

Table I: Hazardous substances in EEE – high priority

ID	Substance name	CAS-Nr.	Hazard	Main use in EEE	Stakeholder Input		
					Specification of use: component(s) in which substance is contained	Quantity	General comments
1	Antimony trioxide	1309-64-4	Carc Cat. 3 R40	Synergist brominated flame retardants;			
2	Antimony compounds	-	Xn; R20/22 N; R51-53	Flame retardant; melting agent in CRT glass; solder material (antimony-tin) Melting agent in CRT glass			
3	Arsenic/arsenic compounds	7440-38-2	T; R23/25 N; R50-53	III-V group semiconductor substrate (GaAs) Flame retardant	Photosensitive layer	5Kg	Used in III -V InGaAs semiconductor photodiodes and lasers; applications:high speed data communications, laser, range finding, IR 2D & 3D imaging
					Trace element in Glas for Channel Photo Multiplier / Image Tub	---	No technically acceptable solution
					Infrared emitting diodes (Ireds)	6.1Mpcs/year	The substance is used as material for the chip
					laser diodes, APDs	350Kpcs/year	The substance is used as material for the chip
					Analog Optocoupler	1Mpcs/year	

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4	Beryllium metal	7440-41-7	Carc. Cat. 2; R49 T+; R26 T; R25-48/23 Xi; R36/37/38 R43	In alloys; copper-beryllium alloy; Connectors: contact springs, improves elasticity of copper alloy; Finger clips PCs: maintains electrical conductivity in metal housing; Monitors Relays: improves properties of copper contact springs Switches: high strength, high conductivity Laser printers: Rotating mirror, lightweight rigidity for precision instrumentation	Coolig rings Anode and cathode contacts Material for dynodes in Channel Photo Multiplier Ireds, Photodiodes & phototransistors in Metal-Can package Industrial flash lamp	30000pcs --- --- 867kpcs/year 200kpcs/year	No technically acceptable solution --- No technically acceptable solution The material is used in the metal can housing of the component No other known technical substitute available or in development
5	Beryllium oxide BeO	1304-56-9	Carc. Cat. 2; R49 T+; R26 T; R25-48/23 Xi; R36/37/38 R43	In ceramics, as cooling device; Thermally conductive electrical insulator			
6	Tetrabromo bisphenol A and related compounds (see Table II)	79-94-7	Dangerous to the environment N; R50/53	Flame retardant			
7	Bisphenol A (4,4'-	80-05-7	Repr. Cat. 3; R62	Polycarbonate plastic in	epoxy resin adhesive	200kg	Used in various

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	Isopropylidendiphenol)		Xi; R37-41 R43	electronic devices, medical equipment; in PVC as hardener, catalyst, binding agents, stabiliser; epoxy resin production	<p>Photodiodes, Ireds, Phototransistors in cast epoxy package</p> <p>Photodiodes, Ireds, Phototransistors in Mold package</p> <p>Photodiode arrays</p> <p>Industrial flash lamps Photocell sensor</p> <p>Infra Red Detector, Thermopile Sensor</p>	<p>21.4Mpcs/year</p> <p>15.3Mpcs/year</p> <p>1.1Mpcs/year</p> <p>5.0Mpcs/year 1.8Mpcs/year</p> <p>7500kg/year</p>	<p>semiconductor photodiodes. Application IR 2D & 3D imaging</p> <p>The substance is used as material in casting epoxies, molding compound, and potting epoxies</p> <p>The substance is found on the connector wires of the sensor assembly</p> <p>The substance is used as material in casting epoxies, molding compound, and potting epoxies</p> <p>No other known technical substitute available or in development</p>
8	Diethylhexylphthalate (DEHP)	117-81-7	Repr. Cat. 2;	Plasticizer in PVC cables	Industrial and commercial sensors	255kpcs/year	The substance is found on the connector wires

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			R60-61		(coin sensors, papers sensors, etc. Industrial flash lamp with PVC cable	5Mpcs/year	of the sensor assembly No other known technical substitute available or in development
9	Butylbenzylphthalate (BBP)	85-68-7	Repr. Cat.2; R61 Repr. Cat.3; R62 N; R50-53	Plasticizer in PVC cables	Industrial and commercial sensors (coin sensors, papers sensors, etc.) Industrial flash lamp with PVC cable	255kpcs/year 5Mpcs/year	The substance is found on the connector wires of the sensor assembly No other known technical substitute available or in development
10	Dibutylphthalate (DBP)	84-74-2	Repr. Cat. 2; R61 Repr. Cat. 3; R62 N; R50	Plasticizer in PVC cables	Industrial and commercial sensors (coin sensors, papers sensors, etc.) Industrial flash lamp with PVC cable	255kpcs/year 5Mpcs/year	The substance is found on the connector wires of the sensor assembly No other known technical substitute available or in development
11	Diethylphthalate (DOP)	117-84-0	Dangerous to the Environment	Plasticizer in PVC cables	Industrial and commercial sensors (coin sensors, papers sensors, etc.)	255kpcs/year	The substance is found on the connector wires of the sensor assembly

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					Industrial flash lamp with PVC cable	5Mpcs/year	No other known technical substitute available or in development
12	Dimethylformamide (DMF)	68-12-2	Repr. Cat. 2; R61 Xn; R20/21 Xi; R36	Electrolyte capacitors	All power supplies	5000pcs	No technically acceptable solution
13	Formaldehyde	50-00-0	Carc. Cat. 3; R40 T; R23/24/25 C; R34 R43	Preservatives, monomer (e.g. phenol resin and melamine resin)	Industrial Flash lamps	1kg/year	
14	Gallium arsenide	1303-00-0	Human carcinogen*	Power semiconductors amplifiers,	III - V semiconductor substrate	100kg	III - V GaAs semiconductor lasers and GaAsFET's ; applications:high speed data communications, laser, range finding, IR 2D & 3D imaging
					Photo cathodes	---	No technically acceptable solution
					Infrared emitting diodes(Ireds)	6.1Mpcs/year	The substance is used as material for the chip
					laser diodes, APDs	350Kpcs/year	The substance is used as material for the chip

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					Infra Red Detector Analog Optocoupler	3kpcs/year 1Mpcs/year	No other known technical substitute available or in development
15	Hexabromocyclododecane (HBCDD) and further brominated flame retardants (see table II)	3194-55-6	not (yet) classified in the Annex I of Directive 67/548/EEC; proposal: R33, R64, N R50-53; PBT	Flame retardant			
16	Liquid crystals e.g. MBBA (4-methoxybenzylidene-4-butylaniline); 5CB (4-pentyl-4-cyanobiphenyl)			Electroactive layer in liquid crystal displays of cellular phones, notebooks, PC monitors			
17	Medium-chained chlorinated paraffins (MCCP) (Alkanes, C14-17, chloro)	85535-85-9		secondary plasticisers in PVC (cable) flame retardant plasticisers in rubbers	Injection molding housing in all lamp assembly Industrial and commercial sensors (coin sensors, papers ensors, etc.)	30000pcs 255kpcs/year	No technically acceptable solution The substance is found on the connector wires of the sensor assembly
18	Nickel ¹	7440-02-0	Carc. Cat. 3; R40	Stainless steel, plating;	all lamp assembly	250000pcs	No technically

¹ Only in those applications where nickel is likely to result in direct and prolonged skin exposure

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					Specification of use: component(s) in which substance is contained	Quantity	General comments
			R43	Decorative metal finishes, barrier layers	Gaps , metal cans, thyratrons Tungsten Rod, trace element Sensor housing (Caps Headers) of Ireds, Diodes, Photodiodes, Phototransistors, Photodiode arrays, sensor module assembly	20000pcs 5µ/g x 1073500g 43Mpcs/year	acceptable solution --- Is a traceelement in tungsten; No technically acceptable solution The substance is found on the PCB through hole, pinner wires, terminal pins, metal cansubstrates or header, and lead frames
19	Nonylphenol Nonylphenolpolyglycoethers (Nonylphenoethoxylates)	25154-52-3 9016-45-9	Repr.Cat.3; R62 Repr.Cat.3; R63 Xn; R22 C; R34 N; R50-53	Surfactants, antioxidant in plastics			
20	Perfluorooctane sulfonates ²	1763-23-1	-				
21	PVC	9002-86-2	Dependent on the	Sleeve material (of capacitors),	Plastic packaging	100kg	Used for shipping ESD

² iRestriction does not apply to the following applications or processes: 1) photoresists or antireflective coatings for photolithography processes; 2) photographic coatings applied to films, papers, or printing plates; 3) mist suppressants for nondecorative hard chromium (VI) plating; 4) wetting agents for use in controlled electroplating systems

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			additives (stabilizers and plasticizer) used; Dioxin formation during incineration; Source of organic bound chlorine	cables, tubing films labels and gaskets, insulator, chemical resistance, transparency, sheath material	Cable assemblies, electrode capacitors Industrial and commercial sensors (coin sensors, papers sensors, etc.) Industrial flash lamp with PVC cable	5000pcs 255kpcs/year 5Mpcs/year	sensitive semiconductor components --- The substance is found on the connector wires of the sensor assembly No technically acceptable solution
22	PCBs Polychlorinated Biphenyls	1336-36-3 and various others	R33 N; R50-53 Dioxin/furan formation during incineration	Flame retardant in PVC plastic cable; capacitors	All lamp modules Infra Red Detector	30000pcs 600kpcs/year	No technically acceptable solution No technically acceptable solution
23	PCT Polychlorinated Terphenyls	61788-33-8 and various others		Electrical insulation medium, Plasticizers, fire retardants, coatings for electrical wire and cable, dielectric sealants	All power supplies Industrial and commercial sensors (coin sensors, papers sensors, etc.) Industrial Flash lamps	5000pcs 255kpcs/year 12000meter/year	No technically acceptable solution The substance is found on the connector wires of the sensor assembly No technically

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					Photonics lamps		acceptable solution
24	Polychlorinated Naphthalenes	70776-03-3		lubricant, paint, stabilizer (electric characteristic, flame-resistant, water-resistant) insulator, flame retardant			
25	Selenium	7782-49-2	T; R23/25 R33 R53 Toxic/ Danger of cumulative effects / Environment**	Rectifiers and detector instruments, photoreceptor, semiconductor material, light receiving element, photocell	Photo sensitive layer Photocell sensor	--- 6.2Mpcs/year	No technically acceptable solution No other known technical substitute available or in development
26	Short-chained chlorinated paraffins (SCCP) (Alkanes, C10-13, chloro)	85535-84-8	Carc. Cat. 3; R40 N; R50-53	plasticisers in PVC (cable) flame retardant plasticisers	All power supplies Industrial and commercial sensors (coin sensors, papers ensors, etc.) Industrial Flash lamps ; Photonics lamps	5000pcs 255kpcs/year 12000meter/year	No technically acceptable solution The substance is found on the connector wires of the sensor assembly No other known technical substitute available or in development
27	Synthetic vitreous fibres -glass fibres - mineral wool	142844-00-6	RCF: Carc. Cat. 2;	Thermal insulation materials in domestic electrical appliances	Photocell sensor	1.5Mpcs/year	No other known technical substitute available or in development

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					Specification of use: component(s) in which substance is contained	Quantity	General comments
	- refractory ceramic fibre (RCFs)						development
28	Tributyl Tin (TBT) compounds Triphenyl Tin (TPT) compounds	various	T; R25-48/23/25 Xn; R21 Xi; R36/38 N; R50-53; T; R23/24/25 N; R50-53	Stabilizer, antioxidant, antibacterial and antifungal agents, antifoulant, antiseptic, anti-fungal agent, paint, pigment, antistaining			
29	Tributyl Tin Oxide (TBTO)	56-35-9	No classification according to 67/548	antiseptic, antifungal agent, paint, pigment, antistaining, refrigerant, foaming agent, extinguishant,			
30	dinickel trioxide	1314-06-3	Carc. Cat. 1; R49 R43 R53	May be used as an electrolyte			
31	diarsenic trioxide; arsenic trioxide	1327-53-3	Carc. Cat. 1; R45 T+; R28 C; 34 N; R50-53	May be used in certain glass-materials, less than 5000ppm			
32	4,4'-methylenedi-o-toluidine	838-88-0	Carc. Cat. 2; R45 Xn; R22 R43 N; R50-53	Potential use as a dye			
33	Petrolatum; Petrolatum	8009-03-8	Carc. Cat. 2; R45	Used in solder fluxes/pastes	white ceramics	6.1Mpcs/year	The substance is found on the conductive paste used in electrical pattern printing process of the ceramic substrate

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					Specification of use: component(s) in which substance is contained	Quantity	General comments
34	nickel dihydroxide	12054-48-7	Carc. Cat. 3; R40 Xn; R20/22 R43 N; R50-53	May be present in certain plastics, metallic- or ceramic materials			
35	tributyl phosphate	126-73-8	Carc. Cat. 3; R40 Xn; R22 Xi; R38	May be present in certain plastics, metallic- or ceramic materials			
36	divanadium pentaoxide; vanadium pentoxide	1314-62-1	Muta. Cat. 3; R68 Repr. Cat. 3; R63 T; R48/23 Xn; R20/22 Xi; R37 N; R51-53	May be present in certain plastics, metallic- or ceramic materials			
37	nickel sulphate	7786-81-4	Carc. Cat. 3; R40 Xn; R22 R42/43 N; R50-53	May be present in certain plastics, metallic- or ceramic materials	In CERMAX lamp assembly	330000pcs	No technically acceptable solution
38	cobalt oxide	1307-96-6	Xn; R22 R43 N; R50-53	May be present in certain plastics, metallic- or ceramic materials	Sealing glas for Channel Photo Multiplier	---	No technically acceptable solution
39	cobalt	7440-48-4	R42/43 R53	May be present in certain plastics, metallic- or ceramic materials	All lamp assembly Tungsten Rod, trace element	250000pcs 10µg/g x 1073500g	No technically acceptable solution Is a traceelement in tungsten; No technically acceptable solution
40	2-ethylhexyl acrylate	103-11-7	Xi; R37/38 R43	2-Ethylhexyl acrylate is used as a monomer in the chemical industry for the production of polymers and copolymers, which	fork light barrier	428kpcs/year	The substance is used on the adhesive to fully seal the sensor module

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				are mainly processed further to aqueous polymer dispersions. The polymers and polymer dispersions are used in adhesives and as binders for paints. Other applications include coatings raw materials and uses in the plastics and textiles industries.			housing
41	Naphthenic acids, copper salts; copper naphthenate	1338-02-9	R10 Xn; R22 N; R50-53	May be present in certain plastics, metallic- or ceramic materials			
42	phenyl bis(2,4,6-trimethylbenzoyl)-phosphine oxide	162881-26-7	R43 R53	May be present in certain plastics, metallic- or ceramic materials			
43	thallium	7440-28-0	T+; R26/28 R33 R53	May be present in certain plastics, metallic- or ceramic materials	Dopant used in the manufacture of digital medical x-ray detectors	2000	Thallium is a critical component required for converting x-ray to visible light. There is no feasible alternative to Thallium. Elimination of Thallium would greatly reduce image quality and thus medical quality. X-ray detector can not be manufactured without it.

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44	bromobenzylbromotoluene , mixture of isomers	99688-47-8	Xn; R48/22 R43 N; R50-53	May be present in certain plastics, metallic- or ceramic materials			
45	2,2'-(ethylenedioxy)diethyl diacrylate; triethylene glycol diacrylate	1680-21-3	Xi; R36/38 R43	May be used in carton materials			
46	Rosin; colophony [1]	8050-09-7 [1] 8052-10-6 [2] 73138-82-6 [3]	R43	Used in solder fluxes/pastes	Printed circuit boards assemblies connector to tungsten rod solder joints white ceramics Industrial flash lamp	40000pcs approx 1kg/ year Rosin concentration varies 1% - 5% 6.1Mpcs/year 500Kpcs/year	--- required for reliable high temperature applications The substance is found on the conductive paste used in electrical pattern printing process of the ceramic substrate No other known technical substitute available or in development

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precisely.

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Table II: Brominated flame retardants (other than PBBs or PBDEs) (JIG, 2007)

Brominated Flame Retardants (other than PBBs or PBDEs)	CAS Numbers
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(14) [Aliphatic/alicyclic brominated compounds]	-
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(15) [Aliphatic/alicyclic brominated compounds in combination with antimony compounds]	-
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(16) [Aromatic brominated compounds excluding brominated diphenyl ether and biphenyls]	-
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(17) [Aromatic brominated compounds excluding brominated diphenyl ether and biphenyls] in combination with antimony compounds]	-
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(22) [Aliphatic/alicyclic chlorinated and brominated compounds]	-
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(42) [Brominated organic phosphorus compounds]	-
Poly(2,6-dibromo-phenylene oxide)	69882-11-7
Tetra-decabromo-diphenoxy-benzene	58965-66-5
1,2-Bis(2,4,6-tribromo-phenoxy) ethane	37853-59-1
3,5,3',5'-Tetrabromo-bisphenol A (TBBA)	79-94-7
TBBA, unspecified	30496-13-0
TBBA-epichlorhydrin oligomer	40039-93-8
TBBA-TBBA-diglycidyl-ether oligomer	70682-74-5
TBBA carbonate oligomer	28906-13-0
TBBA carbonate oligomer, phenoxy end capped	94334-64-2
TBBA carbonate oligomer, 2,4,6-tribromo-phenol terminated	71342-77-3
TBBA-bisphenol A-phosgene polymer	32844-27-2
Brominated epoxy resin end-capped with tribromophenol	139638-58-7
Brominated epoxy resin end-capped with tribromophenol	135229-48-0
TBBA-(2,3-dibromo-propyl-ether)	21850-44-2
TBBA bis-(2-hydroxy-ethyl-ether)	4162-45-2
TBBA-bis-(allyl-ether)	25327-89-3
TBBA-dimethyl-ether	37853-61-5
Tetrabromo-bisphenol S	39635-79-5
TBBS-bis-(2,3-dibromo-propyl-ether)	42757-55-1
2,4-Dibromo-phenol	615-58-7
2,4,6-tribromo-phenol	118-79-6
Pentabromo-phenol	608-71-9
2,4,6-Tribromo-phenyl-allyl-ether	3278-89-5
Tribromo-phenyl-allyl-ether, unspecified	26762-91-4
Bis(methyl)tetrabromo-phthalate	55481-60-2
Bis(2-ethylhexyl)tetrabromo-phthalate	26040-51-7
2-Hydroxy-propyl-2-(2-hydroxy-ethoxy)-ethyl-TBP	20566-35-2
TBPA, glycol-and propylene-oxide esters	75790-69-1
N,N'-Ethylene -bis-(tetrabromo-phthalimide)	32588-76-4
Ethylene-bis(5,6-dibromo-norbornane-2,3-dicarboximide)	52907-07-0
2,3-Dibromo-2-butene-1,4-diol	3234-02-4
Dibromo-neopentyl-glycol	3296-90-0
Dibromo-propanol	96-13-9

Tribromo-neopentyl-alcohol	36483-57-5
Poly tribromo-styrene	57137-10-7
Tribromo-styrene	61368-34-1

Table III: Hazardous substances in EEE already regulated by existing legislation

Substance name	CAS-Nr.	Main use in EEE	Hazard	Key Legal and Regulatory Information
Asbestos	12001-28-4 132207-32-0 12172-73-5 77536-66-4 77536-68-6 77536-67-5 12001-29-5	Brake lining pad, insulator, filler, abrasive, insulator, filler, pigment, paint, talc, adiabatic material	Carc. Cat. 1; R45 T; R48/23	76/769/EEC, Marketing and Use of Dangerous Substances and amendments: (83/478/EEC; 85/610/EEC; 87/217/EEC; 91/659/EEC; 99/77/EEC)
Specific Azocolourants and azodyes (which form certain aromatic amines)	Various	Pigment, dyes, colorants		76/769/EEC, Marketing and Use of Dangerous Substances and amendments: (2002/61/EC; 2003/03/EEC).
Ozone Depleting Substances and Hydrochlorofluorocarbons	Various	Refrigerant, foaming agent, insulation extinguishant		Regulation (EC) No. 2037/2000 on substances that deplete the ozone layer