Polychlorinated Biphenyls (PCB) Inventory Guidance

PCB Elimination Network (PEN)
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Foreword

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Abbreviations

BCCC	Basel Convention Coordinating Center for Asia and the Pacific
BRS Secretariat	Secretariat of the Basel, Rotterdam and Stockholm Conventions
COP	Conference of the Parties
DBMS	Database management system
DTIE	Division of Technology, Industry and Economics
ECA	Economic Commission for Africa
ECE	Economic Commission for Europe
ECLA	Economic Commission for Latin America
ECWA	Economic Commission for Western Asia
ELCD	Electrolytic conductivity detector
ESCAP	Economic and Social Commission for Asia and the Pacific
ESM	Environmental sound management
GC-ECD	Gas chromatography with election capture detector
GC-MS	Gas chromatography and mass spectrometry
GEF	Global Environmental Facility
IAs	Implementation Agencies of Stockholm Convention
IPEN	International POPs Elimination Network
NGO	Non-Governmental Organization
NIP	National Implementation Plan (under the Stockholm Convention)
QA	Quality assurance
QC	Quality control
OCB	Oil circuit breaker
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl(s)
PCT	Polychlorinated terphenyl(s)
PEN	PCB Elimination Network
POPs	Persistent organic pollutants
mg/kg	part per million
PVC	Polyvinylchloride
SCRCAP	Stockholm Convention Regional Centre for Capacity-building and the Transfer of Technology in Asia and the Pacific
SOP	Standard operating procedure
TOX	Total organic halogen
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
US EPA	United States Environmental Protection Agency

1. INTRODUCTION

The Stockholm Convention on Persistent Organic Pollutants (POPs)[1] requires Parties to eliminate the use of polychlorinated biphenyls (PCB) in equipment by 2025 and to ensure the environmentally sound waste management of liquids containing PCB and equipment contaminated with PCB by 2028. Many Parties to the Convention have undertaken preliminary PCB inventories during the preparation of their National Implementation Plan (NIP). Those preliminary inventories are useful as they serve as a basis for future detailed inventories and provide baseline information allowing Parties to better understand the complex task of a complete PCB inventory.

However, a more detailed analysis shows that the majority of these preliminary inventories are incomplete and in many cases unreliable (see also Annex I: Existing PCB Inventories from NIPs). Further work is necessary to achieve a global picture of the current PCB status and to assert whether the goals under the Stockholm Convention are being achieved. Implementing environmentally sound management of PCB and complying with the goals of the Stockholm Convention set for 2025 and 2028 thus remains a major challenge for most developing countries and countries with economies in transition as well as some developed countries. A comprehensive PCB inventory is the first step towards a reliable PCB management process and will help to meet relevant obligations under the Convention. The 'Consolidated Assessment of Efforts Made Towards the Elimination of PCB'[2] supports these observations.

The 'PCB Inventory Guidance' is intended to serve as a guide on how to set up and/or update a comprehensive PCB inventory by following a step-by-step approach, focusing especially on awareness raising, stakeholder participation, sampling and testing, and PCB database development and information management. The Guidance is organized as follows:

- **Section 1 – Introduction**: defines PCB, introduces the background and objectives of this document and explains the need for developing and updating a PCB inventory.
- **Section 2 – Scope of a PCB Inventory**: provides a brief introduction of the history and current situation of PCB use, historic applications, potentially PCB holders and relevant requirements under the Stockholm Convention.
- **Section 3 – Preconditions for a PCB Inventory**: describes some key preconditions for a comprehensive PCB inventory, including the organizational set up, regulatory preconditions, stakeholder identification and awareness raising.
- **Section 4 – Conducting or Updating a PCB inventory**: provides a step-by-step approach for conducting a PCB inventory, including sampling, screening, analyzing and labeling of PCB.
- **Section 5 – Information Management**: outlines the basic requirements for the development and management of a PCB database.
- **Section 6 – Annex I**: gives an overview of the NIP process and existing PCB inventories;

[1] Stockholm Convention on Persistent Organic Pollutants, http://www.pops.int

[2] Available at: http://www.unep.org/chemicalsandwaste/POPs/ChemicalsManagementandReduction/PhasingoutPCBcopy/AssessmentsOfPCBEliminationCopy/tabid/1061161/Default.aspx

summarizes the preliminary results of PCB inventories.

- **Section 7 – Annex II**: lists existing guidance on PCB.

1.1 WHAT ARE PCB?

PCB (CAS No: 1336-36-3) are a class of organic compounds with one to ten chlorine atoms attached to a biphenyl, which is a molecule composed of two benzene rings. The chemical formula for PCB is C12H10-xClx. Theoretically, 209 different PCB congeners are possible, although only about 130 congeners are found in commercial PCB mixtures[3]. The chemical structure of PCB is shown in Figure 1. The possible positions of chlorine atoms on the benzene rings are denoted by numbers assigned to the carbon atoms.

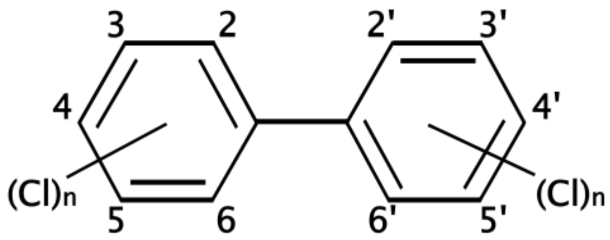

Figure 1: Chemical structure of PCB

PCB are mainly formed by chlorination of biphenyl with chlorine gas in the presence of a catalyst and they are either oily liquids or solids and are colorless to light yellow. PCB have low water solubility and low vapor pressures at room temperature, but they have high solubility in most organic solvents, oils, and fats[4]. PCB are excellent insulating oils and heat transfer agents because they have high dielectric constants, thermal conductivity, flash points (from 170 °C to 380 °C) and are chemically inert, being extremely resistant to oxidation, reduction, addition, elimination, and electrophonic substitution.

While PCB have good physico-chemical properties as industrial materials, they are toxic to humans and wildlife. This includes the indicator PCB and twelve congeners that share a structural similarity and exhibit the same toxic mode of action as 2,3,7,8-tetrachlorodibenzodioxin (TCDD). More than 40 years ago, PCB were recognized as environmental contaminants when Soren Jensen detected PCB in pike from Sweden[5]. Studies of workers provided evidence that PCB were associated with certain types of cancer in humans, such as cancer of the liver and biliary tract. Rats fed with commercial PCB mixtures throughout their lives developed liver cancer[6]. Consequently, the International Agency for Research on Cancer (IARC) classified PCB as Group 1 “carcinogenic to

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3 Table of PCB species by CAS Registry Number, U. S. Environmental Protection Agency, Region 5, http://www.epa.gov/toxteam/PCBid/

4 Technical Factsheet on: Polychlorinated Biphenyls (PCB), http://www.epa.gov/safewater/pdfs/factsheets/soc/tech/PCB.pdf

5 Soren Jensen, "Report of a New Chemical Hazard," NEW SCIENTIST Vol. 32 (1966), pg. 612.

6 Kuratsune M, Nakamura Y, Ikeda M. Analysis of deaths seen among patients with Yusho-a preliminary report. Chemosphere 1987,16:2085-2088

humans". Among POPs, the second highest concentrations in human milk is for PCB. Once in the environment, PCB enter the food chain: More than 90% of human exposure to PCB is through food. Such exposure also has neurotoxic and immunotoxic effects. In addition, PCB undergo long-range transport through air, water and migratory species. They travel across international boundaries and are deposited far from their point of release, and accumulate in terrestrial and aquatic ecosystems. There is therefore an urgent need for PCB to be inventoried, taken out of use and managed in an environmentally sound manner.

1.2 PCB Inventory Requirements and National Reporting

Given the recognition of PCB as an environmental problem of global proportions, with numerous studies having detected PCB in various compartments of the environment and in remote areas[7], they were listed in the Stockholm Convention as one of the initial twelve POPs. All remaining uses of PCB (e.g. PCB transformers, capacitors or other receptacles containing liquid stocks) must be eliminated by Parties to the Convention on Persistent Organic Pollutants by the year 2025.

The requirement to prepare a PCB inventory is clearly regulated in Part II of Annex A of the Stockholm Convention, according to which each Party shall take action in accordance with the following priorities:

(i) Make determined efforts to identify, label and remove from use equipment containing greater than 10 % PCB and volumes greater than 5 liters;

(ii) Make determined efforts to identify, label and remove from use equipment containing greater than 0.05 % PCB and volumes greater than 5 liters;

(iii) Endeavour to identify and remove from use equipment containing greater than 0.005% PCB and volumes greater than 0.05 liters.

Environmentally sound waste management of liquids containing PCB and equipment contaminated with PCB needs to be achieved by 2028. The undertaking of a detailed inventory is an indispensable prerequisite for the achievement of the 2028 objective.

Furthermore, paragraph (f) of the Stockholm Convention stipulates that each Party shall endeavor to identify other articles containing more than 0.005 % (e.g. cable-sheaths, cured caulk and painted objects) and manage them in an environmentally sound manner. Such so-called 'open applications' are, however, not the focus of this guidance, but shall be addressed in a separate document.

Article 15 of the Convention requires each Party to report to the Conference of the Parties (COP) on the measures it has taken to implement the provisions of the Convention and on the effectiveness of such measures in meeting the objectives of the Convention. The Conference of the Parties (COP) decided at its first meeting that national reports shall be submitted every four years. The information provided in the national reports is one of the main references to be used for the evaluation of the effectiveness of the Convention in accordance with its Article 16 including the progress towards the elimination of PCB.

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[7] Wania F, Potential of Degradable Organic Chemicals for Absolute and Relative Enrichment in the Arctic, Environ. Sci. Technol. 2006, 40, 569-577

Setting up a national PCB inventory is a dynamic process as it needs to be constantly updated to reflect changes in stocks. Each party to the Stockholm Convention shall make determined efforts to identify, label and remove from use liquids containing PCB and equipment contaminated with PCB and report periodically on progress in eliminating PCB to the COP of the Convention. The PCB inventory prepared should fulfill the reporting requirements under the Stockholm Convention and gather enough information to support the environmental sound management of PCB. Each Party is required to report on[8]:

- data on total quantities of its production, import and export of PCB or a reasonable estimate of such data;
- the list of the States from which it has imported PCB and the States to which it has exported PCB, to the extent practicable;
- the measures it has taken to implement the provisions of PCB elimination and on the effectiveness of such measures in meeting the objectives of the Convention.

1.3 Needs for Developing and Updating a PCB Inventory

The elimination of PCB on a global scale remains a significant challenge. Developing countries and countries with economies in transition in particular, but also a number of developed countries, still have many obstacles in identifying their PCB burden, removing PCB from use, and achieving environmentally sound waste management of liquids containing PCB and equipment contaminated with PCB. Some of the key challenges are discussed below.

Lack of Stakeholder Participation from Weak Awareness

It is important that PCB holders, especially owners of electrical equipment, cooperate during the establishment of inventories and interact with PCB inventory field teams. However, it was commonly found in developing countries that stakeholders and especially industry show a lack of interest to engage in the identification process. It is also unclear whether and to what extent the private sector and small consumers are included in existing inventories.

Stakeholder commitment is also limited because a lack of understanding prevails as regards the different roles and responsibilities in the inventory process. Furthermore, in many cases, the person contacted is not the appropriate contact point. As for the responsible government agencies, developing countries in particular often lack trained and dedicated staff to undertake the inventory.

PCB inventories often do not take into account the informal sector. The validity of the inventories is therefore reduced where the informal sector represents a significant share of economic activity, which is the case in many developing countries[9]. The main reason why industry and small consumers are often hesitant to provide the requested information or to allow authorities access to their sites is the fear of being sanctioned if PCB is found on their premises, and the costs associated with the environmentally sound management of PCB.

Awareness-raising and targeted trainings are therefore critical elements of any inventory campaign.

8 COP Decisions on Reporting (Article 15), Decision SC-2/18: Reporting

9 Urs K. Wagner, Inventories of PCB- An Expert's Point of view, PEN Magazine (Issue 01), 2011: 09

This should ideally involve all stakeholders from responsible decision-making bodies to the mid-management level, relevant representatives from the private sector as well as those who might be exposed to PCB in the workplace.

LACK OF ADEQUATE INVENTORY APPROACHES

Another lessons learned from past PCB inventories is the fact that setting up a PCB inventory is a dynamic process, whereby a single inventory is not sufficient[10]. In practice, it is not feasible to identify all liquids and equipment through one campaign. The mid-term objectives of a PCB investigation should also take into account the social and economic situation in a country.

The scope of any PCB inventory should meet the requirements listed above. Thus, it should cover at least the liquid PCB containing equipment (e.g. the oil found in transformers, capacitors or other receptacles containing) and equipment contaminated with PCB content above 0.005%.

LACK OF EFFECTIVE INFORMATION MANAGEMENT

Lack of effective information management is a common shortcoming in the undertaking of PCB inventories. Many countries lack reliable records on current and past PCB production, imports and exports. Data on storage sites with retired PCB equipment is also lacking in most countries. Similarly, records on companies engaged in retro-filling is rarely available. Some of the reasons for not achieving effective information management are a poorly executed organizational structure, lack of information back up, and retention policies, plus the cost of collecting, storing, and securing PCB information throughout its life cycle. When developing new inventories, it is important to avoid these mistakes and to set up an effective information management system. This may include the development and maintenance of a national database that is periodically updated.

LACK OF PCB SAMPLING AND ANALYSIS

Analysis of the initial NIPs, as well as some of the updated ones, shows that most countries' PCB inventories are rough estimates that may in fact depict a highly inaccurate picture of the actual situation. These inventories are based on a large number of extrapolations and assumptions that are not verified. Only few countries undertake laboratory testing of the PCB content, instead relying on initial rapid screening tests. Most preliminary PCB inventories focus only on electrical equipment, specifically big transformers in the electrical sectors, because of limited time and resources. However, Tanabe's study shows that only less than half of the PCB produced was used for transformer oil[11]. About 21% of PCB production was used for capacitors, 21% for "open uses" and 10% for other 'nominally closed' systems. Other sectors therefore need to be taken into account.

Cross-contamination is another neglected issue. A study by Elizabethton Electric System (USA), prepared in 1998 and updated in 2006 on "Distribution Transformer Manufacturers and available PCB Information" provided statistical results linking PCB contamination to transformation manufacturers. Their study shows that, although transformers from some manufacturers did not

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[10] Mauricio Limón Aguirre, Alfonso Ramirez Flores, Alberto Villa Aguilar, Mexican experience - A single inventory is not enough. PEN Magazine (Issue 01), 2011: 66

[11] Tanabe S, PCB problems in the future: Foresight from current knowledge, Environmental Pollution 1988, 50:5-28

have any PCB, the incidence rate for others was around 25% to 32%[12]. The chemical has most likely worked its way throughout the electrical system and other relevant sectors.

Current PCB estimations often do not take cross-contamination between electrical equipment into account during their maintenance. The degree to which a given electrical system has been contaminated can vary and the range of possible applications of PCB is extremely wide. The only means of identifying PCB contaminated transformers is by carrying out sampling and analysis of the dielectric fluids.

[12] Luciano A. Gonzalez, Transformers with PCB-contaminated mineral oil: myth or reality? PEN Magazine (Issue 01), 2011: 96

2. Scope of a PCB Inventory

This section describes briefly the history of PCB production and application, identifies the PCB products, major PCB holders and industries and places used, and introduces the scope of PCB inventories.

2.1. PCB Production, Application and Wastes

The first PCB were synthesized in 1881 and the production of PCB mainly occurred over the period 1929–1993. PCB are no longer produced in any countries, except one[13, 14]. A study had estimated the cumulative global production to be on the order of 1,325,000 t between 1930 and 1993[15]. The 'Consolidated Assessment of Efforts Made Towards the Elimination of PCB'[16] estimated total production at between 1 and 1.6 million tonnes, with production limited to 12 countries and 17 companies.

The first producers were Monsanto (US), Bayer AG (West Germany) and Prodelec (France). Production of PCB peaked in the 1960s, by which time the U.S. Congress made PCB mandatory safety equipment in electricity utilities. In 1972, PCB production plants existed in Austria, China, Czechoslovakia, the Federal Republic of Germany, France, Great Britain, Italy, Japan, Spain, and USSR. PCB have been produced in many countries under various brand names, such as Aroclor (in the USA and the UK) and Kanechlor (in Japan), as shown in Table 2-1 and Table 2-2.

[13] Peter O'Toole, Health Risks Associated With Polychlorinated Biphenyls, JAMA2005,293:1725.

[14] See the Meeting Report of the PCB Expert Meeting and Sixth Meeting of the Advisory Committee of the PEN, available at: http://www.unep.org/chemicalsandwaste/POPs/ChemicalsManagementandReduction/PhasingoutPCBcopy/PCBEliminationNetworkCopy/tabid/1061160/Default.aspx

[15] Knut Breivik, Andy Sweetman, Jozef M. Pacyna, Kevin C. Jones, Towards a global historical emission inventory for selected PCB congeners — a mass balance approach 1. Global production and consumption, The Science of the Total Environment 290 (2002) 181–198

[16] Available at: http://www.unep.org/chemicalsandwaste/POPs/ChemicalsManagementandReduction/PhasingoutPCBcopy/AssessmentsOfPCBEliminationCopy/tabid/1061161/Default.aspx

Table 2-1: Total PCB production as reported in the literature (in tons)[17]

Producer	Country	Start	Termination	Amount (t)
Monsanto	USA	1930	1977	641,246
Geneva Ind.	USA	1971	1973	454
Kanegafuchi	Japan	1954	1972	56,326
Mitsubishi	Japan	1969	1972	2,461
Bayer AG	Federal Rep. of Germany	1930	1983	159,062
Prodelec	France	1930	1984	134,654
S.A. Cros	Spain	1955	1984	29,012
Monsanto	U.K.	1954	1977	66,542
Caffaro	Italy	1958	1983	31,092
Chemko	Czechoslovakia	1959	1984	21,482
Orgsteklo	Soviet Union	1939	1990	141,800
Orgsintez	Soviet Union	1972	1993	32,000
Xi'an	China	1960	1979	8,000
Total		1930	1993	1,324,131

Table 2-2: Brand names of PCB mixtures in different countries[18]

Aceclor (t)*	Cloresil	Montar
Adkarel	Clorphen (t)	Nepolin
ALC	Delor (Czech Rep.)	Niren
Apirolio (t, c)*	Diaclor (t, c)	No-Famol
Aroclor (t, c) (USA)	Dialor (c)	No-Flamol (t, c) (USA)
Aroclor 1016 (t, c)	Disconon (c)	NoFlamol
Aroclor 1221 (t, c)	Dk (t, c)	Nonflammable liquid
Aroclor 1232 (t, c)	Ducanol	Pheneclor
Aroclor 1242 (t, c)	Duconol (c)	Phenoclor (t, c) (France)
Aroclor 1254 (t, c)	Dykanol (t, c) (USA)	Phenochlor
Aroclor 1260 (t, c)	Dyknol	Phenochlor DP6
Aroclor 1262 (t, c)	EEC-18	Plastivar
Aroclor 1268 (t, c)	Electrophenyl T-60	Pydraul (USA)
Areclor (t)	Elemex (t, c)	Pyralene (t, c) (France)
Abestol (t, c)	Eucarel	Pyranol (t, c) (USA)
Arubren	Fenchlor (t, c) (Italy)	Pyrochlor
Asbestol (t, c)	Hexol (Russian Federation)	Pyroclor (t) (USA)
ASK	Hivar (c)	Saf-T-Kuhl (t, c)
Askarela (t, c) (USA)	Hydol (t, c)	Saft-Kuhl
Bakola	Hydrol	Santotherm (Japan)
Bakola 131 (t, c)	Hyvol	Santotherm FR
Biclor (c)	Inclor	Santoterm
Chlorextol (t)	Inerteen (t, c)	Santovac
Chlorinated Diphenyl	Kanechlor (KC) (t, c) (Japan)	Santovac 1
Chlorinol (USA)	Kaneclor	Santovac2

[17] Breivik, K., et al., Towards a global historical emission inventory for selected PCB congeners --A mass balance approach: 3. An update. Science of The Total Environment, 2007. 377(2-3):296-307

[18] "Brand names of PCB — What are PCB?". Japan Offspring Fund / Center for Marine Environmental Studies (CMES), Ehime University, Japan. 2003. http://tabemono.info/report/former/pcd/2/2_2/e_1.html. Retrieved 2008-02-11.

Chlorobiphenyl Clophen (t, c) (Germany) Clophen-A30 Clophen-A50 Clophen-A60 Clophen Apirorlio	Kaneclor 400 Kaneclor 500 Keneclor Kennechlor Leromoll Magvar MCS 1489	Siclonyl (c) Solvol (t, c) (Russian Federation) Sovol Sovtol (Russian Federation) Therminol (USA) Therminol FR

* t = transformer; c = capacitor

The commercial utility of PCB was based largely on their chemical stability, including low flammability, and desirable physical properties, including electrical insulating properties. PCB were used as dielectric, hydraulic and coolant fluids especially as insulating fluids for transformers and capacitors, as shown in Table 2-3.

Table 2-3: PCB products and the major places used[19]

PCB uses		Examples of products, and the places they are used
Dielectric Fluids	For transformers	Transformers for buildings, hospitals, railroad vehicles, vessels, etc.
	For capacitors	Power Factor Correction Capacitors, Motor Start Capacitors, Light Ballasts and Capacitor for fluorescent lights and mercury lamps. Household electrical appliances, such as air-conditioners, washing machines, monochrome television sets, and microwave ovens. Fixed paper capacitors for motors, capacitors for direct currents, capacitors for accumulation of electricity
	Other electric utilities	Switches, voltage regulators, liquid filled electrical cables, liquid filled circuit breakers
Hydraulic fluids as heat medium (heating and cooling)	Hydraulic fluids	Mining equipment; aluminum, copper, steel, and iron forming industries
	Heat transfer fluids	Heating and cooling agent in various chemical, food and synthetic resin industry. Preheating agent of the fuel oil of vessels, central heating systems, and panel heaters
	Vacuum pumps oil	Electronic components manufacture; laboratory, instrument and research applications; and waste water discharge sites
	Lubricating oil	Lubricating oil for high temperature, fluid for oil-hydraulic circuits, vacuum pump oil, etc.
Others	Printer and printing inks	Non carbonic papers (solvents), electronic type copying papers, paints for fire-resistance, corrosion-resistance, chemical-resistance, and waterproof printing inks
	Plasticizer	For insulation, for resistances to flame or mixed to adhesives, varnish, wax, and asphalt
	Dissipative usage	Coating of papers, sealants of cars, coloring of China glassware, color television parts, the effect extension agents of agricultural chemicals, oil additive agents

Other PCB applications include plasticizers in paints and cements, stabilizing additives in flexible PVC coatings of electrical wiring and electronic components, pesticide extenders, cutting oils,

19 UNEP(1999), Guidelines for the Identification of PCB and materials containing PCB, First Issue

reactive flame retardants, lubricating oils, hydraulic fluids, and sealants[20] (for caulking in schools and commercial buildings), adhesives, wood floor finishes, paints, de-dusting agents, water-proofing compounds, casting agents, vacuum pump fluids, fixatives in microscopy, surgical implants, and in carbonless copy paper[21].

Knut Breivik et al[22] estimated the cumulative global consumption pattern for total PCB consumption in 114 individual countries based on a mass-balance approach. His results suggested that almost 97% of the intentionally produced PCB had been used in the Northern Hemisphere. Furthermore, approximately 18% of the total had been used between 40th and 42th northern latitude, as shown in Figure 2.

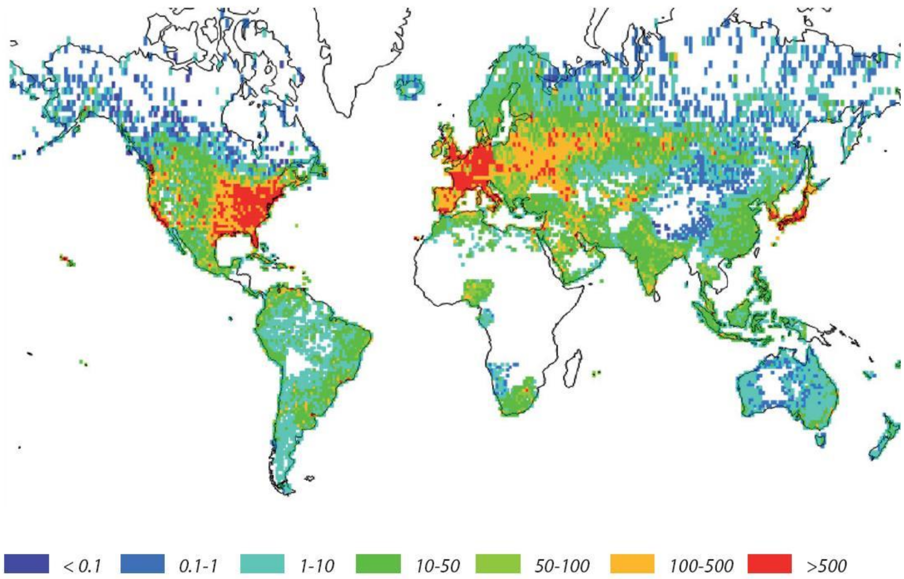

Figure 2: Estimated cumulative global usage of PCB (legends in t)[23]

Most production of PCB was phased out by the 1990s. Consequently, the focus has shifted to the PCB in use, existing stockpiles, PCB containing wastes and contaminated sites as major issues of PCB pollution control in the near future.

[20] Rudel, R A, Seryak, L M, and Brody, J G (2008). "PCB-containing wood floor finish is a likely source of elevated PCB in resident's blood, household air and dust: a case study of exposure". Environmental Health 7: 2.

[21] The Ministry of Environment, Japan (2001); "For proper processing of polychloro biphenyl (PCB) waste."

[22] Knut Breivik, Andy Sweetman, Jozef M. Pacyna, Kevin C. Jones, Towards a global historical emission inventory for selected PCB congeners — a mass balance approach 1. Global production and consumption, The Science of the Total Environment 290 (2002) 181–198; Towards a global historical emission inventory for selected PCB congeners — a mass balance approach 3. An update, Science of the Total Environment 377 (2007) 296–307

[23] *Ibid*.

2.2. Scope of a Comprehensive/Complete PCB Inventory

The equipment with liquids containing PCB (e.g. transformers, capacitors or other receptacles containing liquid stocks) with a volume above 0.05 liter and equipment contaminated with PCB content above 0.005 % need to be included in a PCB inventory. The scope could be adjusted to the actual situation in the country in question and the list could be shorted if some of the following PCB products were never produced or imported in a country.

It is believed that a large share of the PCB containing equipment are already beyond their lifetime. Most of the equipment containing or contaminated with PCB has been discarded in an inappropriate manner. Waste, discarded equipment and sites should therefore be a major concern for countries and need to be included in PCB inventories. A comprehensive PCB inventory should include the following:

Transformers

Transformers probably represent the largest source of PCB. PCB or Askarel transformers are easily identifiable since their nameplates indicate that they are insulated with PCB dielectric. Oil transformers need to be tested even if they were manufactured after 1980, because they may have been cross-contaminated during their maintenance.

Capacitors

Capacitors are estimated to constitute the second largest source of PCB. Nonetheless, capacitors are often neglected during the assessment of in-service PCB equipment. It should be noted, that capacitors can be hidden in switchgear or form parts of other electrical equipment, such as fans.

Hydraulic Compressors

Hydraulic compressors were often contaminated when they were serviced using PCB-contaminated hydraulic fluid. In many cases, there is contamination that can be detected on the outside of the compressor where oil leaked and accumulated dirt over time.

Oil Filled Pumps and Motors

Oil filled pumps and motors are not as common as other PCB equipment and can usually be identified as PCB waste by virtue of the fact that they were specifically designed and fabricated for PCB. Each piece of old equipment (prior to 1980) should be sampled for PCB.

Waste Ballast, Liquid Filled Cable and Oil Circuit Breakers

Light ballasts are commonly used in fluorescent lamps to assist light start and limit the amount of current in an electric circuit. Liquid filled cable or fluid-filled cables have been used in power lines at extra high-voltage distribution networks. Oil circuit breakers are typically found in outdoor substations with mineral oil transformers. They may be mixed with waste electrical and electronic equipment (WEEE) or other municipal solid wastes and go unnoticed when conducting a PCB investigation.

Waste Oil, Paints and Solvents

Waste oil, paints and solvents often get mixed with other oil and solvents that contain PCB, especially heat transfer fluids, hydraulic fluids, lubricating oil and re-used oil. It is common for municipalities to inherit several drums of PCB contaminated paint and paint sludge. Those stored oil and solvents may be released into the workplace or environment through a number of different ways including, leaks, spills, over-filling, accidental damage, fires, and vandalism[24].

2.3. MAJOR PCB HOLDERS AND INDUSTRIES

The major holders and industries with potentially significant amounts of PCB equipment are shown in Table 2-4. Sector-specific investigations are a critical element for the PCB inventory preparation and management. All of the possible target industries listed should be regarded as PCB stakeholders with high priority and need to be actively involved in the preparation of a PCB inventory.

Table 2-4: Major PCB holders and industries[25]

Possible target industries	Common PCB-containing applications
Electric power stations and distribution stations	Transformers Large capacitors Small capacitors Switches Voltage regulators Liquid filled electrical cables Circuit breakers Lighting ballasts
Industrial Facilities (including mining, aluminum, copper, iron and steel, cement, chemicals, plastics, synthetics, and petroleum refining industries)	Transformers Large capacitors Small capacitors Heat transfer fluids Hydraulic fluids (equipment) Voltage regulators Circuit breakers Lighting ballasts Heat transfer fluids Vacuum pumps Lubricating oil
Railroad systems	Transformers Large capacitors Voltage regulators Circuit breakers Vacuum pumps Lubricating oil

[24] PCB Disposal Inc., http://www.PCBdisposalinc.com/images/pdfs/PCB%20Site%20Remediation.pdf

[25] "Proceedings of the Subregional Awareness Raising Workshop on Persistent Organic Pollutants (POPs), Bangkok, Thailand". United Nations Environment Programme. November 25-28th, 1997.

Possible target industries	Common PCB-containing applications
Military installations	Transformers Large capacitors Small capacitors Circuit breakers Voltage regulators Hydraulic fluids (equipment)
Electronics and mechanical manufacturing and maintenance plants	Transformers Switches Voltage regulators Circuit breakers Vacuum pumps Lighting ballasts Small capacitors
Research laboratories	Vacuum pumps Fluorescent light ballasts Small capacitors Circuit breakers
Waste water discharge facilities	Vacuum pumps Well motors
Automobile service stations	Re-used oil Vacuum pumps
Waste recycling and recovery plants and sites	Decommissioned equipment Small capacitors (in washing machines, hair dryers, neon tubes, dishwashers, power supply units, etc.) Circuit breakers Lighting ballasts Building demolition Fluff Spills

Other relevant PCB stakeholders may also include: relevant government departments, business and employer associations, electrical contractors associations, hazardous waste contractors and waste management industries, farming associations, representative bodies in the demolition and construction industry and local authorities. Institutions undertaking PCB sampling, testing and analysis and who could provide IT support for electronic storage of data during the inventory survey are also important stakeholders.

3. PRECONDITIONS FOR A PCB INVENTORY

In order to support the inventory taking and to avoid misunderstandings, establishment of regulatory prerequisites, an appropriate organizational set-up and the undertaking of awareness-raising campaigns for the relevant stakeholders and the general public are important issues to be addressed, not only to ensure the successful completion of the PCB inventory but also for all subsequent activities towards the environmentally sound management of PCB liquids and equipment.

3.1. REGULATORY PREREQUISITES

Experience in many developing countries showed that a lack of an adequate regulatory framework on PCB may seriously impede the inventory process. In many cases, roles and responsibilities are not clear, meaning that no single institution is responsible for regulating and monitoring the use of PCB. A broad national legal and institutional framework is necessary for the issuance of such regulations and their enforcement. The national environmental policy should provide a broad framework for the proper and responsible management of PCB wastes and the protection of human health and the environment.

There is also a need to strengthen enforcement capacities, including related institutions, inspectors and provision of specialized skills and field-testing equipment. The law in many developing countries needs to be reviewed to incorporate stringent provisions on the monitoring of health effects as well as liability and compensation for damage resulting from exposure to PCB.

Based on the results obtained through the inventory process, the legal framework might need to be revisited and adopted to address issues identified during the inventory. Participation of different stakeholders in the identification process as well as having a better idea of the real size of the PCB problem will provide significant input and direction for the development of legislative and regulatory measures. Taking into account that it may not be possible to initiate activities relating to the PCB inventory without an adequate legal basis, a regulation on PCB management and disposal should be established before the inventory process is started.

Parties to the Stockholm Convention might also want to take actions to modernize their legislation related to the Convention and incorporate provisions for a broader and integrated chemical safety approach. This will include drafting specific regulatory acts and supporting operational guidelines/handbooks for practical application. An important element could be the creation of adequate institutional arrangements for co-ordination of POPs related activities country-wide and the dissemination of experience gained for overall chemical safety aspects. Parties might also wish to develop an integrated system of POPs management with the transposition of modern regulations and international obligations under several international treaties related to POPs and specifically the Stockholm Convention on Persistent Organic Pollutants, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain hazardous Chemicals and Pesticides in International Trade and other international obligations for POPs, hazardous wastes and dangerous substances.

The regulatory framework on PCB could cover the following issues:

- Responsibilities of the various stakeholders;
- prohibition of production and use;
- instruction on performing PCB inventories and identification of contaminated sites;
- instruction on field- and laboratory identification of PCB content in dielectric oils and other materials;
- regulation on statistical reporting on PCB wastes, products, installations and contaminated sites;
- recommendations for safe usage of PCB materials;
- management, labeling, storage and transport of contaminated equipment and oils;
- management of abandoned storehouses and contaminated sites;
- import/export and transboundary movement of PCB; and
- instruction on disposal of PCB-contaminated oil and equipment.

However, a cost-benefit analysis needs to be done when preparing the PCB regulation in order to assert the feasibility related to:

(i) available human resources and related ministries for implementation (issuing of permits, monitoring, reporting, etc.);
(ii) planned economic instruments (i.e., user taxes; waste disposal fees, packaging fee/taxes, etc.);
(iii) required institutional arrangements (on national and local level);
(iv) required additional investments in public and private sector monitoring and reporting; and
(v) needed supporting guidelines, stakeholders awareness and information campaign to stakeholders.

Specific regulations should be established for implementing the requirements of the framework legislation and allowing the establishment of priorities regarding the schedule for legislation preparation, particularly those related to the project schedule needs. The legal acts and regulations need to be clearly communicated and understood by all relevant stakeholders and should be supported by relevant operational and methodological guidance and, where necessary, targeted trainings.

3.2. Organizational Set-up

An office or a team should be designated as the national lead coordinating and implementing agency for developing the PCB inventory. The team should consists of the representatives from the major government departments, industries and other relevant stakeholders concerned with PCB production, usage, import, export, storage and waste handling and treatment. It should also include the entities responsible for implementing the Stockholm Convention in the country, for example the national committee for the implementation of the Stockholm Convention; the Stockholm Convention Focal Point; the department of industry; the department of environmental protection; the department of import and export; local governments, PCB equipment holders; PCB monitoring institutes, PCB disposal enterprises, scientific institutions, and other private sector representatives (see Figure 3). A possible distribution of responsibilities of some of these stakeholders is described below.

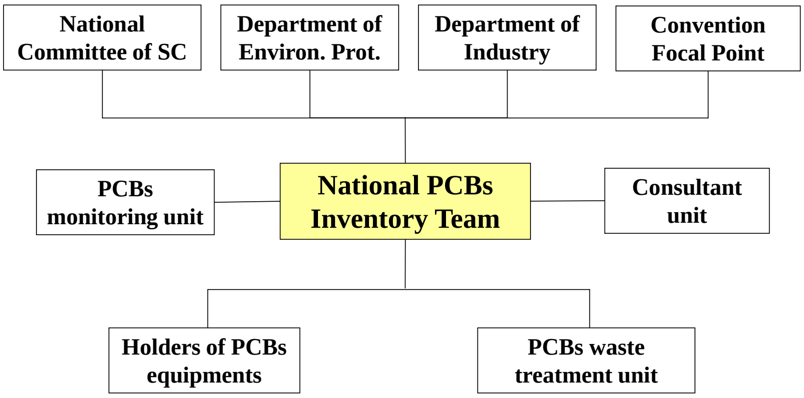

Figure 3: Stakeholders of a PCB inventory

A **national committee for the implementation of the Stockholm Convention** could serve as the national leading or coordination committee that consists of the major governmental departments. This committee could provide overall guidance and coordination for the preparation of the PCB inventory, strategy and action plans as well as the development of the POPs National Implementation Plan. The committee could provide overall guidance to:

(i) review significant policies related to PCB;

(ii) oversee implementation of the NIP;

(iii) act as steering committee for implementation of other relevant and potentially linked POPs projects;

(iv) assign and supervise PCB activities;

(v) provide direction to the local agencies; and

(vi) coordinate with stakeholders, including the Global Environment Facility (GEF), other donors, implementing agencies, and relevant domestic ministries and agencies.

The national committee could consist of representatives of the following agencies:

- The department of environment protection;
- the department of finance;
- the department of industry;
- the department of health; and
- the relevant industry associations and non-governmental organizations (NGOs).

A **national PCB inventory team** could be the national implementing agency for the PCB inventory. The inventory team will carry out the PCB survey, including preparation of PCB inventory guidelines adopted to domestic circumstances, completion of the PCB form, selection and use of PCB identification methods, establishment of a PCB database, identification of PCB holders, provision of training, collection of the PCB questionnaire, provision of guidance on PCB equipment labeling, physical inspection and verification of the results, updating of the PCB database and reporting of data.

The inventory is undertaken by sending questionnaires directly to the potential holders of the equipment. In their reporting, PCB holders should also indicate PCB management plans and changes in stocks. The inventory team will coordinate with the hazardous waste unit in order to develop the future PCB management system as an integrated part of the general hazardous waste management system.

The **Stockholm Convention Focal Point** could be responsible for day-to-day compliance with the Stockholm Convention, including to:

(i) provide technical support to international negotiations and policy studies on the PCB management;
(ii) provide support to the development and implementation of corresponding PCB policy and regulations, as well as to coordinate with key governmental stakeholders;
(iii) screen, prepare and implement activities relevant to the Convention;
(iv) raise co-financing (bilateral and domestic) for international collaborative programs; and
(v) collect data and information, prepare reports, organize trainings, and undertake education and awareness-raising activities.

The **Department of Environmental Protection** (or another governmental body with similar responsibilities) could be responsible for the national policy construction, capacity building, management and safe disposal of the stocks of obsolete and banned PCB and POPs waste. Guidelines and standards on PCB management should be prepared and issued by the department.

The **Department of Industry** could provide supervision and training of the state-owned power transmission companies, power distribution companies and the private sectors. It could also facilitate communication and engagement of relevant stakeholders from the private sector.

A **PCB monitoring unit** could be responsible for the analysis of transformer oils sampled by the holders of equipment using the test kits. In doing so, they may need to advise the holders of the equipment on the specifics of the sampling methods. For the enforcement of the PCB regulation, the inspectorate could, in cooperation with the PCB inventory team, prepare plans for inspections and undertaking random sampling of the equipment and liquids held by the industry. In cooperation with the PCB inventory team, the PCB monitoring unit could arrange a training workshop for selected inspectors.

A **consultant unit** could be invited to provide technical expertise and assist in the supervision of the PCB inventory, environmentally sound management of stockpiles, and dismantling and disposal of the obsolete PCB equipment. The consultant unit will monitor and evaluate the performance of the PCB management and help to build the local capacity as required.

The **holders of liquids and equipment** could be responsible for the identification of the PCB-containing equipment, oil sampling, notification and labeling in accordance with the proposed regulation. Furthermore, holders of PCB liquids and equipment could have the responsibility of preparing management plans and notifying the relevant authorities of any changes in the amount of such equipment. The holders should be informed about their duties and receive guidelines on PCB identification, notification, labeling and management. The potential holders include power plants, power distribution companies, industrial companies, waste treatment plants, army units, universities, etc.

The **PCB waste treatment unit**, in most cases a hazardous waste treatment company, could be selected for planning and implementing the packing of the PCB wastes, transport to the destruction facility and final disposal. The PCB waste treatment companies should be licensed for management of PCB waste as required by the PCB regulation.

3.3. Awareness-raising and Training

Awareness-raising and identification and involvement of the different potential holders of PCB are very important steps for the preparation of a PCB inventory and can define the success of the inventory project. They are often the first step of a comprehensive PCB inventory. The holders need to be included in the process as early as possible.

The main aim of the awareness raising activities is to familiarize the main stakeholders as well as the general public with PCB, answering questions such as the following: What are PCB? Where are PCB found? How do PCB affect humans and the environment? What are the state's obligations under the Stockholm Convention with respect to PCB, including, for example, labeling, appropriate personal protective equipment and disposal? Awareness raising could be used to engage the stakeholder organizations and the general public in the form of a public information campaign focusing on the basic PCB knowledge.

Electric companies and other industrial enterprises are the major importers, users and owners of PCB containing transformers and capacitors. However, their capacity to manage PCB containing oil and equipment is poor in most of the developing countries and there is little awareness on the dangers posed by PCB. Often, there is no database on existing PCB equipment. During field visits, it is commonly found that some of the PCB' oil containing transformers is leaking due to poor maintenance, thus posing great risk of contamination of surrounding water, underground water, the soil and food, among others. Generally, there is little awareness on the risks of PCB to human health and the environment, particularly among exposed workers or even within the management of PCB holders. Some workers of electric companies are suspected to suffer from cancer due to exposure to PCB in transformer oils.

It is important to enhance the capacity of electric companies and local authorities to monitor PCB levels in transformer oil, soil, water and human blood. Policy makers, professionals in the electricity sector and the public often have limited knowledge of the physical and chemical properties of PCB, their various applications and their adverse effects on human health and the environment. Local governments should increase awareness and knowledge among the management and personnel in companies and other relevant institutions.

National and regional workshops could be organized for the public and the private sectors, media and NGOs. Workshops designed for the competent authorities and for PCB owners could stress their responsibility for ensuring the environmentally sound management of PCB and cover issues such as: history, regulation and definition of PCB, impacts of PCB on health and the environment, current development of technology and regulations and PCB in the electric generation and distribution sector.

Brochures on PCB could be widely circulated to industries where PCB are likely to be found and to local authorities for them to distribute them to any member of the public interested in the issue.

Production and distribution of a brochure containing all relevant information, accompanied by a series of regional information workshops could alleviate much regional concerns on PCB issues. Publications and technical magazines on PCB could benefit the local authorities responsible for PCB management. Informative material (flyers and leaflets) about PCB could be disseminated and the PCB issues could be also popularized in the mass media — newspapers, television and radio.

In addition, in order to increase the level of awareness on PCB and to improve the rate of information reported, the government could publish the PCB inventory and management plans and circulate them to the relevant stakeholders. They could also train representatives of the relevant ministries, non-governmental organizations and industry, as well as other stakeholders, on the legal requirements for PCB.

4. Conducting or Updating a PCB Inventory

Development and use of a standard operating procedure (SOP) is an important element to ensure the success of the PCB inventory project. Existing international guidelines are good references for the compilation of the SOP. A 10-step approach[26] to completing or updating an inventory of liquids, equipment and the materials containing or contaminated with PCB is shown in Figure 4. Such inventory procedures also need to take into account 'soft criteria' such as the specific domestic circumstances and culture.

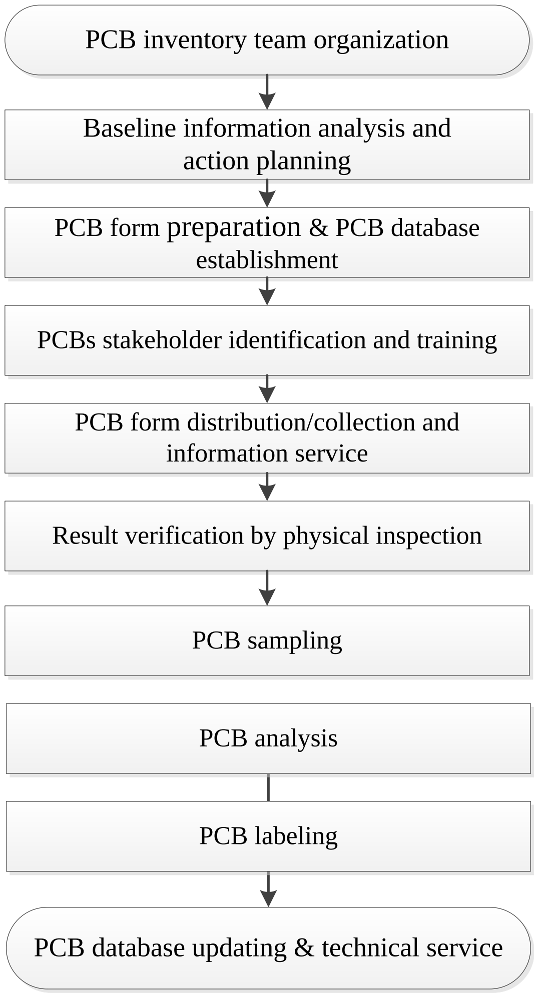

Figure 4: Flow chart for PCB inventory by a step-by-step approach

4.1. PCB Inventory Team Organization

A specialized PCB inventory team is necessary to ensure the completeness and accuracy of the PCB inventory. Available experience suggests that the 'self-reporting methodology' may not be an effective tool in some developing countries, especially when the PCB holders have little prior knowledge and lack awareness. The team should consist of the representatives and experts of the various relevant stakeholders and institutions.

[26] Step-by-step approach to completing a PCBPCB inventory, PEN magazine, issue 01, 2010: 27

4.2. Baseline Information Analysis and Action Planning

The collection of baseline information is a critical issue, since each country differs in terms of the situation regarding PCB production, usage, import, export and management. Also, the target of a PCB inventory should be adjusted accordingly. For example, the PCB inventory in China can put more emphasis on PCB capacitors because China had no domestic PCB transformer production.

Another important activity is to provide an estimate of existing PCB equipment in the country via a mass balance approach or by analyzing historic data on electricity consumption throughout the period of PCB usage. The related estimates could outline a general aim to achieve and help to determine the scope of the inventory in the next step.

4.3. PCB Form Preparation and PCB Database Establishment

A PCB investigation form should be prepared before the in-field investigation. The PCB Inventory Form prepared by UNEP could be used as a basic methodology[27]. Guidance for PCB holders on how to complete the PCB form and on the identification of PCB equipment should also be prepared.

The framework of the PCB database should also be established during this phase. A PCB database is an ideal tool to set priorities, to assess risks and to prepare adequate management plans and budgets. A database enables the authorities to control the location and nature of the PCB equipment, as well as the success of all related activities. The PCB database should include the full list of PCB-containing equipment, including the producer, type, mode, series number, size, picture, and so on. Databases facilitate the preparation of different reports using different parameters, including the periodic reporting to the COP of the Stockholm Convention. In the future, these databases should be used to track the lifecycle of PCB.

As for the PCB-containing equipment identification, the equipment nameplate is the first useful tool for judgment. The PCB-containing equipment numbering was specifically regulated specifically and PCB has various brand names in different countries (as shown in Table 2-2), so the identification method should be prepared accordingly. It is advisable to prepare a list of PCB containing equipment, including its producer, type, model number, capacitance, dimensions, power etc.[28]. A very useful tool for the identification of PCB equipment without nameplates is comparing them with photos from a database. It is therefore recommended to take photos of the equipment whenever possible and to record them in the PCB database.

Considering the fact that – except in one country which is not known to export PCB – no PCB were produced after 1993, it can be assumed that capacitors and other closed equipment manufactured after this date are PCB-free. As for transformers and other half-closed facilities, both the equipment nameplate and the maintenance recorders may have been contaminated during retro-filling of the equipment.

Oil sampling and analysis are critical to judge whether a facility is 'PCB' or 'PCB-Free'. Such

[27] UNEP, PCB Inventory Form, 2002, http://www.pops.int/documents/guidance/PCBinvform.pdf

[28] ANZECC, Identification of PCB-Containing Capacitors, 1997, http://www.environment.gov.au/settlements/publications/chemicals/scheduled-waste/pubs/pcbid.pdf

sampling and analysis needs to be undertaken by professional operators. If the equipment could not be identified as ‘PCB Free’, it has to be regarded as potentially containing or contaminated with PCB until the sampling and analysis performed by a qualified institute indicates otherwise.

Not only the capacitors and transformers in use have to be checked, but also those no longer in use or in reserve. Rigorous examination must also include spare oils and other equipment that could contain PCB (circuit breakers, heat exchangers, oil cisterns and pipe systems etc.).

4.4. PCB Stakeholder Identification and Training

Electric companies and relevant departments of electricity generation and distribution are the most important PCB holders, since the bulk of PCB can be found in capacitors and transformers in the power distribution network. Past PCB inventories have shown that PCB has also been used in electrical equipment to prevent fires in hospitals, schools, mines and electrical generation stations.

In some countries, food processing, construction, light industry, telecommunication enterprises, water supply, hazardous waste management companies and public institutions represent the second major group of holders of potentially PCB-containing or -contaminated electrical equipment. The risk of exposure in these companies could be much higher than in the electricity sector, as these entities lack trained maintenance and repair staff.

In sum, there is no a static way to identify PCB holders. Rather, each country needs to determine their specific target groups and key stakeholders based on the domestic situation.

Potential PCB stakeholders should be trained fully for completion of the PCB form and identification of PCB equipment.

4.5. PCB Form and Information Service

The PCB form should be send to the key industries and stakeholders that were identified. Also, the PCB form and related technical guidelines should be pomade publicly available. An internet-based reporting system is recommended to broaden the scope of the PCB inventory work.

Moreover, an online technical and information service is necessary to give further guidance, answer questions and provide assistance on completion of the PCB form, PCB equipment identification, and usage of the reporting system.

The information collected via the PCB forms should be checked carefully and then inserted into the PCB database. Next, the PCB team should compare and analyze the information from different areas and industries. Since there is a close correlation between the electricity utilization and PCB usage, a thorough analysis could give the PCB team further information about the completeness and accuracy of the date reported through the PCB forms. Potential areas of interest and concern could thus be verified through physical inspection.

4.6. Result Verification by Physical Inspection

Physical inspections can be an important tool for the PCB team to validate data and to address any problems that may have been raised in the PCB inventory. On-site communication with the stakeholders can also provide documentation to support enforcement actions which become necessary when PCB owners/agents will not voluntarily implement corrective actions.

Physical inspection should place their primary focus on those sites where significant PCB facilities were reported, where some information was lacking, or where further investigation and sampling was needed to verify PCB content/contamination. The PCB team should call the PCB owner/agent at least two weeks before the date on which they wish to conduct the inspection. At that time, the PCB team and owner should reach agreement on a date and determine the location of PCB facilities to be checked. The sampling facilities should also be available, if necessary.

The major purpose of the physical inspection is to verify results. A physical inspection report should be prepared for each of the inspections. When PCB sampling is undertaken during the inspection, the analysis result should be included in the inspection report. The PCB team should mail the inspection report to the PCB owners as soon as it has been completed. If the report contains serious findings, for example if a PCB leakage or pollution was found in the site, a formal letter should advise the owner/agent on the next steps to be undertaken.

4.7. PCB Sampling

Although the lack of sampling and analysis is a common shortcoming for many PCB inventories in developing countries, it is recommended that the sampling is undertaken only by professional staff or fully-trained operators equipped with adequate personal protection equipment. A strict quality assurance (QA)/quality control (QC) procedure should be followed to get representative and non-contaminated samples.

Transformer Oil Sampling

Oil samples can be taken using the drain tap which is usually located at the bottom of the transformer. The standard operation procedure (ASTM D 3613-92) of syringe-sampling and metal-cylinder-sampling could be followed for the sampling of transformer oil. Transformers can be sampled using a hand pump via the oil filling cap. However, the oil taken from the expansion receptacle is not representative and cannot be used as a sample for PCB analysis, because it does not circulate and thus it is not sufficiently mixed. Normally, 0.2 oil is enough for quantitative analysis of PCB concentration.

Capacitor Oil Sampling

It is advisable only to sample capacitors that are already out of service. Capacitors still in service and manufactured before 1993 with missing information about the dielectric liquid have to be labeled as PCB-suspect equipment. In the event that no data is available, it is best to label these with a yellow ‘suspect’ label and take a sample at the end of their service life before 2025.

If there is a series of the same capacitors, it is usually sufficient to sample only two devices out of the series. If a designation is missing and relevant information from the manufacturer is not available, the only way to test the dielectric liquid is to drill a hole in the casing at the top or cut the isolator and retrieve an oil sample. This can be done by using a pipette (use only once). After this exercise, the capacitor is unusable and, as it is now damaged, it must be stored in appropriate containers.

Storage Site Sampling

As for the sampling of PCB waste and contaminated sites, the 'Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup'[29] and the 'Protocol for Sampling and Testing at PCB Storage Sites in Ontario'[30] can be used to collect a PCB waste sample that represents the concentration of PCB contaminated soil, rocks, concrete and asphalt, wood, electrical cables, liquid and sludge stored in drums and piles.

Personal Protective Equipment

Because PCB is toxic and bio-accumulative, it is imperative that workers avoid all exposure to skin and eyes and avoid any potential for accidental ingestion by wearing suitable chemical and/or oil resistant gloves, goggles if there is potential for a chemical or oil splash hazard and protective clothing such as a coverall or work apron during a sampling process or under normal working conditions

If PCB comes into contact with the skin, immediately rinse the affected area with large amounts of running water. This may be done in a sink if the hands are the only portion of the body contacted or under a safety shower if the exposure area is more extensive. If large parts of the skin came in contact with PCB, please remove contaminated clothing while under the shower for a minimum of 15 minutes. Eyewash stations are required in areas where personnel can come into contact with corrosive liquids or gases.

4.8. PCB Analysis

PCB analysis can be divided into two categories: specific and non-specific methods. Although the density based quick test was mentioned in some technical guidelines, it only provides reliable information in case of pure or highly contaminated PCB oil. To speed up the inventory process and reduce the cost of PCB analysis, the samples should be screened via a fast testing process. Analysis is then only necessary for those containing or contaminated with PCB. Similar as with PCB sampling, PCB analysis should be undertaken by the professionals or fully trained workers with a strict QA/QC. This is also the case for a fast PCB testing process.

Quick testing

Most quick testing is undertaken using non-specific methods widely used in PCB screening, which measure the chlorinated hydrocarbons or total organic halogen (TOX) of samples. Although x-ray fluorescence spectrometry and microcoulemetric titration could be used for the measurement of chlorine contents, the following quick testing kits are more convenient for operation: Clor-N-Oil (for oil samples)[31], L2000 PCB/Chloride Analyzer (for soil and oil samples)[32], DR/2010 Portable

[29] USEPA, Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup, EPA-560/5-86-017, 1986

[30] Ministry of the Environment of Canada, Protocol for Sampling and Testing at PCB Storage Sites in Ontario, January 2000

[31] This detection kit can be obtained from the Dexsil Corporation. The Internet site to visit for more information is http://www.dexsil.com.

Datalogging Spectrophotometer[33] and DR/800 Series Colorimeters (for water samples)[34.]

EQUIPMENT ANALYSIS

Although considerable analytical costs and time are saved by using rapid screening tests, it is always useful to consider that these methods only screen the presence of chlorine in the samples. As a result, other chlorinated compounds will cause false positive results, because the analysis method reads all chlorinated compounds as PCB. False negative results should not occur, since PCB cannot be present absent any chlorine. If a screening test shows a negative result it must be true, so there is no need of verification by another method. Meanwhile, positive results only indicate that PCB may be present and confirmation will be required using laboratory procedures. Most of these kits will provide all the needed equipment to perform the tests[35].

The laboratory PCB analysis could be operated by GC-ECD or GC-MS, which is an accepted technique for quantitatively determining both congeners and Aroclor types. The United States Environmental Protection Agency (US EPA) guidelines in SW-846 could be potentially used as reference, such as the Method 8082A- Polychlorinated Biphenyls (PCB) by Gas Chromatography and Method 8275A (PDF)-Semivolatile Organic Compounds (PAHs and PCB) in Soils/Sludge and Solid Wastes Using Thermal Extraction/Gas Chromatography/Mass Spectrometry (TE/GC/MS).

4.9. PCB LABELING

Once the PCB containing or contaminated equipment has been identified, it must be labeled appropriately. Appropriate labels guarantee easy recognition whether or not the equipment contains PCB. In case of accidents, these labels ensure that the hazards can be assessed at first glance from the color of the label. The marking should be placed on the equipment so that it can be easily read during inspections and servicing. Preferences might differ but basically it seems favorable to use labels in bright colors for easy recognition. Labels should be in accordance with local or international requirements. The PCB storage areas should also be marked to allow expeditious identification and response to a PCB accident.

LABELING PCB EQUIPMENT

Labels should be affixed as soon as possible when the equipment was identified. Equipment in use containing 50 mg/kg of PCB at prescribed locations, such as a drinking water treatment plant, food or feed processing plant, child care facility, school, or hospital should receive special attention. The label should be big enough to be easily readable. Not too much text should be written; a brief explanation of the content and a contact address are sufficient. A 24-hours emergency phone number should also be added. Figure 5 shows an example of PCB label prepared by Insignia Labels. PCB labels are required to be placed in a readily visible location on accessible parts of the

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[32] The Internet site to visit for more information is http://www.dexsil.com.

[33] The spectrophotometer comes preprogrammed with 120 Hach analysis methods. The Internet site to visit for more information is http://www.hach.com.

[34] This is a small colorimeter that can check for PCB (chloride) in water. It is designed for field use. The Internet site to visit for more information is http://www.hach.com.

[35] UNEP, Guidelines for the Identification of PCB and Materials Containing PCB, 1999

equipment or associated equipment, whether in use or dismantled.

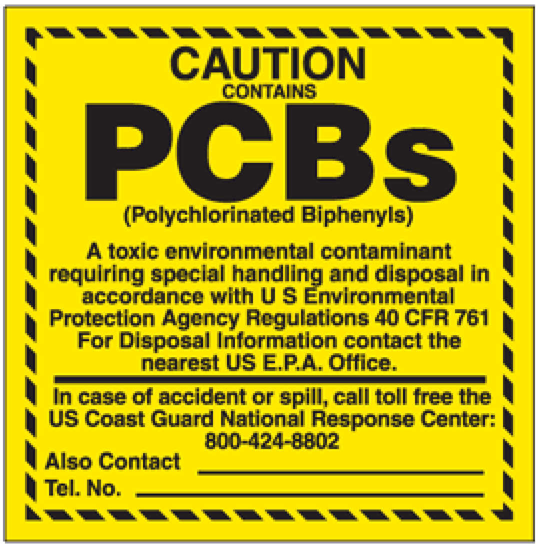

Figure 5: An example of PCB equipment labeling[36]

LABELING A PCB STORAGE SITE

A PCB label should be attached at a readily visible location for any stored product containing 50 mg/kg or more of PCB that falls under the requirements of the Stockholm Convention. The label could be placed near the entrance of the PCB storage site. The date on which the storage began should be indicated on the label (Figure 6).

Figure 6: An example of PCB storage site labeling

NON-PCB LABELING

It is also recommended that newly procured equipment and existing equipment certified as PCB-free be labeled with an appropriate marker, although there are few regulatory marking requirements for non-PCB-containing equipment. Figure 7 shows an example of Non-PCB labeling

[36] http://www.printedlabels-bristol.co.uk/products-pcb-labels.html

prepared by the New Pig.

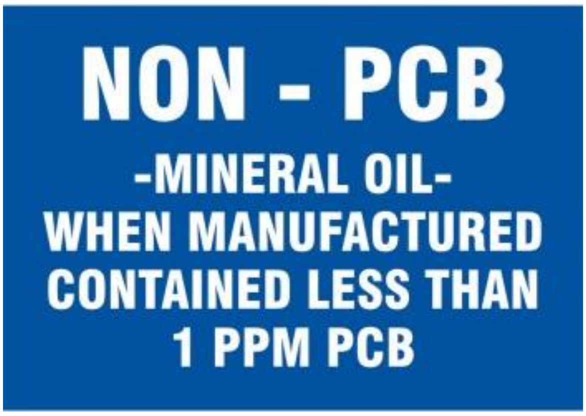

Figure 7: An example of non-PCB Labeling[37]

4.10.PCB Database Updating and Technical Service

The PCB database needs to be continuously maintained and updated. As soon as a piece of equipment has been treated or eliminated in an environmentally sound manner, the status of this equipment in the database must be updated. Long-term technical service is a key to update a comprehensive PCB inventory, since the inventory work is a dynamic process. Even in developed countries, which began their first inventory of PCB in electrical equipment in the 1990s, relevant quantities of small- and low-voltage PCB capacitors are still in use and, occasionally, formerly unknown PCB sources are detected. Today, many countries in the Northern Hemisphere focus on PCB in open systems considering it now as the most problematic source of exposure[38].

Some criteria were also proposed[39] to measure the success of a PCB inventory, such as PCB quantities found/removed, awareness of PCB users, general population, government leaders, number of PCB incidents reduced and the access to PCB facilities such as laboratories, disposal and transport.

[37] http://www.newpig.com/us/non-pcb-mineral-oil-less-than-1mg/kg-pcb-label/SGN688

[38] Urs K. Wagner, Inventories of PCB- An Expert's Point of view, PEN Magazine (Issue 01), 2011: 11

[39] Subregional Workshop on Management of PCB and Dioxins/Furans, http://www.chem.unep.ch/pops/pops_inc/proceedings/tanzania/Tanzania_2000.pdf

5. Information Management

A data collection on PCB is the starting point for the formulation of a plan to manage liquids and equipment containing or contaminated with PCB as well as wastes and contaminated sites in an environmentally sound manner. The establishment of PCB databases is indispensable to successfully manage inventories in the long-term and to meet the 2025 and 2028 objectives of the Stockholm Convention.

5.1. Elements of a PCB Database

The information covered by a PCB database varies based on the management requirements. Generally, the following information should be stored in a PCB inventory database for PCB containing equipment:

- Information on PCB Equipment Ownership
  - Company
  - Street
  - City
  - State Zip
- Contact Information
  - Name of contact person
  - Contact phone
- PCB Equipment Location Information
  - Site
  - Street
  - City
- PCB Equipment Information
  - Type (Transformers, capacitors, or others)
  - Use/Storage situation
  - Equipment model and serial numbers
  - Weight of Equipment
  - Size of PCB Equipment
  - Production date
  - Manufacturer of equipment
  - Leakage and contamination information
  - Pictures of the PCB equipment
- Official Information
  - Name
  - Title
  - Date Signed

Additional information can be requested and added into the PCB database to facilitate local PCB management. However, the database should be clean and easy to access and maintain. The contents should be fitted with the PCB form prepared by the PCB inventory team.

5.2. PCB Database Maintenance

A database management system (DBMS) is recommended for the effective maintenance of a PCB database. DBMS is a software package with computer programs that control the creation, maintenance, and use of a database. It allows organizations to conveniently develop databases for various applications. A DBMS allows different user application programs to concurrently access the same database and provides facilities for controlling data access, enforcing data integrity, managing concurrency control, and recovering the database after failures and restoring it from backup files, as well as maintaining database security. Although all the stakeholders should be able to read the data, entering, recording the PCB and updating data should be the responsibility of some specialized operators through the required process.

Once a PCB database has been established, it needs to be continuously maintained and updated. When PCB equipment has been identified, a set of specific reporting sheets should also be prepared, processed and recorded in the PCB database in agreed formats. Where new information is available regarding PCB liquids or equipment, the PCB owner in question should submit a report to the local PCB management authorities to report the new situation through on- or off-line methods. As soon as a piece of equipment has been treated or eliminated in an environmentally sound manner, the status of this equipment in the database must be updated. Tracking all related PCB devices is essential in order to achieve the 2028 goals of the Stockholm Convention for implementing the environmentally sound management of PCB.

5.3. US EPA PCB Transformer Databases: a Case Study

The U.S. Environmental Protection Agency has a PCB webpage to provide information on PCB and makes it available to the public through the Transformer Registration and PCB Activity Databases.

The EPA Form 7720-12 is shown in Figure 8, where PCB Transformer means any transformer that contains 0.005 % or more PCB dielectric. The PCB owner has to report the following information to the Office of Pollution Prevention & Toxics, U.S. Environmental Protection Agency: company name, address, contact name and phone number, location of PCB transformers, number (no.) of transformers and weight (wt.) and any transformers containing flammable dielectric fluid.

USEPA	United States **Environmental Protection Agency** Washington, DC 20460	Form Approved OMB No. 2070-0112

PCB TRANSFORMER REGISTRATION

Return To: Fibers & Organics Branch (7404T) Office of Pollution Prevention & Toxics U.S. Environmental Protection Agency 1200 Pennsylvania Ave., N.W. Washington, DC 20460-0001	**For Official Use Only**

1. Company Name	Address	Contact Name & Phone #

2. a. Location of PCB Transformer(s) - Location #1	2. a. Location of PCB Transformer(s) - Location #2
b. No. of Transformers and wt. (kg):	b. No. of Transformers and wt. (kg):
c. Any transformers containing flammable dielectric fluid: **Yes** or **No**	c. Any transformers containing flammable dielectric fluid: **Yes** or **No**
2. a. Location of PCB Transformer(s) - Location #3	2. a. Location of PCB Transformer(s) - Location #4
b. No. of Transformers and wt. (kg):	b. No. of Transformers and wt. (kg):
c. Any transformers containing flammable dielectric fluid: **Yes** or **No**	c. Any transformers containing flammable dielectric fluid: **Yes** or **No**

7. Certification

Under civil and criminal penalties of law for the making or submission of false or fraudulent statements or representations (18 U.S.C. 1001 and 15 U.S.C. 2615), I certify that the information contained in or accompanying this document is true, accurate, and complete. As to the identified section(s) of this document for which I cannot personally verify truth and accuracy, I certify as a company official having supervisory responsibility for the persons who, acting under my direct instructions, made the verification that this information is true, accurate, and complete.

Signature	Name and Official Title (Type of Print)	Date Signed

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EPA Form 7720-12 (06/02)

Figure 8: PCB transformer registration form and database of EPA[40]

The EPA provides the updated Transformer Registration Database showing the most recent registrations[41]. That database indicates the best known current status of registered PCB transformers. The file is in a spreadsheet format and could be viewable in most spreadsheet applications such as MsExcel. The public can view PCB transformer registration information by clicking on the file and saving it to a disk or hard drive and opening it using their spreadsheet

40 http://www.epa.gov/epawaste/hazard/tsd/PCB/pubs/772012.pdf

41 http://www.epa.gov/osw/hazard/tsd/PCB/pubs/most2-11.xls

software. The field defined in the database includes:

(i) tracking fields;
(ii) information on PCB transformer ownership;
(iii) contact information;
(iv) PCB transformer location information;
(v) PCB transformer information; and
(vi) official information.

6. ANNEX I: EXISTING PCB INVENTORIES FROM NIPS

As of September 2016, 180 countries ratified the Stockholm Convention on POPs[42] (as shown in Figure 6-1), Most, but not all of these Parties have submitted their initial and – in a number of cases updated – NIPs, including preliminary – and in some cases consolidated – PCB inventories[43]. For additional and updated information on PCB inventories, please see the 'Consolidated Assessment of Efforts Made Towards the Elimination of PCB' (2016).

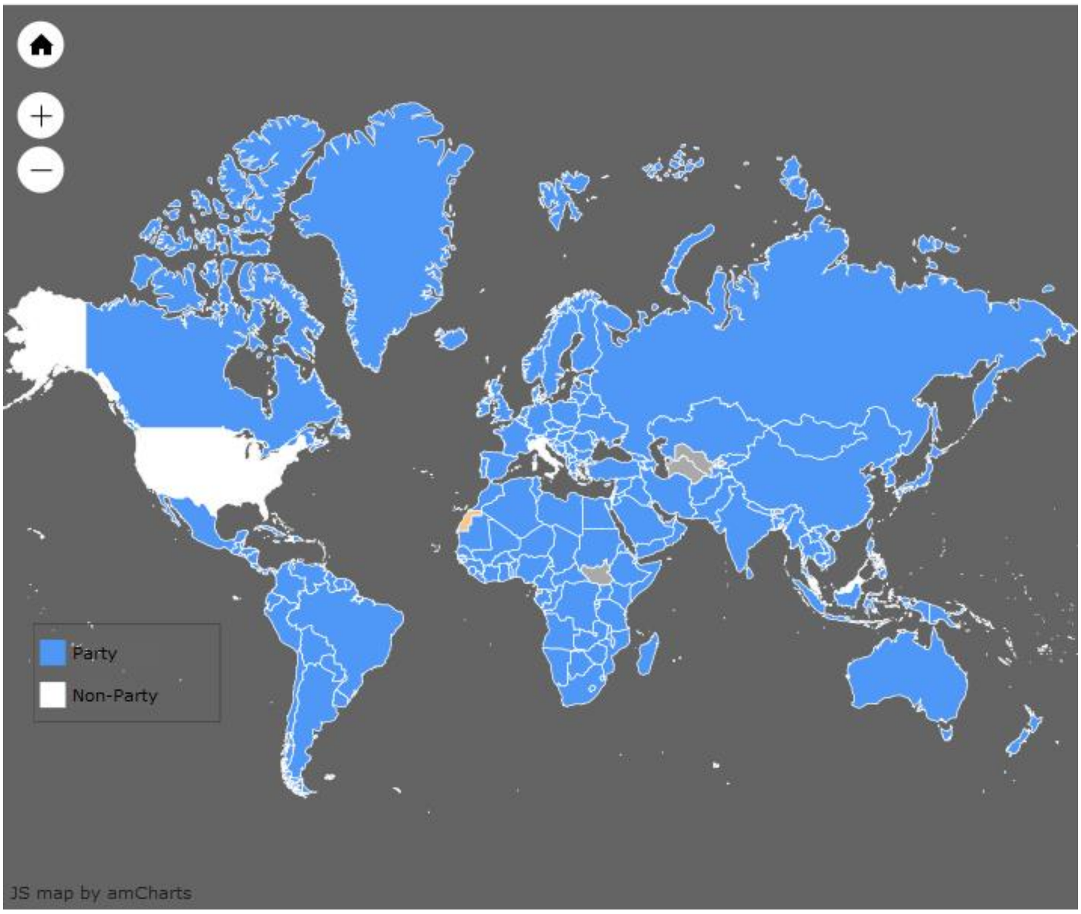

Figure 6-1: Stockholm Convention Status of Ratification as of September 2016

6.1. PCB MANAGEMENT IN UNESCAP

The Economic and Social Commission for Asia and the Pacific (UNESCAP) is the largest of the United

[42] Stockholm Convention Status of Ratifications, http://chm.pops.int/Countries/StatusofRatifications/tabid/252/language/en-US/Default.aspx

[43] National Implementation Plans, http://chm.pops.int/Countries/National%20Implementation/tabid/253/language/en-US/Default.aspx

Nations' five regional commissions with a membership of 62 Governments[44] and a geographical scope that stretches from Turkey in the west to the Pacific Island nation of Kiribati in the east, and from the Russian Federation in the north to New Zealand in the south.

In the Asia -Pacific region, China, the Democratic People's Republic (DPR) of Korea and Japan used to produce PCB and export PCB containing equipment. In the DPR Korea, where production is still ongoing, PCB have been produced by the 2.8 Vinalon Complex and the Sunchon Vinalon Complex relying on domestic materials and techniques since the late 1960s. The total amount PCB produced was about 28,000 tons[45]. The production of PCB oils began in 1965 in China and there were 4 production enterprises. The production was gradually stopped from 1974 to the 1980s. According to preliminary investigation and analysis, the accumulative production output was about 7,000 to 10,000 tons[46].

In Japan, the production of PCB was started by Kanegafuchi Chemical Co. Ltd. (Kaneka) in 1954. The product was marketed under the trade name "Kaneclor (KC)". PCB production, use and import were banned in 1972. The accumulated output was about 58,784 tons[47]. Most countries in the region imported some devices containing PCB form these nations and western countries, though little data is available[48].

In the Asian-Pacific region, PCB were mainly used in the production and maintenance of electric equipment, heavy machinery, such as transformers, capacitors, circuit breakers, hydraulic equipment, heat exchangers, etc. They were also used in the production of insulating paints, among others. Figure 6-1 lists some results of the preliminary PCB inventories in this region[48].

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[44] Member States (53): 1. Afghanistan, 2. Armenia, 3. Australia, 4. Azerbaijan, 5. Bangladesh, 6. Bhutan, 7. Brunei Darussalam, 8. Cambodia, 9. China, 10. Fiji, 11. France, 12. Georgia, 13. India, 14. Indonesia, 15. Iran (Islamic Republic of), 16. Japan, 17. Kazakhstan, 18. Kiribati, 19. Korea (Democratic People's Republic of), 20. Korea (the Republic of), 21. Kyrgyzstan, 22. Lao People's Democratic , Republic(the), 23. Malaysia, 24. Maldives, 25. Marshall Islands (the), 26. Micronesia (Federated , States of), 27. Mongolia, 28. Myanmar, 29. Nauru, 30. Nepal, 31. Netherlands (the), 32. New Zealand, 33. Pakistan, 34. Palau, 35. Papua New Guinea, 36. Philippines (the), 37. Russian Federation (the), 38. Samoa, 39. Singapore, 40. Solomon Islands, 41. Sri Lanka, 42. Tajikistan, 43. Thailand, 44. Timor-Leste, 45. Tonga, 46. Turkey, 47. Turkmenistan, 48. Tuvalu ,49. United Kingdom of Great Britain and Northern Ireland (the), 50. United States of America (the), 51. Uzbekistan, 52. Vanuatu, 53. Viet Nam;
Associate Members (9): 1. American Samoa, 2. Cook Islands (the), 3. French Polynesia, 4. Guam, 5. Hong Kong, China, 6. Macao, China , 7. New Caledonia, 8. Niue, 9. Northern Mariana Islands (the)

[45] National Implementation Plan on Stockholm Convention of DPR Korea, http://www.pops.int

[46] National Implementation Plan on Stockholm Convention of China, http://www.pops.int

[47] Knut Breivik, Andy Sweetman, Jozef M. Pacyna, Kevin C. Jones, Towards a global historical emission inventory for selected PCB congeners — a mass balance approach 1. Global production and consumption, The Science of the Total Environment 290 (2002) 181–198; Towards a global historical emission inventory for selected PCB congeners — a mass balance approach 3. An update, Science of the Total Environment 377 (2007) 296–307

[48] Jinhui Li, Xiaoyang Wu and Nana Zhao, Review of PCB Management in the Asia-Pacific region. PEN magazine(Issue 01), 2010, 28

Table 6-1: Preliminary PCB inventories in UNESCAP

Countries	Preliminary PCB inventories
Bangladesh	About 55.8 t of PCB in use, 403 t of contaminated oil contained in waste equipment, 519 t of contaminated waste transformer oils and 22.5 t of PCB contained in materials of old ships
Cambodia	About 762 PCB transformers and 116 PCB-contaminated equipment
China	About 1,000 t of PCB used in open applications and 6,000 t of PCB used as an impregnant for electrical capacitors
Iran	About 750 t of PCB, 1,150 t of PCB polluted oils, 3,350 pieces of contaminated equipment, 1,150 t of PCB in use and 1,600 pieces of PCB-containing equipment in use
Japan[49]	Most PCB wastes come from high-voltage transformers and a limited number of other products The equipment in-use includes (units): high-voltage transformer: 3,400, high-voltage condensers: 58,000, other devices (low-voltage transformers, low-voltage condensers, reactors, discharge coils, etc.): 10,900 Equipment in storage covers high-voltage transformer: 11,079, high-voltage condensers: 219,106, other devices: 40,744 Waste PCB: 70 t, PCB-containing waste oils: 2,610 t
Jordan	Old transformers contain about 12,500 kg of PCB cooling oil and 521 transformers may contain PCB in the northern region
Kyrgyzstan	No reliable information on volumes of PCB is available, equipment possibly containing PCB includes 19,230 transformers, 14,285 t of transformer oils, 139.7 t of transformer oils on stock, 2,373capacitors and 24.4 t of capacitor oil
Lebanon	Total quantities of PCB oil estimated at 42 t and 16,000 distribution transformers may contain PCB oil
Philippines	143 equipment have PCB oil
Thailand	60 PCB transformers; 379 PCB capacitors; 973 PCB-containing transformers and capacitors with a total weight of 1,912 tons
Vietnam	11,800 pieces of potentially PCB-containing electrical equipment and 7,000 tons of potentially PCB-containing oils

PCB equipment is still in use in the Asia-Pacific region. PCB oil, PCB containing wastes and contaminated sites are posing significant risks to the human health, in particular in the surrounding of ‘hot spots’.

6.2. PCB Inventories in UNECA

The United Nations Economic Commission for Africa (UNECA) has a membership of 54

49 National Implementation Plan on Stockholm Convention of Japan, http://www.pops.int

Governments[50]. The South African Republic is the only country among the 54 countries in Africa that produced electrical equipment potentially containing PCB. Other countries in the UNECA region have imported such equipment from Europe, America, Asia and South Africa for various applications[51].

The preliminary PCB inventories of some African countries are listed in Table 6-2. These focused exclusively on the electricity production, transportation and distribution sector.

Table 6-2: Preliminary PCB inventories of PCB in UNECA

Countries	Preliminary PCB inventories
Comoros	6 PCB transformers, 84 PCB contaminated mineral oil facilities with a concentration higher than 50 mg/kg and PCB oils 35 t
Congo	188 PCB electrical transformers with 457 t of PCB oils, 130,000 liters of pure PCB and 340,000 liter of PCB containing oil
Ethiopia	2,505 PCB- containing transformers with 1,182 t PCB oil and 40 PCB-containing capacitors with 1.255 t PCB oil
Gambia	19,765 kg of PCB transformer oils and 37,692 kg of transformer oils assumed to be PCB contaminated
Ghana	455 pre-1972 possible PCB-containing transformers, 147 pieces of possible PCB-containing capacitors. There is the possibility that the post-1972 transformers may also contain significant amounts of PCB as a result of retro-filling
Lesotho	379 transformers manufactured during the period 1960s-1989, 60 transformers did not have either dates of manufacture nor name plates and the weights of suspected equipment making a total weight of about 723,450 kg
Liberia	840-1,400 PCB transformers still existing in the entire country
Malawi	616,993 liters of PCB contaminated oil and 421 PCB contaminated electrical equipment (mainly transformers and oil circuit breakers).

[50] ECA Member States: 1. Algeria, 2. Angola, 3. Benin, 4. Botswana, 5. Burkina Faso, 6. Burundi, 7. Cameroon, 8. Cape Verde, 9. Chad, 10. Comoros, 11. Congo, Democratic Republic of the, 12. Congo, Republic of the, 13. Côte d´Ivoire, 14. Djibouti, 15. Egypt, 16. Eritrea, 17. Ethiopia, 18. Gabon, 19. Gambia, 20. Ghana, 21. Guinea, 22. Guinea-Bissau, 23. Guinée équatoriale, 24. Kenya, 25. Lesotho, 26. Liberia, 27. Libyan Arab Jamahiriya, 28. Madagascar, 29. Malawi, 30. Mali, 31. Maroc, 32. Mauritania, 33. Mauritius, 34. Morocco, 35. Mozambique, 36. Namibia, 37. Niger, 38. Nigeria, 39. Rwanda, 40. Sao Tome and Principe, 41. Senegal, 42. Seychelles, 43. Sierra Leone, 44. Somalia, 45. South Africa, 46. Sudan (also English), 47. Swaziland, 48. Tanzania, United Republic of, 49. Togo, 50. Tunisia, 51. Tunisie, 52. Uganda, 53. Zambia, 54. Zimbabwe

[51] Kola Sanda, Update on PCBPCB inventories in sub-Saharan Africa, PEN magazine(Issue 01), 2010, 14

Countries	Preliminary PCB inventories
Mauritius	80 low-level contaminated transformers (ranging from 53 to 143 mg/kg of PCB), 20 tons of PCB-contaminated oil; no analysis was carried out for capacitors
Morocco	573 transformers with 200 tons of PCB are still functioning, 342 condensers using PCB are still functioning; contaminated transformers: 3,500 tons of mineral oils for transformers are contaminated (containing more than 50 mg/kg of PCB); stocks of wastes containing PCB: 20 indentured sites, of which 10 are presenting floor pollution traces
Mozambique	The survey of electrical equipment that use fluids containing PCB in 2004 showed that there are at least 79 devices containing 240,571 t of oil suspected to contain PCB
Nigeria	The total number could be at least 341 transformers with oil containing PCB that are currently in use; the inventory could not consider other sectors (power generation, distribution and private sector transformers) due to logistic and other constraints
Rwanda	343 transformers containing PCB dielectric fluids; this corresponds to 153.58 tons of fluids with PCB and 352.58 tons of solid wastes contaminated with PCB
Seychelles	99 of the transformers were manufactured between 1963 and 1986 and therefore suspected of containing PCB, since the worldwide ban on production of PCB was imposed in 1986; this represents a total volume of 4,813 liters which is considered to be containing PCB
Sierra Leone	179 transformers containing 103.372 t of oil were manufactured before 1978; the 103.372 t of in the transformers manufactured before 1978 possibly have PCB concentrations at 500 mg/kg or above
Swaziland	572 electrical units were found to be transformers with a PCB concentration above 50 mg/kg but less than 200 mg/kg; among the electrical units inventoried were a total of 312 PCB containing capacitors; the total oil found to contain PCB was in excess of 314,019 kg
Tanzania	There are 418 equipment containing 273 t of oil suspected to contain PCB; 216 transformers and 17 oil circuit breakers containing 105 t of oil are out of use
Uganda	Uganda has an estimated 7,115 transformers; 12.5 percent of the samples were found to have PCB levels beyond the recommended threshold i.e. 50 mg/kg; 52 % of the PCB equipment is contaminated
Zambia	There were 15,262 transformers countrywide, 76 were PCB containing and these were stored, 57 t of PCB contaminated soil and 2,700 liters of PCB-oil was stored

6.3. PCB INVENTORIES IN UNECWA

The Economic Commission for Western Asia (ECWA) comprises 14 Arab countries in Western Asia: Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, the Sudan, the Syrian Arab Republic, the United Arab Emirates and Yemen. The PCB inventories of some Western Asian countries are listed in Table 6-3.

Table 6-3: Preliminary PCB inventories in UNECWA

Countries	PCB inventory
Egypt	The preliminary inventory shows that 3,666 condensers and 26 transformers manufactured during the period from 1955 to 1977 could be contaminated with PCB; the total mass of potentially PCB containing oil is 20,490 kg
Jordan	9 PCB transformers containing about 12,500 kg cooling oil
Lebanon	Total quantities of PCB oil were estimated at 42 t in both in-use and out-of-service transformers
Oman	36 transformers were assumed to be PCB contaminated
Qatar	27 PCB containing transformers and 20 contaminated sites
Sudan	The estimated quantity of PCB in liquid phase (stored at the NEC's premises) is about eight tons while the quantities of PCB and PCB contaminated dielectric in the equipment are 246.3 and 32.5 tons, respectively

6.4. PCB INVENTORIES IN UNECE

The United Nations Economic Commission for Europe (UNECE) region covers more than 47 million square kilometers. The UNECE has a membership of 56 Governments[52]. Table *2-1* summarizes the PCB production in Central and Eastern European countries, while Figure 6-2 provides an overview over inventoried pieces of equipment that contain or might contain PCB in the Central and Eastern European region.

[52] UNECE Member States: 1. Albania, 2. Andorra, 3. Armenia, 4. Austria, 5. Azerbaijan, 6. Belarus, 7. Belgium, 8. Bosnia and Herzegovina, 9. Bulgaria, 10. Canada, 11. Croatia, 12. Cyprus, 13. Czech Republic, 14. Denmark, 15. Estonia, 16. Finland, 17. France, 18. Georgia, 19. Germany, 20. Greece, 21. Hungary, 22. Iceland, 23. Ireland, 24. Israel, 25. Italy, 26. Kazakhstan, 27. Kyrgyzstan, 28. Latvia, 29. Liechtenstein, 30. Lithuania, 31. Luxembourg, 32. Malta, 33. Monaco, 34. Montenegro, 35. Netherlands, 36. Norway, 37. Poland, 38. Portugal, 39. Republic of Moldova, 40. Romania, 41. Russian Federation, 42. San Marino, 43. Serbia, 44. Slovak Republic, 45. Slovenia, 46. Spain, 47. Sweden, 48. Switzerland, 49. Tajikistan, 50. The former Yugoslav Republic of Macedonia , 51. Turkey, 52. Turkmenistan, 53. Ukraine, 54. United Kingdom of Great Britain and Northern Ireland, 55. United States of America, 56. Uzbekistan

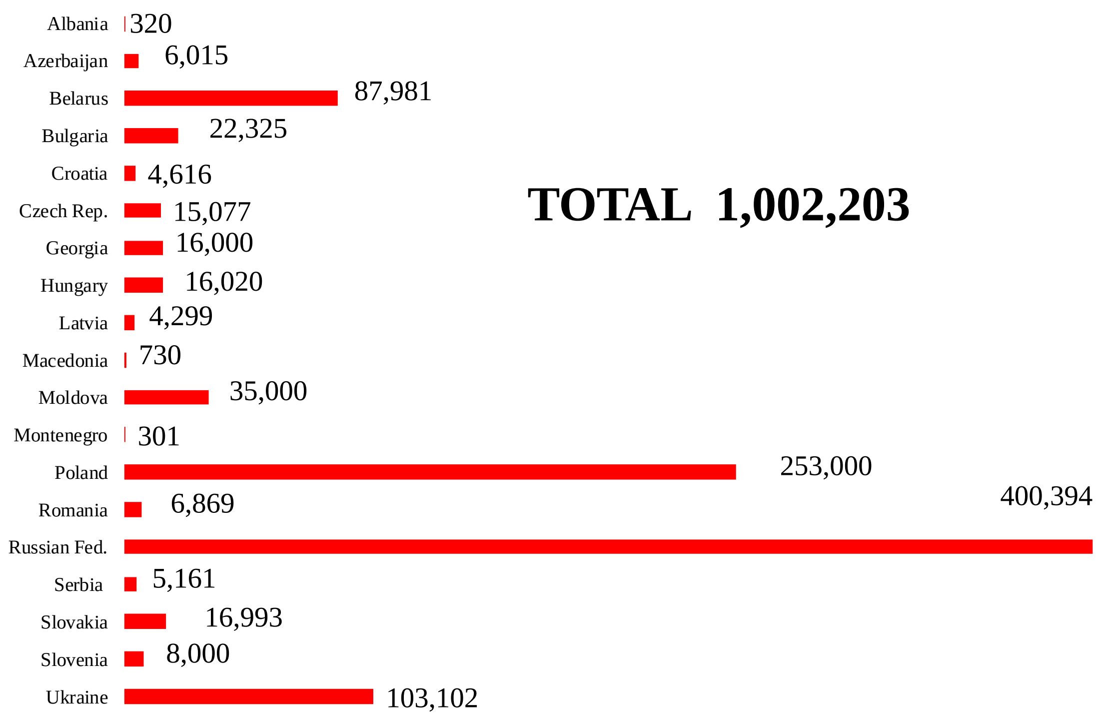

Figure 6-2: Equipment that contains or might contain PCB in the Central and Eastern European region[53]

Table 6-4: PCB production in UNECE[54]

Country	Trademarks example	Former production(t)	Production period
Former Czechoslovakia	Delor, Deloterm, Hydelor	21,500	1959 – 1984
Poland	Tarnol, Chlorofen	679	1971 – 1976
Former Soviet Union	Sovol	53,000	1939 – 1993
	Sovtol	57,000	1939 – 1993
	Trichlorobiphenyl	70,000	1963 – 1993
Total		202,179	

6.5. PCB Inventories in UNECLA

The Economic Commission for Latin America (ECLA) has a membership of 52 governments[55]. The

[53] Jaromír Manhart, Large quantities of PCB demanding ESM in Central and Eastern European Countries, PCBPEN Magazine issue 1, 2010: 43

[54] Jaromír Manhart, Large quantities of PCB demanding ESM in Central and Eastern European Countries, PCBPEN Magazine issue 1, 2010: 42

PCB inventories of some Latin American and Caribbean countries is listed in *Table 6-5*.

Table 6-5: Preliminary inventories of PCB in UNECLA

Countries	Preliminary PCB inventories
Antigua & Barbuda	Two transformers have oil that has been tested positive for PCB, one was found to be intact and in use, while the other was out of service and all the oil removed
Barbados	2 pieces of equipment have been confirmed as containing PCB
Belize	Less than 3% of the 5,000 electric units are estimated to contain PCB; there are no obsolete stocks
Canada	Canada has prohibited the manufacture, import and sale of PCB and restricted their use to existing closed electrical and hydraulic systems since 1977; PCB are not manufactured in Canada, and federal, provincial and territorial regulations strictly control any stockpiles
Costa Rica	The main known use in Costa Rica has been as dielectric fluid in equipment of distribution of electricity; 15 PCB transformers with 22 t PCB oil
Dominican Republic	The Dominican Republic has never produced PCB; hence the introduction of these compounds into the country is entirely through imports; 96 (17 in use, 79 out of service) of the evaluated transformers and 14 of the containers had a PCB content greater than 50 mg/kg;: the total quantity of PCB found in the inventoried applications was 113,858.80 kg, equivalent to 114 tons
Germany	Until 1982, PCB were manufactured in Germany on an industrial scale; they were used as insulating fluids in transformers and capacitors, as plasticizers in products such as sealants, ceiling coverings, electrical cable insulation, as a flame retardant in wall paints, varnishes, adhesives and in hydraulic oils; in 2004, approx. 1,650 t of small capacitors were disposed of in underground landfills and the quantity in 2005 will be of a similar order
Paraguay	4 distribution transformers, 417 capacitors containing 8.49 t PCB oil and 48 kg PCB wastes
Portugal	The production and the import of PCB have been forbidden in Europe since 1985. Data collected until the end of 2005 indicates that 117 companies belonging to the sectors of energy,transportation,

[55] Member States: 1. Antigua y Barbuda, 2. Argentina, 3. Bahamas, 4. Barbados, 5. Belize, 6. Bolivia, 7. Brazil, 8. Canada, 9. Chile, 10. Colombia, 11. Costa Rica, 12. Cuba, 13. Dominica, 14. Dominican Republic, 15. Ecuador, 16. El Salvador, 17. France, 18. Germany, 19. Grenada, 20. Guatemala, 21. Guyana, 22. Haiti, 23. Honduras, 24. Italy, 25. Jamaica, 26. Japan, 27. Mexico, 28. Netherlands, 29. Nicaragua, 30. Panama, 31. Paraguay, 32. Peru, 33. Portugal, 34. Republic of Korea, 35. Saint Kitts and Nevis, 36. Saint Lucia, 37. Saint Vincent and the Granadines, 38. Spain, 39. Suriname, 40. Trinidad and Tobago, 41. United Kingdom of Great Britain and Northern Ireland, 42. United States of America, 43. Uruguay, 44. Venezuela, Associate members:, 1. Anguila, 2. Aruba, 3. British Virgin Islands, 4. Caiman Islands, 5. Montserrat, 6. Puerto Rico, 7. Turks and Caicos Islands, 8. United States Virgin Islands

	transformation and heavy chemicals industries, have declared to hold about 1,400 tonnes of equipment contaminated with PCB, mostly consisting of transformers and capacitors.
Saint Lucia	Asphalt and lubricating oils are the major applications in Saint Lucia. In 2003 and 2004, 928 and 1,983 dielectric transformers were imported
Uruguay	PCB were never used in the national industry as dielectric oil, it has been found that a great proportion of these transformers might be contaminated with PCB as a result of bad management by the maintenance firms

7. ANNEX II: GUIDELINES, FORMS AND MANUALS

The following section provides a snapshot of international guidelines, forms and manuals that have been developed in the context of the Basel and Stockholm Conventions and that are relevant to the undertaking of PCB inventories.

GUIDELINES FOR IDENTIFICATION OF PCB AND MATERIALS CONTAINING PCB

The 'Guidelines for the Identification of PCB and Materials Containing PCB'[56] (1999) were the first guide on identifying PCB and materials containing PCB. It fulfilled the second part of the UNEP Governing Council's request that UNEP develop and publish information to assist countries in ensuring the environmentally sound management of PCB. It provides information on the known names, characteristics, and uses for PCB, as well as on sampling and analysis techniques to indicate their presence. The document consists of 4 sections and 3 annexes:

- Background: provides general information on PCB, including definition, uses, physical and chemical characteristics, and effects on the environment and human health.
- Initial identification of potential PCB-containing materials: provides a more detailed discussion of the end-uses of PCB, focusing on likely PCB locations and potential PCB-containing materials (including wastes); uses are designated as closed, partially closed, and open applications.
- PCB presence and concentration tests: provides various analytical tests for assessing PCB presence in suspect products and other media (e.g., waste, soil, paint etc.).
- Interim storage and permanent disposal: provides a brief introduction to the current options for the storage and disposal of PCB-containing products and waste.
- Step-by-step approach for PCB identification: provides a general road map for PCB identification using a series of easy reference tables.
- Sources of additional information: provides listings of organizations and websites that can provide further guidance on PCB.
- Compendium of relevant documents: provides brief summaries of significant documents relating to the identification and management of PCB-containing materials.

PCB INVENTORY FORM (2002)

This guideline[57] provides sample forms for the inventory of PCB-containing equipment. It aims to assist countries in the preparation of their first nation-wide PCB inventory for the following purposes:

(i) Identification of owners and locations of potentially PCB-containing equipment and wastes (section A);

(ii) Identification and quantification of potentially PCB-containing equipment such as transformers, capacitors, vacuum pumps, lamp ballast, and electrical cables (section B); and

[56] UNEP, Guidelines for the Identification of PCB and Materials Containing PCB, http://www.chem.unep.ch/Publications/pdf/GuidIdPCB.pdf

[57] UNEP, PCB Inventory Form, 2002

(iii) Identification and quantification of waste PCB or PCB-contaminated sites (section C).

PCB Transformers and Capacitors: From Management to Reclassification and Disposal (2002)

The guideline[58] is a guide to the management, reclassification and disposal of PCB transformers and capacitors. It provides practical assistance to those responsible for PCB containing transformers and capacitors, as countries work towards safe management and disposal of this equipment. Guidance is provided on the main issues encountered in the management of PCB transformers and oils, including their reclassification and taking out of service. 12 sections and 3 annexes are featured in the guideline, including the following:

- Introduction: PCB properties, PCB electrical equipment and description.
- Management of PCB transformers: identification of PCB transformers, identification of PCB oils, maintenance of PCB transformers, leaks from transformers and performance evaluation.
- Health and safety: handling PCB contaminated liquids and equipment, health precautions, personal protective equipment (PPE), ventilation respiratory protective equipment (RPE), environmental monitoring, leaks and spills, emergencies and leaks from transformers.
- Reclassification and retrofilling of transformers: retrofilling decision check-list, required characteristics of PCB replacement oils, other considerations, control measures for retrofilling, handling of PCB-containing transformers, provision of facilities for handling and dismantling equipment containing PCB, precautions required when cutting PCB-containing equipment, emptying of PCB transformers, precautions needed for flushing equipment to remove PCB and handling PCB-containing capacitors.
- Alternative fluids for retrofilling: mineral oils, silicone fluids, synthetic ester materials.
- Elimination and/or replacement of PCB transformers: transformer elimination, transformer replacement.

Technical Guidelines Developed Under the Basel Convention

The 'Technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with PCB, PCTs or PBBs'[59] (2006) supersedes the Basel Convention's technical guidelines on wastes comprising or containing PCB, PCT and PBB. It provides more detailed information on the nature and occurrence of wastes consisting of, containing or contaminated with PCB, PCTs or PBBs for the purpose of identifying and managing them. The guidelines address the following issues:

- Legislative and regulatory framework;
- waste prevention and minimization;
- identification and inventories;
- sampling, analysis and monitoring;
- handling, collection, packaging, labeling, transportation and storage;
- environmentally sound disposal;
- remediation of contaminated sites;

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[58] UNEP, PCB Transformers and Capacitors: From Management to Reclassification and Disposal, 2002

[59] Basel Convention, Methodological guide for the undertaking of national inventories of hazardous wastes within the framework of the Basel convention, 2000

- health and safety;
- emergency response; and
- public participation.

Methodological Guide for the Undertaking of National Inventories

This 'Methodological guide for the undertaking of national inventories of hazardous wastes within the framework of the Basel convention'[60] (2000) is mainly intended for the national authories responsible for the development and implementation of environmentally sound national management policies on hazardous wastes. There are several methods of developing and maintaining national inventories of hazardous wastes. The manual provides a chosen method comprising three distinct stages:

(i) preparation of the inventory;

(ii) incorporation of the first results; and

(iii) maintenance of the inventory (permanent inventory).

Training Manual for Hazardous Waste Project Managers

The 'Training Manual for Hazardous Waste Project Managers, Destruction and Decontamination Technologies for PCB and other POPs Wastes under the Basel Convention (Volume I - III and III Annexes)'[61] was developed and published by the Secretariat of the Basel Convention. The Training Manual includes sections dealing with inventories.

Training Manual for a National Environmentally Sound Management Plan

This manual[62] provides PCB owners with a comprehensive methodology for the environmentally sound management of equipment containing or contaminated with PCB. It covers the following:

- PCB awareness-raising module;
- PCB inventory methods;
- use of statistical data;
- preparation of a national PCB management plan;
- general on-site technical safety measures;
- transport and storage of PCB;
- draft regulations on polychlorinated biphenyls and polychlorinated terphenyls (PCB and PCTs); and
- financial tools for the management and destruction of PCB.

Other Documents on PCB management and Disposal

Other relevant documents include the following:

[60] Basel Convention, Methodological guide for the undertaking of national inventories of hazardous wastes within the framework of the Basel convention, 2000

[61] Secretariat of Basel Convention, Training Manual for Hazardous Waste Project Managers, Destruction and Decontamination Technologies for PCB and other POPs Wastes under the Basel Convention, October, 2002

[62] Secretariat of Basel Convention, Preparation of a National Environmentally Sound Management Plan for PCB and PCB-Contaminated Equipment, March, 2003

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