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BASEL CONVENTION

Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
Twelfth meeting
Geneva, 4–15 May 2015
Agenda item 4 (b) (i)

Matters related to the implementation of the Convention: scientific and technical matters: technical guidelines

Technical guidelines

Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with polychlorinated biphenyls, polychlorinated terphenyls or polybrominated biphenyls including hexabromobiphenyl

Note by the Secretariat

At its twelfth meeting, the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal adopted, in decision BC-12/3 on technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants, the technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with polychlorinated biphenyls, polychlorinated terphenyls or polybrominated biphenyls including hexabromobiphenyl, on the basis of the draft technical guidelines contained in document UNEP/CHW.12/5/Add.5. The technical guidelines referred to above were prepared by Japan as lead country for this work, in close consultation with the small intersessional working group on the development of technical guidelines on persistent organic pollutants wastes and taking into account comments received from parties and others and comments provided at the ninth meeting of the Open-ended Working Group of the Basel Convention. The technical guidelines were further revised on 10 April 2015 taking into account comments received from parties and others by 23 January 2015, as well as the outcome of the face-to-face meeting of the small intersessional working group on the development of technical guidelines on persistent organic pollutants wastes held from 17 to 19 March 2015 in Ottawa, Canada (see document UNEP/CHW.12/INF/12). The text of the final version of the technical guidelines, as adopted, is set out in the annex to the present note.

Annex

Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with polychlorinated biphenyls, polychlorinated terphenyls, polybrominated biphenyls including hexabromobiphenyl

Revised final version (15 May 2015)

Contents

Abbreviations and acronyms

ABS	acrylonitrile-butadiene-styrene copolymers (plastics)
ABNT	Associação Brasileira de Normas Técnicas (Brazilian National Standards Organization)
AOAC	Association of Official Agricultural Chemists (United States of America)
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry (United States of America)
CAS	Chemical Abstracts Service
DIN	Deutsches Institut für Normung e.V. (German Institute for Standardization)
EN	European Standards
EPA	Environmental Protection Agency (United States of America)
ESM	environmentally sound management
HBB	hexabromobiphenyl
HCB	hexachlorobenzene
IARC	International Agency for Research on Cancer
IPCS	International Programme on Chemical Safety (of WHO)
ISO	International Organization for Standardization
JIS	Japanese Industrial Standards
NEN	The Netherlands Standardization Institute
NVN	Dutch standards
OEWG	Open-ended Working Group of the Basel Convention
PBB	polybrominated biphenyl
PBDD	polybrominated dibenzo-p-dioxin
PBDF	polybrominated dibenzofuran
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-p-dioxin
PCDF	polychlorinated dibenzofuran
PCN	polychlorinated naphthalene
PCT	polychlorinated terphenyl
PeCB	pentachlorobenzene
POP	persistent organic pollutant
TEF	toxic equivalency factor
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
WHO	World Health Organization

Units of measurement

mg	milligram
kg	kilogram
Mg	megagram (1,000 kg or 1 tonne)
mg/kg	milligram per kilogram. Corresponds to parts per million (ppm) by mass.

I. Introduction

A. Scope

1. The present document supersedes the *Updated technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with polychlorinated biphenyls (PCBs), polychlorinated terphenyls (PCTs) or polybrominated biphenyls (PBBs)* of March 2007.

2. The present technical guidelines provide guidance on the environmentally sound management (ESM) of wastes consisting of, containing or contaminated with hexabromobiphenyl (HBB), polybrominated biphenyls (PBBs), polychlorinated biphenyls (PCBs) or polychlorinated terphenyls (PCTs) pursuant to several decisions of two multilateral environmental agreements on chemicals and wastes.[1] PCB was listed in Annex A to the Stockholm Convention at the time of its adoption. HBB was listed in Annex A to the Stockholm Convention in 2009, through the adoption of an amendment that entered into force in 2010.

3. The present technical guidelines address PCBs and HBBs together with PCTs and PBBs other than HBB as a class or category of substances, owing to similarities in the physico-chemical and toxicological properties of all of these substances. Among other topics, the guidelines address all activities pertaining to waste management. It should be noted that PCTs and PBBs other than HBB are not currently subject to the Stockholm Convention.

4. Unintentionally produced PCBs are not covered by the present technical guidelines. They are covered instead by the *Technical guidelines on the environmentally sound management of wastes containing or contaminated with unintentionally produced polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans* (PCDFs), *hexachlorobenzene* (HCB), *polychlorinated biphenyls or pentachlorobenzene* (PeCB) (Unintentional POPs technical guidelines) (UNEP, 2015).

5. The present document should be used in conjunction with the *General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants"* (UNEP, 2015a) (hereinafter referred to as "general technical guidelines"). The general technical guidelines are intended to serve as an umbrella guide for the ESM of wastes consisting of, containing or contaminated with persistent organic pollutants (POPs) and provide more detailed information on the nature and incidence of wastes consisting of, containing or contaminated with PCBs, PCTs or PBBs, including HBB, for purposes of their identification and management.

B. Description, production, use and wastes

1. Description

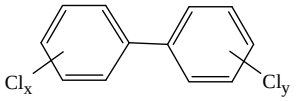
(a) PCBs

6. PCBs are synthetic aromatic compounds formed in such a manner that the hydrogen atoms on the biphenyl molecule (two benzene rings bonded together by a single carbon-carbon bond) may be replaced by up to 10 chlorine atoms. The basic chemical structure of PCBs is shown in figure 1 below; the general molecular formula for PCBs is $C_{12}H_{10-n}Cl_n$, where n=1-10 (CAS No. 1336-36-3). In theory there are 209 congeners, although only about 130 congeners have actually been found in commercial chemical formulations (Holoubek, 2000). Typically, four to six of the 10 possible substitution sites are occupied by a chlorine atom (Environment Canada, 1988). In case of dielectric fluids, PCB mixtures mainly containing either tri-, tetra-, or pentachlorinated homologues are used. The physical properties are, for instance, regarding trade named Aroclor 1254 which is one of the popular commercial PCB products consisting most of pentachlorobiphenyls, the boiling point is of 365°C -390°C, the specific gravity (at 25°C) is 1.54 g/cm,[3] the vapour pressure (at 25°C) is 0.010 Pa, the water solubility (at 24°C) is 0.057mg/L, and it is viscous liquid at an ordinary temperature (US

[1] Decisions V/8, VI/23, VII/13 and VIII/16, BC-10/9, BC-11/3 and BC-12/3 of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal; decisions OEWG-I/4, OEWG-II/10 OEWG-III/8, OEWG-IV/11, OEWG-V/12, OEWG-8/5 and OEWG-9/3 of the Open-ended Working Group (OEWG) of the Basel Convention; resolution 5 of the Conference of Plenipotentiaries of the Stockholm Convention on Persistent Organic Pollutants; decisions INC-6/5 and INC-7/6 of the Intergovernmental Negotiating Committee for an International Legally Binding Instrument for Implementing International Action on Certain Persistent Organic Pollutants; and decisions SC-1/21, SC-2/6 and SC-4/13 of the Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants.

ATSDR, 2000). The more highly chlorinated PCB congeners are virtually insoluble in water and highly resistant to degradation.

Figure 1: Chemical structure of PCBs



7. Since PCBs are stable to heat and biodegradation, once released into the environment they are persistent and accumulate in the organic components of soils, sediments, biological tissues and organic carbons dissolved in aquatic systems, thereby entering the ecological food chain. PCBs especially accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water. The general population may be exposed to PCBs by ingesting contaminated food and by inhaling contaminated air. PCBs are transported from soil and sediment to the atmosphere and can easily cycle between air, water and soil and enter the air by evaporation from both soil and water. In air, PCBs can be carried long distances and have been found in snow and seawater in areas far away from where they were released, such as the Arctic (ATSDR, 2000).

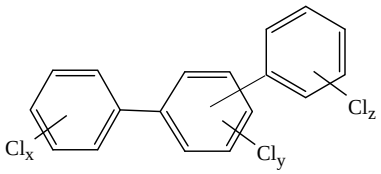
8. PCBs include 12 congeners to which the World Health Organization (WHO) has assigned toxicity equivalency factors (TEFs) because they exhibit dioxin-like toxicity (Van den Berg et al, 2006).

9. PCBs, including the abovementioned 12 dioxin-like congeners, have been classified as carcinogenic to humans (Group 1) by the International Agency for Research on Cancer (IARC, 2014).

(b) PCTs

10. PCTs also constitute a group of halogenated hydrocarbons. They are very similar to PCBs in terms of chemical structure, except that they contain three phenyl rings instead of two and therefore can have up to 14 chlorine atoms attached. The number of possible PCT congeners is large; however, only a few occur in commercial chemical formulations. PCTs and PCBs have similar chemical and physical properties. PCTs are virtually insoluble in water and highly resistant to degradation. One difference between PCTs and PCBs is that PCTs are generally less volatile. The basic chemical structure of PCTs is shown in figure 2 below; PCTs have the general molecular formula $C_{18}H_{14}$-nCln, where n=1-14 (CAS No: 61788-33-8).

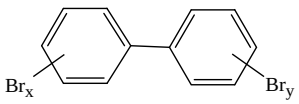
Figure 2: Chemical structure of PCTs



(c) PBBs

11. PBBs are the bromine analogues of PCBs and thus there are 209 possible PBB congeners. Only a few, however, occur in commercial chemical formulations (IPCS, 1994). They are solids or waxy substances at room temperature. They are virtually insoluble in water and highly resistant to degradation. The basic chemical structure of PBBs is shown in figure 3 below; PBBs have the general molecular formula $C_{12}H_{10-n}Br_n$, where n=1-10.

Figure 3: Structural formula of PBBs



12. HBB belongs to a wider group of PBBs. Hexabromo congeners possibly exist in 42 isomeric forms, which are listed under a variety of CAS numbers, e.g., CAS No. 36355-01-8 for all HBB isomers and CAS No. 59080-40-9 for 2,2',4,4',5,5'-HBB. HBB is white and solid at normal temperatures and has a vapour pressure of $6.9x10^{-6}$ Pa and a melting point of 72°C (ATSDR, 2004).

13. Some PBBs have been assigned toxicity equivalency factors similar to those of PCBs (Van den Berg et al., 2013).

14. PBBs have been classified by IARC as probably carcinogenic to humans (Group 2A) (IARC, 2014).

2. Production

(a) PCBs

15. PCBs have excellent dielectric properties, longevity, non-flammability and resistance to thermal and chemical degradation. For this reason, prior to national bans they were manufactured for use in electrical equipment, heat exchangers, hydraulic systems and several other specialized applications.

16. The main period of manufacture of PCBs was from 1930 to late 1977 in the United States of America, up to 1983 in China, up to the mid-1980s in Europe, up to 1993 in the Russian Federation and from 1954 to 1972 in Japan.[2]

17. Chlorination of PCBs was conducted continuously until a certain target percentage of chlorine based on weight was achieved. Manufactured PCBs were used as insulating oils and as heat media. Electric equipment can contain notably high concentrations of PCBs. For example, capacitors may be filled with up to 100 per cent PCBs and transformers with approximately 60-70 per cent PCBs. In addition, PCBs were added in small quantities to inks, plastics, paints, sealants, adhesives and dye solvents for carbonless paper. At room temperature, most of the PCBs added to these products were oily liquids or waxy solids.

18. Prominent trade names of PCB products include those listed below (see annex I to the present guidelines for a more detailed list of PCB trade names and synonyms, and section IV.D for a discussion of trade names in inventory identification):

(a) Apirolio (Italy);

(b) Aroclor (United States of America and United Kingdom of Great Britain and Northern Ireland);

(c) Askarel (United States and United Kingdom);

(d) Clophen (Germany);

(e) Delor (Czechoslovakia);

(f) Elaol (Germany);

(g) Fenchlor (Italy);

(h) Inerteen (United States);

(i) Kanechlor (Japan);

(j) Phenoclor (France);

(k) Pyralene (France);

(l) Pyranol (United States);

(m) Pyroclor (United States and United Kingdom);

(n) Santotherm (Japan);

(o) Sovol (former Union of Soviet Socialist Republics (USSR));

(p) Sovtol (former USSR).

19. In the Aroclor series, a four-digit number follows the word Aroclor. The first two digits of the number are either 10 or 12. The number 12 indicates a normal Aroclor while the number 10 indicates a distillation product of an Aroclor. The second two digits of the four-digit code indicate the percentage of chlorine in the mixture by weight. Therefore, Aroclor 1254 contains approximately 54 per cent chlorine by weight.

[2] The estimated production amount and the period of manufacture of PCBs are summarized in table 1 of UNEP/POPS/COP.7/INF/9.

20. Commercial PCB products and articles were sold for their industrial properties rather than for their chemical composition (IPCS, 1992). They contained a number of impurities and were often mixed with solvents, such as tri- and tetrachlorobenzenes. PCBs mixed with tri- and tetrachlorobenzenes were called askarel. Contaminants in commercial mixtures include PCDFs and chlorinated naphthalenes. Studies have found from 0.8 mg/kg to 40 mg/kg of PCDFs in PCB commercial mixtures (IPCS, 1992). PCBs are also formed unintentionally in some thermal and chemical processes.

21. The cumulative worldwide production of PCBs has been estimated to be 1-1.5 million tonnes.[3]

(b) PCTs

22. PCTs were manufactured in much smaller quantities than PCBs and were given the same or similar trade names. They were used for the same sorts of applications as PCBs, although most were used in waxes, plastics, hydraulic fluids, paints and adhesives (Jensen and Jørgensen, 1983). In the United States, Aroclor series PCTs were identified by the digits 54 in the first two spaces of the four-digit code, e.g., Aroclor 5432, 5442 and 5460 (IPCS, 1992). See annex I to the present guidelines for examples of trade names and section IV.D for a discussion of trade names in inventory identification.

23. Examples of PCB trade names are Aroclor (United States) and Kanechlor KC-C (Japan).

24. PCTs were produced in the United States, France, Germany, Italy and Japan until the early 1980s, when all production is thought to have ceased. The cumulative world production is estimated to have been 60,000 tonnes between 1955 and 1980 (UNECE, 2002).

(c) PBBs

25. PBBs exhibit unusual chemical stability and are stable in acids, bases, heat, and reducing and oxidizing agents. However, in chemical reactions, bromine is better than chlorine as a leaving group (IPCS, 1994). For this reason, PBBs were manufactured mainly for use as flame retardants.

26. It is estimated that at least 11,000 tonnes of PBBs were produced worldwide, but the amounts of production of some PBB-producing countries are not available (IPCS, 1994). In the United States, the commercial production of PBBs began in 1970, and about 6,000 tonnes were produced from 1970 to 1976. The first PBB compound produced in the United States was HBB, but its production was discontinued in 1975. HBB was commercially called FireMaster in the United States and its production constituted about 88 per cent of total PBB production (ATSDR, 2004). PBBs were also manufactured in the United Kingdom until 1977, and in Germany until the mid-1980s. Although PBBs were never produced in Japan, they were imported into that country until 1978. It has been reported that PBB production ended worldwide with the cessation of decabromobiphenyl production in France in 2000 (UNEP, 2006).

27. PBBs produced for commercial uses include mixtures of various brominated biphenyls, mainly containing HBB and octa-, nona- and decabromobiphenyls, as well as other PBB congeners (IPCS, 1994). All commercial PBB mixtures were relatively highly brominated, with bromine contents ranging from about 76 per cent HBB to 81-85 per cent octa- to decabromobiphenyl mixtures (IPCS, 1994; IARC, 2014).

28. Prominent trade names of PBB products include those listed in table 1 below (see annex I to the present guidelines for a more detailed list of PBB trade names and synonyms, and section IV.D for a discussion of trade names in inventory identification).

[3] http://chm.pops.int/Implementation/PCBs/Overview/tabid/273/Default.aspx.

Table 1: Main constituents, trade names and country of origin[4]

Main PBB congener	Trade name	Country in which the chemical has been produced
Hexabromobiphenyls	FireMaster FF-1	United States
	FireMaster BP-6	United States
Octabromobiphenyls	BB-8	
	Bromkal 80	Germany
	Bromkal 80–9D	Germany
	Octabromobiphenyl FR 250 13A	United States
	Technical octabromobiphenyl	United States
Decabromobiphenyl	Adine 0102	France
	Berkflam B-10	United Kingdom
	Flammex B-10	United Kingdom
	HFO 101	United Kingdom
	Technical decabromobiphenyl	United States

3. Use

(a) PCBs

29. PCBs were used in a very wide variety of industrial and consumer applications. Such applications have been categorized by WHO as completely closed, nominally closed, and open-ended (IPCS, 1992), and included the following:

(a) Completely closed systems:

(i) Electrical transformers;

(ii) Electrical capacitors (including lamp ballasts);

(iii) Electrical switches, relays, breakers, reclosers and others;

(iv) Electrical cables;

(v) Electrical bushings;

(vi) Electrical reactors;

(vii) Electrical regulators;

(viii) Electric motors and magnets (very small amounts);

(b) Nominally closed systems:

(i) Hydraulic systems;

(ii) Heat transfer systems (heaters, heat exchangers);

(iii) Vacuum pumps;

(iv) Vapour diffusion pumps;

(c) Open-ended systems:

(i) Plasticizer in polyvinyl chloride, neoprene and other artificial rubbers;

(ii) Ingredient in paint and other coatings;

(iii) Ingredient in ink and carbonless copy paper;

[4] IPCS, 1994 and IARC, 2014.

(iv) Ingredient in adhesives;

(v) Pesticide extender;

(vi) Ingredient in sealants and caulking material;

(vii) Fire retardant in fabrics, carpets, polyurethane foam, etc.;

(viii) Lubricants (microscope oils, brake linings, cutting oils, bridge bearings, other lubricants).

30. Although electrical transformers containing PCBs are defined as a "completely closed" application, industrial practices caused these PCBs to be transferred to other types of equipment, thus creating additional points of contact with the environment. A common practice was to top up or recharge non-PCB (mineral oil) transformers with PCBs when no other fluid was available.

31. PCB oils were also added to or disposed of with non-PCB fluids such as heating or cooling fluids, hydraulic fluids, brake fluids, engine oils and off-specification fuels. There are numerous anecdotal reports of employees in electrical utilities using PCB fluids to wash their hands and taking PCB fluids home for use as lubricants in home heaters, hydraulic systems and motors. Since most of the fluorescent lamp ballasts that were made before PCBs were banned contained PCBs, many homes and businesses that installed fluorescent lamps unknowingly acquired PCBs.

(b) PCTs

32. PCTs were used in almost exactly the same applications as PCBs but in much smaller amounts. Little is known, however, about remaining quantities of PCTs because PCT inventories have not been developed (UNECE, 2002). It is known that very small amounts of PCTs were used in electrical equipment (Jensen and Jørgensen, 1983).

(c) PBBs

33. The principal use of PBBs was as flame retardants. PBBs are an additive type flame retardant. Mixed with a dry solid or liquid polymeric material, PBB provides a filter-type, flame retardant action by chemically releasing hydrogen bromide when ignited. Other uses of PBBs are: as color activators in light sensitive compositions; as relative molecular mass control agents for polybutadiene; as wood preservatives; as voltage stabilizing agents in electrical insulation; and as functional fluids, such as dielectric media (IPCS, 1994).

34. In the United States and Canada, FireMaster was used as a flame retardant in three main commercial products: acrylonitrile-butadienestyrene (ABS) thermoplastics (10 per cent PBBs) for housing business machines, industrial equipment (e.g., motor housing) and electronic products (e.g., radio and TV parts); as a flame retardant in coatings and lacquers; and in polyurethane foams for auto upholstery. Of the estimated 2,200 tonnes of HBB produced in 1974, about 900 tonnes were used in ABS plastic products and an even larger amount was used in cable coatings. Decabromobiphenyl Adine 0102 was used as a flame retardant in thermoplastics and thermosets (e.g., in polyesters, epoxy resins, polystyrene, ABS, polyolefines and PVC), elastomers (e.g., in PU-elastomers and India rubber) and cellulosics (e.g., in chip-boards), as well as in paints and varnishes (IPCS, 1994).

35. More recently, PBBs of predominantly low bromine content were found in electronic waste such as cable coatings, stuffing powder for electronic components and circuit boards, suggesting that it was used in such equipment (Zhao et al., 2008; IARC, 2014).

4. Wastes

36. Wastes consisting of, containing or contaminated with PCBs, PCTs or PBBs (hereinafter referred to as "PCB, PCT or PBB wastes") can be found in:

(a) Equipment containing or contaminated with PCBs (capacitors, circuit breakers, electrical cables, electric motors, electromagnets, heat transfer equipment, hydraulic equipment, switches, transformers, vacuum pumps, voltage regulators);

(b) Solvents contaminated with PCBs or PCTs;

(c) Waste vehicles and shredder light fraction (fluff) containing or contaminated with PCBs;

(d) Demolition wastes containing or contaminated with PCBs (painted materials, resin-based floorings, sealants, sealed glazing units);

(e) Oils consisting of, containing or contaminated with PCBs (dielectric fluids, heat transfer fluids, hydraulic fluids, motor oil);

(f) Electrical cables isolated by polymers containing or contaminated with PCBs or PBBs;

(g) Soils and sediments, rock and aggregates (e.g., excavated bedrock, gravel, rubble) contaminated with PCBs, PCTs or PBBs;

(h) Sludge contaminated with PCBs, PCTs or PBBs;

(i) Plastics containing or contaminated with PBBs and equipment containing such materials;

(j) Fire suppression equipment containing or contaminated with PBBs; and

(k) Containers and absorbent materials contaminated through the handling, packaging, transportation or storage of PCB, PCT or PBB wastes.

37. It should be noted that the abovementioned categories apply mainly to PCBs, which were produced in much larger quantities than PCTs and PBBs and are stored as wastes awaiting disposal. PCTs and PBBs are rarely found in large quantities and therefore do not have the potential to form large amounts of waste. However, since PBBs were used in electrotechnical products and automotive parts, it is possible that such products, if manufactured prior to 2000, contain PBBs. PBBs may also be present in shredder residue generated during the recycling process of waste vehicles and waste electrical and electronic equipment (WEEE).

II. Relevant provisions of the Basel and Stockholm conventions

A. Basel Convention

38. Article 1 (“Scope of Convention”) defines the types of waste that are subject to the Basel Convention. Subparagraph 1 (a) of that Article sets forth a two-step process for determining whether a “waste” is a “hazardous waste” subject to the Convention: first, the waste must belong to any category contained in Annex I to the Convention (“Categories of wastes to be controlled”), and second, the waste must possess at least one of the characteristics listed in Annex III to the Convention (“List of hazardous characteristics”).

39. Annex I to the Convention lists some of the wastes that may consist of, contain or be contaminated with PCBs or PCTs. These include:

(a) Y6: Wastes from the production, formulation and use of organic solvents;

(b) Y8: Waste mineral oils unfit for their originally intended use;

(c) Y9: Waste oils/water, hydrocarbons/water mixtures, emulsions;

(d) Y10: Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs);

(e) Y11: Waste tarry residues arising from refining, distillation and any pyrolytic treatment;

(f) Y12: Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish;

(g) Y13: Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives;

(h) Y14: Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known;

(i) Y18: Residues arising from industrial waste disposal operations;

(j) Y39: Phenols; phenol compounds including chlorophenols;

(k) Y41: Halogenated organic solvents;

(l) Y42: Organic solvents excluding halogenated solvents;

(m) Y45: Organohalogen compounds other than substances referred to in this Annex (e.g. Y39, Y41, Y42, Y43, Y44).

40. Annex I to the Convention lists some of the wastes that may consist of, contain or be contaminated with PBBs. These include:

(a) Y10: Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs);

(b) Y12: Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish;

(c) Y13: Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives;

(d) Y14: Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known;

(e) Y18: Residues arising from industrial waste disposal operations;

(f) Y41: Halogenated organic solvents;

(g) Y42: Organic solvents excluding halogenated solvents;

(h) Y45: Organohalogen compounds other than substances referred to in this Annex (e.g. Y39, Y41, Y42, Y43, Y44).

41. Annex I wastes are presumed to exhibit one or more Annex III hazardous characteristics, which may include H4.1 “Flammable solids”, H6.1 “Poisonous (Acute)”, H11 “Toxic (Delayed or chronic)”, H12 “Ecotoxic”, or H13 “Capable after disposal of yielding another hazardous material” unless, through “national tests”, they can be shown not to exhibit such characteristics. National tests may be useful for identifying a particular hazardous characteristic listed in Annex III until such time as the hazardous characteristic is fully defined. Guidance papers for Annex III hazardous characteristics H11, H12 and H13 were adopted on an interim basis by the Conference of the Parties to the Basel Convention at its sixth and seventh meetings.

42. List A of Annex VIII describes wastes that are “characterized as hazardous under Article 1, paragraph 1 (a) of this Convention” although “their designation on this Annex does not preclude the use of Annex III [hazard characteristics] to demonstrate that a waste is not hazardous” (Annex I, paragraph (b)). The following Annex VIII waste categories in particular are applicable to PCBs, PCTs or PBBs:

(a) A1180: Waste electrical and electronic assemblies or scrap[5] containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or contaminated with Annex I constituents (e.g., cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III (note the related entry on list B B1110)[6];

(b) A3180: Wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (PCB), polychlorinated terphenyl (PCT), polychlorinated naphthalene (PCN) or polybrominated biphenyl (PBB), or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more[7].

43. List A of Annex VIII includes a number of wastes or waste categories that have the potential to contain or be contaminated with PCBs or PCTs, including:

(a) A1090: Ashes from the incineration of insulated copper wire;

(b) A1100: Dusts and residues from gas cleaning systems of copper smelters;

(c) A2040: Waste gypsum arising from chemical industry processes, when containing Annex I constituents to the extent that it exhibits an Annex III hazardous characteristic (note the related entry on list B B2080);

(d) A2060: Coal-fired power plant fly-ash containing Annex I substances in concentrations sufficient to exhibit Annex III characteristics (note the related entry on list B B2050);

(e) A3020: Waste mineral oils unfit for their originally intended use;

[5] This entry does not include scrap assemblies from electric power generation.

[6] PCBs are at a concentration level of 50 mg/kg or more.

[7] The 50 mg/kg level is considered to be an internationally practical level for all wastes. However, many individual countries have established lower regulatory levels (e.g., 20 mg/kg) for specific wastes.

(f) A3040: Waste thermal (heat transfer) fluids;

(g) A3050: Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives excluding such wastes specified on list B (note the related entry on list B B4020);

(h) A3070: Waste phenols, phenol compounds including chlorophenol in the form of liquids or sludges;

(i) A3120: Fluff - light fraction from shredding;

(j) A3150: Waste halogenated organic solvents;

(k) A3160: Waste halogenated or unhalogenated non-aqueous distillation residues arising from organic solvent recovery operations;

(l) A4070: Wastes from the production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish excluding any such waste specified on list B (note the related entry on list B B4010);

(m) A4100: Wastes from industrial pollution control devices for cleaning of industrial off-gases but excluding such wastes specified on list B;

(n) A4130: Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics;

(o) A4140: Wastes consisting of or containing off specification or outdated[8] chemicals corresponding to Annex I categories and exhibiting Annex III hazard characteristics;

(p) A4150: Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on human health and/or the environment are not known;

(q) A4160: Spent activated carbon not included on list B (note the related entry on list B B2060).

44. List A of Annex VIII includes a number of wastes or waste categories that have the potential to contain or be contaminated with PBBs, including:

(a) A3050: Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives excluding such wastes specified on list B (note the related entry on list B B4020);

(b) A3150: Waste halogenated organic solvents;

(c) A3160: Waste halogenated or unhalogenated non-aqueous distillation residues arising from organic solvent recovery operations;

(d) A4070: Wastes from the production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish excluding any such waste specified on list B (note the related entry on list B B4010);

(e) A4100: Wastes from industrial pollution control devices for cleaning of industrial off-gases but excluding such wastes specified on list B;

(f) A4130: Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics;

(g) A4140: Wastes consisting of or containing off specification or outdated[8] chemicals corresponding to Annex I categories and exhibiting Annex III hazard characteristics;

(h) A4150: Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on human health and/or the environment are not known;

(i) A4160: Spent activated carbon not included on list B (note the related entry on list B B2060).

45. List B of Annex IX to the Convention lists wastes that "will not be wastes covered by Article 1, paragraph 1 (a), of this Convention unless they contain Annex I material to an extent causing them to exhibit an Annex III characteristic."

[8] "Outdated" means unused within the period recommended by the manufacturer.

46. List B of Annex IX includes a number of wastes or waste categories that have the potential to contain or be contaminated with PCBs or PCTs and its related substances, including:

(a) B1100: Metal-bearing wastes arising from melting, smelting and refining of metals.[9]

47. List B of Annex IX includes a number of wastes or waste categories that have the potential to contain or be contaminated with PBBs, including:

(a) B3010: Cured waste resins or condensation products and fluorinated polymer wastes;[10]

(b) B3030: Textile wastes.[11]

48. For further information, see section II.A of the general technical guidelines.

B. Stockholm Convention[12]

49. The present technical guidelines cover intentionally produced PCBs and HBB whose production and use are to be eliminated in accordance with Article 3 of, and Annex A to, the Stockholm Convention.

50. Annex A, part I, to the Convention does not include any exemption for the production or use of HBB.

51. Annex A, part II ("Polychlorinated biphenyls") outlines specific requirements for PCBs, as follows:

"Each Party shall

(a) With regard to the elimination of the use of polychlorinated biphenyls in equipment (e.g. transformers, capacitors or other receptacles containing liquid stocks) by 2025, subject to review by the Conference of the Parties, take action in accordance with the following priorities:

(i) Make determined efforts to identify, label and remove from use equipment containing greater than 10 per cent polychlorinated biphenyls and volumes greater than 5 litres;

(ii) Make determined efforts to identify, label and remove from use equipment containing greater than 0.05 per cent polychlorinated biphenyls and volumes greater than 5 litres;

(iii) Endeavour to identify and remove from use equipment containing greater than 0.005 per cent polychlorinated biphenyls and volumes greater than 0.05 litres;

(b) Consistent with the priorities in subparagraph (a), promote the following measures to reduce exposures and risk to control the use of polychlorinated biphenyls:

(i) Use only in intact and non-leaking equipment and only in areas where the risk from environmental release can be minimised and quickly remedied;

(ii) Not use in equipment in areas associated with the production or processing of food or feed;

(iii) When used in populated areas, including schools and hospitals, take all reasonable measures to protect from electrical failure which could result in a fire, and regular inspection of equipment for leaks;

(c) Notwithstanding paragraph 2 of Article 3, ensure that equipment containing polychlorinated biphenyls, as described in subparagraph (a), shall not be exported or imported except for the purpose of environmentally sound waste management;

[9] Refer to Annex IX to the Basel Convention for a full description of this entry.

[10] *Ibid*.

[11] *Ibid* 9.

[12] This section does not apply to PCTs or to PBBs other than HBB.

(d) Except for maintenance and servicing operations, not allow recovery for the purpose of reuse in other equipment of liquids with polychlorinated biphenyls content above 0.005 per cent;

(e) Make determined efforts designed to lead to environmentally sound waste management of liquids containing polychlorinated biphenyls and equipment contaminated with polychlorinated biphenyls having a polychlorinated biphenyls content above 0.005 per cent, in accordance with paragraph 1 of Article 6, as soon as possible but no later than 2028, subject to review by the Conference of the Parties;

(f) In lieu of note (ii) in Part I of this Annex, endeavour to identify other articles containing more than 0.005 per cent polychlorinated biphenyls (e.g. cable-sheaths, cured caulk and painted objects) and manage them in accordance with paragraph 1 of Article 6;

(g) Provide a report every five years on progress in eliminating polychlorinated biphenyls and submit it to the Conference of the Parties pursuant to Article 15".

52. For further information, see section II.B of the general technical guidelines.

III. Issues under the Stockholm Convention to be addressed cooperatively with the Basel Convention[13]

A. Low POP content

53. The provisional definition of low POP content for PCBs and HBB is 50 mg/kg for each.[14]

54. The low POP content described in the Stockholm Convention is independent from the provisions on hazardous waste under the Basel Convention.

55. Wastes with a content of PCBs or HBB above 50 mg/kg must be disposed of in such a way that the POP content is destroyed or irreversibly transformed in accordance with the methods described in section IV.G.2. Otherwise, they may be disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option in accordance with the methods described in section IV.G.3.

56. Wastes with a content of PCBs or HBB at or below 50 mg/kg should be disposed of in accordance with the methods referred to in subsection IV.G.4 outlining disposal methods when POP content is low and sections IV.I.1 and IV.I.2 addressing pertinent higher and lower risk situations.

57. For further information on low POP content, refer to section III.A of the general technical guidelines.

B. Levels of destruction and irreversible transformation

58. For the provisional definition of levels of destruction and irreversible transformation, see section III.B of the general technical guidelines.

C. Methods that constitute environmentally sound disposal

59. See section IV.G below and section IV.G of the general technical guidelines.

IV. Guidance on environmentally sound management (ESM)

A. General considerations

60. For further information, see section IV.A of the general technical guidelines.

[13] This section does not apply to PCTs and PBBs other than HBB.

[14] Determined in accordance with national or international methods and standards.

B. Legislative and regulatory framework

61. Parties to the Basel and Stockholm conventions should examine their national strategies, policies, controls,[15] standards and procedures to ensure that they are in agreement with the two conventions and their obligations under them, including those that pertain to ESM of wastes consisting of, containing or contaminated with PCBs and HBB.

62. Elements of a regulatory framework applicable to PCBs, PCTs and PBBs should include measures to prevent the generation of wastes and to ensure the environmentally sound management of generated wastes. Such elements could include the following:

(a) Environmental protection legislation establishing a regulatory regime, setting release limits and establishing environmental quality criteria;

(b) Prohibitions on the production, sale, use, import and export of PCBs, PCTs and PBBs;

(c) Phase-out dates for PCBs that remain in service, inventory or storage;

(d) Transportation requirements for hazardous materials and waste;

(e) Specifications for containers, equipment, bulk containers and storage sites;

(f) Specification of acceptable analytical and sampling methods for PCBs, PCTs and PBBs;

(g) Requirements for waste management and disposal facilities;

(h) Definitions of hazardous waste and conditions and criteria for the identification and classification of PCB, PCT and PBB wastes as hazardous wastes;

(i) A general requirement for public notification and review of proposed government waste-related regulations, policy, certificates of approval, licences, inventory information and national emissions data;

(j) Requirements for identification, assessment and remediation of contaminated sites;

(k) Requirements concerning the health and safety of workers; and

(l) Other legislative measures on, e.g., waste prevention and minimization, inventory development and emergency response.

63. The timing of the phase-out of PCBs (and, to a lesser extent, of PCTs and PBBs) will probably be the most critical legislative concern for most countries, given that most of them already have some form of legislative framework dealing with PCBs.

64. For further information, see section IV.B of the general technical guidelines.

C. Waste prevention and minimization

65. Both the Basel and Stockholm conventions advocate waste prevention and minimization, and PCB compounds and HBB are targeted for a complete phase-out in the Stockholm Convention. PCBs, PCTs and PBBs should be taken out of service and disposed of in an environmentally sound manner.

66. Quantities of waste containing these compounds should be minimized through isolation and source separation to prevent mixing and contamination of other waste streams. For example, electrical equipment, painted materials, resin-based floorings, sealants and sealed glazing units containing PCBs can contaminate large amounts of demolition waste and should be separated where practicable prior to demolition.

67. The mixing and blending of wastes with a PCB or HBB content above a 50mg/kg with other materials solely for the purpose of generating a mixture with a PCB or HBB content at or below 50mg/kg is not environmentally sound. Nevertheless, the mixing or blending of materials before waste treatment may be necessary in order to enable treatment or to optimize treatment efficiency.

68. To facilitate the reuse of electrical equipment containing insulation oil contaminated with PCBs, such as transformers, a procedure called retrofilling may be implemented in which the equipment is emptied of the insulation oil contaminated with PCBs and refilled with PCB-free insulating oil, such as mineral oil. In retrofilling procedures, care should be taken to avoid cross-

[15] In these guidelines, national legislation and control measures include sub-national and other applicable forms of governance.

contamination of retrofilled oils with any PCBs that may have penetrated the porous parts of the equipment, such as wood, cardboard, insulating paper and resins, and may gradually leach into retrofilled oils. As a preventive measure, some countries have enacted regulations whereby, in the absence of analyses to determine the presence or absence of PCBs in electrical equipment oils, such oils are presumed to contain PCBs until proven otherwise.[16] Decontamination methods should be planned carefully to reduce the number of times that retrofilling procedures are conducted by requiring that initial PCB levels be considered and that every effort be made to empty equipment entirely. Retrofilled equipment should be periodically tested for PCBs and, when PCB levels exceed the low POP content, retrofilling should be performed again.

69. For further information, see section IV.C of the general technical guidelines.

D. Identification of wastes

70. Article 6, paragraph 1 (a), of the Stockholm Convention requires each party to, *inter alia,* develop appropriate strategies for the identification of products and articles in use and wastes consisting of, containing or contaminated with POPs. The identification of POPs wastes is the starting point for their effective ESM.

71. For general information on identification of waste, see section IV.D of the general technical guidelines.

1. Identification

72. PCBs and PCTs have historically been found in a number of locations, as follows:

(a) In completely closed or nominally closed systems, including:

(i) Electrical utilities: transformers, capacitors, switches, voltage regulators, circuit breakers, light ballasts, and waste electrical and electronic equipment (WEEE) containing small capacitors and cables;

(ii) Industrial facilities: transformers, capacitors, voltage regulators, circuit breakers, light ballasts, heat transfer fluids and hydraulic fluids;

(iii) Railroad systems: transformers, capacitors, voltage regulators and circuit breakers;

(iv) Mining operations: hydraulic fluids and earthing coils;

(v) Military installations: transformers, capacitors, voltage regulators and hydraulic fluids;

(vi) Residential/commercial buildings: capacitors, circuit breakers and light ballasts;

(vii) Research laboratories: vacuum pumps, light ballasts, capacitors and circuit breakers;

(viii) Electronics manufacturing plants: vacuum pumps, light ballasts, capacitors and circuit breakers;

(ix) Wastewater discharge facilities: vacuum pumps and well motors;

(x) Automotive service stations: reused oil;

(b) In open-ended systems, including:

(i) Residential/commercial buildings: elastic joints and fillers, sealants,[17] paints, concrete and plaster;

(ii) Steel structures such as bridges, tanks, ships or laying pipes: paints and coatings.

73. When identifying wastes, parties may find it is useful to refer to *the Guidelines for the identification of PCBs and materials containing PCBs* (UNEP, 1999).

[16] For example, see Argentina's 2002 *Law 25.670.*

[17] Buildings built mainly between 1950 and 1980 may contain PCBs in joint sealants.

74. For closed electrical equipment such as transformers and capacitors, generally it is possible to identify whether such equipment contains PCBs or PCTs by inspecting the type designation on the equipment name plates and the product labels or literature issued by the manufacturer, and by referring to the date of production of the equipment. It should be noted that even recently manufactured equipment could be contaminated with PCB/PCT above 50 mg/kg through retrofilling or maintenance work. The insulating oils in all closed electrical equipment should therefore be analysed for possible PCB or PCT content. In the case of light ballasts and WEEE equipped with small capacitors, it is difficult to determine whether they contain PCBs or PCTs as dielectric fluids. The PCB or PCT content of such equipment should be carefully determined by referring to equipment type designations and production dates.

75. For open-ended materials such as joint sealants or paints separated from demolition waste, it is impossible to judge whether these contain PCBs or PCTs solely from their appearance. Therefore, the time when such materials were applied should be verified and, if the materials were produced during the time when PCBs or PCTs were used as plasticizers, a test for the presence of PCBs or PCTs in the waste should be performed.

76. It is difficult even for experienced technicians to identify the characteristics of effluents, substances, containers or equipment solely from their external appearance or labels. With respect to electrical equipment such as transformers and capacitors, it is possible to identify the brand of the equipment and thus confirm the year and country where it was manufactured, as well as its manufacturer. By referring to available information or by contacting the manufacturer, it is possible to determine whether the equipment contains PCBs. If PCB-containing equipment does not have any label pertaining to its insulating oil, experienced investigators can obtain information on the original contents and other information through labels of similar equipment, by referring to relevant guidance manuals, such as the Guidelines for the Identification of PCBs and Materials Containing PCBs (UNEP, 1999), or by contacting the manufacturer.

77. PBBs have historically been found in a number of consumer products where they were used as flame retardants, including a variety of plastic products such as computer monitors, televisions, textiles and plastic foams (including those in WEEE and shredder residue generated during the recycling process of waste vehicles).

78. Parties may find the information on production, use and waste types provided in section I.B of the present guidelines useful in identifying PCBs, PCTs and PBBs.

2. Inventories

79. Inventories are an important tool for identifying, quantifying and characterizing wastes. A step-by-step approach for the development of national inventories of PCBs, PCTs and PBBs generally includes the following steps:

(a) Step 1: planning (i.e., identifying relevant sectors of use and production of PCBs, PCTs and PBBs);

(b) Step 2: choosing data collection methodologies using a tiered approach;

(c) Step 3: collecting and compiling data from national statistics on the production, use, import and export of PCBs, PCT and PBBs;

(d) Step 4: managing and evaluating the data obtained in step 3 using an estimation method;

(e) Step 5: preparing an inventory report; and

(f) Step 6: periodically updating the inventory report.

80. For further information, refer to the *Guidelines for the identification of PCBs and materials containing PCBs* (UNEP, 1999).

E. Sampling, analysis and monitoring

81. For general information on sampling, analysis and monitoring, see section IV.E of the general technical guidelines.

1. Sampling

82. It is difficult to extract dielectric fluid samples from sealed waste electrical equipment such as capacitors. To obtain such samples, a small hole should carefully be drilled on the top of the equipment. After taking the sample, the hole should be plugged and repaired.

83. During sampling of shredder residue, efforts should be made to ensure sample homogeneity.

84. The types of matrices that are of special interest for analysis of PCBs, PCTs and PBBs include:

(a) Industrial synthetic PCBs and PCT-containing oils from transformers or other equipment or in bulk storage;

(b) Mineral oils from retrofilled transformers contaminated with PCBs or in bulk storage;

(c) Waste motor oils and other waste oils, fuels and organic liquids;

(d) Elastic joints and fillers, sealants and paints; and

(e) Fire suppressants and retardants (PBBs).

2. Analysis

85. Analysis refers to the extraction, purification, separation, identification, quantification and reporting of POP concentrations in the matrix of interest. The development and dissemination of reliable analysis methods and the accumulation of high-quality analytical data are important to understand the environmental impact of hazardous chemicals, including POPs.

86. As with all polybrominated flame retardants, samples should not be exposed to sunlight prior to analysis, since PBBs are unstable when exposed to ultraviolet radiation (IARC, 2014).

87. Methods of analysing the various matrices for POPs have been developed by ISO, the European Committee for Standardization (CEN – EN standards), ABNT, AOAC, ASTM, DIN, EPA, JIS, NEN and NVN. Some examples of analytical methods for PCBs include the following:

(a) Methods for oils or insulating liquids:

(i) EN 12766-1 (2000): Petroleum products and used oils - Determination of PCBs and related products - Part 1: Separation and determination of selected PCB congeners by gas chromatography (GC) using an electron capture detector (ECD);

(ii) EN 12766-2 (2002): Petroleum products and used oils - Determination of PCBs and related products - Part 2: Calculation of polychlorinated biphenyl (PCB) content;

(iii) EN 61619 (1997): Insulating liquids - Contamination by polychlorinated biphenyls (PCBs) - Method of determination by capillary column gas chromatography;

(iv) EPA Method 4020: Screening for polychlorinated biphenyls by immunoassay (www.epa.gov/solidwaste/hazard/testmethods/sw846/pdfs/4020.pdf);

(v) EPA Method 8082A: Polychlorinated biphenyls (PCBs) by gas chromatography (www.epa.gov/osw/hazard/testmethods/sw846/pdfs/8082a.pdf);

(vi) EPA Method 9079: Screening test method for polychlorinated biphenyls in transformer oil (www.epa.gov/solidwaste/hazard/testmethods/sw846//pdfs/9079.pdf);

(vii) ABNT NBR 13882:2005: Electrical Insulating Liquids - Determination of PCB contents;

(b) Methods for solid materials:

(i) EN 15308 (2008): Characterization of waste - Determination of selected polychlorinated biphenyls (PCBs) in solid waste by using capillary gas chromatography with electron capture or mass spectrometric detection;

(ii) EPA Method 8080: Organochlorine Pesticides and PCBs;

(iii) Methods for Examining Standards of General Wastes under Special Control and Industrial Waste under Special Control, Notice 192 of the Japan Ministry of Welfare and Labour, 3 July 1992;

(c) Methods for water, sludge, gases and others:

(i) DIN 38414-20 (1996): German standard methods for the examination of water, waste water and sludge - Sludge and sediments (group S) - Part 20: Determination of 6 polychlorinated biphenyls (PCBs) (P 20);

(ii) EN 1948 (2006): Stationary source emissions - determination of the mass concentration of PCDDs/PCDFs and dioxin-like PCBs. Part 1 Sampling, Part 2: Extraction and clean-up of PCDDs/PCDFs, Part 3: Identification and quantification of PCDDs/PCDFs;

(iii) EPA Method 1668, Revision A: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by HRGC/HRMS, United States Office of Water, EPA No. EPA 821-R-00-002, Environmental Protection Agency (4303), December 1999;

(iv) EPA Method 8275A: Semivolatile organic compounds (PAHs and PCBs) in soils/sludges and solid wastes using thermal extraction/gas chromatography/mass spectrometry (TE/GC/MS), EPA analytical chemistry guidance SW-846;

(v) EPA Method 9078: Screening test method for polychlorinated biphenyls in soil (www.epa.gov/epaoswer/hazwaste/test/pdfs/9078.pdf);

(vi) ISO 6468 (1996): Water quality - Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes - Gas chromatographic method after liquid-liquid extraction;

(vii) ISO 10382 (2002): Soil quality - Determination of organochlorine pesticides and polychlorinated biphenyls - Gas-chromatographic method with electron capture detection;

(viii) JIS K 0093 (2006): Testing method for polychlorinated biphenyls in industrial water and wastewater;

(ix) NEN 7374 (2004): Leaching characteristics - Column test for the determination of the leaching of PAH, PCB, OCP and EOX, phenol and cresoles from granular materials - Solid earthy and stony materials;

(x) Norwegian Institute for Water Research method no. H 3-2: Determination of organochlorine compounds in sediments, water and biological material by gas chromatography;

(xi) NVN 7350 (1997): Leaching characteristics of solid earthy and stony building and waste materials - Leaching tests - Determination of the leaching of PAH, PCB and EOX from granular materials with the cascade test;

(xii) NVN 7376 (2004): Leaching characteristics - Determination of the leaching of PAH, PCB, OCP and EOX, phenol and cresoles from building and monolithic waste materials with a diffusion test - Solid earthy and stony materials.

88. Methods of analyzing electrotechnical products for PBBs have been developed by the International Electrotechnical Commission (IEC), as follows:

(a) IEC 62321 (2008): Electrotechnical products – Determination of levels of six regulated substances (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, polybrominated diphenyl ethers).

Furthermore, useful knowledge can be obtained from the following literature regarding the method of analysis of various matrices for PBBs:

(a) US Agency for Toxic Substances and Disease Registry, 2004. *Toxicological profile for polybrominated biphenyls and polybrominated diphenyl ethers*;

(b) Kemmlein, S. et al., 2009. “Brominated flame retardants in the European chemicals policy of REACH-Regulation and determination in materials”, *Journal of Chromatograpy A*, vol. 1216 No. 3, pp. 320-333;

(c) Clarke, B. et al., 2008. “Polybrominated diphenyl ethers and polybrominated biphenyls in Australian sewage sludge”, *Chemosphere*, vol. 73, pp. 980-989;

(d) Covaci, A. et al., 2003. “Determination of brominated flame retardants, with emphasis on polybrominated diphenyl ethers (PBDEs) in environmental and human samples: A review”, *Environment International*, vol. 29, pp. 735-756;

(e) Hanari, N. et al., 2006. "Occurrence of polybrominated biphenyls, polybrominated dibenzo-p-dioxins, and polybrominated dibenzofurans as impurities in commercial polybrominated diphenyl ether mixtures", *Environmental Science & Technology*, vol. 40, pp. 4400-4405.

89. To determine dioxin-like PCBs and PBBs, which could be of special interest to parties, internationally accepted methods such as those for analysing PCDDs/PCDFs should be applied.

90. For screening purposes, test kits are available for the quantification of PCBs in oils and soils (based on immunoassays or chlorine determinations). If the result is negative, a confirmatory PCB analysis is not necessary. If the result is positive, confirmatory chemical analysis should be performed, or the waste may be regarded as waste containing or contaminated with PCBs.

3. Monitoring

91. Monitoring and surveillance serve as elements for identifying and tracking environmental concerns and human health risks. Information collected from monitoring programs feeds into science-based decision-making processes and is used for the evaluation of the effectiveness of risk management measures, including regulations.

92. Monitoring programmes should be implemented in facilities managing PCB, PCT or PBB wastes.

F. Handling, collection, packaging, labelling, transportation and storage

93. For general information on handling, collection, packaging, labelling, transportation and storage, see section IV.F of the general technical guidelines.

1. Handling

94. Special attention should be paid to possible PCB leakages due to corrosion or defects of PCB-containing electrical equipment such as transformers and capacitors, as such equipment generally has a lifetime of several decades. Special attention should also be paid to damages that may result from moving such equipment. Heavy electrical machineries require caution in handling bushings, as these are prone to breakage under heavy loads. When dealing with highly concentrated PCBs, operators should use masks and rubber gloves to avoid inhalation of volatilized PCBs or skin contact with PCBs.

95. When conducting repairs in or renovation or demolition of older buildings, renovators and contractors should pay attention to the possibility of PCBs being contained in building joints, window or door sealants or fillers, and paint coatings on steel bridges or structures. Should these materials contain PCBs, they should be carefully removed and isolated to prevent PCB-containing dust from spreading to surrounding areas. The work should be conducted wearing appropriate protective equipment such as suitable gloves, disposable coveralls, protective goggles and respiratory protection masks that meet international standards.

2. Collection

96. A significant fraction of total national inventories of PCBs, PCTs and PBBs may be held in small quantities by small business owners or homeowners (for example, in PCB fluorescent light ballasts; small electrical devices, heat exchangers and heaters containing PCB or PCT fluids; fire suppression systems containing PBBs; and small containers and small stockpiles of those substances). It is difficult for those who own small quantities of PCBs, PCTs or PBBs to dispose of such materials. For example, regulations may require them to be registered as waste generators, logistical considerations may prevent or discourage pick-up (e.g., no industrial waste pick-up is allowed or available in their neighbourhood), and disposal costs may be prohibitive. National, regional and municipal governments should consider establishing collection stations for those small quantities so that each small-quantity owner does not have to make individual transport and disposal arrangements.

97. In cases where PCBs and PCTs are found when conducting repairs in, or renovation or demolition of, older buildings (e.g., elastic joints and fillers, sealants, paints, concrete and plaster containing PCBs and PCTs), the safety of workers should be ensured and wastes should be carefully removed and collected separately to prevent dust containing PCBs and PCTs from spreading to surrounding areas.

98. Collection arrangements and collection depots for PCB, PCT and PBB wastes should provide for the separation of those wastes from other wastes.

99. It is imperative that collection depots do not become long-term storage facilities for PCB, PCT or PBB wastes. Large amounts of wastes, even if properly stored, pose a higher risk to the environment and human health than small quantities scattered over large areas.

3. Packaging

100. PCB, PCT and PBB wastes should be properly packaged before storage for ease of transport and as a safety measure to reduce the risk of leaks and spills:

(a) With regard to transformers whose insulating oils have been drawn out, drained oils and carcasses should be packed separately. The risk of leakage during transport to a treatment facility may be lowered by separating insulating oils from transformers. Such separation should ideally be taken into account when evaluating packaging methods. Separation procedures should be performed by professional operators using special tools;

(b) Liquid wastes should be placed in double-bung steel drums or other approved containers;

(c) Solid wastes such as sealants and paints should be placed in steel drums or other approved containers lined with plastic bags;

(d) Regulations governing the transport of hazardous materials often require the use of containers that meet certain specifications (e.g., 16-gauge, made of steel, internally coated with epoxy). Containers used for storage should meet such specifications given that they may be transported in the future;

(e) Large drained equipment may be stored as is or may be placed inside large containers (overpack drums) or heavy plastic wraps if leakage is a concern;

(f) Small pieces of equipment, whether drained or not, should be placed in drums with an absorbent material, where appropriate, to prevent excessive movement of container contents and enable any free liquids and spills to be absorbed. Numerous small pieces of equipment may be placed in the same drum so long as an adequate amount of absorbent material is present in the drum. Loose absorbents may be purchased from safety suppliers;

(g) Drums and equipment may be placed on pallets for movement by forklift truck and for storage. Drums and equipment should be strapped to the pallets before they are moved.

4. Labelling

101. Every container and piece of equipment containing or contaminated with PCBs, PCTs or PBBs should be clearly labelled with a hazard-warning label and a label giving details of the equipment or container. Such details should include the contents of the container or equipment (e.g., exact counts of equipment, volume of liquid, type of waste carried), the name of the site from which the container or equipment originated so as to allow its traceability and, if applicable, the date of repackaging and the name and telephone number of the person responsible for the repackaging operation.

5. Transportation

102. Since PCBs are transported mostly in liquid form, measures should be taken to prevent leakage during transport. Transformers and capacitors, for example, should be secured in metallic containers to reduce the risk of breakage of equipment bushings from impact during transport, and include absorbent materials in their packaging.

6. Storage

103. While many countries have adopted storage regulations or developed storage guidelines concerning PCBs, most do not have specific storage regulations or guidance concerning PCTs and PBBs. Although PCTs, PBBs and PCBs have similar toxicity, PCBs are liquid at room temperature, while PCTs and PBBs are solid at room temperature and have a lower vapour pressure. The storage conditions required for PCTs and PBBs may therefore differ from those required for PCBs.

104. An oil pan (steel tray) should be laid underneath stored equipment. Storage sites should be maintained and inspected to verify whether there have been any releases of PCBs, PCTs or PBBs into the environment.

105. In order to prevent the spillage of PCBs from equipment that has tumbled down during disasters such as earthquakes, tornadoes and heavy rains, or from leakage due to equipment corrosion,

storage sites should have structures to prevent underground leakage. Moreover, it should be taken into account that PCBs might be released into the environment through vaporization during storage.

G. Environmentally sound disposal

1. Pre-treatment

106. Cutting and milling of capacitors or disassembling of external parts such as radiators, conservators and bushings of transformers for the purpose of size reduction should be carried out before destruction in dedicated facilities. Caution should be taken during disassembling and dismantling operations, since such operations increase the risk of operator exposure to PCBs and of PCBs releases into the environment.

107. When destroying PCBs in waste oils or liquid wastes through alkali metal reduction, dewatering or oil-water separation should be done as a pre-treatment procedure in order to avoid the violent reaction of water with, and the excessive consumption of, alkali metals.

108. Since wastes containing PCBs from open-ended systems such as joint sealants or paints are generally bulky, crushing or shredding should be done as a pre-treatment to reduce them into smaller pieces and, when necessary, thermal desorption or vacuum thermal desorption should be implemented to effectively treat the PCBs in the wastes.

109. For further information on pre-treatment, see subsection IV.G.1 of the general technical guidelines.

2. Destruction and irreversible transformation methods

110. For information on destruction and irreversible transformation methods relating to PCBs and HBB, see subsection IV.G.2 of the general technical guidelines.

111. It should be noted that PCDDs/PCDFs can be generated from the combustion and incineration of PCB wastes, while the combustion and incineration of PBB wastes can generate PBDDs/PBDFs.

3. Other disposal methods when neither destruction nor irreversible transformation is the environmentally preferable option

112. For information, see subsection IV.G.3 of the general technical guidelines.

4. Other disposal methods when the POP content is low

113. When cleansing or decomposing PCB-contaminated transformer insulating oils on site the spilling or leakage of effluents should be prevented even if the level of PCBs in the oils is relatively low.

114. For further information, see subsection IV.G.4 of the general technical guidelines.

H. Remediation of contaminated sites

115. For information, see subsection IV.H of the general technical guidelines.

I. Health and safety

116. For further information, including on the distinction between higher- and lower-risk situations, see section IV.I of the general technical guidelines.

1. Higher-risk situations

117. For information on higher-risk situations, see subsection IV.I.1 of the general technical guidelines. Potential higher-risk situations specific to PCBs, PCTs or PBBs may include:

(a) In electrical rooms with large or multiple PCB transformers, circuit breakers or capacitors;

(b) At sites at which PCB-containing transformers, circuit breakers, hydraulic equipment or vacuum pumps have been used or maintained;

(c) At sites where PCBs are separated from equipment and transferred to another container or where pre-handling measures such as disassembling of equipment are carried out. Caution should be taken at those sites, since they present increased risk of exposure for operators; and

(d) In buildings in which PCBs have been used in elastic joints and fillers, paints or sealants.

2. Lower-risk situations

118. For information on lower risk situations, see subsection IV.I.2 of the general technical guidelines. Lower-risk situations specific to PCBs, PCTs, PBBs may include:

(a) Those that involve only products or articles that contain or are contaminated with PCBs in small quantities or at low concentrations (e.g., some electrical and electronic equipment and waste equipment); and

(b) Those that involve electrical transformers or other equipment with low-level PCB-contaminated mineral oils.

J. Emergency response

119. Emergency response plans should be in place for PCBs, PBBs and PCTs that are in service, in storage, in transport and at disposal sites. Further information on emergency response plans is given in section IV.J of the general technical guidelines and in *Preparation of a national environmentally sound plan for PCBs and PCB-contaminated equipment: training manual* (UNEP, 2003).

K. Public participation

120. Parties to the Basel or Stockholm Convention should have open public participation processes.

121. For further information see section IV.K of the general technical guidelines.

Annex I to the technical guidelines

Synonyms and trade names for PCBs, PCTs, PBBs other than HBB and HBB

Chemical	Some synonyms and trade names[1]
PCBs	Abestol, Aceclor, Adkarel, ALC, Apirolio (Italy), Apirorlio, Areclor, Arochlor, Arochlors, Aroclor/Arochlor(s) (USA), Arubren, Asbestol (USA), Ask/Askarel/Askael, Auxol, Bakola, Biclor, Blacol (Germany), Biphenyl, Clophen (Germany), Cloresil, Chlophen, Chloretol, Chlorextol (USA), Chlorfin, Chlorinal/Chlorinol, Chlorinated biphenyl, Chlorinated diphenyl, Chlorobiphenyl, Chlorodiphenyl, Chlorofen (Poland), Chlorphen, Chorextol, Chorinol, Clophen/Clophenharz (Germany), Cloresil, Clorinal, Clorphen, Crophene (Germany), Decachlorodiphenyl, Delofet O-2, Delor (Czechoslovakia), Delor/Del (Czechoslovakia), Delorene, Delorit, Delotherm DK/DH (Czechoslovakia), Diaclor (USA), Diarol, Dicolor, Diconal, Disconon, DK (Italy), Ducanol, Duconal, Duconol, Dykanol (USA), Dyknol, Educarel, EEC-18, Elaol (Germany), Electrophenyl, Elemex (USA), Elinol, Eucarel, Euracel, Fenchlor (Italy), Fenclor (Italy), Fenocloro, Gilotherm, Hexol, Hivar, Hydelor, Hydol, Hydrol, Hyrol, Hyvol (USA), Inclor, Inerteen (USA), Inertenn, Kanechlor (Japan), Kaneclor, Kennechlor (Japan) , Kenneclor, Leromoll, Magvar, MCS 1489, Montar, Monter, Nepoli, Nepolin, Niren, NoFlamol, No-Flamol (USA), Non-Flamol, Olex-sf-d, Orophene, Pheaoclor, Pheneclor, Phenochlor, Phenoclor (France), Plastivar, Polychlorinated diphenyl, Polychlorinated diphenyls, Polychlorobiphenyl, Polychlorodiphenyl, Prodelec, Pydraul, Pyraclor, Pyralene (France), Pyranol (USA), Pyroclor (USA), Pyrochlor, Pyronol, Safe-T-Kuhl, Saft-Kuhl, Saf-T-Kohl, Saf-T-Kuhl (USA), Santosol, Santotherm (Japan), Santothern, Santovac, Sat-T-America, Siclonyl, Solvol, Sorol, Soval, Sovol (USSR), Sovtol, Tarnol (Poland), Terphenychlore, Therminal, Therminol, Turbinol
PCTs	Aroclor (USA), Clophen Harz (W), Cloresil (A,B,100), Electrophenyl T-50 and T60, Kanechlor KC-C (Japan), Leromoll, Phenoclor, Pydraul
PBBs other than HBB	Adine 0102 (France), Berkflam B_{10} (United Kingdom of Great Britain and Northern Ireland), Bromkal 80 (Germany), Bromkal 80-9D (Germany), Octabromobiphenyl FR250 13A (USA), Flammex B-10 (United Kingdom of Great Britain and Northern Ireland), HFO 101 (United Kingdom of Great Britain and Northern Ireland), BB-8, BB-9, OBB, Technical octabromobiphenyl(USA), DBB, Technical dexabromobiphenyl (USA)
HBB	FireMaster BP-6 (USA), FireMaster FF-1 (USA)

[1] The list of trade names provided in annex I is not intended to be exhaustive.

Annex II to the technical guidelines

Bibliography

ATSDR, 2000. *Toxicological Profile for Polychlorinated Biphenyls (PCBs).* Available at: www.atsdr.cdc.gov/toxprofiles/tp17-c4.pdf.

ATSDR, 2004. *Toxicological Profile for Polybrominated Biphenyls and Polybrominated Diphenyl Ethers (PBBs and PBDEs)*. Available at: www.atsdr.cdc.gov/toxprofiles/tp68.pdf.

Environment Canada, 1988. *Polychlorinated biphenyls (PCB) - Fate and effects in the Canadian environment*. Environment Canada report EPS 4/HA/2, May 1988.

Holoubek, 2000. *Polychlorinated biphenyls (PCB): World-wide contaminated sites*. TOCOEN report No. 173. Available at: recetox.muni.cz/res/file/reporty/tocoen-report-173-id438.pdf.

IARC, 2014. *Polychlorinated Biphenyls and Polybrominated Biphenyls: IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, vol. 107. Lyon, France.

IPCS, 1992. *Environmental Health Criteria 140: Polychlorinated biphenyls and polychlorinated terphenyls*. Published by UNEP, ILO and WHO, Geneva. Available at: www.inchem.org/documents/ehc/ehc/ehc140.htm.

IPCS, 1994. *Environmental Health Criteria 152: Polybrominated biphenyls*. Published by UNEP, ILO and WHO, Geneva. Available at: www.inchem.org/documents/ehc/ehc/ehc152.htm.

Jensen, A.A. and Jørgensen, K.F., 1983. "Polychlorinated terphenyls (PCT) uses, levels and biological effects", *Science of the Total Environment*, vol. 27, pp. 231-250.

UNECE, 2002. *Report on production and use of PCT (draft).* Prepared for the UNECE Expert Group on POPs.

UNEP, 1999. *Guidelines for the identification of PCBs and materials containing PCBs*. Available from: www.chem.unep.ch.

UNEP, 2003. *Preparation of a national environmentally sound plan for PCBs and PCB-contaminated equipment: Training manual*. Available from: www.basel.int.

UNEP, 2006. UNEP/POPS/POPRC.2/17/Add.3. *Risk profile on hexabromobiphenyl.* Available from: chm.pops.int.

UNEP, 2015. *Technical guidelines on the environmentally sound management of wastes containing or contaminated with unintentionally unintentionally produced polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, hexachlorobenzene, polychlorinated biphenyls or pentachlorobenzene.*

UNEP. 2015a. *General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants*.

Van den Berg, M. et al, 2013. "Polybrominated Dibenzo-p-Dioxins, Dibenzofurans, and Biphenyls: Inclusion in the Toxicity Equivalency Factor Concept for Dioxin-Like Compounds", *Toxicological Sciences*, vol. 133 No. 2, pp. 197-208.

Van den Berg, M. et al, 2006. "The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds", *Toxicological Sciences*, vol. 93, pp 223-241. Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2290740/.

Zhao, G. et al., 2008. "PBBs, PBDEs, and PCBs levels in hair of residents around e-waste disassembly sites in Zhejiang Province, China, and their potential sources", *Science of the Total Environment*, vol. 397, pp. 46-57.