HELSINKI COMMISSION
Baltic Marine Environment Protection Commission

Polychlorinated Biphenyls

(PCBs)

A compilation of information, derived from HELCOM Recommendations, EU-Directives, UN-ECE-LRTAP, UNEP and OSPAR, and analysis of appropriate measures aiming at safe handling and reduction of releases of PCB from PCB-containing equipment in use.

submitted by the Co-ordinator of the HELCOM Project Team on Hazardous Substances
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"Implementation of the HELCOM Objective with regard to Hazardous Substances" – Project funded by European Communities (Subv 99/79391), Sweden and HELCOM.

Table of content

1. INTRODUCTION

Chemical name: Polychlorinated Biphenyls

CAS-NO. 133-63-63[1]

Trade Names/Synonyms: Aroclor, Chlorextol, chlorinated biphenyl, chlorinated diphenyl, Clophen, chlorobiphenyl, Dykanol, Fenclor, Inerteen, Kanechlor, Noflamol, Phenoclor, polychlorobiphenyl, Pyralene, Pyranol, Santotherm, Sovol, Sovtol, Tarnol, Therminol.

PCBs are a group of some 209 individual chemical compounds, produced in various industrial mixtures by introducing elementary chlorine in various degrees into biphenyl. Commercial use of PCB began in 1929, and production is believed to have finally ceased in the mid-1980s. At that time, approximately 1.5 million tons were produced for all applications, worldwide (excluding the Soviet Union), of which a significant portion is still in use. PCB was also produced at two sites in the former USSR. From 1939 to 1993 the total PCB production was about 180,000 tonnes of the three main PCB brands Sovol, Sovtol and TCB (AMAP 2000).

Due to their very low biodegradability in the environment and their tendency to bioaccumulate, and biomagnify, PCBs belong to the so-called persistent organic pollutants (POPs). They can be transported over long distances in various media, with evidence of deposition and accumulation in the Arctic region, a result of the cold condensation or distillation effect. PCBs can enter the environment in a number of different ways, e.g. direct releases from equipment still in use or in storage, emissions from PCB contaminated waste or from contaminated sites, disposal areas, etc. PCBs volatilise from water surfaces in spite of their low vapour pressure, and partly as a result of their hydrophobicity.

Many of the individual PCB compounds exhibit toxic properties. PCBs rarely cause acute toxic effects but most of the effects observed are the result of a repetitive or chronic exposure. The presence of even more toxic contaminants like polychlorinated dibenzofurans is probably responsible for some cases of poisoning of food that have been reported. There is growing evidence linking PCBs and other persistent halogenated aromatic hydrocarbons to reproductive and immunotoxic effects in wildlife. Effects on the liver, skin, immune system, reproductive system, gastrointestinal tract and thyroid gland of laboratory rats have been observed and PCBs are classified as probable human cancer promoters.

PCB is chemically stable/inert, heat resistant and non-flammable, and has particularly useful dielectric properties. Consequently, it was used worldwide as a dielectric in electrical components (transformers and capacitors) and as an additive in hydraulic-, cutting- and lubricating oils. Other uses of PCBs included ink solvents, plasticizers in paint, sealants and other polymers and as flame retardants.

[1] There are many CAS numbers for PCBs and there are other classifications numbers, like index no (according to directive 67/548/EEC) and EG number (according to EINECS). In some cases the monochloro- and dichloro-biphenyls are excluded from the definition of PCBs. Some substances that from a chemical point of view not at all are PCBs, are included in the directive on disposal of PCB/PCT.

2. MAIN LEGISLATION AND REGULATIONS WITH RELEVANCE FOR THE PCB PROBLEMATIC

2.1 EU-LEGISLATION

2.1.1 COUNCIL DIRECTIVE 67/548/EEC

on the approximation of laws, regulations and administrative provisions in relation to the classification, packaging and labelling of dangerous substances (Dangerous Substances Directive) was adopted in 1967 and has since been amended a number of times, e.g. by **Council Directive 97/69/EEC**, which adapts Directive 67/548/EEC to technical progress for the 23rd time. National transposing legislation was required to have been adopted and communicated to the Commission by the 16 December 1998 at the latest.

2.1.2 COUNCIL DIRECTIVE 76/769/EEC

of 27 July 1976 relating to restrictions on the marketing and use of certain dangerous substances and preparations (e.g. TBT, PCBs). This Directive has been also amended several times, e.g. by **Council Directive 85/467/EEC** of 1 October 1985 on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations (PCBs/PCTs). The objective is to restrict the marketing and use of PCBs and PCTs. Thus, the use of PCBs and PCTs is prohibited in closed-system electrical equipment transformers, resistors and inductors, in large capacitors (> 1 kg total weight), in certain small capacitors, in heat-transmitting fluids in closed-circuit heat-transfer installations, in hydraulic fluids for underground mining equipment from July 1986 on. **Council Directive 89/677/EEC** of 21 December 1989 on the approximation of the laws, regulations and administrative provisions of the member states relating to restrictions on the marketing and use of certain dangerous substances and preparations amended this Directive for the 8th time. The Directive prohibits the use and reuse of PCBs and PCTs and any mixture containing them in more than 0,005 % by weight.

2.1.3 COUNCIL DIRECTIVE 96/59/EC

of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCBs/PCTs), replacing **Council Directive 76/403/EEC** (ban of use of PCBs in EC in open applications, 1976). According to **COUNCIL DIRECTIVE 96/59/EC** Member States must submit an inventory and detailed plans for the disposal of the relevant PCB wastes and the decontamination/disposal of relevant equipment containing more than 5 litres (> 5 dm^3) of PCB until September 1999[2]. The year 2010 has been set as a deadline for complete disposal or decontamination of equipment containing PCBs. Any equipment, which is subject to inventory, must be labelled. Transformers containing between 500 and 50 ppm of PCB are allowed to remain in service indefinitely. Furthermore the Member States must prohibit the separation of PCBs from other substances for the purpose of reusing the PCBs and the topping-up of transformers with PCBs. Member States have also to establish plans for the collection and disposal of equipment not subject to the inventory.

[2] The limit for what is a PCB equipment is very strict and covers e.g equipment with contaminated fluids containing as little as 0.25 g of PCB (50 mg/litre*5 litres = 250 mg). A typical small capacitor used as fluorescent lamp ballast contains about 50 g and is not classified as a PCB equipment. This is not consistent, even though the amount of insulating fluid in transformers are as small as 5 litres and the mode and time scale for the emissions may be different.

2.1.4 COUNCIL DIRECTIVE 96/61/EEC

of 24 September 1996 concerning integrated pollution prevention and control **(IPPC-Directive).** The objective is to prevent or minimise air, water and soil pollution by emissions from industrial installations in the Community, with a view to achieving a high level of environmental protection. This Directive requires certain conditions for the licensing of industrial installations. In the context of the execution of the Directive so called BAT notes are elaborated laying down requirements for progressive technologies. Such BAT notes are foreseen e.g. for PCB sources such as certain combustion sources (for power generation and waste incineration) and production and processing of metals. Article 15 (3) of the Directive requires Member States to inventory and supply data on principle emissions and responsible sources, that is from all large facilities with one or more activities as mentioned in Annex I to this Directive.

2.1.5 COUNCIL DIRECTIVE 94/67/EC

of 16 December 1994 on the incineration of hazardous waste. The objective is to prevent or reduce the effects of hazardous waste incineration on the environment and the ensuing risks for public health.

2.1.6 COUNCIL DIRECTIVE 96/82/EEC

This Directive (Seveso II) aims at the prevention of major accidents involving dangerous substances.

2.1.7 COUNCIL REGULATION (EEC) NO 2455/92

of 23 July 1992 concerning the export and import of certain dangerous chemicals. Official Journal L 251, 29/08/1992 p. 0013 – 0022. The purpose of this Regulation is to establish a common system of notification and information for imports from and exports to third countries of certain chemicals (e.g. PCB) which are banned or severely restricted on account of their effects on human health and the environment and to apply the international notification and 'prior informed consent' (PIC) procedure established by the United Nations Environment Programme (UNEP) and the Food and Agriculture Organization (FAO). This Regulation shall also ensure that the provisions of Directive 67/548/EEC on the classification, packaging and labelling of substances dangerous to man or the environment when they are placed on the market in the Member States shall also apply to such substances when they are exported from the Member States to third countries.

2.1.8 COUNCIL REGULATION (EEC) 259/93/EEC

of 1 February 1993 on the supervision and control of shipments of waste within, into and out of the European Community. The regulation is EU's implementation of the Basel Convention and corresponding OECD's rules on transport of waste. It deals with a "trafficlight" system for waste types concerning forms of license for transboundary transport. The red list – which is the most restricted list – contains few wastetypes, among these are PCB/PCT:

Wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (PCB) and/or polychlorinated terphenyl (PCT) and/or polybrominated biphenyl (PBB), including any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more.

Wastes that contain, consist of or are contaminated with any of the following:

- Any congener of polychlorinated dibenzo-furan
- Any congener of polychlorinated dibenzo-dioxin

2.1.9 DECISION NO 2179/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 24 September 1998 on the review of the European Community programme of policy and action in relation to the environment and sustainable development "Towards sustainability". (Fifth European Community environment programme: towards sustainability.) The objective is to present the new Community strategy on the environment and the measures to be taken towards sustainable development for the period 1992-2000. In relation to industry, the priority objectives of the Community shall be (among others) the further promotion of environmental awareness on the part of industry, including, in particular, small and medium-sized enterprises (SMEs) and the phasing-out or banning of persistent organic pollutants (POPs).

2.1.10 PROPOSED EU-DIRECTIVES ON WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE) AND RESTRICTIONS ON HAZARDOUS SUBSTANCES (ROHS)

Work is in progress on drafting two Directives of the European Parliament and of the Council concerning waste electrical and electronic equipment (WEEE), and restrictions on use of hazardous substances in such products (ROHS).

Principal objectives of the WEEE-Directive are to protect soil, water and air from pollution caused by current management of WEEE (waste electrical and electronic equipment), to avoid the generation of waste, which has to be disposed of and to reduce the harmfulness of WEEE. The objectives are to be achieved by means of a wide range of measures, including measures on the separate collection of WEEE, the treatment of WEEE and the recovery of such waste. The Directive will further include provisions for the producer to bear the disposal costs. This is considered to contribute to an environmentally safe disposal which will also stimulate the producer to use less and recyclable hazardous substances and to construct long lasting electronic equipment.

The proposed ROHS-Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment will contribute to the same objectives by ensuring that substances causing major problems during the waste management phase, such as lead, mercury, cadmium, hexavalant chromium, PCBs and certain brominated flame retardants are substituted.

2.1.11 COMMUNITY STRATEGY TO REDUCE THE PRESENCE OF DIOXINS AND PCBS IN THE ENVIRONMENT

Communication outlining this strategy will be published by September 2001. The EU Commission is currently elaborating a Community Strategy to reduce the presence of dioxins and PCBs in the environment. First informal expert meetings have taken place in March 2001 in Brussels. It was recognised that PCBs in by products and in recycling processes may present a significant source, that further data have to be compiled and that further measures may be taken with regard to these sources.

2.2 HELCOM

2.2.1 HELCOM RECOMMENDATION 6/1

Recommendation regarding the elimination of the use of PCBs and PCTs (adopted 13 March 1985, having regard to Article 13, Paragraph b) of the Helsinki Convention). The Contracting Parties should stop the production of PCBs and PCTs and the marketing of articles and

equipment containing PCBs/PCTs from 1987 on. National programmes should be established to identify and/or label, collect, dispose and destruct PCB-containing articles. Equipment containing PCBs/PCTs should be disposed of or destructed in an environmentally safe manner: hydraulic fluids in underground mining equipment, closed system electrical equipment (transformers, resistors, inductor, capacitors > 1 kg total weight) as soon as possible, small capacitors at the latest when they reach the end of their service life. This Recommendation is fully implemented only by the EU-countries.

2.2.2 HELCOM RECOMMENDATION 16/10

Recommendation regarding the reduction of discharges and emissions from production of textiles (adopted 15 March 1995 having regard to Article 13, Paragraph b) of the Helsinki Convention).
Within the production of textiles the Contracting Parties should apply best available technology and should not use (among other hazardous substances) PCB. These measures should be implemented by 1 January 1998 for new plants and by 1 January 2000 for existing plants.

2.2.3 1992 HELSINKI CONVENTION

Annex 1, Part 2.2: In order to protect the Baltic Sea Area PCBs shall be banned for all uses, except in existing closed system equipment until the end of service life or for research, development and analytical purposes in the Baltic Sea Area and its catchment area.

2.3 PARCOM/OSPAR

2.3.1 PARCOM DECISION 92/3

on the Phasing Out of PCBs and Hazardous PCB Substitutes. This Decision aims at preventing PCBs and hazardous PCB substitutes from entering the marine environment. Measures shall be taken to phase out and to destroy in an environmentally safe manner all identifiable PCBs as soon as possible with the aim of complete destruction, including the interim options of safe deep underground disposal in dry rock formation of capacitors and empty transformers.

2.4 UN/ECE

2.4.1. UNECE-LRTAP: CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

adopted in Geneva on 13 November 1979; extended *inter alia* by the 1998 Protocol on Persistent Organic Pollutants (POPs). This Convention was the first internationally legally binding instrument to deal with problems of air pollution on a broad regional basis. It was signed in 1979 and entered into force in 1983. The 1998 Aarhus Protocol on Persistent Organic Pollutants is so far signed by 36 countries and ratified by 6 (e.g. Sweden). The objective of the present Protocol is to control, reduce or eliminate discharges, emissions and losses of persistent organic pollutants. To this end each Party shall take effective measures to eliminate the production and use of PCB in accordance with the implementation requirements specified therein; to ensure that destruction or disposal is undertaken in an environmentally sound manner, taking into account relevant subregional, regional and global regimes governing the management of hazardous wastes and their disposal, in particular the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. PCBs should be restricted to the uses described, in accordance with the implementation requirements

specified therein. Production of PCB shall be eliminated. Use of PCB shall be restricted. Countries with economies in transition shall eliminate production as soon as possible and no later than 31 December 2005.
Parties shall make determined efforts designed to lead to:
(a) The use of identifiable PCBs in equipment (i.e. transformers, capacitors or other receptacles containing residual liquid stocks) containing PCBs in volumes greater than 5 dm3 and having a concentration of 0.05 % PCBs or greater, shall be eliminated as soon as possible, but no later than 31 December 2010, or 31 December 2015 for countries with economies in transition;
(b) The destruction or decontamination in an environmentally sound manner of all liquid PCBs referred to in subparagraph (a) and other liquid PCBs containing more than 0.005 % PCBs not in equipment, as soon as possible, but no later than 31 December 2015, or 31 December 2020 for countries with economies in transition; and
(c) The decontamination or disposal of equipment referred in subparagraph (a) in an environmentally sound manner .
This shall not apply when PCBs occur: (i) as contaminants in products; or (ii) in articles manufactured or in use by the implementation date; or (iii) as site-limited chemical intermediates in the manufacture of one or more different substances and are thus chemically transformed.

2.5 UNEP

2.5.1 THE BASEL CONVENTION

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted in 1989 and entered into force on 5 May 1992. This global environmental treaty strictly regulates the transboundary movements of hazardous wastes and provides obligations to its Parties to ensure that such wastes are managed and disposed of in an environmentally sound manner. According to the main principles of the Basel Convention transboundary movements of hazardous wastes should be reduced to a minimum consistent with their environmentally sound management, hazardous wastes should be treated and disposed of as close as possible to their source of generation and hazardous waste generation should be reduced and minimized at source.

2.5.2 THE ROTTERDAM CONVENTION

The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade was adopted in Rotterdam on 10 September 1998. It will enter into force once 50 instruments of ratification are deposited. The objective of this Convention is to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm and to contribute to their environmentally sound use, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

2.5.3 THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS (POP)

Mindful of the precautionary approach as set forth in Principle 15 of the Rio Declaration on Environment and Development, the objective of this Convention is to protect human health and the environment from persistent organic pollutants. The treaty calls for urgent global actions to reduce releases of Persistent Organic Pollutants (POP), initially beginning with the 12 identified POPs (Aldrin, Chlordane, Dieldrin, DDT, Endrin, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, PCBs, Dioxins, Furans) with the goal of their continuing minimization and, where

feasible, ultimate elimination. It calls *inter alia* for measures to reduce or eliminate releases from intentional production and use, from unintentional production, as well as from stockpiles and wastes. The Convention makes also provisions for identifying additional persistent organic pollutants as candidates for future international action. With regard to the elimination of the use of PCBs in equipment (transformers, capacitors or other receptacles containing liquid stocks) by 2025, the Contracting Parties shall *inter alia* identify, lable and remove from the use equipment containing > 10 % PCBs and volumes > 5 litres, > 0.05 % PCBs and volumes > 5 litres, > 0.005 % PCBs and volumes > 0.05 litres (order of priorities). That means, the continued use of electrical equipment containing PCBs will still be permitted until 2025 as long as the equipment does not leak. The Stockholm Convention on Persistent Organic Pollutants (POP) will be signed in Stockholm in May 2001. It has to be ratified by 50 nations before it can take effect.

2.6 NATIONAL LEGISLATION

In all HELCOM Contracting Parties being Member States of the EU extensive regulations apply for the use in open and closed systems. However, some countries have not taken their responsibilities regarding PCBs seriously enough. For example, Germany, has been subject to legal action by the European Commission for failing to implement the 1996 EC Directive on the disposal of PCBs, which should have been transposed into national law by March 1998 at the latest. Now in Germany an Executive Order implementing the EC Directive has been adopted (Executive Order of 26 June 2000, published BGBl. 2000 I, p. 932 - 936). A stricter cut off value of 1 litre instead of 5 litres with regard to liquid PCB waste has been set.

National legislation to implement HELCOM Recommendation 6/1 is developed in all Baltic Sea States, except Poland and Estonia. In Denmark, Germany, Finland, Latvia and Russia national programmes are established to identify and/or label PCB-containing articles in use. Estonia is developing programmes. All Baltic Sea States, except Latvia, Lithuania and Estonia, have or have had programmes to identify and label PCB-containing articles in use. Estonia is planning programmes. All Baltic Sea States, except Estonia and Lithuania, have established an obligation to deliver PCB/PCT-waste to a reception facility. In the four EU-member states destruction takes place at a treatment plant for hazardous waste. In these states there exists also a timetable for terminating the use of PCB/PCT articles. It is assumed that these timetables include articles mentioned in the recommendation (hydraulic fluids in underground mining equipment and closed system electrical equipment).

Council Directive 96/59/EC is – besides in the EU-countries – also transposed in national legislation in Estonia, Latvia and Poland but not yet implemented.

2.7 SUMMARY OF THE LEGISLATIVE SITUATION

EU, HELCOM, PARCOM/OSPAR, UN/ECE and UNEP have all established instruments with regard to PCBs and PCTs.

The most important regulations – Council Directive 96/59/EC and HELCOM Recommendation 6/1 have been fully implemented only by the EU-Countries. But PCBs/PCTs are not produced in any of the Baltic Sea States.

With regard to the national PCB legislation at least the Nordic countries have more stringent requirements than what EU legislation is stipulating (e.g. lower volume levels, more stringent timetables).

3. USES/APPLICATIONS

An extensive overview of PCB-containing applications can be found in various documents. Most of them differentiate between closed and open applications. A closed PCB application is one in which the PCBs are held completely within the equipment. In open applications, PCBs are in direct contact with their surroundings and thereby may be easily transferred to the environment. UNEP-documents assess PCB-containing oils as partly closed applications, where the oil is not directly exposed to the environment, but may become so periodically during typical use. Most of the other documents add these forms of application to the closed ones or describe it as closed circulatory system.

Tab. 1: PCB-containing applications

Closed applications	❑ Electrical transformers (insulation and cooling liquid)
	❑ Electrical capacitors (dielectricum)
	  ❑ Power factor capacitors in electrical distribution systems
	  ❑ Lighting ballasts
	  ❑ Motor start capacitors in refrigerators, heating systems, air conditioners, hair dryers, water well motors, washing machines, clothes dryers, ventilating fans etc.
	  ❑ Capacitors in electronic equipment including TV, microwave ovens, etc.
	❑ Electrical motors
	❑ Electric magnets

Partially closed applications	❑ PCB-containing oil
	  o Heat transfer fluid (e.g. oil radiator)
	  o Hydraulic fluid (e.g. in mines)
	  o Vacuum pumps
	  o Switches
	  o Voltage regulators
	  o Liquid filled electrical cables
	  o Liquid filled circuit breakers

Open applications	❑ Lubricants
	  ❑ Immersion oils for microscopes
	  ❑ Brake linings
	  ❑ Cutting oils
	  ❑ Lubricating oils
	❑ Adhesives
	  ❑ Special adhesives
	  ❑ Adhesives for waterproof wall coatings
	❑ Casting Waxes
	❑ Surface Coatings
	  ❑ Paints
	  ❑ Surface treatment for textiles
	  ❑ Carbonless copy paper
	  ❑ Flame retardants (on ceiling tiles, furniture, walls)
	  ❑ Dust control (dust binders, asphalt, natural gas pipelines)
	❑ Inks
	  ❑ Dyes
	  ❑ Printing inks
	❑ Plasticizers
	  ❑ Gasket sealers
	  ❑ Sealants in joints in buildings
	  ❑ PVC
	  ❑ Rubber seals (around vents, doors, windows)
	❑ Other uses
	  ❑ Insulating materials
	  ❑ Pesticides (additives)

However, most of the closed as well as the open applications are “controlled”, meaning they have been addressed by Directives, Decisions, and Recommendations (see above). But, for instance, products with a low concentration of PCBs (e.g. mineral oil contaminated with PCB), which have been marketed in large quantities, and products with a small volume of pure PCBs (e.g. capacitors in strip light fittings) are “uncontrolled applications”.

Closed, uncontrolled applications are probably mainly limited to small capacitors, e.g. in washing machines, CH circulation pumps, domestic fuel oil burners, strip light fittings, and in lights along motorways and municipal roads.

In EU-Countries PCBs were no longer used in open applications after 1973. Due to the limited life cycle of most of these applications the amount of PCB arising from open applications in the year 2000 should be rather small. Nevertheless, the problem of open, uncontrolled applications should not be neglected, especially with regard to uses in paints and buildings/constructions and the open uses in Non-EU-Countries.

Theoretically, the forming of PCB as a (unintended) by-product is possible in any chemical process involving chloride and organic carbon (e.g. PCP-production, chlorine bleaching of cellulose). But industry is not obliged to analyse PCBs in products. Finally, there are indications, that some countries (e.g. the Peoples Republic of China) are still producing PCBs (OSPAR 2001). Thus, an import of (non-labelled) PCB-containing articles and equipment cannot be excluded.

3.1 Main PCB-containing equipment

3.1.1 Transformers

A transformer is a device that is used to raise and lower voltage. PCB-containing transformers are typically located in electricity generating facilities or buildings, industrial facilities, railroad systems, and military installations. The physical size and shape of transformers vary greatly, from not much bigger than a pea up to the size of a small house. The main structure of a transformer consists of one or more electrical coils linked together by a magnetic circuit or core. Large transformers or transformers for high voltages are often oil-filled. The entire unit is filled with an insulating fluid (typically mineral oil, but for use in an environment where flame resistance is required, like an oil refinery or a steelwork, a PCB-containing oil) to increase the insulation between and to cool the electric coils.

3.1.2 Capacitors

A capacitor is a device for accumulating and holding a charge of electricity. PCB-containing capacitors are typically located in electricity generating facilities or buildings, industrial facilities, railroad systems, residential/commercial buildings, research laboratories, and military installations. The main structure of a capacitor consists of electrical conducting surfaces separated by a dielectric material. It can consist of a winding of aluminium foil and paper impregnated with a suitable fluid e.g. mineral oil or PCB. Capacitor batteries for phase compensation of power transmission lines may consist of thousands of capacitors each containing 15 kg of PCB. Large capacitors used as power factor correction capacitors for inductive loads like electric motors may contain about 1.4 kg of 100 % PCB fluid and can be found in factories, offices, schools, hospitals, stores, and military installations. Small capacitors like motor start capacitors contain less than 1.4 kg of dielectric fluid and can be found in all electrical appliances (see above). Lighting ballasts in fluorescent, mercury, and sodium lighting fixtures and neon lights consist of small transformers and capacitors, which contain approximately 0.1 kg of PCB fluid (UNEP 1999).

4. EMISSIONS AND WASTE

4.1 Emissions from Closed applications

Under ordinary circumstances, no PCBs would be available for exposure to the user or the environment. However, PCB emissions may occur during equipment servicing/repairing, decommissioning, refilling, storage or as a result of damaged equipment, leakage, accidents and fires. According to various estimations the dominating PCB emissions today (1999/2000) arise from electrical equipment due to leakage etc (UBA 1998, Popcycling-Baltic 1999/2000). The largest contribution of PCB-emissions to the air in OSPAR countries arises from leaks and spills from large capacitors (2000). PCBs can be emitted from small capacitors in household appliances during use. After termination of service life most of the small capacitors end up with normal waste (because there is for the time being no effective collection scheme) and therefore contribute to emission.

4.2 Emissions from Open applications

Open applications have been very diverse. PCB emissions arise from evaporation, losses, discharges, and waste during and after use and are very difficult to estimate. Since PCBs were no longer used in open applications after 1973 and assuming a service life of the relevant products of 10 – 20 years, in principle no emissions arising from open applications in use should be assumed for EU-Countries. However, some open applications, like construction materials, were designed for longer periods of use and are thus still a source of emissions. In Non-EU-CPs PCBs were partly used in open applications until the early 90s. PCB inventories in these countries are not yet finished.

4.3 Others Emissions

Emissions can also be expected from various thermal processes. The forming of PCBs as a by-product is possible in any chemical process involving chloride and organic carbon. This means that PCBs can be emitted from open burning or incomplete incineration of waste. Depending of its stability, emissions of PCBs can be expected from incinerating liquid or gaseous fuels containing or contaminated with PCBs. High chlorine content, incomplete combustion and slow cooling of the flue gas favours the formation of dioxins. The same factors probably increase the emission of PCBs.

PCBs can be deposited from air subsequent to volatilisation from contaminated water, soil, sludges etc. (re-emission). Soil is the greatest source of PCB for the atmosphere through re-circulation. The major input of PCBs to freshwater ecosystems is by the atmosphere.

The use of PCB-containing fluids in underground mining (especially coal mining) is a significant source of emissions. However, no data are currently available on the extent of PCB entry into the environment by ventilation systems, mine output and pit water.

Volatilisation and leaching of PCBs from landfills is likely to be low, when the disposal had been carried out in a proper way (stabilised and enclosed in containers or plasticized resins). But PCBs can be emitted from improper waste disposal. A long delay can be expected when PCBs are enclosed in aluminium cans, which is the case for small PCB capacitors.

4.4 PCB-containing wastes

Tab. 2: Activities/sources and locations from which PCB-containing wastes derive

Activity / Sources	Typical Locations
Fluff*)	Landfills (municipal, industrial)
Inadvertent production by chemical plants	Industrial waste water streams & disposal sites from pesticide, organic pigment, chemical and aluminium refining industry
Navigational dredging	Dredged water bodies & their sediments
Transfer spillage	Soil or water near landfills & industrial sites, along transport routes
Accidents/fires	Power distribution networks, industrial sites, material from burnt buildings
Vacuum pump cooling water or condensate	Water discharge sites & leakage
Floor and equipment clean-up wastes	Landfills, industrial dump sites
Repair or decommissioning of equipment	Equipment repair/decommissioning shop grounds & sites, waste disposal sites, industrial facility grounds
Building demolition	Landfills, waste disposal sites
Various recycling operations	Recycled oil equipment, industrial plants, pesticide & soft soap formulations, natural gas pipeline, automobile service stations
PCB in used oil	Industrial and automotive sources, electrical equipment

*) Waste consisting of the light fraction derived from the shredding of cars and appliances
Source: Data from UNEP 1999 (Table A.5 in Guidelines for the Identification of PCBs and materials containing PCBs, UNEP 1999).

4.5 Summary of main PCB emission sources

- leakage and spillage from PCB containing equipment still in use or stored
- fires and accidents at sites where PCB containing equipment is still in use or stored
- inappropriate disassembling of PCB containing equipment
- improper waste disposal
- various thermal processes (production, waste incineration, burning of fuel etc.)
- open applications (e.g. products in buildings)
- “uncontrolled” applications (e.g. small capacitors in household appliances)

Thus, PCBs can end up in the environment by way of accidents, through leaks, diffusion and leaching from the various applications and by improper treatment and dumping of PCB-containing waste. All this causes emissions to air, water, soil and sediment.

5. IDENTIFIED POSSIBLE MEASURES

In all Baltic Sea States/all CPs PCBs are no longer produced and not taken into uses. However, equipment in various amounts is still in use in all countries. Therefore, measures concerning the safe handling and thus the reduction of releases of PCBs from PCB-containing equipment in use have to be developed.

In principle, the most sustainable measure would be to support the PARCOM idea of phasing out and completely destructing in an environmentally safe manner all identifiable PCBs. This would cover also all "uncontrolled" applications - products with a low concentration of PCBs (e.g. mineral oil contaminated with PCB) but marketed in large quantities and products with a small volume of pure PCBs (e.g. capacitors in strip light fittings). It would also cover the phasing-out of hazardous PCB-substitutes. Therefore, there would be a need to establish an appropriate timetable taking into account the different possibilities of the Contracting Parties. It would also be necessary to either define the term "lifetime" or to set an ultimate deadline/timetable for the phasing out of all applications. However, a total ban on ongoing use of all PCB containing materials, equipment and appliances, regardless of whether they constitute a serious source of PCB emissions, might be not a very cost-efficient measure. The wording of PARCOM Decision 92/3 might have been too general in order to achieve optimal coverage of the problem. Thus, for the time being, preference should be given to other more specific measures.

The following list of measures, which should be taken into consideration, does not claim to be complete.

5.1. Capacity-building

In those countries where a deficiency of capacity exists, knowledge, skills, management and personnel as well as financial resources within trade/industry and state institutions have to be developed to such an extent that PCB can be successfully phased out. This can be i) training and education, ii) development and practical use of information-, communication-, assessment-management instruments, iii) developing the institutional set up. This probably has to go hand in hand with the recommended measures regarding technology transfer and information exchange and information campaigns and educational measures.

5.2 Avoidance and control of unintended by-production and ban of the import of PCB-containing products

Unintended by-production of PCBs should be avoided by introduction of BAT at chemical production sites. The import of PCB-containing products, especially from the eastern market should be banned. Therefore PCB presence and concentration tests in suspicious existing or imported articles (e.g. pesticides, soft soap) and equipment as well as in new products, which due to their way of production could possibly contain PCBs as a by-product, should be carried out. An overview of available analytical tests and detection kids for determining the presence of PCBs in a material is given in UNEP Chemicals` Guidelines for the identification of PCBs and materials containing PCBs (August 1999).

5.3 Inventories (identification and labelling) of PCB-containing equipment and products

Inventories (identification and labelling) of PCB-containing equipment and products should be carried out if not yet done (e.g. in Estonia, Latvia, Lithuania). To assist in the recognition of PCB-containing products, several lists with trade names are available (e.g. in the Technical Guidelines of the Basel Convention). If the holders of equipment do not know that they hold PCB containing equipment they consequently will not declare it. Therefore they need assistance from the authorities or (trade organisations of) other countries. A detailed proposal for a preparation of an inventory is given in the Danish EPA Strategic Report 2000. Equipment containing PCBs should be subject to labelling, registration and regular inspections to confirm that it is in good condition and is not leaking. This should also apply to equipment, which,

originally contained PCBs, but subsequently has been drained and refilled with a non-PCBs dielectric fluid. This equipment contains residual PCBs concentrations.

5.4 Improved inspection, instructions and maintenance in order to prevent, avoid and discover accidents, abnormal operation conditions, leakage and spillage

All possible measures should be taken to avoid accidents, abnormal operation conditions, leakage and spillage from equipment. Prevention must consider acute risks like cases of emergency, risk for fire or spillage to water and more long-term risks like continuous emission. Emergency plans for cases of accidents (e.g. explosions or overheating of transformers and capacitors), leakages, spillages, etc. including education and special training in clean-up procedures with employers, service teams, recyclers etc. should be established.

At all locations where PCB-containing equipment is located the following precautionary measures should be taken:

- warning notices placed near equipment
- all drain valves should be securely closed in a way to prevent inadvertent or unauthorised opening
- regular inspections should be undertaken
- installation of reception tanks
- emergency plans must be available
- emergency equipment to tackle accidents must be available
- training of personnel
- authorities must be informed about accidents
- the repair of equipment or the clean-up of spillages and leaks containing PCBs should be carried out by competent staff only

In addition to the prescriptive approach of the Seveso II – Directive voluntary measures for the prevention of accidents would be reasonable because they are more far-reaching than legal regulations and should therefore be supported. Voluntary approaches such as EMAS are based on the objective of “continuous improvement” of activities with environmental impact. Those approaches can be also of economical advantage for enterprises.

5.5 Clean repair and decommissioning of equipment

Repair and decommissioning should be carried out with appropriate equipment, precautions to avoid accidents and spillage and by specialised personnel.

5.6 Decontamination and avoidance of re-introduction of PCBs via recycling of contaminated equipment and material

Decontamination of material for recycling should be carried out with appropriate equipment for controlled shredding of articles such as capacitors, and for the careful emptying, flushing, dismantling, dismemberment and decontamination of larger items of equipment such as transformers. Only specialised personnel should carry out decontamination and other preparations for recycling.

It is no longer considered environmentally sound practice to seek to recover PCBs. Thus, this should be avoided.

The refill of used/recycled oil in transformers containing uncontaminated mineral oil or in transformers, which originally contained a lower PCB concentration than the transformer, from which the recycled oil arises, should be avoided. (Compare this example from Estonia: By the

refilling procedure one PCB containing transformer can potentially contaminate nearly 1000 transformers to a level above the limit of 50 ppm.)

Used PCB transformer oil has often been mixed with used mineral oil in oil recycling operations, so that low concentrations of PCBs are often found in recycled oil used in trucks and automobiles. This mixing and also mixing and diluting of PCB-waste with other waste streams and/or products should be avoided. Moreover, it is not in accordance with the Directive on waste. Separation of hazardous substances at source is fundamental for improved waste management. Recycling or reuse of waste insulating oil may unnecessarily spread PCB contamination. A stricter requirement than "less than 50 ppm PCB" would be a valuable tool for clean-up of electrical, oil filled equipment.

5.7 Clean building renovation and demolition

PCB containing components (sealants, filling material for joints of concrete structures, flame-retardant coatings on sealing boards or tiles, fluorescent light ballasts, coatings on furnishings, surface treatments for textiles, adhesives for waterproof wall coatings, paints, insulating materials, sealant putties, large and small capacitors in appliances and electrical devices, double glazed window units) should be analysed and separated prior to demolition or renovation of the relevant building. These compounds should then be disposed or incinerated in an appropriate manner[3].

A program is running in Sweden for identifying PCBs in buildings. The estate owners and the building industry have set up a voluntary agreement for the replacement of risky material. Norway's pollution control authority is to launch a study of the polychlorinated biphenyls (PCBs) content of plaster, mortar, concrete admixtures and similar building materials. The aim is to formulate criteria for safe cleansing and waste disposal (ENDS Daily 4 April 2001).

5.8 Information campaigns and educational measures

Measures must be taken to increase public awareness of the PCB problem. These measures have to be applied to the different target groups, like public, schools, industry, importers, waste producers, recyclers, dismantlers etc.

Due to the problem of widely distributed small capacitors used in private households a broad public has to be reached in order to increase the acceptance of relevant collection schemes, to avoid dumping of smaller electric appliances with household waste and to encourage people to participate in separate collection programs (e.g. by incentive programs)
Information material in national languages has to be prepared covering various aspects for different target groups:

- increase public awareness in common (broad public)
- provide background information on PCB management (e.g. IFCS 2001)
- inform about safe destruction technologies (recyclers, shredder companies etc.)
- inform about notification and labelling duty (e.g. authorities, traders, importers, industry)
- inform about safe treatment and environmentally sound disposal of PCB containing waste (waste producers, traders, electricians[4], industry, recyclers, dismantlers etc.)
- carry out regional workshops addressing the specific problems of the different Contracting Parties

[3] Because of the difficulties with making reliable lists on PCB capacitors, coils and resistors, all such components containing fluids should be handled as PCB components unless otherwise is documented.
[4] Appliances like fluorescent light fittings, ventilation fans etc. are often permanently installed which means that the electrician involved must be well informed about waste management of the exchanged appliance.

5.9 Technology transfer and information exchange

The promotion of technology transfer and information exchange could be realised by various measures such as supporting programmes to further develop abatement technologies, technology transfer programmes, description of the actual state of progressive industries in the relevant BAT notes, communication and information measures in the relevant industries and decision support manuals for abatement measures and consulting programmes at enterprise level.

5.10 Avoidance of PCB emissions from incineration processes

Important sources of PCB emissions are coal-fired power plants, metal industry, secondary steel production, fire places (oil, wood, coal), diesel powered vehicles (UBA 1998). BAT should be applied to minimise PCB emission from these processes.

5.11 Establishment of safe collection and storage schemes

Safe collection and storage schemes have to be established to ensure a separate and controlled disposal route for equipment with capacitors. All electrical equipment/smaller electric appliances, should be collected separately and not to be dumped with household waste. CPs should therefore provide the possibility:

- of delivering appliances to recycling centres/landfill sites
- of returning appliances when bulky refuse is collected
- of returning appliances in separate containers
- of collection at request
- of returning appliances to the trader

The Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment includes measures on the separate collection of WEEE, the treatment of WEEE and the recovery of such waste. Waste separation at source is a method for improving recycling of e.g. metals without causing increased emissions to the environment or conservation of dangerous substances that are to be phased out. An effective implementation of the proposed WEEE directive may improve the selective collection of dangerous components of waste from electric and electronic products. The proposed measures should be taken already into account although it will take some more time/years until this Directive will be adopted.

5.12 Proper/safe interim storage

PCB wastes and PCB contaminated equipment need to be stored under environmentally sound and regulated conditions before getting decontaminated or destructed. The storage area should be on a firm, impermeable base coated with a suitable sealant and roofed. Areas storing drums and equipment containing PCBs should be bonded. All stored items should be clearly labelled. Care must be taken to avoid losses and especially to avoid contamination of the storage building and other materials to avoid increasing the quantity of materials needed to be classified as PCBs. Emission of PCBs with particles of used absorbents must be avoided.

5.13 Safe destruction and environmentally sound disposal / incineration

5.13.1 Decontamination processes for PCB-contaminated equipment

- removal of liquid PCBs from equipment to allow safe disposal or recycling of the solid components (heating might facilitate the drainage of the liquid)
- solvent extraction or heat treatment (170 – 550 °C) of metal components
- fine cleaning of metal parts in an ultrasonic bath

- dissolving of the remaining porous substances (paper wrappings of the coils) in the so-called Low Temperature Recycling
- decontaminated equipment may then be recycled in conventional plants such as metal foundries
- contaminated components can be treated in a destruction facility
- contaminated solvents should be distilled
- propane, butane or hexane can be used to treat soils and sludges
- PCB containing residues have to be disposed in an environmentally sound manner
- retrofilling: removal of PCBs from equipment (e.g. transformers), washing of internals with a solvent, refill with a substitute oil and return to service; disadvantages: complex internal parts are difficult to wash, process has to be repeated several times, PCB amounts remain after retrofilling, efficiency is difficult to assess

Decontamination is never completely applied to all components, this means that a residue remains which must be incinerated. For capacitors this washing technique might not be appropriate due to its construction. They have then to be shredded or cut into pieces and incinerated.

5.13.2 Current PCB destruction technologies

A comprehensive overview is given in the UNEP Chemicals` "Survey of currently available non-incineration PCB destruction technologies" (August 2000).

- Incineration (minimum temperature 1200 °C, 2-5 sec residence time, atmosphere with at least 6 % surplus oxygen and a turbulence of the gas stream equivalent to at least 65000 R_e)
    - rotary kiln incinerators
    - liquid injection incinerators
    - static kiln incinerators
    - fluidised bed incinerators
    - cement kilns
- Dechlorination processes: designed to allow the reuse/recycling of chlorine free oil
    - chemical dechlorination: based on reactions with either an organically bound alkali metal or an alkali metal oxide or hydroxide
    - hydrotreating/hydration: treatment of oils with high pressure hydrogen gas in the presence of a catalyst; PCBs are thus converted to hydrogen chloride and hydrocarbons
    - solvated electron technology
- Plasma Arc Systems: pyrolysis into ions and atoms at a temperature above 3000 °C.

UNEP Chemicals has prepared an inventory of worldwide PCB destruction capacity in 1998 performing information about different facilities, offered services and wastes and equipment accepted.

Tab.: 3 Features of PCB destruction processes

Process	Waste types	Advantages	Disadvantages
Incineration (above 1200 °C)	oils, residues from separation processes PCB-containing waste equipment	high destruction efficiencies, calorific contribution of waste facilities can treat chlorinated as well as non-chlorinated wastes	PCB content only as a fuel, solid feeds may require some pre-processing costly (1000-3000 US$/t)
Chemical dechlorination and hydrotreating	liquid PCBs	dechlorinated oil can be used for other purposes	need to establish treatment conditions for individual components
Plasma Arc Systems	liquid PCBs and pumpable solids	low process inventory	limited operational experience high investment costs

Data from United Nations Environment Programme: Inventory of worldwide PCB destruction capacity. First issue December 1998. Prepared by UNEP Chemicals.

5.14 Landfilling: to be carried out properly or avoided

Landfilling should be avoided whenever possible because PCB remains a threat. Landfilling should be regarded as a method for disposing of PCBs contaminated wastes, only in exceptional and limited cases. Prior to landfilling, transformers can be processed by a solidification technology that leads to an inert, non-leachable solid product. So-called long-term storage of equipment and articles containing PCBs, possibly after removal of any free liquid, is practised using special stores, underground vaults or old mine workings. The intention is that the waste should be accessible for treatment and/or disposal in the future.
As already mentioned, volatilisation and leaching of PCBs from landfills is likely to be low, when the disposal had been carried out in a proper way (enclosed in containers or plasticized resins). However, measures have to be taken to avoid leaching of PCBs, arising e.g. from damaged containers or improper disposal.

5.15 Restricted transport

Transport should take place only in order to dispose or destruct the substance in a more environmentally sound manner than in the place from which the PCBs/PCB-containing equipment are being transported. Restrictions concerning transboundary transport of PCBs should be only lifted in that case.

5.16 Waste inventories

Inventories of PCB containing waste should be carried out, waste management plans should be elaborated and effective waste destruction programmes including finance plans established. For those countries that have no existing hazardous waste management yet (e.g. Estonia) this should include the following:

- Construction of facilities for temporary storage of PCB containing waste (including suitable drums and steel trays)
- Preparation of an inventory list of PCB containing equipment
- Preparation of guidelines for decontamination of equipment
- Determination of the price for transport, temporary storage and final treatment of PCB containing equipment
- Construction of facilities for destruction of PCB containing equipment

5.17 Substitution of PCB

Talking in terms of substitutes for a substance that was identified as a widely spread pollutant already 35 years ago seems a bit awkward. The alternatives have been available since at least 1978, maybe earlier. Possibly there may be an exception for the highest voltages use in Russia in their power lines. Nevertheless, the following should be considered:

- Promote selfcommittments of industry like the Swedish industry selfcommittment to substitute/decontaminate PCB in buildings (sealant, nonskid flooring) before 2003[5]
- Promotion of production and use of less hazardous substitutes
  Lists of less hazardous substitutes are available (e.g. OSPAR, Germany: Technische Regeln für Gefahrstoffe 616: Ersatzstoffe, Ersatzverfahren und Verwendungs-beschränkungen für Polychlorierte Biphenyle (PCB). Bundesarbeitsblatt, Heft 5 (1994) 43-49).
- Ban the use of hazardous PCB-substitutes covered by Directive 91/339/EEC

5.18 Decontamination of PCB-contaminated sites and soils

PCB contaminated sites and soils should be decontaminated in order to avoid volatilisation and diffuse re-circulation of PCBs from contaminated water, soil and sewage sludges. Soils for example can be bio-remediated with the use of bacteria, which break down the chlorinated (and other) hydrocarbons[6], it can be also incinerated or extracted by means of venting (passage of air to remove vapours) or by solvent washing.

5.19 Summary of identified possible measures

- Full implementation of Council Directive 96/59/EC and HELCOM Recommendation 6/1
- Capacity-building
- Avoidance and control of unintended by-production
- Ban of the import of PCB-containing products
- Carry out inventories (identification and labelling) of PCB-containing equipment and products
- Improved inspection, instructions and maintenance in order to prevent, avoid and discover accidents, abnormal operation conditions, leakage and spillage
- Clean repair and decommissioning of equipment
- Decontamination and avoidance of re-introduction of PCBs via recycling of contaminated equipment and material
- Clean building renovation and demolition
- Information campaigns and educational measures
- Technology transfer and information exchange
- Avoidance of PCB emissions from incineration processes
- Establishment of safe collection and storage schemes
- Proper/safe interim storage
- Safe destruction and environmentally sound disposal/incineration
- Landfilling: to be carried out properly or avoided
- Restricted transport
- Waste inventories
- Substitution of PCB
- Decontamination of PCB-contaminated sites and soils

[5] This is rather decontamination than substitution of PCBs because the new sealants often do not need a plasticizer.
[6] Technical PCBs are a mixture, which may undergo biological degradation only to a certain extent. Highly chlorinated PCBs often remain intact.

6. PRIORITIZATION OF MOST EFFECTIVE MEASURES

The following chapter does not provide a complete evaluation of the most (cost) effective measures to reduce releases of PCB to the environment, but tries to give a certain guide to prioritise the above identified possible measures.

The highest priority should be given to measures concerning existing equipment containing significant amounts of PCB (transformers and power capacitors). Main types of measures would therefore include:

- Carry out inventories (identification and labelling) of PCB-containing equipment and products
- Guidelines, improved inspection, instructions and maintenance in order to prevent, avoid and discover accidents, abnormal operation conditions, leakage and spillage
- Clean repair and decommissioning of equipment
- Efficient decontamination and avoidance of re-introduction of PCBs via recycling of contaminated material
- Establishment of safe collection and storage schemes
- Proper/safe interim storage
- Safe destruction and environmentally sound disposal/incineration

In a similar manner measures could be identified for other main PCB sources (not in order of importance):

- Clean building renovation and demolition (covering open uncontrolled applications)
- Establishment of safe collection and storage schemes (covering closed, uncontrolled applications in small capacitors, e.g. in washing machines, CH circulation pumps, domestic fuel oil burners, strip light fittings, and in lights along motorways and municipal roads)
- Avoidance and control of unintended by-production
- Avoidance of PCB emissions from incineration processes
- Decontamination of PCB-contaminated sites and soils
- Landfilling: to be carried out properly or avoided

Further, the following basic measures should be taken into account:

- Information campaigns and educational measures
- Technology transfer and information exchange
- Ban of the import of PCB-containing products
- Restricted transport
- Waste inventories

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List of abbreviations

AMAP	Arctic Monitoring and Assessment Programme
BAT	Best Available Technology
CPs	Contracting Parties
e.g.	exempli gratia / for example
EINECS	European Inventory of Existing Commercial Substances
EMAS	Eco-Management and Audit Scheme
EMEP	European Monitoring and Evaluation Programme
EPA	Environmental Protection Agency
EU	European Union
FAO	Food and Agriculture Organisation
HELCOM	Helsinki Commission (Baltic Marine Environment Protection Commission)
IFCS	Intergovernmental Forum on Chemical Safety
IPPC	Integrated Pollution Prevention and Control
LRTAP	Long-range Transboundary Air Pollution
OECD	Organisation for Economic Cooperation and Development
OSPAR	Oslo and Paris Commissions
PBB	polybrominated biphenyl
PCB	Polychlorinated Biphenyls
PCT	Polychlorinated Triphenyls
PIC	Prior Informed Consent
POP	Persistent Organic Pollutants
ppm	parts per million
Rec.	Recommendation
ROHS	restrictions on use of hazardous substances in electrical and electronic equipment
SME	Small and Medium-Sized Enterprises
UBA	Umweltbundesamt (German Federal Environmental Agency)
UN/ECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
WEEE	waste electrical and electronic equipment