the environment. Of the additive FR's evaluated all are associated with additional adverse human health impacts, particularly silicon dioxide in amorphous and crystalline forms. Five out of the eight FR's are also persistent in the environment. *EU ENFIRO project* A number of potential substitutes are identified by the non-halogenated flame retardant association PINFA. It is understood that these have been subject to hazard assessment as part of the EU funded ENFIRO project. The following FR's have been identified as 'generally safe' in a range of applications: ○ Aluminium diethylphosphinate (Alpi), ○ Aluminium hydroxide (ATH), ○ Ammonium polyphosphate (APP), ○ Melamine polyphosphate (MPP), ○ Dihydrooxaphosphaphenanthrene (DOPO), ○ Zinc stannate (ZS), ○ Zinc hydroxstannate (ZHS) Of these Alpi, MPP, ATH and DOPO were also evaluated by the US EPA study. The other alternatives are understood to be of less market relevance. *Additional substitution benchmarks:* ○ Aluminium hydroxide (ATH) CAS No 21645-51-2. Status: Status: 1263 entries in C&L Inventory suggest that it is not classified. Evidence in the Joint REACH dossier is conclusive and not enough for classification. EFRA claim they are not suitable for portable devices [5]. ○ Fyrol PMP (Aryl Alkylphosphinate) CAS No. *not available*. Status: Not registered. The US EPA and ENFIRO assessed the substance as being of low hazard, having a similar profile to DOPO with the exception of being persistent. - The resin reaction product has a similar profile to that of DOPO ○ Aluminium or zinc salts of diethylphosphinic acid (AlPi, ZnPi) with Melamine Polyphosphinate synergist. Status: Pre-registration of AlPi. 18 entries in the C&L Inventory suggest that the synergist is not classified. The US EPA suggests that AlPi has a favourable hazard profile.
S1.4 CPU and GPU chip sets and cooling system	See S1.5 for the cooling system structure	It is understood that by some manufacturers have required CPU's to fulfil the iNEMI and IEC 61249-2-21 halogen free status [6]. Intel detail their initiatives to design halogen free chipsets, moving from the use of brominated FR's in solder resist, build-up and the core to, it is understood, metal hydroxides [7]. It is understood that FR is incorporated into the plastic structure of the cooling unit, and that major chipset manufacturers as illustrated by AMD and Intel product claims [8]. It is not clear the extent to which this is also addressed by OEM's specifying that CPU's are halogen free.		See S1.5 for the cooling system structure. More information is required on the alternatives now used for the three main components of the chipset, although it is understood that metal hydroxides may be used.

S1.5 Internal connectors and switches	Preventation of smoke from burning cables requires compliance with UL 94 V0 or V1 fire safety (EN 61440). In addition Glow Wire and Glow Wire Ignition tests according to EN 60065-2-11 must be complied with. *Current hazard benchmark:* ○ Ethane bis (pentabromophenyl) (EBP) CAS No 84852-53-9 (353 notifications, H413) with Antimony Trioxide synergist CAS No 1309-64-4 (Harmonised classification, H351). *It is noted by the US EPA as being Very Persistent.* ○ Ethylene 1,2 bis(tetrabromophthalimide) (EBTBP) CAS No 32588-76-4. Status: 19 notifications in the C&L Inventory state that it is not classified. *Also with Antimony Trioxide synergist.*	The extent to which OEM's have specified FR chemistry for internal connectors and switches is not clear. Feedback has not been received to date on this specific sub-component.		A range of connectors and switches may be present within the internal components of a computer. These include terminal blocks, insulated connectors, socket connectors and PWB connectors. A range of potential FR's are identified by EFRA, PINFA and the ENFIRO project as being used in thermoplastics associated with connectors. Flexibility is required because of the range of possible plastics that may be used, including Polybutylene Terephthalate (PBT), Nylon 6 and 6,6, Polyethylene Terephthalate (PET) and polyolefines, and the technical characteristics they must display. *Proposed hazard benchmarks (dependant on the polymer):* ○ Melamine cyanurate + phosphorus synergist: CAS No 15541-60-3. Status: 18 notifications in the C&L Inventory state non-classification. The US EPA suggest that it is persistent. ○ Aluminium or zinc salts of diethylphosphinic acid (AlPi, ZnPi) with Melamine Polyphosphinate synergist. Status: Pre-registration of AlPi. 18 entries in the C&L Inventory suggest that the synergist is not classified. The US EPA suggests that AlPi has a favourable hazard profile. ○ Magnesium hydroxide (MDH) CAS No.1309-42-8. Status: 413 entries in the C&L Inventory suggest that it is not classified. The US EPA suggests that AlPi has a favourable hazard profile.
S1.6 Power supply unit and transformer (internal/external)	See S1.5	The extent to which OEM's have specified FR chemistry for power supply units is not clear. Feedback has not been received to date on this specific sub-component.		See S1.4
S1.7 External power cables	Prevention of smoke from burning cables requires compliance with UL 94 V0 or V1 fire safety. *Current hazard benchmark:* ○ Use of PVC, which is an inherently flame retardant material, as the material for the cable sheath. Ethane bis (pentabromophenyl) (EBP) (H413) with Antimony Trioxide (H351) is also used. ○ Phosphate FR's may also be added which are classified under DSD as H410: - IPPP, CAS No. 28108-99-8 - TXP, CAS No 25155-23-1 - TCP, CAS No 1330-78-5	PINFA detail the state-of-the-art in the use of metal hydroxides including aluminium hydroxide (ATH), aluminium oxide hydroxide (AOH) and magnesium hydrovide (MDH), which are stated to be the most significant to the cable industry [9]. Intumescent systems based on phosphate chemistry are also identified as having been adopted by industry. The benefits of these FR systems are understood to include a substantial reduction in smoke when compared to halogenated FR's. Their disadvantage is understood to be the high concentrations and fill required. The substitutes available will depend on the chosen material for the cable sheath. Metal phosphinates are detailed as solutions for Thermoplastic Elastomers (TPE's), co-polyester elastomers and thermoplastic urethanes. The addition of nitrogen synergists such as melamine cyanate and melamine polyphosponate can be used to improve performance to IL94 V0. It is noted, however, that combinations of Antimony Trioxide with brominated FR's may still be required in some TPE cables. The cases in which there may be a requirement for this combination are to be identified. *Proposed hazard benchmarks:* ○ Aluminium hydroxide (ATH) CAS No 21645-51-2. Status: Status: 1263 entries in C&L Inventory suggest that it is not classified. Evidence in the Joint REACH dossier is conclusive and not enough for classification. ○ Ammonium polyphosphonate (APP) CAS No. 68333-79-9. Status: 319 entries in the C&L Inventory suggest that it is not classified. ○ Magnesium hydroxide (MDH) CAS No.1309-42-8. Status: 413 entries in the C&L Inventory suggest that it is not classified.		Summary analysis of the comparative performance of relevant substitutes identified can also be found under the printed circuit boards headings. The nitrogen synergists used are to be identified in order to complete the evaluation.
S1.8 Data storage drives (HDD or SSD) and optical drives	See S1.1 – 1.3 and S1.9	It is understood that drives have been required by some manufacturers to fulfil the iNEMI and IEC 61249-2-21 halogen free status. The major HDD manufacturers have halogen-free product lines but further information is needed on the focus for substitution – PWB or casing.		See S1.1 – 1.3 and S1.9

S1.9 External casing	Casings are specified to meet a UL 94 V1, EN 60065-7 FR-4 or equivalent fire protection rating. This cannot be achieved by using inherently fire retardant polymers alone. *Current hazard benchmark:* ○ Tetrabromobisphenol (TBBPA) (H410, P or vP) CAS No. 79-94-7. Status: Harmonised classification of H400,H410 ○ Ethane bis (pentabromophenyl) (EBP) CAS No 84852-53-9 (353 self-notifications, H413) with Antimony Trioxide synergist CAS No 1309-64-4 (Harmonised classification, H351)	ABS, steel or aluminium are commonly used for desktop form factors. PC/ABS blends, aluminium or magnesium alloys are used for notebook casings. Substitute FR's that are understood to be used by major manufacturers include the following aromatic phosphate esthers [10]: ○ TPP: Triphenyl Phosphate CAS No. 115-86-6 ○ RDP: Resorcinol Bis (Diphenyl Phosphate) CAS No. 57583-54-7 ○ BDP (BPADP): Bisphenol A Bis (Diphenyl Phosphate) CAS No.5945-33-5 ○ RDX: Resorcinol bis(2,6-dixylenyl phosphate) CAS No. 139189-30-3 *Closed loop recycling of halogenated FR's* A number of studies have been reported in which the function of flame retardants subject to restrictions or phase-out may be re-used where they are contained in recycled plastic such as PC/ABS and HIPS/PPE [11]. Given concerns relating to dioxin and furan formation, as well as the re-utilisation of critical raw materials such as antimony, this may be a preferable route to landfilling or incineration. *Proposed substitute benchmarks:* ○ Triphenyl phosphate (CAS 115-86-6) Status: Self-notifications in the C&L Inventory indicate classification with H400 and H410. ○ Resorcinol Bis (Diphenyl Phosphate) (CAS 57583-54-7). Status: 60 self-notifications in the C&L Inventory indicate classification with H412. 34 self-notifications indicate no classification. ○ Bisphenol A Bis (diphenyl Phosphate) (CAS No. 5945-33-5) Status: Harmonised classification with H413 however the opinion of RAC is that it should be declassified. ○ RDX: Resorcinol bis(2,6-dixylenyl phosphate) CAS No. 139189-30-3. Status: Harmonised classification with H413. An anti-dripping agent PTFE at 0.5% w/w is required in order to meet a VO fire rating. PTFE may be manufactured using PFOA (CAS No 335-67-1) and production residue may remain. *A condition could therefore be considered, but the potential to verify this along the supply chain would need to be examined.*	*ECHA Candidate List substances* Hexabromocyclododecane (HBCDD) (CAS No. 25637-99-4 and 3194-55-6) is an ECHA Candidate List substance (28/10/08). HBCDD is an IEC 62474 Declarable Substance and is understood not to be used anymore by industry. *Endocrine Disruptors of relevance* Of the priority list of substances identified in the EU's Strategy for Endocrine Disruptors resorcinol (CAS No.10846-3) is a precursor and breakdown product of the FR RDP (CAS No. 57583-54-7). *Ecolabel hazard restrictions* The successful label TCO restricts FR's according to their hazard classification. FR's classified with the following hazards are restricted: H340, H341, H350, H350i, H351, H360F, H360D, H361d, H361f, H362, H372, H373, H400, H410, H411 The following FR's are additionally not permitted in plastic parts weighing more than 25 grams: ○ Antimony(III) oxide (Sb2O3), CAS: 1309-64-4 ○ Tri-o-cresyl phosphate, CAS: 78-30-8 It is to be noted that although some literature identifies the following as potential substitutes the following FR's are likely to be restricted in the next version of TCO Certified due to their hazard classifications: ○ Zinc borates (CAS: 138265-88-0) ○ Triphenyl phosphate (CAS: 115-86-6) ○ Sodium toluene-4-sulphonate (CAS: 657-84-1) ○ Bis phenolA bis (biphenyl) phosphate (CAS: 181028-79-5) ○ (1-methylethylidene)di-4,1- phenylenetetraphenyl diphosphate (CAS: 5945-33-5) ○ Tri-cresyl phosphate (CAS: 1330-78-5) ○ Cresyl diphenyl phosphate (CAS: 26444-49-5) ○ Resorcinol bis (diphenyl diphosphate) (CAS: 57583-54-7) *OEM antimony restriction* Antimony trioxide FR and synergist (CAS No.1309-64-4) classified with H351 is restricted by a number of OEM's at concentrations greater than 0.1%. ATO is normally used as a synergist in combination with halogenated flame retardants such as EBP. With substitution of brominated FR's by OEM's it is therefore less likely to be used. Derogation of ATO as a FR synergist has been accepted in two other EU Ecolabel product groups for non-skin contact applications based on functional need, a lack of suitable alternatives and evidence submitted by the International Antimony Association.	*EU ENFIRO project* A number of potential substitutes for FR's of concern such as TBPPA have been identified by the non-halogenated flame retardant association PINFA. It is understood that these have been subject to hazard assessment as part of the EU funded ENFIRO project. The following FR's have been identified as 'generally safe': ○ Aluminium diethylphosphinate (Alpi), ○ Aluminium hydroxide (ATH), ○ Ammonium polyphosphate (APP), ○ Melamine polyphosphate (MPP), ○ Dihydrooxaphosphaphenanthrene (DOPO), ○ Zinc stannate (ZS), ○ Zinc hydroxstannate (ZHS) RDP and BDADP were additionally identified as being of 'some concern for potential environment and humans'. A significant reduction in the durability of PC/ABS was also identified for phosphorus FR combinatinons. Alpi, ATH, APP, MPP and ZS were evaluated by a US EPA study of alternatives to decaBDE in enclosures [12]. The US EPA study indicates reduced hazards relating to developmental, neurological and developmental end-points as well as persistence and bio-accumulation in the environment. *Plastic TV enclosure Green Screen assessment of RDP and BPADP* Whilst the previously referred to PINFA guide to substitute flame retardants lists four potential alternatives, the US EPA study and a recent Green Screen assessment of UL96 V0 compliant plastic casing FR's suggests that decisions relating to the alternatives are more complex [13]. The Green Screen assessment (2007) illustrates the challenge. The assessment compared decaBDE with bisphenol A diphosphate (BPADP) and resorcinol bis(diphenylphosphate) (RDP). For each alternative the separate ingredients together with potential breakdown products were assessed. BPADP consists of three ingredients: ○ 85% phosphoric acid, (1-methylethylidene)di-4,1-phenylene tetraphenyl ester (CAS No. 5945-33-5), ○ 11% phosphoric acid, bis[4-[1-[4-[(diphenoxyphosphinyl)oxy]phenyl]-1-methylethyl]phenyl] phenyl ester (CAS No. 83029-72-5), ○ <3% triphenyl phosphate (CAS No. 115-86-6). The breakdown products phenol (CAS No.108-95-2) and bisphenol A (CAD No.80-05-07) and diphenylphosphate (CAS No.838-85-7) were also assessed. RDP consists of three ingredients: ○ 65-80% phosphoric acid, 1,3-phenylene tetraphenyl ester (CAS No. 57583-54-7), ○ 15-30% phosphoric acid, bis[3-[(diphenoxyphosphinyl) oxy]phenyl] phenyl ester (CAS No. 98165-92-5), and ○ <5% triphenyl phosphate (CAS No. 115-86-6) The breakdown products phenol (CAS No.108-95-2) and resorcinol (CAS No.108-46-3) and diphenylphosphate (CAS No. 838-85-7) were also assessed. The two alternatives were assessed to have a very similar Benchmark profile, with the two main ingredients both assessed as Benchmark 2 (based on the then harmonised classification of H413 for the main ingredient of BPADP and Self-notification of H412 for the main ingredient of RDP) and for the third ingredient Benchmark 3 with self-notifications in the C&L Inventory suggest H400 and H410. It should be noted that the RAC has adopted an opinion that BPADP should be declassified as H413. With reference to possible breakdown products, both FR's are associated with phenol (Benchmark 2) and diphenylphosphate (not enough data to benchmark, no relevant self-classifications in the C&L Inventory) whilst RDP is associated with resorcinol (Benchmark 3) and BPADP with Bisphenol A (Benchmark 1). Bisphenol A has a harmonised EU classification of H361f. In conclusion, whilst RDP's main ingredient is of higher concern than BPADP, BPADP can result in a Benchmark 1 breakdown product, albeit of lesser concern than those of decaBDE (penta and octaBDE). The conditions under which the breakdown product may become present will therefore be important in decision-making.
Substance group 2: Plasticisers				

S2.1 External power cables and power packs	Plasticisers provide the flexibility and durability required for power cables. Extenders may be added in order to enhance the effect of plasticisers. *Current hazard benchmarks:* ○ DEHP (CAS No. 117-81-7) Status: ECHA Candidate List, H360FD ○ BBP (CAS No.85-68-7) Status: ECHA Candidate List, H360Df, H400, H410 ○ DBP (84-74-2) Status: ECHA Candidate List, H360Df, H400	*Phthalate substitutes* OEM's have substituted the low molecular weight phthalates DEHP, BBP and DBP. The substitutes identified as having been used are Trioctyl trimetallate (TOM/TOTM) CAS No. 3319-31-*1 and dioctyl terephthalate (DOTP) CAS No.6422-86-2* [14]. *It is understood that these two substitutes provide the same functionality and are now used across all products by at least one OEM.* The high molecular weight phthalates DIDP and DINP were also identified by an OEM as being substitutes. *A Green Screen assessment for a partnership involving OEM's and their supply chain suggests that other substitutes may be being considered (see evidence column). More information is required from stakeholder OEM's on their use in computer models sold in the EU.* *Phthalate-free TPE plastics* *Alternatives to the use of PVC for wires and cabling have been approved for use in electronic equipment*, for example thermoplastic elastomers (TPE). These alternatives are not understood to require the addition of phthalate plasticisers [15]. An example is the co-polyester Arnitel XG (CAS No. 9078-71-1). No information could be found on comparative technical performance of thermoplastic substitutes although it is understood that a number of the alternatives meet the UL 62 requirements for wiring and cabling. A streamlined cradle to grave LCA comparing PVC with two alternatives – a 'bio-based' plastic and TPE - suggests that there may be a trade-off in the case of TPE between a reduction in hazardous monomers and additives and higher energy requirements for manufacturing [16], although the power cable is not a significant contributor to the overall environmental impact of computer products. *Proposed substitute benchmarks:* ○ DIDP CAS No. 26761-40-0. Status: 100 notifications in the C&L Inventory indicate no classification. 85 notifications indicates classifications of either H400, H400/H410 or H411. ○ DINP CAS No. 28553-12-0. Status: 796 notifications in the C&L Inventory indicate no classification. 23 notifications indicates classifications of H400/H410 ○ Trioctyl trimetallate (TOM/TOTM) CAS No. 3319-31-1 Status: Notifications (353) in the C&L Inventory suggest that it is not classified, but a small number of notifications indicate either H361 (50) with no specific effect identified or H413 (6) ○ Dioctyl terephthalate (DOTP) CAS No.6422-86-2. Status: The majority of notifications in the C&L Inventory (168) suggest that it is not classified.	*ECHA Candidate List entries* The low molecular weight phthalates DEHP, BBP and DBP were included in the ECHA Candidate List on 28/10/08 and are IEC 62474 Declarable Substances. DIBP was included in ECHA's Candidate List on 13/01/10. DEHP, BBP and DIBP has been proposed for inclusion in Annex II of the RoHS Directive 2011/65/EU [17]. The phthalates DMEP, DIPP, DPP, DnPP and DnHP have been included in the ECHA Candidate List and are IEC 62474 Regulated Substances. *REACH Annex XVII restrictions* The high molecular weight phthalates DIDP, DINP and DNOP are listed in IEC 62474 as Regulated Substances with a sum concentration limit of 0.1%. They are restricted under REACH Annex XVII for use only in children's toys and childcare articles. *OEM Medium Chained Chlorinated Paraffins declaration* Medium Chained Chlorinated Paraffins (MCCP's) Alkanes C14-17 are declared by a number of OEM's at 1000 ppm. Classifications include H362 and H410. They are understood to be used in combination with DEHP [18]. Their continued requirement as an extender in combination with substitute plasticisers is to be verified. *Proposed restriction:* ○ 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.	A Green Screen assessment has been carried out of the hazard profile of potential substitutes for DEHP [19]. DEHP was assessed as a benchmark 1 substance. The verified results for TOM/TOTM and DOTP indicate a difference in their hazard profile but data gaps mean that their final benchmark scores are inconclusive: ○ Whilst TOM/TOTM did not fulfill the requirements for Benchmark 1 there was insufficient data to conclude on Benchmark 2 status. Data gaps related to carcinogenic and endocrine properties. ○ Whilst DOTP fulfilled the requirements for Benchmark 4 there were still data gaps, because of which it was given a Benchmark 3 score. Data gaps related to neurotoxicity and respiratory sensitivity. Of the other two verified assessments Diisononyl cyclohexanedi carboxylate (CAS No. 166412-78-8) was Benchmark 2 on the basis of its endocrine activity and whilst Bis(2- ethylhexyl) azelate (CAS No.103-24-2) did not fulfill the requirements for Benchmark 1 and there was insufficient data to conclude on Benchmark 2 status. Data gaps related to carcinogenic and endocrine properties. Three other potential substitutes were assessed but the results were not verified, with information about two remaining confidential.
S2.2 External casing	It is understood that plasticisers are not required in casing materials such as ABS, HIPS and PC.	The use of phthalates in external casing does not appear to have been a focus for substitution by OEM's. An OEM restricted substance list indicates that restrictions on the use of phthalates shall not apply to post-consumer recycled plastic content [20].		
S2.3 Internal wiring	Plasticises and stabilisers are functional additives as for external power cables.	See S2.1 – Application of the proposed hazard benchmark will depend on whether internal wiring is to be within the scope of the criteria.	See S2.1 – Application of the proposed restrictions will depend on whether internal wiring is to be within the scope of the criteria.	See S2.1
Substance group 3. Plastic stabilisers				
S3.1 External soft plastics	Stabilisers are required to prevent the photo-oxidation of polymers. *Current hazard benchmark:* ○ Lead stabiliser has now been entered onto the Candidate List.	Substitute stabilisers based on calcium/zinc and organotin compounds are understood to be available and used [21]. The most significant in the market is understood to be the combination of Calcium acetylacetonate (self-classifications include H361, H311 and H331) and Zinc acetylacetonate (self notifications suggest no relevant classifications) [22]. *Proposed substitute benchmarks:* ○ Feedback is requested on relevant stabiliser formulations given the hazard profile of Calcium acetylacetonate, which includes H361 (sub-classification to be confirmed).	*ECHA Candidate List entry* Lead stabilisers were included in a group of lead compounds in the ECHA Candidate List on 19/12/12 and are IEC 62474 Declarable Substances. *OEM lead stabiliser restrictions* OEM lists set concentration limits below the RoHS limit for homogenous materials of 0.1%. A limit of 0.03% is set for PVC external cables, wires and connecting cords. This includes peripherals such as mice. *Proposed restriction:* ○ Lead shall not be present in external cables, wires and connecting cords at or greater than 300 ppm. *A test method is proposed to be specified.*	

Substance group 4. Plastic colorants				
S4.1 Plastic casings, power packs, cables and peripherals (keyboard and mouse)	Colour is required to give the plastic a uniform tone and make the product attractive to the consumer. *Current hazard benchmark:* ○ Information is pending from a major pigment and dye manufacturer.	No information could be found on the pro-active substitution of pigments by OEM's. Discussion within the hazardous substance sub-group confirmed that colourants have not yet been addressed by OEM's.	*REACH Annex XVII restrictions and ECHA Candidate List entries for metal-based pigments.* Traditionally inorganic pigments with metal chromophores have been used to dye opaque plastics. REACH Annex XVII and the Candidate List contain restrictions on specific inorganic pigments, mainly based on their metal content. These include antimony, lead, chromium VI and cadmium. Azo colourants that cleave to carcinogenic aromatic amines are restricted under REACH Annex XVII. It is understood that these may be used to achieve uniform coloration of transparent plastics. *ECHA call for evidence on cadmium pigments* A recent call for information by ECHA on the use of cadmium highlights concerns relating to the ongoing use of metals that are of high concern in articles [23]. Cadmium is currently restricted in REACH Annex XVII for use to colour PVC and HIPS. If pigments are considered to require screening for hazards the contact will be required with pigment manufacturers who are leading in hazard substitution e.g. Clariant, BASF. However, it has been emphasised by OEM's the verification would be very difficult. *Proposed restrictions:* ○ Colourants containing lead, chromium VI and cadmium, including those included in the Candidate List, shall not be used. ○ Pigments and dyes used to colour ABS shall be colour fast. Expert input is required to specify this condition.	Different parts of the product casing may have different colours depending on the product range and target market. Depending on the type of plastic organic dyes or inorganic pigments may be used [24]. Inorganic pigments are stable, insoluble and have very limited potential for migration from a polymer matrix. Organic pigments and soluble organic dyes are used to achieve greater colour ranges and uniformity but have greater potential, depending on the type of plastic, for migration. High performance organic (solvent) pigments are used for ABS because the butadiene rubber content creates the potential for migration. It is advised by a major chemical manufacturer that such dyes should be tested for potential migration before use with ABS. Only selected organic and inorganic pigments and polymer soluble dyes can be used with PC.
Substance group 5. Biocides in plastic and rubber				
S5.1 Keyboards, mice, trackpads and external cables	Given the trend for longer periods of time to be spent in front of a computer keeping keyboards and peripherals hygienic has arisen. Some OEM's are therefore now offering keyboards and peripherals that incorporate anti-bacterial agents[25].		*OEM biocide restrictions* The biocide triclosan (CAS No. 3380-34-5) with a harmonised classification of H400 and H410 is restricted in some OEM restriction lists at a concentration limit of 10 mg/kg (10 ppm). A major OEM restricts the use of nanosilver biocidal treatments. *Proposed restrictions:* ○ Biocides intended to provide a hygiene (anti-bacterial) function shall not be added to keyboards and peripherals.	
S5.2 Soft plastics	Soft plastics may require biostatic or biocidal protection. *Current hazard benchmark:* ○ Triclosan (CAS No. 3380-34-5) with a harmonised classification of H400 and H410		*OEM biocide restrictions* The biocide triclosan (CAS No. 3380-34-5) with a harmonised classification of H400 and H410 is restricted in some OEM restriction lists at a concentration limit of 10 mg/kg (10 ppm).	Biocides may be added to protect PVC. These may include organostannic substances and triclosan. Further feedback is required on their functional need and the specific biocides used.
Substance group 6. Plastic contaminants				
S6.1 Plastic or rubber that may be in prolonged skin contact	PAH's do not have a functional role. They may be present as contaminants in extenders and carbon black in plastics and man-made rubber. Extenders are used in the manufacturing of plastics such as ABS, PP and man-made rubber. *Current hazard benchmark:* ○ The German Federal Institute for Risk Assessment has identified 16 PAHs as Category 1B carcinogens		*REACH XVII PAH restriction* PAHs were currently restricted in Annex XVII of REACH for use in tyres. Further restrictions on PAHS in consumer products came into force on the 6th December 2013 as an amendment to Annex XVII [26] . The PAHs restricted are: ○ Benzo[a]pyrene, ○ Benzo[e]pyrene, ○ Benzo[a]anthracene, ○ Chrysen, ○ Benzo[b]fluoranthene, ○ Benzo[j]fluoranthene, ○ Benzo[k]fluoranthene ○ Dibenzo[a,h]anthracene, The restriction states that *'Articles shall not be placed on the market for supply to the general public, if any of their rubber or plastic components that come into direct as well as prolonged or short-term repetitive contact with the human skin or the oral cavity, under normal or reasonably foreseeable conditions of use, contain more than 1 mg/kg (0,0001 % by weight of this component)'.*	The German Federal Institute for Risk Assessment identified 16 PAHs based on risk assessments by the US EPA. The PAHs are identified as Category 1B carcinogens of high concern where there exists the potential for skin and dermal absorption by consumers [27]. An analysis of a sample of consumer products was carried out. This indicated that guidance levels for these PAH's may be being exceeded.

			It is not clear the extent to which this would apply to only those parts of an electronic products with repeated skin contact (e.g. a keyboard, mouse, touch pad of palm rest). *OEM PAH restrictions* A number of OEM's identify lists of PAHs in their restriction lists. Up to 18 PAHs are identified in OEM restriction lists, some at higher concentration limits of 10-20 mg/kg and with sum concentration limits. These lists identify *all external surfaces* that have the potential for skin contact by consumers. Internal parts are derogated. Additional restrictions are as follows: Acenaphthene 83-32-9 Acenaphthylene 208-96-8 Anthracene 120-12-7 Benzo[ghi]perylene 191-24-2 Fluoranthene 206-44-0 Fluorene 86-73-7 Indeno[1,2,3-cd]pyrene 193-39-5 Naphthalene 91-20-3 Phenanthrene 85-01-8 Pyrene 129-00-0 *Proposed restrictions:* ○ 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	
Substance group 7. Electrical contacts and connectors				
S7.1 Soldered joints	Soldered joints are required to fuse together wiring joining cables and circuity in electronic products *Current hazard benchmark:* ○ It is understood from OEM feedback that the standard industry solders are tin, copper and silver.	The RoHS Directive has led to the substitution of lead in solder applications. Other metals such as bismuth, indium and antimony are, based on feedback from OEM's, not understood to be used or were previously present as contaminants in lead.	*RoHS restrictions and exemptions* The use of lead solder is restricted under RoHS although there are time-limited exemptions that are relevant to the product group and which are reflected in OEM chemical lists. Exemptions that appear to have relevance to the product group comprise the following uses: ○ An alloying agent in steel, aluminium and copper (expires July 2016); ○ Solder in servers (expires July 2016); ○ In dielectric ceramic materials in capacitors (expires July 2016). According to Article 5 of the Directive these exemptions may be subject to extension but for the purposes of the EU Ecolabel any derogation would depend on the status of substitutes. Feedback suggests that the solder in servers exemption is likely to sunset and so is not required. *Antimony OEM restrictions and derogations* Antimony is restricted by a number of OEM's at concentrations greater than 0.1% with the exception of antimony metal (CAS No. 7440-36-0) in tin-lead solders for integrated circuits at concentrations 0.12-2.4% [28]. *Proposed restrictions and exemptions:* ○ RoHS exemption 7b for solder in small-scale servers shall not be granted to ecolabelled computers ○ 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).	

S7.2 Electrical contacts	Cadmium may be required in specific electrical contacts (see RoHS exemption 8b). No information could be found on the extent to which cadmium has been substituted in electrical contacts, or any technical variation there may be between different forms of contacts.		*RoHS exemption for review* RoHS exemption 8b which has a five year time limit until it is to be reviewed is identified in OEM restriction lists. No concentration limit is specified. Feedback is that it is no longer required and the exemption will sunset. *Proposed restriction:* ○ RoHS exemption 8b shall not be granted to ecolabelled computers	
S7.3 External connectors and sockets	Connectors that are subject to continuous use require resilient connection interfaces. This is particularly the case with the trend towards miniaturisation. *Current hazard benchmark:* ○ Beryllium oxide (CAS No. 1304-56-9) has a harmonised classification with H301, H330, H350i and H372.	Beryllium is no longer understood to be used in external connectors used in computers such as USB, VGA and HDMI.	*OEM beryllium restrictions and derogations* Beryllium and its compounds are listed in a number of OEM hazardous substance management lists. These lists reflect Beryllium oxide's listing within IEC 62474 as 'for information only' at concentrations of greater than 0.1%. In a number of OEM's it is stated that beryllium compounds shall not be used but this requirement is derogated for applications of beryllium copper (CAS No.11133-98-5) as there is 'no suitable alternative'.	The greatest risk of exposure to associated with beryllium compounds is understood to relate to processing of the beryllium metal. This could potentially form the basis for a derogation condition if it is demonstrated that there is no substitutes for beryllium for this required function. *However, feedback to date is that it is no longer relevant to this product group.*
Substance group 8. Thermal conductors				
S8.1 Ceramic heat conducting elements	Substances with a high dielectric strength and thermal conductance are required to carry heat away from processing units. *Current hazard benchmark:* ○ Beryllium oxide (CAS No. 1304-56-9) Status: Harmonised classification with H301, H330, H350i and H372.		*OEM beryllium restrictions and derogations* Beryllium and its compounds are listed in a number of OEM hazardous substance management lists. These lists reflect Beryllium oxide's listing within IEC 62474 as 'for information only' at concentrations of greater than 0.1%. In a number of OEM's it is stated that beryllium compounds shall not be used but this requirement is derogated for ceramic heat conducting applications as there is 'no suitable alternative'. *Proposed restriction:* ○ Beryllium and its compounds shall not be used in parts at concentrations greater than 0.1%	It is not understood to be used generally in large heat sinks for computers with the exception of high end servers. It may, however, be used in a range of small component devices such as voltage regulators, diodes and switches. If used it would be present at <0.1% in individual small parts. The weight of these parts relative to the proposed 25g threshold is to be investigated further. The greatest risk of exposure is understood to relate to the processing of the beryllium metal. In a ceramic form it is inert during the use phase of the product.
Substance group 9. Coolants				
S9.1 Cooling system	In some desktop computers heat pipes which contain refrigerants are used to conduct away heat from processing units.		*Internationally restricted ODS substances* Ozone Depleting Substances (H420) are restricted under the international Montreal Protocol and subsequent regulatory initiatives taken by the EU. Controlled substances are listed in Regulation (EC) 1005/2009 on substances that deplete the ozone layer. It is understood that working fluids of the kind used in some desktop heat pipe systems [29] or small scale server cooling systems are likely to be of limited relevance to the product group. *Proposed restriction:* ○ Refrigerants in cooling systems shall not be classified as Ozone Depleting Substances (H420) or Controlled substances under the Montreal Protocol.	
Substance group 10. Battery electrolytes				
S10.1 Lithium ion and polymer batteries	Batteries with high power density are required for portable applications. The electrolyte is a fundamental part of battery electrochemistry. *Current hazard benchmarks:* ○ Ethylene carbonate (CAS No. 96-49-1) ○ Dimethyl carbonate (CAS No.616-38-6), ○ Diethyl carbonate (CAS No.105-58-8). Notifications in the C&L Inventory for these substances do not suggest that they are classified with relevant hazards, although they are highly flammable.		*ECHA Candidate List entries* A number of possible electrolytes have been entered onto the ECHA Candidate List, including three glycol ether compounds (see IEC 62474 screening). Examination of their ECHA Annex XV Dossiers does not suggest they are relevant to the product group. Polymer electrolytes are also understood to be used in slim form factors such as tablets and ultrabooks but their hazard profile is to be verified [30].	
Substance group 11. Metal chassis and enclosures				

S11.1 Steel chassis, enclosures and external parts	Nickel is used to provide additional corrosion protection for stainless steel. Nickel and/or nickel compounds may be present in various steel parts of a computer – internally and externally.		*OEM nickel restrictions* Nickel (CAS No. 7440-02-0) has harmonised classifications of H317, H373, H351 and H412. Stainless steel is used predominantly in desktop computers for the chassis, but may also be used in the external casing. A number of OEM restriction lists refer to the threshold for migration threshold for nickel in REACH Annex XVII (27). The REACH restriction relates mainly to skin contact jewellery and stipulates a release threshold of 0.5 ug/cm^2/week from any external surface. Six additional compounds are identified in OEM lists and IEC 62474 – mainly organonickel compounds the relevance of which is to be checked. *Proposed restriction:* ○ 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.* ○ The proposed derogation shall be accepted where nickel is required to provide the necessary workability and corrosion protection for the chassis and enclosures.	*Derogation request: Nickel in stainless steel* A derogation has been submitted by Eurofer for nickel in stainless steel. This derogation has been accepted previously for imaging equipment. *Please see the attached derogation request form.*
S11.2 Metallic coatings	Chromium is used in some protective coatings to provide corrosion protection. Chromium may be used in metallic coatings for some parts of the enclosure of a desktop computer.		*OEM chromium restrictions* Hexavalent chromium (CAS No 18540-29-9) is restricted by manufacturers in any metallic coatings. Status: 54 notifications in the C&L Inventory indicate a self-classification of H317, H350, H400 and H410. Test methods are specified by OEM's in order to verify that it is not present. *Proposed restriction:* ○ Hexavalent chromium shall not be present in metallic coatings applied to parts of a computer. *Verification shall be by analytical testing of coated parts.*	
Substance group 12. Screen glass fining agents				
S12.1 Glass screen (where specified)	Notebook screens are required to be very flat and without gas bubbles remaining in the glass. Fining agents are used to remove these imperfections. *Current hazard benchmark:* ○ Arsenic trioxide additive (CAS No. 1327-53-3) Status: Harmonised classification with H300, H350, H400, H410	An alternative process technology avoids the use of arsenic trioxide additives (CAS No. 1327-53-3) in order to fine the glass. The glass is held at higher temperatures for a longer period of time [31]. This technology has now been specified by a number of OEM's on notebook models with glass screens.	*ECHA Candidate List entry* Arsenic trioxide (CAS No. 1327-53-3) has been entered onto ECHA's Candidate List. *Proposed restriction:* ○ 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.*	
Substance group 13. Liquid crystals in displays				
S13.1 Metal additives in colour filters and other parts of the LCD unit	Liquid crystals form a fundamental part of an LCD display unit. *Current hazard benchmark:* ○ Mo/MoOx is used in thin films Molybdenum trioxide MoO_3 (Cas No. 1313-27-5) with a harmonised classification of (H351)			More information is needed on liquid crystals, the risk of migration from the LCD unit and /or risks that may be associated with exposure during manufacturing and/or dismantling.
Substance group 14. LED doping and luminescence				
S14.1 Semi-conductor diode and chip	LED's are required to provide low energy backlights in displays. The basis of an LED semiconductor diode is often gallium linked to arsenic, phosphorous or nitrogen [32]. *Current hazard benchmark:* ○ Gallium arsenide *(GaAs)* (CAS. 1303-00-0) Status: 23 notifications in the C&L Inventory indicates (H301) (H331) (H400) (H410) ○ Gallium Nitride (GaN) (CAS. 25617-97-4) Status: 24 notifications in the C&L Inventory indicate (H317)		*REACH Annex XVII restrictions* Arsenic compounds are given an exemption for use in semiconductors.	Gallium is one of the important components of an LED chip. Gallium arsenide is a fundamental component of the chip. In an LED diode, the semiconductors gallium nitride (GaN) and indium gallium nitride (InGaN) emit light in the blue-green to ultra violet spectral region which is converted to white light by a luminescent substance applied to the chip. In white LEDs indium gallium nitride is mainly used in the chemical formula InxGa1-xN. EPA has classified inorganic arsenic as a human carcinogen. It is understood that it may in the future be reclassified by ECHA as H350 or H351, with the potential to be entered onto the Candidate List. More information is required on the risk of migration from the diode and /or risk of exposure during manufacturing and/or dismantling. *Proposed interim approach:* ○ *Given the importance of LED's to achieving low energy performance and the fundamental role of gallium arsenide and other gallium compounds in the LED chip/diode it is proposed that:* *- subject to confirmation of its % concentration within the LED part, a derogation is*

				considered, *- but that the potential to minimise workforce exposure is explored further, and* *- Potential variations in gallium content based on chip dimensions shall also be explored as it is understood that they can vary significantly*
S14.1 Luminescent material	LED's are required to provide low energy backlights in displays. Luminescent substances are required to convert high-frequency blue or near UV light from an LED chip into a continuous spectrum in the visible wavelength range. *Current hazard benchmark:* o Benchmarking of the luminescent substances is to be carried out			The composition of the luminescent material is critical for the performance of an LED. Manufacturers' specifications on the exact composition of the luminescent substances they use are not usually published and are therefore very difficult to obtain. It is understood that cold white LEDs usually contain only a yellow luminescent substance whilst a red luminescent substance is added to warm white LEDs. The basis of the yellow luminescent substance in white LEDs is mainly Ce3+-doped yttrium aluminum garnet (YAG) or gadolinium aluminum garnet (Y,Gd) AG:Ce3+. The luminescent substance added in warm white LEDs obtains its red color spectrum from the activator ion Eu2+ as a doping.
Substance group 15. Excluded components				
S15.1 Screws, clips, fixings, adhesive strips	Parts weighing less than 25g are proposed to be exempted from the hazardous substance criteria			

[1] PINFA (2010) *Innovative flame retardants in E&E applications*
[2] International Electronics Manufacturing Initiative (INEMI), *iNEMI Position Statement on the Definition of "Low-Halogen" Electronics (BFR/CFR/PVC-Free)*
[3] International Electrotechnical Commission (2003) *Materials for printed boards and other interconnected structures*, IEC 61249-2-21
[4] International Electronics Manufacturing Initiative (INEMI), *iNEMI timeline for HFR-free electronics & PVC-free cabling for notebook and desktop products*, October 2010
[5] EFRA, *Printed Circuit Boards*, http://www.cefic-efra.com/index.php?option=com_content&view=article&id=110&Itemid=27
[6] Lenovo (2011) *Low halogen transition plans and progress*, http://www.lenovo.com/social_responsibility/us/en/GreenPaper_Low_Halogen.pdf
[7] Intel Corporation, *Halogen free component transition challenges*, October 2009, iNEMI presentation, http://thor.inemi.org/webdownload/newsroom/Presentations/Global_ICT_Env_Oct09/Azimi.pdf
[8] Intel Corporation (2010) *Intel channel Eco Smart programme*, http://www3.intel.com/cd/channel/reseller/asmo-na/eng/403012.htm
[9] PINFA (2010) *Innovative flame retardants in E&E applications*
[10] PINFA (2010) *Innovative flame retardants in E&E applications*
[11] Tange,J et al *Recycling of plastics with flame retardants of electronic waste, a technical and environmental challenge for a sustainable solution*, REWARD programme summary paper and Tange,L *Recycling challenges for plastics containing flame retardants from WEEE*, EFRA Newsletter, February 2014
[12] US EPA, *An alternatives assessment for the flame retardant decaBDE*, Draft report for public comment, July 2012
[13] Clean Production Action, *Evaluating flame retardants for TV enclosures*, March 2007
[14] SUBSPORT, *Proactively eliminating the phthalates DEHP, BBP, DBP and DIBP from electronic products*, Case story database, www.subsport.eu, Accessed January 2014.
[15] SUBSPORT,*Polyvinyl Chloride power cord alternatives,* Case story database, http://www.subsport.eu/case-stories/114-en?lang=, Accessed January 2014.
[16] International Electronics Manufacturing Initiative (INEMI), *Environmentally Conscious Electronics TIG iNEMI PVC Alternatives Project Phase I Final Project Team Report*, 12th September 2011
[17] Environment Agency Austria, *Study for the review of the list of restricted substances under RoHS2*, Final report, January 2014
[18] COWI and the Danish Technological Institute, *Hazardous substances in plastic materials*, Klima-og Forurensingdirektoraret, 15th January 2013
[19] Green Chemistry and Commerce Council, Chemical hazard assessment of alternative plasticisers for wire and cable applications
[20] HP, *HP Standard 011-1 general specification for the environment – substances and materials requirements*, Revision 3, 13th November 2013.
[21] COWI and the Danish Technological Institute, *Hazardous substances in plastic materials*, Klima-og Forurensingdirektoraret, 15th January 2013
[22] KEMI, *Annex XV restriction report: Proposal for a restriction - Lead and its compounds in articles*, Sweden, 21st December 2012.
[23] ECHA, *Call for further evidence on the use of cadmium based pigments in plastics*, 4th July 2013, https://echa.europa.eu/view-article/-/journal_content/title/call-for-further-evidence-on-the-use-of-cadmium-based-pigments-in-plastics
[24] Clariant, *The colouration of plastics and rubber*, Pigments and additives business division, January 2007
[25] Agion Technologies, *Electronics customers*, http://www.agion-tech.com/markets.aspx?id=50
[26] Commission Regulation (EU) No 1272/2013 of 6 December 2013 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards polycyclicaromatic hydrocarbons
[27] BfR, *PAH's in consumer products must be reduced as much as possible*, Expert opinion No. 025/2009, 8th June 2009.
[28] Oeko-Institut, *Hazardous substances in EEE not regulated by RoHS*, Final report, 17th October 2008.
[29] Shuttle, *Integrated cooling engine and heat pipe technology,* http://www.shuttle.eu/_archive/old/en/www.shuttle.eu/index-1088.html
[30] Battery University, *LiPolymer batteries: Substance or hype?* http://batteryuniversity.com/learn/article/the_li_polymer_battery_substance_or_hype
[31] SUBSPORT, *Technology adaptation for arsenic-free glass*, Case story database, http://www.subsport.eu/case-stories/195-en?lang=, Accessed January 2014.
[32] Oeko Institut, *Recycling critical raw materials from waste electronic equipment*, Report for the North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection, 24th February 2012