REDUCTION AND ELIMINATION OF PCBs, PRIORITIZING THE POWER SECTOR IN INDIA

Central Power Research Institute
Prof. Sir. C.V. Raman Road,
Sadashivanagar Post Office,
P.B. No. 8066,
Bangalore - 560 080
www.cpri.res.in

Preparation of a

National Environmentally Sound Management Plan

For PCBs and PCB-Contaminated Equipment in India

Central Power Research Institute
Prof. Sir. C.V. Raman Road,
Sadashivanagar Post Office,
P.B. No. 8066,
Bangalore – 560 080

Preface

PCBs had been used in various applications for their extraordinary stability and good dielectric properties during 1920-1980 all over the world. Later they were found to be seriously persistent and pollutants threatening the live stock and human beings and have potential contamination potential having impact for 100s of years.

PCBs may be considered a historical waste as they have been in industrial use throughout the twentieth century. Even today, PCBs whose production and sale is prohibited continue to be used in operating equipment.
PCBs were first identified in the nineteenth century and started being manufactured on an industrial scale in 1929. They were intensively used between 1920 and 1980.

In India manufacturing of this chemical was never taken up and fortunately not much of material has reached India. The imported equipment for special purposes has been the main source of PCB stocks in the country. Most of the special transformers meant for locations in which vulnerability of fire have been source of this material. In our country Power Sector and Steel sector have been found to be bulk stock owners of this material. Around 10000 tonnes of this material has been found in the country. There is a need to continue the inventory build up activity as there is good possibility of this material to be found in other sectors. It is also needed that we have to look for the components like capacitors and other systems in which PCB's are found be present, in large quantities.

Our country has limited resources for mitigation of this type of pollution. Hence, it is important to note that an efficient awareness among the engineers would help in location and efficient storage of this material. It may also be noted that country is geographically very large, with eco sensitive in terms of long river beds, long coastal lines, several mountain ranges and large agrarian population. Hence, there is serious need for us to take concrete steps, act in harmonious manner to organise quick communication, Labelling of equipment, plan its storage and finally plan its disposal. This would help our country to mitigate this material at much lower cost. Otherwise this material is bound to cause suffering to the humans and live stock for long periods and can affect the social and economic growth of the country.

it is important to educate the working engineers, about the material, about efficient handling, avoid spilling, avoid contamination and help in stocking and maintaining the PCB equipment in a way to facilitate efficient final disposal.

Central Power Research Institute has been given the responsibility of coordination of PCB Management related activities in the country. We request utilities and others to support in this challenging activity of PCB Management.

(N. Murugesan)
Director General

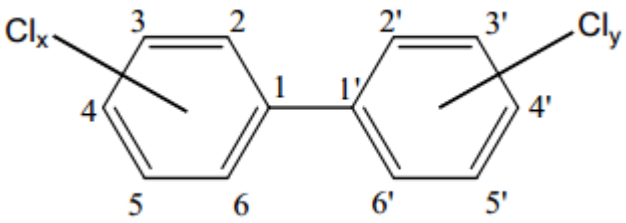
1.0 Persistent Organic Pollutant - Poly Chlorinated Biphenyls (PCBs)

Poly Chlorinated Biphenyls (PCBs) and their Chemistry

These are man-made chemicals, found to have very good dielectric and fire resistance properties. These were manufactured between 1930 and 1980 in large quantities for use in power equipments, hydraulic oils and other applications. In India, PCBs were never manufactured but were imported in the form of electrical and other equipment containing this liquid.

Exact quantity of this liquid, contamination of electrical equipment containing mineral insulating oil and exact level of contamination, location of this equipment under use, stockpile of unserviceable equipment containing this liquid and its contamination have not been estimated till date in our country.

Poly Chlorinated Biphenyls are organic molecules having two benzene rings connected at one end and chlorine atoms at one or more or all the ten corners of the phenyl rings. Of the many types of possible molecular structural combinations present, biphenyls with 2 - 3 chlorine substitutions are found to be predominantly present in the Dielectric applications such as transformer oils.



PCBs are usually known by their brand names such as Arochlor, Phenochlor and Pyralene. These are also named with numbers along with their brand names such as Arochlor 1242, 1254, 1260 etc. In these names, the first two numbers i.e. 12 represent the presence of 12 Carbon atoms in the structure. The next two numbers represent the percentage of chlorine in the molecule.

These molecules are very stable and hence persistent, non biodegradable and have very long periods of bio-accumulation in the fatty tissues of living organisms. It is also observed that they are toxic to the living organisms. Toxicity of these chemicals is due to their planar structure and conversion of molecule to dioxin like structures which are potential carcinogenic chemicals. Increase in toxicity is proportional to the increase in the % of Chlorine in their structure.

1.1 International Conventions on POPs and Hazardous Waste

Stockholm Convention

India is a Party to the Stockholm Convention on Persistent Organic Pollutants (POPs). The Stockholm Convention on POPs explicitly requires to identify, label and remove from use equipment containing more than 0.05 ppm PCB and volumes greater than 5 liters, and to identify and remove from use equipment containing more than 0.005 ppm PCB and volumes greater than 0.05 liters. Despite no technical specification on inventory and labeling having been set by the Stockholm Convention, it is evident that to fulfill these requirements, a system of rules and standards for data management and PCBs traceability must be established.

Definition of PCBs: The Stockholm Convention sets the following definition of PCBs under Annex C (Unintentional Production):

> "Polychlorinated biphenyls" means aromatic compounds formed in such a manner that the hydrogen atoms on the biphenyl molecule (two benzene rings bonded together by a single carbon-carbon bond) may be replaced by up to ten chlorine atoms;

Obligations: Under Part II of the Convention, the following obligations specific to identification and labeling of PCBs, are established:

Each Party

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

(i) Make determined efforts to identify, label and remove from use equipment containing greater than 10 per cent polychlorinated biphenyls and volumes greater than 5 litres;
(ii) Make determined efforts to identify, label and remove from use equipment containing greater than 0.05 per cent polychlorinated biphenyls and volumes greater than 5 litres;
(iii) Endeavour to identify and remove from use equipment containing greater than 0.005 percent polychlorinated biphenyls and volumes greater than 0.05 litres.

Basel Convention

The overarching objective of the Basel Convention is to protect human health and environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as “hazardous wastes” based on their origin and/or composition and their characteristics, as well as two types of wastes defined as “other wastes” (household waste and incinerator ash; Article 1 and Annex II).

The provisions of the Convention center around the following principal aims: (i) the reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal; (ii) the restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management; and (iii) a regulatory system applying to cases where transboundary movements are permissible.

India is a Party to the Basel Convention on transboundary movement of hazardous wastes.

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

Name of POPs	Pesticide	Industrial chemicals	By-product
Aldrin	**x**		
Chlordane	**x**		
DDT	**x**		
Dieldrin	**x**		
Endrin	**x**		
Heptachlor	**x**		
Mirex	**x**		
Toxaphene	**x**		
Hexachlorobenzene (HCB)		**x**	**x**
Polychlorinated biphenyls (PCB)		**x**	**x**
Polychlorinated dibenzo-*p*-dioxins (PCDD)			**x**
Polychlorinated dibenzofurans (PCDF)			**x**

Nine New Pops

At its fourth meeting held from 4th to 8th May 2009, the Conference of the Parties adopted amendments to Annexes A, B and C of the Stockholm Convention to list nine new Persistent Organic Pollutants (SC-4/10-SC-4/18). Pursuant to paragraph 4 of Article 21 of the Convention, the amendments were communicated by the depositary to all Parties on 26th August 2009.

Industrial chemicals: Hexabromobiphenyl, Hexabromodiphenyl Ether & Heptabromodiphenyl Ether, Pentachlorobenzene, Perfluorooctane Sulfonic acid, its salts & Perfluorooctane Sulfonyl Fluoride, Tetrabromodiphenyl Ether& Pentabromodiphenyl Ether;

By-products: Alpha Hexachlorocyclohexane, Beta Hexachlorocyclohexane and Pentachlorobenzene; and

Endosulfan

At its fifth meeting held from 25th to 29th May 2011, the Conference of the Parties adopted an amendment to Annex A of the Stockholm Convention to list technical Endosulfan and its related isomers with a specific exemption (decision SC-5/3). Pursuant to paragraph 4 of Article 21 of the Convention, the amendment was communicated by the depositary to all Parties on 27th October 2011.

Annex I of the convention lists the waste to be controlled, of which the following are PCBs containing waste:

- **Y10**. Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs)
- **Y45**. Organohalogen compounds other than substances referred to in this Annex (e.g., Y39, Y41, Y42, Y43, Y44)

Some other waste listed in Annex I may contain PCBs under certain circumstances:

- **Y6** Wastes from the production, formulation and use of organic solvents
- **Y8** Waste mineral oils unfit for their originally intended use
- **Y9** Waste oils/water, hydrocarbons/water mixtures, emulsions
- **Y11** Waste tarry residues arising from refining, distillation and any pyrolytic treatment
- **Y12** Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish
- **Y13** Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives

- **Y14** Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known
- **Y18** Residues arising from industrial waste disposal operations
- **Y39** Phenols; phenol compounds including chlorophenol
- **Y41** Halogenated organic solvents
- **Y42** Organic solvents excluding halogenated solvents
- **Y45** Organohalogen compounds other than substances referred to in this Annex (e.g., Y39, Y41, Y42, Y43, Y44)

List A of Annex VIII describes wastes that are "*characterized as hazardous under Article 1 paragraph 1(a) of this Convention*" although "*designation of a waste on Annex VIII does not preclude the use of Annex III (hazard characteristics) to demonstrate that a waste is not hazardous*" (Annex I, paragraph (b)). List B of Annex IX lists wastes which "*will not be wastes covered by Article 1, paragraph 1 (a), of this Convention unless they contain Annex I material to an extent causing them to exhibit an Annex III characteristic*".

The following Annex VIII waste categories in particular are applicable to PCBs, PCTs or PBBs:

- **A1180** Waste electrical and electronic assemblies or scrap [1] containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or contaminated with Annex I constituents (e.g., cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III;
- **A3180** Wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (PCB), polychlorinated terphenyls (PCT), polychlorinated naphthalene (PCN) or polybrominated biphenyl (PBB), or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more.

1.2 Global Awareness: Stockholm Convention

The awareness about the material and its serious potential for the contamination has been realized worldwide. International conference was called to bring up an integrated plan to eliminate Persistent Pollutant chemicals from the face of the planet.

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

Stockholm Convention on POPs:

The Convention was adopted and opened for signature in Stockholm Conference of May 22-23, 2001, wherein a number of countries (162) participated. The conference resolutions were entered into force on 17th May '04 and Conference of Parties One (COP1) was from 2-6 May '05 in Uruguay, Conference of Parties Two (COP2) was from 1-6 May '06 in Geneva and Conference of Parties Three (COP3) was from 1-5 May '07 in Dakar.

The convention resolutions were made as legally binding on the participating countries and the global scope and multimedia coverage was taken up for 12 chemicals which included PCBs as one of them. Our country signed on 14th May, 2002 and ratified on 13th January, 2006..

The objective of the convention is to make provisions:

- To control intentionally produced POPs and unintentionally produced POPs

  To Manage:

- the stockpiles and wastes
- additions of new substances
- financial and technical assistance
- implementation aspects

For PCBs which are intentionally produced POPs, the main goals is to cease the production of new PCBs immediately. Entry into force of the Convention to eliminate the use of in-place PCBs equipment by 2025 and the continued use is subject to conditions and restrictions to achieve environmentally sound management of PCB wastes by 2028. Till then parties must report to the COP every 5 years on the progress and the COP will review the progress of the 2025 and 2028 targets every 5 years.

All POPs chemicals to be restricted for trade purposes is listed in Annex A or B

Import/export is limited to environmentally sound disposal or Parties for a use or purpose which is permitted is listed under Annex A or B

Article 5 describes the Unintentionally Produced POPs

Measures to reduce or eliminate releases from unintentional production

This Article states that the Party shall take measure to reduce the total releases derived from anthropogenic sources of each of the chemicals listed in Annex C with the goal of continuing minimization and, where feasible, ultimate elimination.

Party shall:

- develop an action plan within 2 years of entry into force and implement the plan as specified in Article 7
- promote education and training and awareness
- promote application of available, feasible and practical measures to achieve realistic & meaningful level of release, reduction or source elimination
- promote development and where it seems appropriate, require the use of substitute or modified materials, products and processes to prevent formation and release of chemicals listed in Annex C
- For existing sources within the source categories as listed in Part II of the Annex C, the Party shall promote use of Best available techniques (BAT) and Best environmental practices (BEP)
- For new sources, the Party shall promote and, as provided for in an action plan, require use of BAT; phase in BAT as soon as practicable but not later than 4 years after entry into force of the Convention

1.3 PCBs use and present location

Generally it has been observed that stocks of PCBs exist in terms of the following main applications

- Dielectric fluids in transformers and capacitors 60 %
- Adhesives, textiles, printing works and pesticides 25 %
- Industrial and hydraulic fluids, gas turbines 10 %
- Additives in the preparation of insecticides, bactericides 5 %

Globally, the following countries had the manufacturing facilities:
Austria, China, Czechoslovakia, France, Germany, Italy, Japan, Russia, Spain, United Kingdom and United States.

In 1994, a European Commission study (DG XI) was carried out on the quantities of PCBs in Europe. This study looked at the distribution of PCBs in each European Community country, with a view of assessing the quantities of PCBs to be destroyed by 2010.

PCBs wastes were grouped into 3 categories:

- Pure liquid PCBs or Askarel
- Solid PCBs
- PCB-contaminated soil

The study estimated the total quantity of liquid PCBs at 200,000 tons. These liquid PCBs originated from the existing transformers and capacitors, which were almost destroyed. France, Germany and Italy head the league of PCB-holding countries, each having in excess of 40,000 tons, while Greece, Ireland and Portugal appear to have the smallest quantities.

Widespread uses of PCBs were practiced between 1965 and 1975. These formed the basis of many products namely, bonds or plasticizers in varnishes, polishes, paints, inks, glues, copying paper and were also found in various other products, such as insecticides, packaging, lubricating and cutting oils. These can be classified as ***Open Applications***.

In addition, due to their considerable dielectric potential, high heat absorption capacity and fire-resistant properties, they are used as:

- *Dielectric fluids*: fire-resistant liquids in transformers (and, therefore, mixed with chlorobenzenes), in capacitors, switches, etc.
- *Coolants*, in places where no fire-risk may be tolerated (as in the transport by boat for inflammable products).
- *Hydraulic fluids*: for safety reasons where there are heat considerations (e.g., in certain mining installations). All these applications can be classified as ***Closed Applications***.

Types of electrical equipment manufactured with PCBs

Transformers insulated with PCBs
Capacitors
Power switches

Fortunately, if the equipment is preserved, then this material can be easily made available for destruction and environmental pollution can be avoided.

Physio-chemical properties of PCBs used in electrical equipment

- Differ markedly in terms of their chlorine content.
- PCBs come in the form of viscous liquids or even resins. They are colourless or Yellowish and have a distinct smell.
- They are virtually insoluble in water, particularly those with the highest chlorine content. But they are slightly soluble in oil and highly soluble in most organic solvents.
- PCBs are unaffected by light.
- They have remarkable heat stability which increases with increase in the chlorine content and only break down at very high temperature (> 1,000 °C).
- PCBs have a high level of chemical inertia and are highly resistant to chemical agents such as acids, bases and oxidizers.
- They have no effect on base metals, but they dissolve or soften certain rubbers and plastics.

Use of PCBs and their Movement in Environment

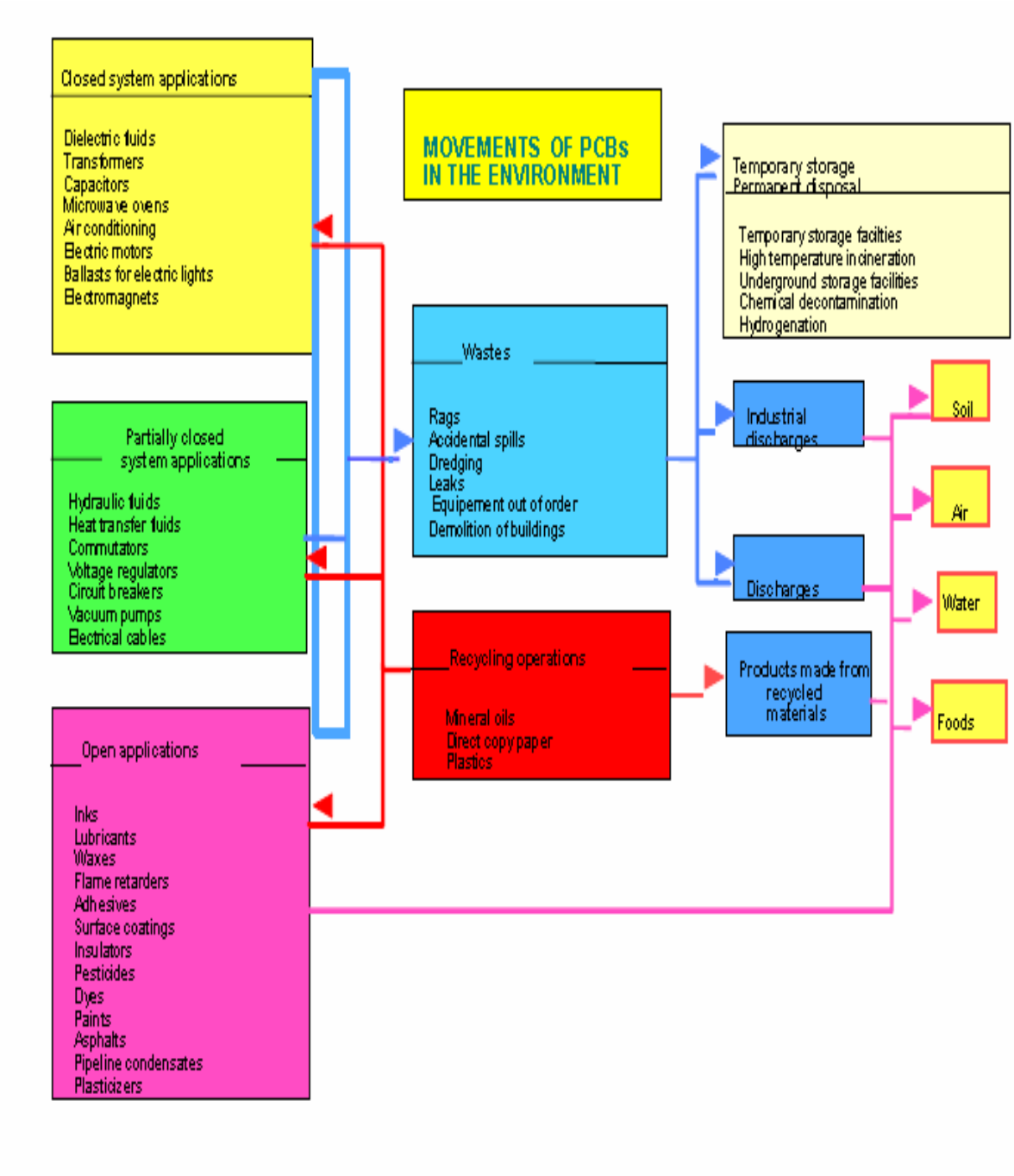


Figure 1: Flow diagram of movement of PCBs

1.4 PCBs Basic Problems

The primary disadvantages of PCBs are:

They are not biodegradable.
Instead, they bio-accumulate.

Since 1966, scientists have noticed that PCBs are virtually indestructible and accumulate in biological chains, thereby damaging the environment and people's health. They are found at all stages of the food chain and studies have revealed their presence in the adipose tissue of live species at the end of this chain: fish, seals, birds and, ultimately, humans. Following levels of PCBs have been found in human adipose tissue:

- 1 mg/kg of PCBs in Canada;
- 8 mg/kg in France;
- Up to 10 mg/kg in Germany (study carried out in 1977).
- Data pertaining to India is not available

Traces of PCBs have even been detected in mother's milk.

1.5 Impacts of PCBs on health and the environment: Bio-accumulation of PCBs in the organism

Laboratory experiments on animals have shown that:

- PCBs are easily absorbed through all exposed areas and remain for the most part in the fatty tissue, where they tend to accumulate.
- More than 90% of ingested PCBs cross the intestinal walls and are retained in the organism.
- The organ favoured by PCBs is the liver, which stores them (the development of both malign and benign tumours has been observed in mice as well as in the monkeys. Sensitivity to PCBs in these animals indicate their possible effects on human beings)
- Acne, skin irritations, hyperpigmentation.
- Hyper secretion of the tear glands, conjunctivitis.
- Liver disorders (hypertrophy et enzymatic changes).
- Blood disorders (anaemia et hyperleucytosis).
- Reproductive effects: changes in the epidermis (hair loss) and the skin (acne, oedema) are observed among the off-springs of the exposed mothers, as well as low birth weight and bone abnormalities. In mice, the lethal dose 50 at eight days (i.e., the lethal dose for 50% of the population at the end of eight days) is only 0.7 g of PCB per kg of the animal.

Actual toxicity of PCBs

PCBs have been the cause of some serious poisonings. For instance, in 1968, in Yusho, Japan, around 1,800 people fell ill with an unidentified disease. Some of the symptoms were rashes, digestive and eye disorders, and numbness of the limbs. It took more than six months to realize that this disease, which had already caused several deaths, was in fact a case of serious mass poisoning caused by the consumption of PCB-contaminated rice oil. The PCBs had leaked from a compressor and were present in a concentration of 2,000 ppm (ppm = part per million; 2,000 ppm = 2 per thousand or 0.2%). In 1979, a similar accident followed in which around 2,000 people were poisoned in Yu-Chen, Taiwan.

Poisoning of humans:

In cases of poisoning caused by accidental absorption of doses measuring 800-1,000 mg/kg of PCB, the first areas to show symptoms are the skin (acne, hyperpigmentation, keratosis, hypersudation) and the eyes (oedema of the eyelids, watering of the eyes).

More general symptoms (fatigue, anorexia and weight-loss), liver disorders, bronchitis, certain peripheral neuropathies and endocrine disruptions complete the clinical picture. These symptoms recede after about a year.

Anomalies have been observed in the children of the women who, during pregnancy, have consumed PCB-contaminated oil. These anomalies are primarily found on the skin, in mucous membrane and the epidermis.

Occupational exposure can cause irritations of the skin and the mucous membrane (eyes and respiratory system), chloracne and, with stronger concentrations, liver disorders.

Carcinogenicity of PCBs

Epidemiological studies have shown no significant increase in the incidence of cancer among people exposed to PCBs. Skin, digestive and liver tumours, and also instances of leukaemia have been noticed. However, scientific analysis has failed to establish a link between increased skin and pancreatic cancer rates and occupational exposure of the victims to PCBs. The International Agency for Research on Cancer (IARC), which is a part of the World Health Organization (WHO), measures the carcinogenic risk of various chemicals and places them in two groups:

- Those which are “carcinogenic to humans” (Group 1);
- Those which are “probably carcinogenic to humans” (Group 2).

The latter group is further subdivided into groups A and B:

- For Group 2 A, evidence of carcinogenicity is “fairly well established”;
- For Group 2 B, evidence is “less well established”.

PCBs are categorized in group 2 B.

Exposure threshold values

In the United States, the threshold limit values for exposure to PCBs in the atmosphere of the workplace have been set by the American Conference of Governmental Industrial Hygienists (ACGIH) at:

- 1 mg/m3 for those with 42% chlorine content;
- 0.5 mg/m3 for those with 54% chlorine content.

The National Institute for Occupational Safety and Health (NIOSH) recommends a much lower limit value: 0.01 mg/m3, to take due account of potential cancer risks. In Sweden, the limit value has been set at 0.01 mg/m3.

Toxicity of products resulting from the breakdown of PCBs

When PCBs are broken down by heat, they first and foremost produce chlorine, hydrochloric gas and carbon monoxide. Hydrochloric gas vapours can cause serious irritation of the respiratory tracts, exposed skin areas, the mucous membrane (particularly of the eyes), resulting in pharyngitis, laryngitis, bronchitis and inflammation of the eyes. With strong concentrations, there is a risk of acute pulmonary oedema. Therefore, a transformer which has been damaged should never be sniffed. In the event of fire or decomposition, PCBs also produce, where oxygen is present, small quantities of toxic compounds which belong to the family of furans and dioxins.

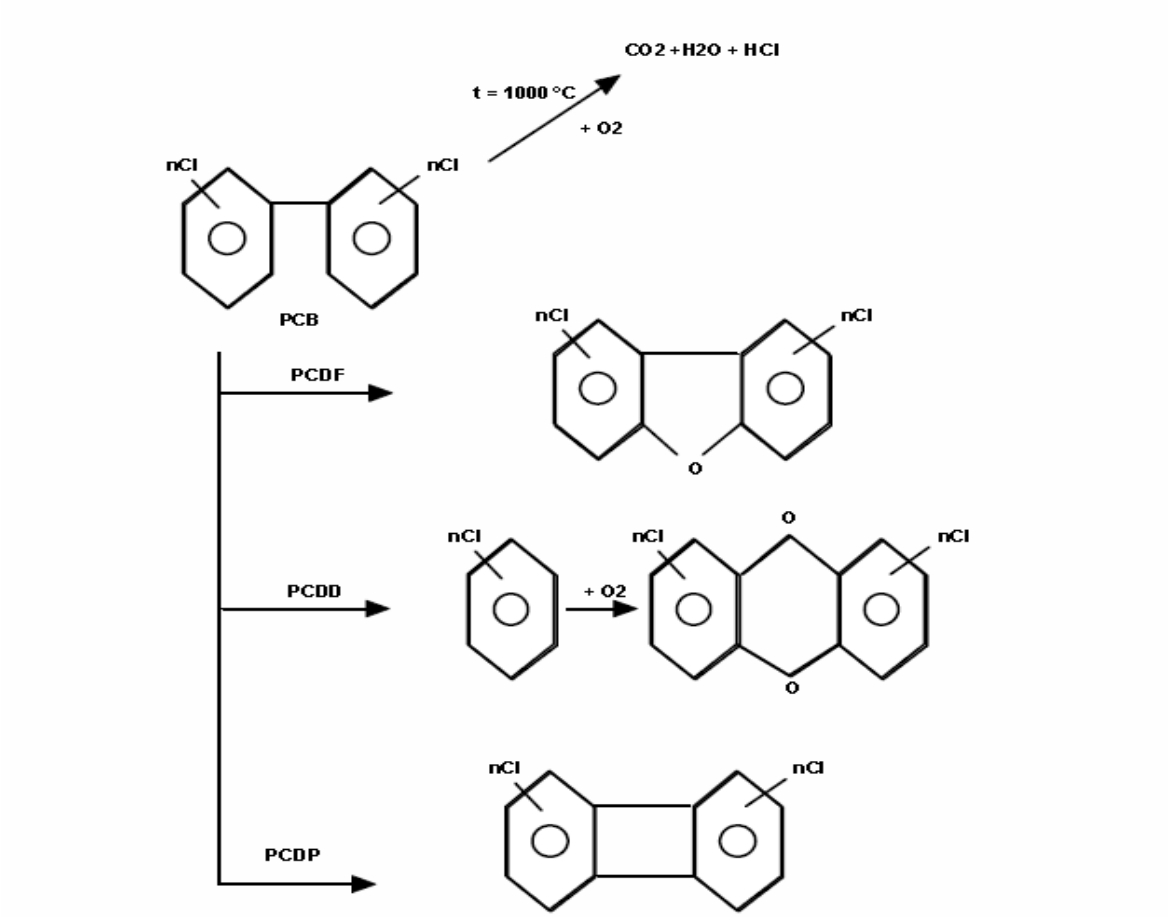
Polychlorinated Dibenzofurans (PCDFs)

Polychlorinated Dibenzodioxins (PCDDs)

Polychlorinated Diphenyls (PCDPs)

Figure 2: Molecular Structure of PCBs derivatives

The precise identification of these products of decomposition is a subject of some debate. They are actually divided into a number of isomers, 212 in all, which are hard to distinguish and the most toxic of them are the tetrachloride derivatives 2.3.7.8 TCDF and 2.3.7.8 TCDD.



Reasons for extensive use of PCB in electrical appliances

It has long been thought that PCB-based electrical transformers represented a considerable step forward from oil transformers, with their fire resisting properties. Companies insuring against fire and electrical accident risks granted discounts of up to 10 per cent of the rates charged for oil transformers. Furthermore, regulations covering public and high-rise buildings prohibited the use of inflammable dielectrics such as oils. At the same time, as the restrictions on the installation of PCB-insulated transformers were less rigorous than those imposed on apparatus insulated with mineral oils, it was cheaper to use PCB-insulated transformers, even though the PCBs themselves cost 25% more than the mineral oils:

- No need for fire protection: PCBs are non-inflammable, and the requirement of firewalls and fire extinguisher systems is not necessary.

- Reduction in the price of electrical cables and reduction in the mains electricity losses, since PCB transformers can be fitted much closer to the use area. This meant that the low tension cables need not be so long.

- Virtually there was no need for transformer maintenance as there was no periodic regeneration of dielectrics.

1.6 PCB accidents

These can be grouped in three main categories:

Accidents involving purely mechanical defects in the electrical equipment, leading to a break in the seal and leakage of PCBs from the casing, but without affecting the composition of the dielectrics. Leaks come, for example, from the seal between the tank and its cover and from rusty spots on the transformer's cooling fan. This type of accident results in the dispersion of PCBs, possibly over a wide area if the apparatus has no retention system. It can occur with installed apparatus or when apparatus is being transported. (e.g., when apparatus is being sent for destruction). Experience shows that PCBs swiftly penetrate the soil and, in some cases, can even reach the underground water. The quantities involved are in the order of tens or hundreds of kilograms. This is called ***"cold pollution"***.

Simple electrical accidents which result from electrical disorders caused by voltage surges and insulation defects. The resulting electrical arc leads to the release of hydrochloric gas and a build-up of pressure which causes the envelope to split and dielectrics to leak as liquid or as spray. The resulting dispersion of PCBs, more vigorous than in accidents of the first group, and the formation of sprays cause contamination by emission. Considerable quantities of hydrochloric acid may be formed and may even cause problems to emergency services. As the PCBs break down in the absence of air, experts believe that there is little probability of dioxins and furans forming. Where environmental protection is concerned, this type of accident is essentially of interest because of the presence of PCBs. Accordingly this is a case of a ***"cold accident".***

Accidents involving fire or the decomposition of PCBs in heat and in the presence of air. The heat-based decomposition of PCBs in the presence of oxygen could result in the formation of PCDFs, PCDDs and PCDPs. Analysis of accidents abroad show a furan content considerably higher than that of dioxins (by a factor of almost 100). It should also be pointed out that the presence of the most toxic dioxin (2.3.7.8 TCDD) has never been attested at detectable volumes, except in Binghamton (United States of America). In accidents of this type, the dispersion of smoke and soot cause the contamination to spread widely. Thus, in the recorded accidents, all the buildings concerned appear to have been the cause of the accidents and seem to play an important role. Finally, there also appears to be a correlation between the content of PCBs and PCDFs decomposition yields of 1%. In accidents of this latter type, the term ***"hot pollution"*** is used.

Causes of a fault and overheating of a transformer:

There are several possible causes of such accidents:

- A voltage surge of atmospheric origin can cause arcing inside the transformer which would normally be suppressed by the primary protection devices.

- A secondary voltage overload or a short-circuit in the main circuits could lead to significant overheating and cause a fire (which, apparently, is what happened in Reims in January 1985). These overloads should normally be picked up and suppressed by upstream protection devices, provided these have been fitted and adjusted in the prescribed manner. The phenomena can be aggravated in the event of the mains power being automatically switched back on, if the apparatus is not fitted with a primary protection device.

- Transformer can be damaged by a fire from adjacent equipment or nearby source.

Examples of PCBs accidents around the world

A few of the best known accidents of the 40 or so which have been recorded around the world are those of Binghamton and Reims, which starkly demonstrated the risks of pyrolysis contamination caused by the use of PCB dielectrics.

Binghamton

In February 1981, in Binghamton, New York State, a fire swept through an 18-floor State Office Building. A simple short-circuit in a circuit-breaker caused the pyrolysis of a portion of 400 litres of PCBs held in a transformer vat. The smoke generated by the fire was dispersed through the building's ventilation system. But the entire building was contaminated and had to be evacuated.

Analysis showed:
PCB levels of 100,000-200,000 ppm,
2,000 ppm of Dibenzofurans, including 2.3.7.8 TCDF,
10-20 ppm of dioxins, including 2.3.7.8 TCDD, the Seveso poison.

Access to the building was prohibited except in sealed protective clothing and masks, and the decontamination exercise, which lasted four years, cost US$ 30 million.

Reims

On 14 January 1985, an EDF 250 kVA transformer, insulated with PCBs, exploded in the basement of a six-floor block of flats, in Reims. Because of the extreme cold (-24° C), the transformer was operating under excessive strain and was being drawn on to an estimated load of 360 kVA. The fire resulting from the explosion was swiftly brought under control by the fire service, but the thick black smoke spread up the stairwell, the waste disposal chute and the ventilation ducts to all the floors. This necessitated the evacuation of the building. Several days later, the formation of certain contaminants was noted and only a highly specialized laboratory was able to identify these, because of the very low toxicity thresholds.

1.7 International guidelines on PCBs

European directive of l October 1985 on PCBs

Example from directive 85/467/EEC of the Council of the European Communities:

- From 1 July 1986, the placing on the market (including the second-hand market) of such PCT or PCT-impregnated equipment, capacitors, inductors, etc., is prohibited.
- From 1 July 1986, the use of PCBs and PCTs heat-transmitting fluids in new closed-circuit heat-transfer installations or as hydraulic fluids, for new underground mining equipment, is prohibited.
- Defines as PCBs (or PCTs), all preparations with a PCB or PCT content higher than 0.01% (100 parts per million) by weight.
- The use of equipment, plant and fluids which were in service on 30 June 1986 continued to be authorized, however, until they were disposed of or reached the end of their service life.

Regulations

The regulations of MOEF are brought in force, generally, by apply the following procedures:

Obligation to make declarations

- Equipment: Owners of transformers, capacitors, etc., which have been insulated with PCBs must declare this equipment;
- Accidents: Obligation to declare any accidents to the classified installations inspectorate (or equivalent authority);
- Verification: Inspections necessary to establish whether or not installations conform to the regulations;
- Retrofitting: Moving installation to another site. This requires a new declaration. The new site is considered as a new installation.

Instruments governing transport of PCBs

PCBs have long been classified with aromatic halogenated compounds and, as such, have been subject to the regulations governing this family of products. In the absence of any instructions specific to PCBs, the following instruments apply:

Inland transport

1. Regulations covering the transport of dangerous goods by rail, road or inland navigation vessels;
2. Regulations covering the transport and handling of dangerous goods in maritime ports;
3. Regulations covering the transport by air of dangerous goods;
4. Regulations covering the transport by sea of dangerous goods under the IMCO (Intergovernmental Maritime Consultative Organization) code.

How to know whether or not a transformer contains PCBs

Generally, the properties of the dielectrics are stated on the appliance's identification plate. As a rule, since 1975, PCB-impregnated appliances are very clearly labelled, in indelible print on a yellow background.

But if the equipment was installed before 1975, it may not have any labels. If there is no other clear indication, PCBs can be identified by their colourless or yellowish appearance, their characteristic smell and their density of about 1.5, as against 0.85-0.9 for oils. They can be identified by density test. Accurate tests based on Gas Chromatography with Electron Capture Detector will be suitable to assess the PCB presence and their concentrations.

Essential aims of regulations covering equipment still in operation

These regulations are designed, above all, to ensure better safety in accordance with the following four principles:

1. Protection against environmental spills and fitting of appropriate retention devices;
2. Protection of equipment against the danger of internal electrical faults which may cause an accident or a fire;
3. Protection against external fire risks to which the equipment might be exposed;
4. Special precautionary measures to be taken during on-the-spot maintenance, regeneration or repair of the equipment.

PCB substitutes

It is normally suggested to eventually eliminate the use of PCBs. But it is still preferable not to rush into a systematic and a prior conversion of all PCB-containing equipment. On one hand, this operation poses the problem of removal and destruction of all the existing equipment and, on the other, of replacing this equipment with other, equally reliable, appliances. When the state of an appliance or its dielectrics necessitates its replacement, two possibilities may be considered:

Changing the liquid ("Retrofilling")
Installing a new appliance.

Changing the liquid

This involves draining the PCB-based liquid and then decontaminating the appliance and refilling it with another dielectric. The substitute must be totally compatible with the type of appliance and all the materials used in its manufacture. Among the dielectrics currently being suggested for this purpose, mineral oils are the easiest to use. In all cases, the choice must only be made after a careful comparative study of the risks and after consulting the equipment's manufacturer. Changing the liquid is a delicate operation, presenting the risk of PCBs escaping into the environment. Hence, this necessitates the need for carrying out the process by duly authorized companies. If the decontamination process cannot guarantee that the new liquid will have a PCB content below 0.05 ppm throughout its service life, because, among other reasons, of the impregnation of the

components by PCBs, the appliance must be subject to the same regulatory restrictions as those containing PCB-based liquids, namely, labelling, preventive measures and elimination. The equipment should be labelled with details such as trade name, properties of new liquid with date of filling and energization.

PCB wastes subject to mandatory treatment

The following are to be considered as wastes subject to mandatory treatment in a proper authorized facility which is capable of destroying molecules:

1. Scrapped appliances containing or having contained PCBs;
2. Mineral oil transformers containing PCBs (> 50 ppm);
3. Non reusable PCBs;
4. Unusable receptacles which have contained PCBs;
5. Clothing, rags, special overalls, gloves, goggles, etc., soiled with PCBs;
6. Washing liquids and water containing more than 0.5 microgram/litre of PCBs;
7. Earth, rubble and other absorbent products containing (before any dilution) more than 50 ppm of PCBs;
8. Transformer cleaning solvents;
9. Filtering adsorbent used for dielectric fluids.

Note: Adsorbent with a PCB content of between 10 and 50 ppm is generally disposed of in approved industrial waste landfills or kept in confinement storage.

1.8 PCBs in Power Sector

It is generally reckoned that 60% of operative transformers in the non-industrialized countries are managed by the public electricity network. The owners of private transformers are, as a rule, industries with an installed capacity of some 200-300 kVA. For lower capacities, the industry is connected directly to the low voltage network. The main electricity supply is divided up as follows:

- Very high voltage systems 400 kV
- High voltage lines 220 kV
- High voltage lines 66 kV
- Medium voltage 30 kV
- Low voltage systems below 30 kV

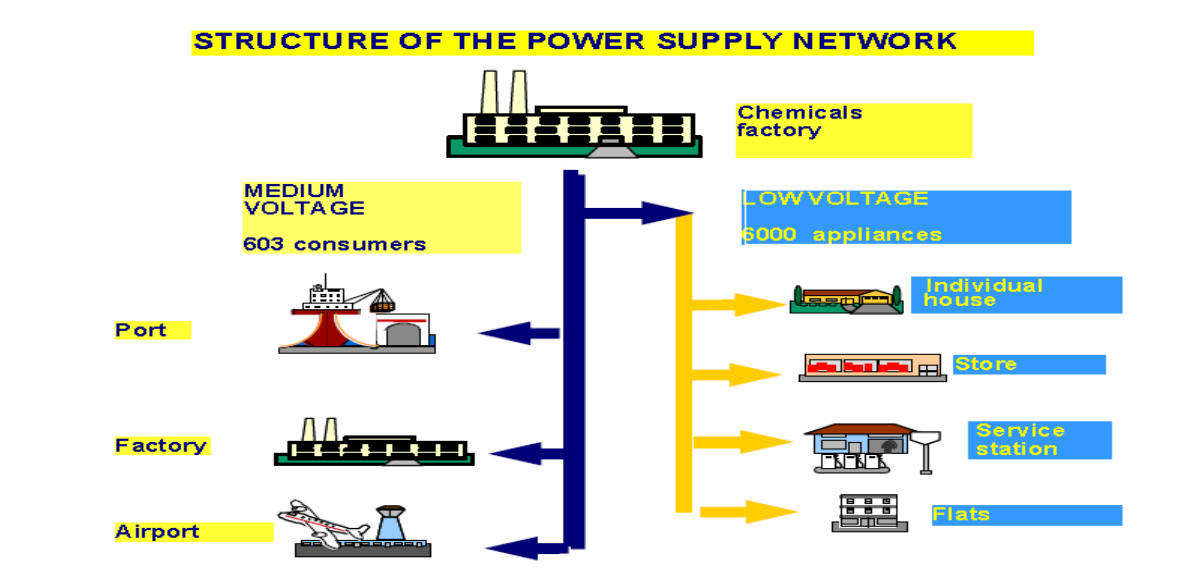


Figure 3: Power System Network

The quantity of dielectric contained in the transformers is directly dependant on the transformer's capacity. The following rule can be applied to estimate this quantity of electricity:

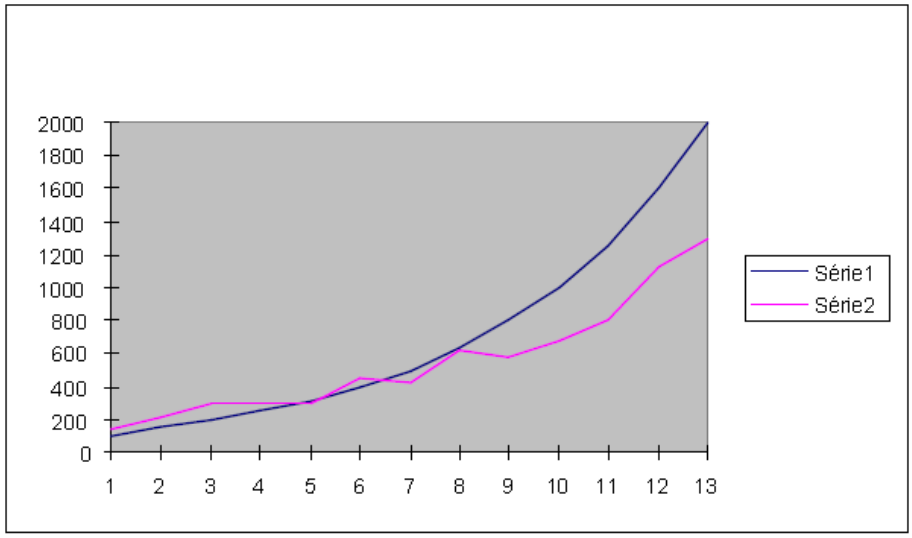
1 kVA = 1 litre of dielectric
1 litre of dielectric = 1.5 kg
100 kVA transformer will therefore contain: 100 kVA x 1 l x 1.5 kg = 150 kg

Generally speaking, the quantities stated on the transformer's specification cards are expressed in mass rather than volume. It should also be borne in mind that this formula is not linear. The weight curve climbs less slowly than that of capacity (see the table below):

Table 1: Quantities of dielectric material PCB usage v/s capacity of power equipment

Quantities of dielectric

CAPACITY OF THE TRANSFORMER	QUANTITY (kg)	VOLUME (Density: 1.56)
100	140	90
160	215	138
200	295	189
250	295	189
315	300	192
400	450	288
500	425	272
630	615	394
800	575	369
1 000	670	430
1 250	800	513
1 600	1 130	724
2 000	1 300	833



Series 1: capacity curve
Series 2: weight curve

Figure 4: Transformer capacity curve and weight curve

1.9 Transformers and their PCBs contamination

The magnetic circuit is totally immersed in the dielectric. After 20 and more years of use, all the porous materials in the magnetic circuit are impregnated with dielectric. These porous materials include the following:

1. The wooden chocks, which absorb 50% of their own weight (thus, a block weighing 10 kg can absorb up to 5 kg of dielectric);
2. Insulating cardboard and paper;
3. Resins coating the copper wires.

Statistics compiled on the decontamination of transformers show that 5% of the initial PCB content on manufacture is impregnated into the transformer's porous components. Thus, a transformer with a total weight of 1,500 kg is made up of:

10 %: 150 kg of tank (metal mass)
60 %: 900 kg of magnetic circuit
30 %: 450 kg of dielectrics (of which 5% of the dielectrics are impregnated in the magnetic circuit i.e., 5% of 450 kg, or 22.5 kg of PCBs. If this quantity is presented as a ratio of the dielectric mass in a PCB transformer, the PCBs constitute a weight ratio of 22.5 kg / 900 kg or a contamination level of 25,000 ppm).

Given that the maximum level allowed is 50 ppm, this is 500 times higher than the normal. Accordingly, the entire metal parts should be considered as PCB wastes and should be destroyed as the PCBs themselves. The procedure for the destruction of these metal parts involves in decontaminating them i.e., extracting the PCBs contained in their metallic and porous components.

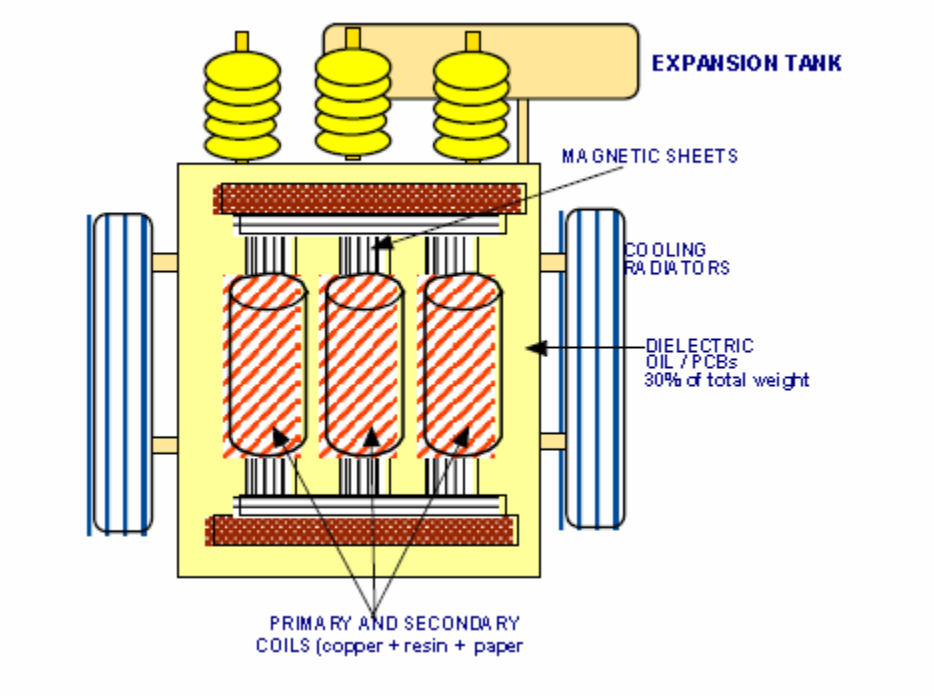


Figure 5: Transformer Coil and Core Assembly

It should be noted that mineral oil transformers can be contaminated by PCBs. This contamination has two causes:

1. Using PCBs to top up the oil in appliances. Because of their technical advantages and the ease with which they mix with mineral oils, PCBs have actually been used as a supplement to dielectrics. PCBs detection tests carried out in various countries on the transformers of electricity supply networks being scrapped have shown contamination (> 50 ppm) levels of the order of 30-40% of the surveyed equipment. The dielectric of these transformers is therefore considered as a PCB waste and should be incinerated in a PCB-approved facility.

2. Retrofilling of PCB transformers with mineral oil. This operation involves draining the transformer of its dielectric and refilling it with PCBs. Given the impregnation potential of PCBs, particularly in the porous parts of the transformer, i.e., the wood of the chocking blocks, the cardboard and the resins, these impregnated PCBs gradually leach back into the replacement mineral oil.

Table 2 Transformer Dielectrics and their comparative evaluation

Type of dielectric	Disadvantages	Advantages	Comments
Mineral oils	Fire hazard	Only slightly toxic and well-known liquid Cheapest of the liquid dielectrics	Need to have a disposal pit or similar system
Heavy oils	• Higher viscosity, necessitating special arrangements for cooling the transformer • Dielectric rigidity less than with normal oils	Mineral oil	Need to have a disposal pit or similar system Not widely available on market
Silicon oils	• Unsatisfactory operation in fire • Relatively high coefficient of expansion, necessitating a special tank • High viscosity • Decomposition produces noxious substances (presence of silica) • Must be protected from humidity • Non biodegradable	Non-toxic liquid	Need to have a disposal pit or similar system
Impregnated transformers	• High price, depending on type of insulation • Behaviour in fire varies depending on technical specifications • Very sensitive to pollution and humidity • Needs an outer casing • Noise level may be on the high side	• Non-pollutant • Low quantity of combustible products in the event of fire • Possibility of rapid cooling	More bulky than a liquid dielectric transformer
Encased transformers	• High price • Decomposition may produce toxic substances (applies to certain resins laden with amino-products) • Noise level may be high	• Non-pollutant • Very good resistance to humidity and to pollution • Possibility of rapid cooling	Need to verify performance under overload conditions Need to conduct reaction tests Bulkier than liquid dielectric transformer
Esters	Good dielectric properties Risk of attacking aluminium on coils Need to protect from humidity	Not easily inflammable Non-irritant	Subject to same rules as mineral oil
NF formula	Not compatible with aluminium and zinc	Non-inflammable Good dielectric properties	Halocarbonated liquid

1.10 Capacitors and PCBs

It is worrisome to note that most of the capacitors manufactured between 1930 and 1977 contain PCBs.

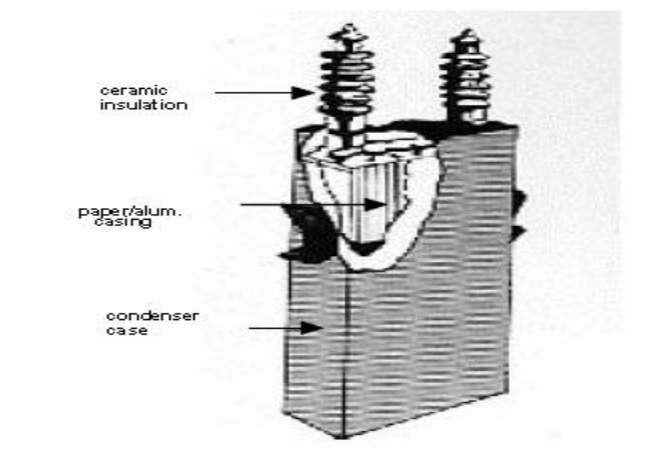


Figure 6: Capacitor - Typical structure

The sizes of these capacitors vary from an ice-cube to that of a refrigerator. They can often be identified by the letters “kVar” on their identification plate. These letters show the electrical classification of the capacitor, which usually lies between 5 and 200 kVar. In practice, all capacitors manufactured between 1930 and 1977 act as substitutes for dielectric liquid contain PCBs.

Purpose of capacitors:

1. To provide the starting torque for single-phase motors;
2. To guard against voltage surges in electric and electronic equipment;
3. To ensure more efficient operation of AC induction motors and boilers;
4. To control power line voltage;
5. To place in the ballasts of fluorescent or high-intensity lights.

PCB-containing light ballasts:

The light ballast ensures that the correct voltage is supplied for the operation of a fluorescent light. The PCB-containing capacitors in these ballasts are usually encased in an asphalt compound placed in a steel case inside the fluorescent light. These capacitors have two electric terminals at the end of a hermetically sealed metal case. A conventional capacitor used in an office fluorescent light contains about 25 grams of PCBs. The PCB capacitors used in high intensity lights contain between 91 and 386 grams of PCBs. Since 1978, these fluorescent lamp ballasts have been manufactured without PCBs.

2.0 PCB Safety Measures

2.1 SAMPLING AND ANALYSIS OF ELECTRICAL EQUIPMENT

Sampling Dielectric oil from PCB Transformers.

Although a system for sampling online transformers has been developed for big transformers to reduce the cost related to the off-line time, sampling of electrical equipment usually requires one to temporarily shut down and fully de-energize the equipment, so that the risk of electrical shock for the operators can be minimized. Transformers (except the very small ones) are usually provided with one or more dielectric oil drainage valves from which the oil can be sampled; when sampling small transformers not equipped with circulation pump, is important to drain the oil contained in the drainage valve and pipes before taking the sample. While performing this operation, all countermeasures to avoid spilling of PCBs on the soil must be adopted, and operators must wear proper PPE. Oil sampling should be preferentially undertaken from the transformer bottom drainage valve instead of from the expansion tank at the top. The procedure for sampling transformer is as follows:

- Obtain clear, plastic tubing (Tygon).
- Attach one end of the tube to the electrical equipment sampling outlet valve and place the other end of the tube in the sample container.
- The tubing between the transformer and the container should be as short as possible to avoid leakage potential.
- Drain some oil through the sample valve and tubing into the overflow bucket or pan to ensure that no contaminants are present in the sampling line. Then close the sample valve.
- After draining some oil through the sampling line, place the tubing in the sample container.
- Open the sample valve of the transformer.
- Fill the sample container.
- When the sample container is completely filled with oil, close the transformer valve.
- Secure the cap tightly.
- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.
- Complete all chain-of-custody documents and record them in the field logbook

2.2 Labeling and Storing Samples

Wide-mouth glass jars with PTFE caps must be used for storing samples. Pre-packaged kits for oil sampling can also be used if accepted by the lab. Sample

volume must be enough to perform several analyses: a volume of at least 500 ml is recommended.

During the sampling activity, at least one person responsible for the analytical work should be present, in order to detect any sampling anomaly that could affect the analytical work, and to verify the sample code. The sampled equipment must not be moved or should not have undergone any further maintenance operation until analytical results are confirmed, and until the need of further sampling can be excluded. If, for unforeseen reasons, the need to move or maintain the equipment arises before analytical results are confirmed, the analytical laboratory must be immediately informed. On its part, the analytical lab must inform without delay the equipment owner about the analytical results.

Samples must be immediately sealed and labeled. On the label, the following information should be written: sampling date and time, address, equipment serial number (the same entered in Form “B”, sampling serial number, operator's name and reference. Digital photo of the sampled equipment must be taken. The above information, including the digital photos, should be recorded in a data base, which will also contain sampling results, for future reference. PCB are persistent substances not expected to degrade significantly, however certain isomer can degrade more quickly when directly exposed to the light, thus it is recommended to store the samples in a cold place at low temperatures, and to perform analysis within one or two weeks after sampling.

2.3 Personal Protective Equipment (PPE)

Before starting the sampling operation, a complete survey of the workplace to identify and assess possible hazards should be conducted. If, from this survey, no significant hazard is identified except the PCBs in the dielectric oil to be sampled, the PPE to be adopted during sampling operation can be limited to a disposable suite, goggles and proper chemical resistant gloves. Wearing respiratory mask is not necessary as the risk of inhalation exposure during sampling is limited. However, if the survey identifies possible PCBs contamination of the site, operator should also wear protective shoes, respiratory mask and a protective suite. Wearing helmet is generally mandatory in workplaces. In any case, the selection of the proper PPE equipment can only be made after the site hazard assessment. It is recommended that a certain amount of different protective equipments in compliance with the OSHA standards be made available to the sampling team before starting the sampling campaign.

2.4 Preliminary Analysis by Fast Kits and Portable Equipment

There are several screening methods that can be used for preliminary analysis of PCBs oil directly on field. On selecting the proper screening methods, the risk of false positive and false negative outcome is carefully considered. Colorimetric or ion specific electrode methods based on the detection of chlorine and subsequent

normalization on the basis of the expected chlorine content of the PCB mixture may be affected by high false positive outcome if the dielectric oil contains other chlorinated compounds (for instance chlorobenzenes) instead of PCBs. Recent evaluation trials performed by US-EPA on chlorine-based determination and on immunoassay methods seem to indicate that the second is apt for performing the screening analysis of PCBs content in oil.

Labeling of PCB Equipment

The objective of labeling of hazardous wastes, and particularly, of PCBs containing equipment items is to **inform** (about possible risk), **prevent** (the outcome of an accident or PCBs releases) and **track** (the status and position of PCBs equipment)

Identification of the target

- Labels must be informative to the person in-charge of emergency response, to allow them to adopt the correct countermeasures in case of an accident (fire, leakage, etc.)
- Labels must be informative to the person in-charge of handling, transporting and disposing PCB waste, with the objective to reduce further risk to the environment by adopting suitable technical rules for handling, transporting and disposing the waste
- Labels must inform the general public that the labeled waste/equipment may present some danger to the health and to the environment.
- Labels must contain contact reference (names, telephone numbers) for emergency and normal operation on PCB equipment.
- Labels should contain univocal reference numbers / codes for the control authorities.

2.5 Clear Assignment of Responsibilities.

As Party to the Stockholm Convention, the Government of India is in charge of identifying, labeling and removing PCBs from use. MOEF (Ministry of Environment and Forests) is the GEF focal point for the Stockholm Convention on POPs, and is therefore in charge of drafting the bills concerning the management of PCBs (including inventory, labeling, disposing), and enforcing the legislation once issued. While arranging the inventory and labeling tasks, the following should be considered:

1. India is a federal union of States comprising twenty-eight States and seven Union Territories. Therefore the Pollution Control Board of each state should be in charge of coordinating the identification of PCBs in their territory. The Central Pollution Control Board should have the role to coordinate the State Pollution Control Board, to provide them with technical

guidance and standards, and to collect and store at central level the information gathered at the State level.

2. The Ministry of Environment & Forest and its Central Pollution Control Board would therefore:
   a) Draft and circulate standard methodologies and documents for the identification and analysis of PCBs equipment of waste;
   b) Design, build and maintain the electronic database of the PCBs inventory, which should exchange information with the State database of PCB inventory. It could be, for instance, a Web Based PCB database.
   c) Elaborate the standards for the labeling of PCBs equipment
   d) Provide technical assistance to the State Pollution Control Board on the PCB identification and labeling issues
   e) Provide training to the State Pollution Control Board on PCBs inventory and labeling issues.

   For the above purposes, a permanent organization should be established at the Central Pollution Control Board.
3. The State Pollution Control Boards should perform the tasks listed below, or coordinate the work of the regional offices if these tasks are performed by them:
   a) List the industries and economic activities who are more likely to be users or owners of PCBs equipment (see chapter “PCBs Application by Industrial Sector);
   b) In coordination with the relevant State Chamber of Commerce or equivalent organizations, identify the industries/companies of the above list and the contact point for each industry/company;
   c) Perform raising awareness training and dissemination;
   d) Perform questionnaire survey by sending appropriate form to the industries;
   e) Confirm doubtful result by telephone call, site visits, sampling and analysis;
   f) Distribute to the owner of PCBs contaminated equipment univocal label serial numbers for the PCBs equipment to be labeled;
   g) Store information on PCBs equipment on a Web-based PCBs inventory database.
4. PCB owners and industries should:
   a) Fill the PCB inventory forms with the information required in the correct format, by using hardcopies or electronic forms provided by SPCB;
   b) Label PCBs equipment with standard labels serialized with the serial number provided by the SPCB, in compliance with the rules established for the PCBs inventory and labeling system;
   c) Adopt any safety measure prescribed by the State Pollution Control Board;
   d) Report on any variation concerning the PCBs equipment listed (for instance, decontamination, maintenance, transportation to another site,

transportation for disposal etc,) to the local authority in charge so that the PCBs data base can be updated;

e) Comply with the requirement established by the India Hazardous Waste Rules, with special reference to the handling and transportation of PCBs containing waste.

Regulatory Implication of Labeling

Below, a list of proposed rules for the management of PCB labeled equipment is proposed.

1. Labels would have the legal meaning of a certificate issued by the local or central authority on the basis of the information provided by the owner of the equipment.
2. In general, three different PCBs labels would be used:
   a. "PCBs containing equipment" label to be placed onto equipment which is certainly contaminated by PCBs over 50 ppm; this label is serialized.
   b. "Equipment potentially contaminated by PCBs" label to be placed onto equipment which, based on available information, is probably contaminated by PCBs over 50 ppm; this label is serialized;
   c. A "PCB Free" label to be placed onto equipment which after analysis has been found not to be contaminated by PCBs. This label is NOT serialized as traceability is not necessary for non PCBs equipment.
3. Once identified as PCBs or PCBs suspected, the equipment must be labeled without delay.
4. If, following sampling and analysis, it is found that the PCBs concentration of a labeled PCBs equipment is below 50 ppm, the authority must be provided with a copy of the analytical certificate, and the PCBs label can be removed and replaced with a "PCB free" label.
5. If, following sampling and analysis, the measured PCBs concentration of a suspected PCBs equipment is found to be above 50 ppm, the authority must be provided with the analytical certificate, and the equipment must be labeled as a "PCBs containing equipment".
6. Equipment labeled as "potentially contaminated by PCBs" should be subjected to sampling and analysis of PCBs within a deadline set.
7. Each label serial number will be associated to a unique PCBs containing equipment; each PCB containing equipment will be identified by its specific label serial number. If, due to the equipment size, more labels are necessary for labeling a PCBs containing equipment, these labels will have the same serial number.
8. The instructions printed on the label are mandatory and must be fulfilled by the person in-charge.

9. The labels cannot be removed, replaced with other labels, deteriorated, hidden. In case the labels are lost, deteriorated, destroyed by accidental causes, they must be replaced without delay.

Information to be Printed on the Label

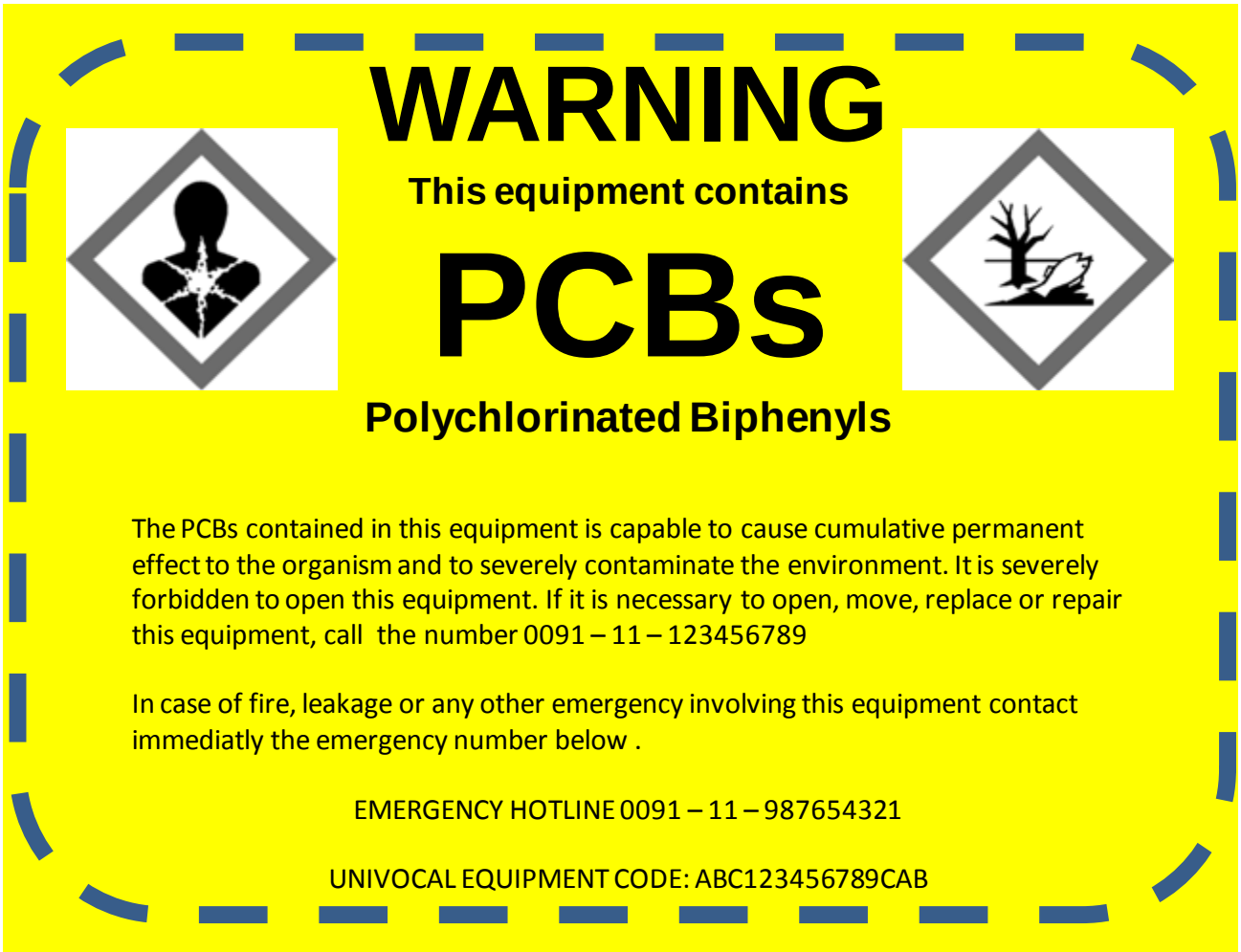
The UN Global Harmonized System for Substance Classification and Labeling and Packaging should be adopted as reference standard. In the Table below, the UN GHS classification for PCBs is reported:

Table 3: GHS classification and hazard phrases for PCBs

Substance Identification:	Name: Polychlorobiphenyls (PCB)	CE Number: 215-648-1 CAS Number: 1336-36-3
Hazard classification and category codes:	STOT RE 2* Aquatic Acute Aquatic Chronic	May cause damage to respiratory system through prolonged or repeated exposure. Hazardous to the aquatic environment, chronic and acute
Hazard statement (code)	H373** H400 H410	H373: May cause damage to respiratory system through prolonged or repeated exposure. H400: Very toxic to aquatic life H410: Very toxic to aquatic life with long lasting effect
Pictogram and sign warning codes	GHS08 GHS09 Wng	
Hazard statement (code)	H373 ** H410	H373: May cause damage to respiratory system through prolonged or repeated exposure.
Supp. Hazard Statement		
Specific Concentration Limit	STOT RE 2 , H 373: C ≥ 0,005%	

1. Labels of PCBs containing equipment should report clearly the following information, or equivalent :
    a. the word “Warning” followed by the sentence “This equipment contains PCBs (Polychlorinated Biphenyls)
    b. The serial number and, if feasible, the barcode of the serial number.
    c. Labeling date
    d. Equipment last Maintenance date
    e. Information on the type of hazard and health effects, as from UN Classification and Labeling.
    f. A sentence reminding that “It is severely forbidden to open this equipment. If it is necessary to open. move, replace, or maintain this equipment call the person in-charge at the number xxxxxxxx”
    g. A phone number to be called in case of leakage, fire or other emergencies;

2. On the basis of the above indication, a possible example of a PCB label is reported below



Printing, Distributing and Placing Labels.

Once the equipment has been identified as containing PCBs, the owner of the equipment shall without delay contact the relevant authority asking for a PCBs serial number for each PCB containing equipment. After receiving an application for one or more PCBs serial number, the authority shall send without delay to the owner of PCBs equipment, by fax or by mail, a list of PCBs label serial number and the specification for a PCBs label. The owners of PCBs containing equipment, after receiving serial numbers by the authority, shall procure PCBs labels in compliance with the technical specification provided by the authority. A temporary label could be used until the final label is ready.

The design criteria for labels are: high visibility (for instance, a black text over a yellow background); high durability of the material and the printed text (both must last at least as long as the equipment itself), even if exposed to the rain and sun; proper size. With reference to the label sample provided above, a suggested size for the label could be in the order of 150x150 mm, as per USA and Canadian standards.

The label will be placed in a prominent position on the exterior of a PCBs containing equipment so that it can be easily read.

Building and Maintaining the Database

In order to ensure traceability, each label must be associated with a record in a centralized database owned and managed by the relevant authorities. Two levels can be envisaged: centralized databases at the State level, and national level database containing all the databases provided by the States. The database should have the same structure as the PCBs Inventory form.

Enforcement

A suitable supervision plan should follow the implementation of the labeling system. Supervision should be performed at 2 levels:

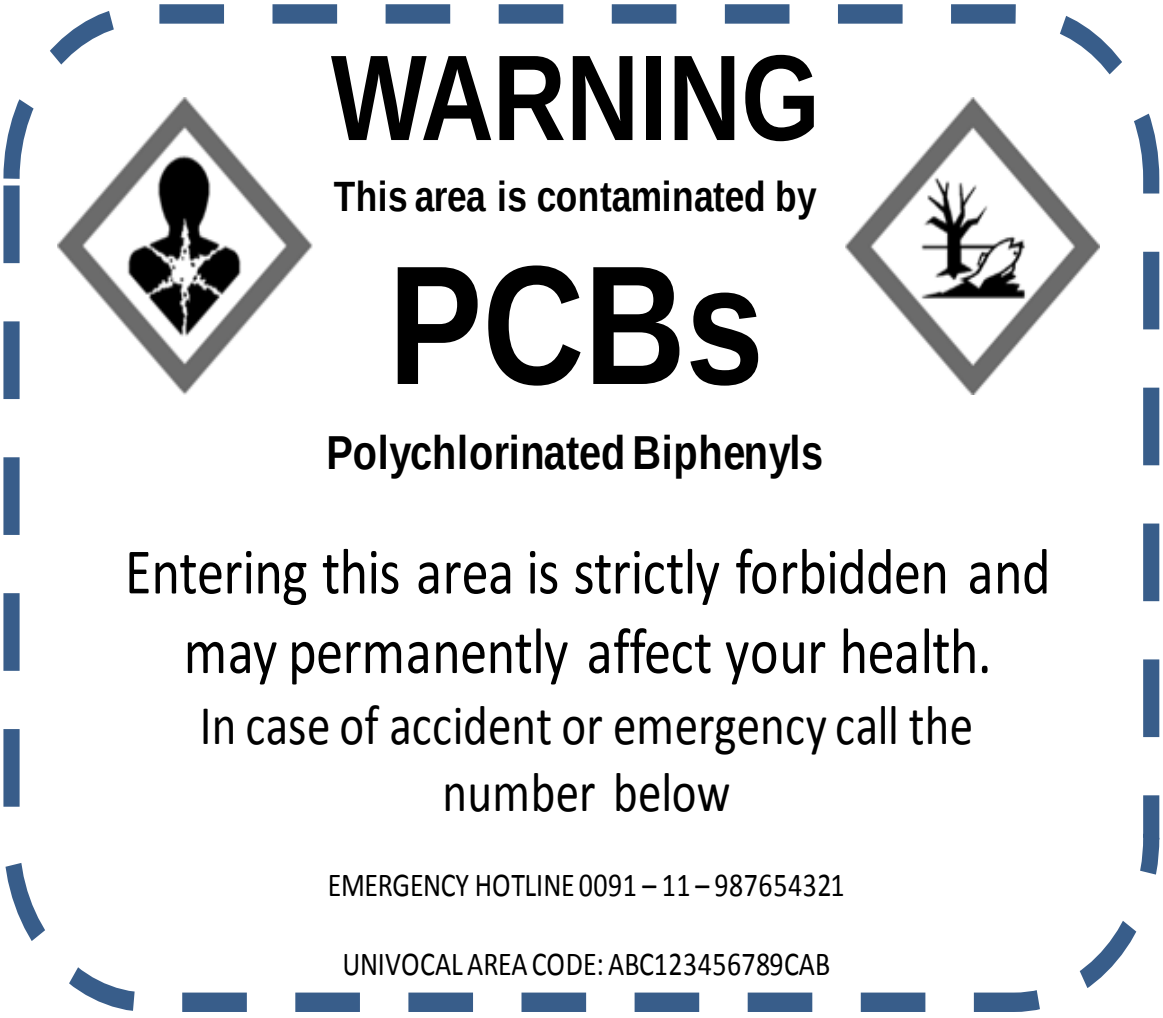
1. Supervision, to be carried out by a central authority, of the activity carried out by provincial authority: this supervision will have the objective to check that the system implemented by the provincial authority is in place, and that it is in compliance with the technical specification and the national legislation;
2. Supervision, to be carried out by a local authority, of the labeling activity carried out by the PCB owners, with the objective to a) verify that the objects that must be labeled have been actually labeled; b) verify conformity between the information reported on the labels and the properties of the labeled object, and c) verify that the labeled objects are used as per the regulatory requirements.

Labeling of PCB contaminated areas (Signaling)

The main objective of Signaling contaminated areas is to prevent people from being exposed to the contaminant present in the area. In case of contaminated areas, traceability is not required, but the PCB waste generated from the contaminated area should be traceable. Moreover, PCB contaminated areas should be inventoried, possibly by using a centralized or a web based data base. The signaling of these sites also has the objective to mark PCB storage area or PCB contaminated area for future reference. In case these sites are not permanently attended, signals and fences must be maintained and inspected regularly. Signals should clearly indicate the strict prohibition to enter the site due to the nature of the hazard (PCB)

- A number to be called in case of accident
- The univocal area code.

A tentative example for a warning signal is reported below.



2.6 PCB trade names

Mixtures of substances containing PCBs are often referred to by trade names. The following have been reported as containing PCBs at some time (but should no longer contain PCBs in current products):

ACECLOR	**ELAOL**	**PRODELEC 3010**
APIROLIO	ELECTROPHENYL	PYDRAUL
AROCLOR	ELEMEX	PYRALENE
ASBESTOL	FENCLOR	PYRANOL
ASKAREL	FENOCLORO	PYROCLOR
AUXOL	GILOTHERM	SAF-T-KUHL
CHLOREXTOL	HYVOL	SANTOSOL
CLOPHEN	INERTEEN	SANTOTHERM
CLOPHENHARZ	KANECHLOR	SOVOL
CLORESIL	KENNECHLOR	SOVTOL
DIACLOR	LEROMOLL	PRODELEC 3010
DELOR	NO-FLAMOL	PYDRAUL
DELORENE	OLEX-SF-D	PYRALENE
DK	OROPHENE	TERPHENYCHLORE
DYKANOL	PHENOCLOR	THERMINOL
		TURBINOL

This list does not contain the names of all PCB mixtures

2.7 Occupational Health and Safety

Health and safety while handling PCB containing materials are of prime importance. The following chapter is not a rigorous presentation of the measures to be taken in that context. Rather, it is a series of guidelines that should encourage the operator to refer to more complete instructions and recommendations made by his local health authorities.

HANDLING PCB CONTAMINATED LIQUIDS AND EQUIPMENT

HEALTH PRECAUTIONS

Operatives handling PCB liquid and contaminated materials must take in to account the following precautions:

a) Ensure adequate ventilation in the working area. Portable fans at ground level should be used in enclosed sub-stations.

b) Wear full protective clothing, i.e.

- one-piece chemical resistant suit;
- chemical resistant gloves;
- boots, or disposable covers for shoes;
- fully approved face breathing mask, with a positive air flow from remote air compressor or bottles; and
- full face mask with Type "CC' replacement canister can be used for low lever exposure.
- The symptoms of PCB exposure are chloracne, eye irritation, drowsiness, headaches and a sore throat.
- Under no circumstance must any operative or observer smoke in the area where PCB is being handled.
- Acceptable threshold limit values (TLV's) are usually not fixed by legislation. However we can cite here, for example, the levels recommended by the United Kingdom Heath and Safety:

- for 42% chlorine content (e.g. Arochlor 1242): long term exposure: 1mg/ m3
- for 54% chlorine content (e.g. Arochlor 1254): long term exposure: 0.5 mg/m3

In Germany, the former Federal Health Office recommended the following:

- Tolerable Daily Intake (TDI): 1 mg per kg body weight per day
- Action to be taken if level exceeds 3,000 mg per m3 of air
- Target: keep level below 30 mg per m3 of air

- Should any spillage of PCBs occur, this must be contained with absorbent materials, which would be placed in steel drums for subsequent approved disposal.

Operatives dealing with spills must take the following first-aid precautions:

- If PCBs come into contact with eyes, immediately wash the eyes with water for at least 15 minutes and seek medical attention.
- If PCBs come into contact with skin, immediately remove any contaminated clothing and wash the affected skin with soap and water.
- If swallowed, wash the mouth several times with clean water, drink water, and seek medical attention.
- If inhaled, move to a fresh air zone and seek medical attention.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Since the main danger from PCBs is skin absorption, careful consideration must be given to the choice of protective clothing including the overalls, boots or overshoes, gloves and eye protection.

PCBs will penetrate most materials, for instance certain materials including natural rubber are particularly permeable to PCBs and are thus unsuitable for use as protective garments. Chemical resistant fluorinated rubbers or elastomers are more suitable and laminated materials that offer the best protection against PCBs. No material is completely impervious to PCBs and therefore it is necessary to make certain that arrangements are in place to regularly change all PPE.

The equipment supplier will normally provide details on the rate at which the PCBs permeate protective equipment. This information will be useful in estimating, for each task, the time it takes for PCBs to penetrate through the protective equipment. This is known as the breakthrough time. This will depend on the frequency and duration of contact of the protective equipment with the PCBs and may vary from one task to the other. The supplier should be able to provide typical breakthrough times for the different applications and say whether there is a need to reduce this time to allow for other factors such as abrasion.

If rubber boots are used, the boots need to be regularly discarded, and the foot protection reinforced by the use of disposable overshoes is to be worn either inside or outside the boot.

For laboratory work, laboratory coats and suitable disposable gloves are necessary for protection against skin contact. If there is a danger of dust or fume formation (for example from heating) then the use of a fume cupboard is recommended. It will be necessary to treat all potentially contaminated protective equipment as PCB waste and dispose it accordingly.

VENTILATION

Adequate ventilation will help ensure that levels of PCB vapor or aerosol do not build up. For purpose-built premises, ventilation can be an integral part of the design. For non-purpose-built premises or on temporary sites, good general ventilation should be adequate as long as air is supplied at a higher level than it is extracted, thus ensuring a down-draught. PCB vapours and aerosols are likely to be heavier than air and more easily controlled by this method. Where mechanical ventilation is necessary it will be necessary to ensure that the air is extracted by air handling equipment with suitable filtration. To prevent environmental contamination, these filters may need to be of the two-stage variety: a fabric or

electrostatic filter will remove aerosol and an activated carbon filter will remove the vapor.

RESPIRATORY PROTECTIVE EQUIPMENT (RPE)

Respiratory protective equipment may be required, particularly if:

- work areas are poorly ventilated;
- work involves the less chlorinated, more volatile PCB congeners or
- work is liable to lead to aerosol formation, and if temperatures are abnormally high.

RPE must be selected which will give adequate protection for workers. This must be fully approved equipment. If workers use non-disposable RPE regularly in a dirty area, they need to be aware that their RPE may become contaminated with PCBs that can be transferred to their face. This contamination can arise from absorption and passage of PCBs through the mask's material, or more likely, from contamination from the inside of the mask due to handling and poor storage during periods of non-use. It must be ensured that workers are aware of these possibilities, and that they are informed about how to minimize these risks by regular cleaning and maintenance of their RPE. It is to be noted that disposable respirators are now being developed.

ENVIRONMENTAL MONITORING

In working areas where PCBs are being handled, it is necessary to monitor the levels of chlorinated solvents. In practice, such chlorinated solvents, which are only very slightly volatile at room temperature, will not be the PCBs themselves. Rather, they will be other similar solvents often used in conjunction with PCBs: chlorinated hydrocarbons, which do have a characteristic smell. These would preferably be monitored automatically and continuously, fixing an alarm level at, say, 20 ppm (parts per million) of a chlorinated solvent in the workshop atmosphere.

It is also possible to use a cheaper, manual system to carry out spot checks, such as testing tubes that change colour in the presence of a chlorinated vapor. Samples of air are drawn through the device at a given flow-rate.
The measurement of PCBs in ambient air is technically possible but a fastidious process, to be carried out in two steps namely, sampling, followed by analysis in an appropriately equipped laboratory.

LEAKS AND SPILLS

EMERGENCIES

In the unlikely event of an accident, spill or leakage during shipment, certain emergency response measures must be taken immediately. Steps must be taken first of all to avoid un-authorized persons from approaching the area. If liquid PCBs are leaking from a vehicle or from damaged or spilled containers, the drivers and/or safety personnel should attempt to control the spread of liquids. Spilled material should be prevented from entering sewers, streams or other bodies of water if at all possible. If practical to do so, the driver's supervisor or responsible official at the utility should be notified. The vehicle should not be left unattended until the spill is cleaned up.

If the operator of the vehicle is incapacitated, the emergency services must rely on the shipping papers to identify the type and quantity of hazardous material being transported. The shipping papers must be kept on the driver's seat or in the driver's side door container. In case of an accident, a timely and proper response can prevent a minor accident and spill from becoming a major catastrophe. Transportation of PCBs is one of the highest risk areas for potential spills or leaks. Most problems occur during loading or unloading. Loading areas should have adequate spill response materials and spill prevention measures should be taken into account and spill control and clean-up materials should be available, should they be needed. Any subsequent movement of the contaminated wastes shall be made in strict accordance with the provisions of the Basel Convention on hazardous waste movements.

LEAKS FROM TRANSFORMERS

In the event of a PCB liquid spill from a transformer or capacitor, the following steps are to be taken into consideration:

1) A crew should respond immediately upon notification that a PCB spill has occurred.

2) All clean-up personnel handling PCBs and/or engaged in the actual clean-up are to wear personal protective clothing and equipment to prevent PCB contamination of clothing on skin.

3) It is extremely important that any PCB fluid must be prevented from reaching storm drains, sewers, drainage ditches, or any other place where water is flowing. The crew is to exercise every available option open to them to contain the PCB spill, including temporary diversion or bunding (use of retaining walls). In addition, the crew should anticipate and prevent water from flowing into the contaminated area from sources such as nearby sprinkler systems and/or street gutter runoff. Every reasonable effort should be made to stop or retard the flow of PCBs and contain that which has been

discharged, using manpower, equipment and material immediately available on the site.

4) If the PCB spill does reach flowing water, storm sewers or any inaccessible area, the first employee arriving at the spill area should initiate notification procedures immediately, and also initiate measures to prevent any additional spill material from reaching water or land.

5) Barricades should be placed around the contaminated areas to prevent pedestrians and vehicles from entering until the spill material is cleaned up and removed.

6) In most cases, oil absorptive material is a useful clean-up tool. If used, it should be spread on the contaminated area and should be left in place for at least one hour, or as long as necessary to ensure that all PCB fluids have been absorbed.

7) After the spilled fluids have been absorbed, the absorptive material, along with any contaminated soils, should be placed in the steel containers provided for that specific disposal purpose. If conditions are such that PCB penetration cannot be determined, then at least 15 cm of soil depth should be removed.

8) All surfaces exposed to the spilled fluid should be decontaminated with swabs containing an efficient solvent, such as trichlorethane.

9) Any contaminated steel structures, wood racks, cable trays (all types) etc., should also be washed down with solvent. All equipment on these structures that may be contaminated by a PCB spill, but will not be removed, must also be similarly cleaned. Caution should be exercised to prevent further contamination of equipment, vehicles etc. in the spill area.

10) All types of structures, building, private vehicles etc. that may be contaminated are to be washed down with solvent (taking care that the solvent does not damage the vehicle varnish). All necessary measures must be taken to prevent the solvent and PCB from entering into any sewer or drainage system.

11) All contaminated items, including tools, clothing, boots, and other equipment, must either be thoroughly cleaned with solvent where practically possible, or disposed of in the steel containers provided specifically for disposal purposes.

12) All drums should be clearly identified and stored or loaded onto a vehicle. Drums must be carefully secured to avoid further spills.

13) The vehicle carrying the drums must also be labeled in accordance with transportation procedures.

14) The containers are to be taken directly to a licensed PCB storage area for subsequent shipment to a disposal point.

15) At large spills in densely populated areas, the spill area will be continuously manned until the spilled PCB oil and all clean-up materials have been removed from the site, secured in drums, or otherwise neutralized.

16) If contact occurs between the skin and PCBs, a waterless hand cleaner should be used on the oil, the cleaner being disposed of in an appropriate container. If eye contact occurs, the eye should be thoroughly washed with water and advice sought from a specialist.

17) Spills into water require special consideration.

RECLASSIFICATION OF TRANSFORMERS

When it has been decided that the condition of a transformer is no longer compatible with the requirements of environmentally sound management (as may be set down in legislation), it is necessary to examine the different options that are available for treating the problem. There can be two basic reasons for reclassification of a transformer:

a) The transformer is found to have a PCB content which is above those levels which are acceptable in the local or regional regulatory situation. However the equipment is still in a satisfactory electrical and mechanical condition justifying its continued use. In such cases, ***Retrofilling*** of the transformer may be an option.

b) The transformer has been found to no longer comply with the specifications related to its use, for example due to poor electrical performance, poor mechanical condition or leaks. In these cases the transformer must be ***replaced*** by a new unit, and must also be ***eliminated*** by methods permitted by the relevant legislation.

Note: It has been found in many countries that there are two different reasons why a transformer may contain PCBs. The first is that the transformer was designed and built to be used with PCB oil. However, experience has shown that many transformers sold, or labeled, as non-PCB transformers can in fact contain PCBs. This is because many transformers using conventional oil have been cross-contaminated by PCBs.

In Europe, this figure may be as high as 45%. The reason is that the facilities used many years ago for filling transformers were often employed both for PCB oils, and for other non-PCB oils. Cross-contamination thus occurred and a transformer marked as a conventional oil transformer may contain well above 0.005 per cent (50 ppm) of PCBs, which is the ultimate threshold specified in Annex A of the Stockholm Convention.

In such cases Retrofilling is a practical method of reducing PCB levels to below 0.005 per cent.

2.8 Risk diagnosis Check List

A risk diagnosis is drawn up for each of the sources listed. This is compiled from information contained in the database. The competent authority can decide on specific measures according to the combined criteria of safety and maintenance. The criteria used in the framework for the preparation of risk diagnosis may be weighed.

1. If the dielectric has not been identified, it must be analyzed;
2. A PCB label must be visible on the transformer;
3. A PCB label must be attached to the wall of the workshop where the transformer is located;
4. PCB markings must be clearly visible on the appliance as well as inside and outside the workshop;
5. The volume of the catch basin must be greater than the quantity of PCB contained in the transformer (PCB density: 1.5 - vol = wt/density);
6. A catch basin must be installed below the transformer;
7. The period of time between inspections should be reduced for safety reasons;
8. Inspections should be carried out in accordance with the age of the transformer;
9. The level should be checked during each inspection;
10. The insulation should be checked during each inspection;
11. Regular analysis is recommended to ascertain the dielectric properties of the fluid;
12. If the PCB concentration is greater than 50 ppm, the transformer must be declared to the competent authorities as a PCB transformer;
13. Test recommended to ascertain the dielectric properties of the fluid;
14. Either the PCB transformer is replaced by a mineral oil transformer or a fire-wall must be erected between the two appliances;
15. Connections to the air conditioning system must be sealed;
16. Ventilation of the workshop must be sufficient to cope with the release of toxic gas should the need arise;
17. It is recommended that access should be restricted to authorized personnel only;
18. Repair work to the transformer is necessary;
19. Contaminated material must be removed and a decontamination inspection carried out and a report submitted to the competent authorities.
20. A transformer more than 35 years old must be replaced

2.9 General on-site technical safety measures

General on-site technical safety measures should be issued in the form of directives which will help promote the enforcement of the regulations within the area in question. The following elements of such directives are provided for information only.

2.10 General technical safety measures

Because of the noxious properties of PCBs and their ability to bio-accumulate strict safety and protective measures must be applied during the storage, handling and use of these products. It is therefore necessary:

1. To warn the staff of the risks posed by these products, the necessary precautions to adopt, and the measures to take in the event of accidents;

2. To prohibit, because of the risks of decomposition and subsequent release of toxic substances, the use of any flame-producing appliance in the presence of PCBs, or any appliances which raise the temperature of a metallic surface to high levels (this means banning of any welding operations and the oxy-acetylene cutting of PCB-containing transformers);

3. To avoid as far as possible the release of vapours in workshops where PCB-containing appliances are repaired, ensure good ventilation in work stations, regularly test the air at the level where it is inhaled by staff;

4. To store products and wastes in sealed and labeled metal containers which must be kept in adequately ventilated premises;

5. To avoid any contact of the products with the skin or the eye area. For this purpose staff must be provided with suitable protective gear namely, Gloves (e.g., made of fluorine elastomers), Wraparound goggles, Overshoes.

2.11 Preventive measures to be taken against the risk of cold pollution

First of all, regular checks should be made of the water tightness of the appliances, but in all cases a watertight mechanism should also be available for the containment of spills.

Existing installations: The existing retention system can be maintained if it is watertight and if there is no danger of overflow seeping into the natural environment or the public sanitation network.

New installations: The mechanism must have a minimum capacity at least equal to the highest of the following values:

100% of the capacity of the largest container;

50% of the total volume stored (a workshop in which there is a transformer containing 400 liters of Pyralene and two other transformers containing 300 liters each must have a minimum retention capacity of 500 liters).

The requirement to have a watertight retention mechanism does not apply to capacitors permeated with PCBs in the form of gel, as this is not likely to escape if the outer casing were to break.

Workshops for repair work, recovery, decontamination and stripping down:
Same measures to be taken as described above.

The flooring of each set of premises must also be made watertight and easy to decontaminate. It would be advisable to have raised thresholds and to block all openings through which Pyralene might spill (e.g., cavities for the passage of cables).

Under floor water drainage and all gas piping is prohibited.

2.12 Measures to be taken in the event of "cold" accidents

Alert the relevant authorities (e.g., the classified installations inspectorate) in the event of any spreading of PCBs and risk of contamination to the environment.

Alert the duty doctor and make sure the staff is equipped with PCB-protective outfits: wrap-around goggles, gloves and overshoes.

Mark out a safety perimeter and, where necessary, ventilate the premises using all the means available.

Limit the PCB spill by sealing the breach (using pieces of rag, plastic film) and by using absorbents (such as sand, sawdust, cement).

Clean the flooring:

1. If it is watertight, scrape thoroughly and use steam to soften the PCBs. Under no circumstances must a flame without protection be used. Chlorinated solvent should not be used. Use only mild Teepol-based detergents such as dishwashing liquid.
2. If it is not watertight, heavily contaminated under floor supports must be removed: concrete, earth etc.

If there is any risk of ground water contamination appropriate measures must be taken immediately to limit, settle and ultimately eliminate the pollution.

Place all the polluted products that have been gathered up (washing water, earth with higher than 100 ppm pollution level, clothing etc.) in watertight containers for their subsequent destruction by incineration at an authorized site.

Note:

- Soil with a pollution level higher than 100 ppm must be treated.
- At a concentrate between 10 and 100 ppm it should be disposed of in an approved landfill or kept on site.
- At under 10 ppm it is considered non-contaminated.
- Water cannot be thrown out unless its PCB content is less than 0.5 µg/liter.

2.13 Measures to be taken to avert “hot” accidents

To avoid the possibility of dielectric decomposition, which can occur when toxic vapours reach 300°C, the following, must be taken into consideration:

1. Ban the accumulation of all inflammable matter (paper, cardboard cartons, rags, paint, solvents) from the vicinity of the equipment or block off the equipment using two hour rated fire-walls (one-hour rated fire-doors) to protect it from the possibility of fire from the outside.

2. Inform fire and emergency services of the presence of PCB-containing equipment, so that their emergency procedures can be adapted accordingly.

3. Check (or have checked by an approved organization) that the PCB-containing appliances are not operating on electrical overload.

4. Check that the electrical equipment has protection ensuring that it switches itself off in the event of any internal malfunction and issue instructions banning the manual re-starting of the equipment before the cause of the original malfunction can be determined.

5. Ensure that gas is kept properly sealed. The sites where PCBs are handled and PCB-containing appliances are kept must be partitioned off from sites where other activities are carried out. It is particularly advisable to take steps to ensure that any smoke and vapor resulting from an accident should be prevented from reaching the neighboring sites or offices (by way of technical shafts, ventilation pipes, waste disposal pipes, etc.).

2.14 Action to be taken in the event of an accident caused by an electrical fault & fire

First scenario: the transformer is intact. There has only been some internal priming, and melting of the fuses.

> Do not replace them without testing first and do not open the transformer without taking precautions. Use an oxygen mask with a gas filter as the internal pressure may have risen adding to the risk of an escape of hydrochloric gas.

Second scenario: arcing has occurred, leading to a crack in the tank of the appliance but no decomposition in the presence of oxygen (no fire).

> This type of accident involves the spread of PCBs in a liquid state with hydrochloric acid vapours. It is a “cold accident” situation and the measures to be taken are those prescribed for the previous scenario.

Third scenario: there has been re-priming of an open, run-down appliance or a fire in the plant.

Both cases present a risk of PCB decomposition due to heat and the presence of oxygen and the formation of not only hydrochloric gas but even more significantly the toxic compounds, namely, furans and dioxins.

2.15 Emergency Measures in case of Accident

1. To disconnect the unit.

2. To call the fire brigade, giving precise details about the nature of the accident so that they will be bring proper equipment for gaining access to the unit and fighting the fire. CO2 and dry ice should be used rather than water, to lessen the risk of the catch basins overflowing into the natural environment.

3. To inform the relevant authorities without delay.

4. To cordon off the polluted area, ensuring that access to it is strictly controlled and accessible only to persons provided with a special protective kit (waterproof overalls, goggles, mask, overshoes) and only when absolutely necessary and for the shortest possible time.

5. To confine the pollution as much as possible by sealing off all channels of communication between polluted and non-polluted areas.

6. The authorities may order the evacuation of the polluted area (if it is widespread) and an inspection of the contamination. This inspection is an extremely complex and delicate exercise and must be carried out under strict conditions. According to the results of these inspections, the classified installations inspectorate or equivalent service might ask the owner to take certain steps essential for the decontamination of the premises in question.

7. Put into a container all rubble, valueless objects and contaminated clothing for their subsequent destruction by incineration at an authorized site.

8. Steam-clean or solvent-wash immovable surfaces and valuable objects to eliminate any removable contamination and to reduce drastically the general contamination with a view to bringing the premises back to normal prior to their reoccupation. Even though the techniques involved are relatively simple, the decontamination of premises damaged by fire must be carried out by professionals.

2.16 Repairs and maintenance procedures

It is possible to carry out certain standard maintenance procedures in-situ, such as:

- Adjustment and standardizing of the dielectrics.
- Treatment of the dielectrics.
- Sampling.

For these operations to be carried out effectively the following steps are necessary:

- Give the doctor on-duty a list of the personnel involved in the work.
- Provide the aforesaid personnel with compulsory PCB-protective kit; (gloves, Wraparound goggles).
- Ensure that the work space is adequately ventilated.
- Avoid any release of PCBs. The work should be done on a watertight surface, with a sheet being added where necessary.
- Ensure that the maintenance materials used are adapted to and compatible with PCBs.
- Avoid contact with naked flame and heating of PCBs or of the appliance itself (especially where welding is involved).
- Collect all the PCB-polluted wastes produced by this work and place it in watertight metallic containers for its subsequent elimination at an authorized site.

All key operations such as decanting, rewinding of coils, changing of voltage etc., must be performed in specially equipped and duly authorized workshops.

2.17 Transport and storage of PCBs

Transboundary movement of dangerous chemicals or hazardous wastes containing PCBs must respect the obligations set out by the Basel and Rotterdam conventions. Our country also has provisions to ban the movement of PCBs. Readers are encouraged to consult both conventions, and to review the legal and institutional aspects of the control of transboundary movements which apply to hazardous chemicals or hazardous wastes in general. The following sections provide information of a general technical nature as well as specific technical information on the collection, transport and storage of PCBs and PCB-contaminated equipment.

2.18 Collection and transport of dangerous materials

General obligations concerning transport operations

This covers:
Information on the merchandise itself;
Information about the loading of the merchandise;
Information about the guaranteed routing of the merchandise.

Guaranteed routing

The transporters guarantee comes into force the moment he takes the merchandise on board. This has the effect of exonerating the consignor from liability for anything that might befall the merchandise between loading and delivery.

Obligation to provide information

The loader is responsible for providing the transporter with all the information needed to ensure fulfilment of the guarantee of safe delivery of the merchandise.

Obligations concerning loading, chocking and stowing

These concern the loader, not the transporter. The transporter must ensure that that these operations are carried out in accordance with the regulations governing the type of transport being used. There are five different kinds of regulations, depending on the type of transport:

1. Domestic transport by land;
2. International transport by land (ADR – RID);
3. Sea transport (IMDG-IMO);
4. Air transport;
5. Rail transport.

It is therefore necessary to use the crating and packaging methods prescribed for the type of transport chosen for any transboundary movement of hazardous materials. These regulations are not specific to industrial hazardous wastes but apply to chemicals in general. In the case of wastes that contain several substances physically mixed up together, the mixture is classified according to the most hazardous of these substances. For example, a mixture of mineral oil with PCB content above 50 ppm is classified as a PCB.

It is crucial that the consignor of a dangerous product be aware of its chemical properties in order:

1. To comply with the packaging directives;
2. To provide the transporter with an exact description of the merchandise to be carried and the risks it poses.

The regulations vary according to the type of transport, the type of packaging and transport depending on the hazard class and the packing class to which the product belongs and the markings on the package.

Hazard classes

There are nine hazard classes:

1a: explosives
1b: ammunition
1c: fireworks ? flares ?
Compressed gases, liquefied or dissolved
Flammable liquids
4.1: Flammable solids
4.2: Substances liable to spontaneous combustion
4.3: Substances which, in contact with water, release flammable gases
5.1: Oxidizing agents
5.2: Organic peroxides
6.1: Poisonous substances
6.2: Infectious substances
Radioactive substances
Corrosive substances
Miscellaneous dangerous substances

Packing groups

The packaging must be appropriate to:

1. The type of merchandise;
2. The risks it poses;
3. The methods of transport and handling involved.
4. It must also, in all circumstances, keep the contents intact;
5. Prevent contact with other merchandise.

All types of merchandise have been divided into three categories or packing groups according to the ***risk level***, except for explosives, gases, organic peroxides and radioactive materials.

1. High risk Packing – Group I
2. Medium risk Packing – Group II
3. Low risk Packing – Group III

The correct packing group for any product or object will be indicated on its card or in the general code index.

Labelling

The purpose of labelling is to identify the nature of the risks presented by the merchandise and to alert all those involved in its transporting or handling to the

appropriate precautions to be taken. Identification and classification of the product are fundamental to all packaging, transportation and storage operations. All chemical products are itemized with a UN code and placed in one of the hazard classes and packing groups.

For example:

1. Liquid waste with an NSA alcohol content (not otherwise specified) has a UN code number 1987, hazard class 3 and packing group M;
2. A solvent used for drying in the electronics industry, trifluorotrichloroethane has the UN code 1082, hazard class 2.1 and packing group M.

Equipping of road transport vehicles

This applies to:

1. Electrical equipment;
2. Fire extinguishers using: Water; Foam; Halocarbons; Carbon dioxide (CO_2); Chemical powders;
3. Miscellaneous equipment:
4. Speed restrictors;
5. Hydraulic hoses;
6. Tachometers;
7. On-board accessories (battery selector switches)
8. Special protective equipment and marking materials (wrapping materials, plastic bags, plastic sheeting, absorbents, spades, masks, marking tape, empty drums both open-top and covered, disposable overalls, special gloves and shoes for this purpose),
9. Safety card clearly displayed in the cabin and warning plates outside the truck (“danger” signs and orange disks)

Special instructions:

1. No transporting of inflammable products;
2. The driver of the specially equipped vehicle must be made aware of the type of product being transported and the risks attached (a safety card should be included with the transport documents);
3. Emergency instructions for incidents and accidents must be known so that fire, hot pollution, cold pollution, spillage and the release of PCBs into the environment can be avoided;
4. Safety instructions for PCBs must be known.

Identification of drums

Drums for the transport of dangerous materials must be duly approved and identified with indelible markings on the outside and on the cover. These markings take the form of a code with the following elements:

1. Sample sign for closed drums 2001 (liquids):
2. Filling level: 90%

1A1	Steel drum with non-detachable top
1A2	Steel drum with detachable top
X or Y	Packing groups I, II and III
	Y for packing groups II and III
1.5	Liquid density if greater than 1.2
S	Solids or hydraulic test pressure for liquids
150	Solids: maximum gross volume
83	Year of manufacture of drum

Sample marking for liquid drum: 1A1/Y 1,4/150/94
Sample marking for solid drum: 1A2/Y 150/S/83

SPECIFIC PROVISIONS FOR PCBs

Categories of PCB-containing products

PCB wastes can be divided into several categories:

1. PCB transformers that have been drained
2. Liquid PCBs in drums originating from drained transformers
3. Liquids polluted by PCB mineral oils, solvents, water (more than 50 ppm)
4. Polluted PCB solids (more than 50 ppm)
5. Capacitors

Types of packaging

1. Liquid PCBs: Sealed drums with metallic and absorbent casing
2. Solid PCBs: Open-top drums (solids)
3. Capacitors: Watertight palleted metallic casing
4. Transformers: Catch basins for drained transformers with absorbents

Taking into consideration the age and condition of the equipment to be destroyed, it is recommended that the transformers be drained before transporting. They can thus be carried, emptied and drained. In any case it should be remembered that transformer tanks cannot be classified as packages approved for transport. As per UN-specification, though metal drums are considered approved containers for transporting these products, it is still recommended that they be packed in metal bins to ensure the safety of both maintenance and transport. For obvious safety reasons, it is not a good idea to put drained transformers and PCB liquid drums into the same bins, as the drums might be damaged by the transformer shells.

UN code	2315	Chlorine content	from 42 to 60 %
IMO class:	9	Melting point	-19 °C
Packing group:	II	Evaporation temperature	325 °
Labelling:	9	Flash point	176 °
IMDG code:	9036	Density	1.5

Storage: Category A on deck or below deck.

Movement of PCB-polluted mineral oil (> 50 ppm)

Category 3

Petroleum products not otherwise specified

IMDG code: 3375
Marine pollutants
Flash point > 61° C
Packing Group III.

When there is a mixture of products the choice of transport category is based on the product with the highest risks. In this case, categories 3 or 9 dominate in relation to category 9.

Transport documentation

1. Packing certificate: The packing certificate must be drawn up by an accredited control company. This certificate must confirm that the following elements conform with the relevant transport regulations:

   a. Verification of the state of the containers,
   b. Validity of the CSC data plate,
   c. Chocking of the appliances,
   d. Labelling,
   e. Packing list,
   f. Total weight of container and
   g. weight of hazardous materials.

2. Packing list: The packing list should show the number, weight and type of all appliances and packages per container, together with a summary of the weight.

3. Declaration of dangerous merchandise (see following page)

   The appliances must be positioned in such a way as to avoid all sideways or lateral or vertical movement throughout the journey. This chocking can either be done with wooden beams or special"airbags" approved for sea transport.

Labelling of the container and vehicle*:*

PCB labels (UN 2315-marine pollutant) must be attached to the four sides of the maritime containers as well as to the metal cases and the transformers inside the containers.

The containers must be padlocked and sealed. The seal number must be shown on the hazardous materials declaration.

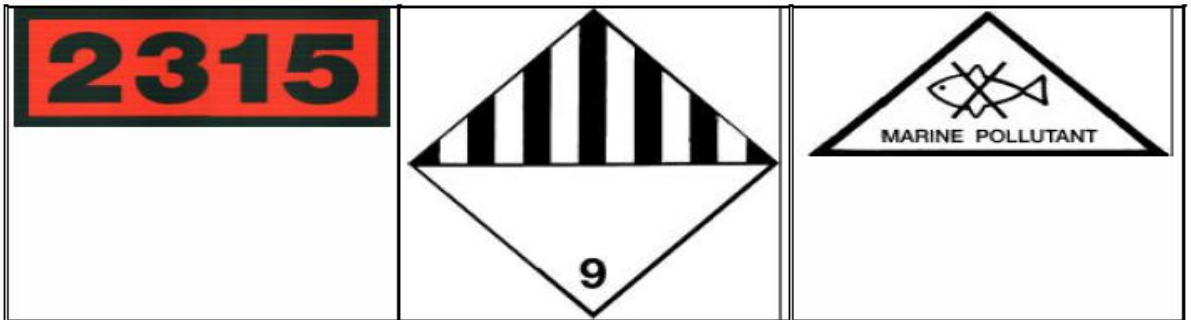


Figure 8: Labelling of PCBs

Management of PCBs in the Country:

The inventory data will be set out and processed to provide quantified information on the main trends observed in the national surveys. Statistics can thus be worked out for the following issues:

1. Distribution by type of business;
2. Distribution of PCBs by age;
3. Numbers of PCBs to be dealt with per year/other period of time;
4. Distribution by capacity level;
5. Distribution by concentration level

This information will help in the realization of the two principal objectives of the report, which are:

1. The preparation of a regulatory framework and
2. The formulation of a national management plan.

3.0 Development of National Inventory of PCBs

3.1 Inventory modalities and resources

PCBs have been used in two different applications: Closed and Open systems. The inventory process here relates only to the closed system PCBs. Different investigation methods are followed with open applications involving environmental releases and these do not apply to closed applications. These investigations apply to such phenomena as concentrations of PCBs in the ecosystem (sediments, phytoplankton, zooplankton, mammal marine animals, food chain, etc.).

The PCB inventory has two purposes:

1. To list all PCB owners and the current quantities of the PCBs;
2. To ensure that PCB appliances can be braced up to the time of their final destruction.

The procedures to be followed are of two kinds:

1. Gathering information;
2. Using information contained in a database.

It is therefore essential that all the concepts employed are clearly defined in advance:

1. Definition of the owner;
2. Definition of PCB wastes;
3. Definition of the inventory categories;
4. Definition of the statistics being gathered.

In addition, the available information sources and the investigation methods must be identified:

(a) Information sources:

1. Electricity generating, supply and elimination companies;
2. Supervisory agencies;
3. Use of the database.

(b) Investigation methods:

1. Site inspections;
2. Questionnaires.

The last stage of the inventory is the processing of the results, with a view of setting in place:

1. Appropriate regulations;
2. An elimination plan;
3. Monitoring of all existing stocks until their final elimination.

3.2 Definitions

The Basel Convention has defined PCBs as any substance or material with a PCB concentration of above 50 ppm. Unidentified appliances must be presumed to be PCB-containing, pending their identification by screening or laboratory analysis. This definition is important because it includes:

- Transformers insulated with PCBs;
- Mineral oil transformers containing PCBs with a concentration of above 50 mg/kg;
- Capacitors;
- Power switches;
- Power distribution units;
- Insulators in very high voltage distribution stations;
- Used oils containing PCBs with a concentration of above 50 mg/kg;
- Magnetic circuit cleaning solvents;
- Contaminated solids such as rags, gloves, and boots.

Particular attention should be given to mineral oil transformers. Pilot programmes have revealed a significant lack of information on this class of appliances and it is therefore strongly recommended that the awareness to managers is raised of the historic causes of the contamination of mineral oil-insulated transformers.

For surface contamination, such as walls contaminated in an explosion, the following should be taken into account:

- Surface contamination, if the wall is not porous;
- Internal contamination, if the wall is porous.

Sampling by the scratching method will ascertain which type of contamination is involved.

PCB Equipment – Owner and their responsibilities

The PCB owner is the individual or legal entity who holds on to his property and for his own use electrical PCB-containing appliances.

Definition of the inventory categories

An inventory card can be prepared on the basis of one or several model cards and adapted to the specific conditions of each country. An example of an inventory card is given in Annex I.

The “PCB inventory and management” tool, developed by the Secretariat of the Basel Convention to assist decision-makers, suggests that the information required should be arranged under four headings namely, “Identification”, “Technical specifications”, “Safety”, “Analysis”, and “Elimination”.

The information gathered is designed to meet the needs of the inventory itself and also to be fed into a database of a programme for the management of operational PCB sources (transformers, capacitors, drums of liquids and drums of solids) until their final destruction. Ultimately, the inventory questionnaire is based on the following two principles:

1. Principle of the mandatory declaration of ownership of PCBs;
2. Principle of traceability until final elimination.

Under this framework, the PCB owner becomes a waste generator. Given this production of waste, he is responsible until the equipment and its contents are destroyed.

Other definitions and key terms – definition of a non-inflammable dielectric
The properties of a liquid dielectric may be measured by a number of criteria:

- Time necessary for deactivation;
- Flash point;
- Fire point;
- Energy released;
- Oxygen index; Opacity, toxicity and corrosiveness of the smoke released, etc. The two most interesting, however are the open flask fire point index and the oxygen index.
- The fire point, or the temperature to which the substance must be heated, in an open container, for a small flame to ignite and to continue to burn spontaneously, gives an indication of the risk of accidental fire. PCBs do not have a fire point measurable below boiling, and this precisely is the current definition of a non-inflammable dielectric;
- The oxygen index, or the necessary initial oxygen content, in a mixture of nitrogen and oxygen, to sustain the combustion of a previously ignited liquid dielectric, gives an indication of the likelihood of self-extinguishment in the case of an outside fire. PCBs have a very high oxygen index, which means a high capacity to self-extinguish does not exist.

3.3 Data Base and its efficient Usage:

These have several purposes:

1. To identify the installations at risk in terms of precise criteria;
2. To define a PCB elimination plan in accordance with several criteria, such as dilapidation, priority sites, PCB concentrations, geographical distribution, etc.

The primary purpose of these statistics is to assist in the preparation of a national elimination plan. The statistics to be gathered are the following:

- PCB transformers Mineral oil transformers > 50 ppm
- Mineral oil transformers < 50 ppm

- PCB capacitors
- PCB-containing drums
- Quantities in operation
- Quantities on standby
- Obsolete quantities awaiting destruction
- Population curve
- Quantities by type of industry
- Total quantity of liquid
- Total quantity of Solids
- Elimination plan
- Storage capacity required
- Liquid destruction capacity
- Solids destruction capacity

Information sources

These can be provided by the public and the private sector:

1. Public sector: The classified installations inspectorate, or equivalent service, may have lists of the sites of PCB transformer owners, in view of the possible dangers of their ownership.

2. Private sector:
   First and foremost, the electricity generating and supply companies, which have client files do not specify whether or not the clients run PCB transformers, but they do contain the addresses of the owners and the date of the installations. The deadline of 1985 could be maintained, even though it post-dates the prohibition;
   Second, the supervisory agencies, which make regular audits of the installations and which are obliged to inform the installation owners if PCBs are manifest;
   Repair companies also have useful information.

3.4 Site Visits and Techniques: Investigation methods

Conduction of site visits is essential for the gathering of observations. One hitch to avoid is making the inspection visit part of some compulsory regulations, which will often cause the visit to be refused. The owner must be left an entirely free hand to volunteer his services, while impressing on him the importance of his participation in the compilation of a national inventory of PCB stocks. A letter must be sent to the owner in advance of any visit, notifying him of its date.

- Communication with those in charge of installations
- Contact the installation managers before preparing the inventory;
- Explain the purpose of the exercise;
- Plan the inventory visits;
- If possible, obtain plans of the installations, and the situation of the equipment;
- Obtain the safety plans;

- If possible, draw up a visit report after the inspection, noting any retrofitting measures that have been carried out.

Equipment required for the inventory exercise

- Overalls;
- Shoes;
- Plastic gloves;
- Safety goggles;
- Lamp;
- Gas mask;
- Notebook, pens;
- Camera;
- Sampling flasks.
- Safety considerations
- Organize a safety briefing;
- If one has not been suggested, request it;
- Obtain a copy of the safety plan, if one exists;
- If there is safety equipment, make sure that you know how to use it;
- Make sure that there is someone who can guide you across the factory;
- Be guided by this person
- Follow their instructions.

Equipment inspection

- Do not touch the equipment;
- Information on the stocktaking can be found on the identification plates visible at a distance;
- If sampling of the dielectric liquid has to be carried out, have it done by the installation's technician. In no event should one try to do the sampling oneself, particularly when the equipment is in use.

3.5 PCB sampling and screening methods

- If the transformer has already been identified as a PCB transformer, no sampling is necessary;
- If the transformer's dielectric has not been identified, a sample must be taken. Any unidentified transformer will be presumed to be a PCB transformer;

The first test to be conducted is the density test:

- Take a 10 ml beaker;
- Pour a little water in the beaker;
- Pour a little of the dielectric into the beaker;
- This recommendation forms part of preparation of an inventory to determine the total stock of PCB-containing equipment, regardless of its concentration.

- If the “oil” phase precipitates to the bottom of the beaker, its density is greater than 1. This means that it most certainly contains more than 50 ppm of PCB and there is no need to continue the tests.
- If the “oil” phase remains above the water, this means that it is mineral oil, as its density is below 1, but further tests should be conducted to ascertain whether the oil has been contaminated with PCBs (phase 4).

PCB level detection test

- If the test is affirmative, this means that the PCB level is above 50 ppm. But this test is not in itself sufficient to determine the contamination level. Move on to phase 5.
- If the test is negative, the transformer may be classified as below 50 ppm, and therefore “non-PCB”.
- Example of negative test: Dark colour
- Example of affirmative test: Light colour

Detection of PCBs with a special chlorine electrode

This method is more accurate than that described above. It can be used when there is a large quantity of PCB to be screened in a short period of time.

PCB analysis: Electrode Analysis

To determine the contamination level a PCB analysis must be conducted by gas chromatography. Gas chromatography analysis can only be carried out in laboratories duly accredited by the competent authorities, in which both the human resources (laboratory technicians) and material resources (laboratory equipment) have been officially approved. While screening oils for PCBs, the preparation of samples and the analysis itself must be carried out according to a specific procedure. These analysis procedures (European Community, French Standards Association (AFNOR) and ISO standards) must be followed if reliable results are to be obtained. Control tests have been made on similar mineral oil samples contaminated by PCBs in several laboratories already set up to work with gas chromatography and mass spectrometry. The results of these varied between 1 and 10. There is clearly a great need for a tailor-made validation system for the screening of mineral oils for PCBs.

PCB analysis: Gas Chromatograph with ECD

Poly Chlorinated Biphenyls are highly soluble in mineral oils which were conventionally used as liquid dielectrics and bulk of PCBs manufactured are used as liquid dielectrics. Hence, these are to be analyzed from this matrix. Pure PCBs differ in their specific gravity (1.9) as compared to (0.83-0.89) of mineral oils. Only when we have known information about the type of oil this test can be used for confirming the PCB usage.

In reality there is a possibility that this is most probably contaminated mineral oil and it has to be evaluated for all ranges of contamination. Gas Chromatographic techniques are very good techniques to evaluate chemicals and Electron Capture

Detector can be very sensitive to chlorinated aromatic systems. Hence, internationally gas chromatography with electron capture detector is popularly used for detection of PCB contamination levels. Gas chromatography with Mass Spectroscopic detector (MSD) can be used. Further, GC with MS techniques has also been used for very low and confirmative evaluations of PCBs. PCBs are generally used in mixture of their congeners. Depending upon their chlorine % they are named as Arochlor. Typically for liquid dielectric applications Arochlor 1242, 1258 & 1260 are representative mixtures of power transformer dielectric applications. Typically IEC 61619, ASTM 4059 and other standard test methods are used for evaluating PCB's from mineral oil matrix.

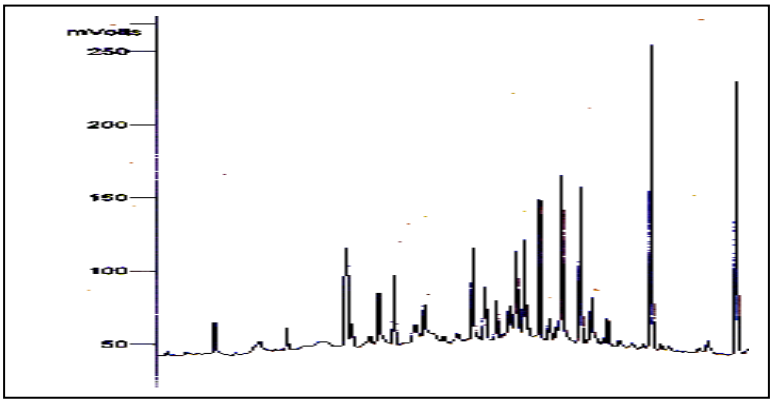


Figure 7: Chromatogram of PCB Analysis in GC with ECD

3.6 Technical report

This is compiled directly from the data and can be undertaken after a visit to the firm in question. The technical recommendations given below apply to retrofitting measures for equipment to ensure the sound environmental management of PCBs.

TECHNICAL RECOMMENDATIONS FOR RETROFITTING (examples)

1. Drums must be stored under safe conditions, with no inflammable liquid in the vicinity, and must be labeled PCBs;
2. PCB transformers must be declared to the competent authorities;
3. Possession of PCB transformers must be declared to the competent authorities;
4. If the transformer has been retro filled, the oil from the transformer must be analyzed to determine its PCB content;
5. If the dielectric has not been identified it must be analyzed;
6. The transformer must be stored under safe conditions;
7. A PCB label must be visible on the transformer;
8. If not, a PCB label must be attached to the wall of the workshop where the transformer is located;
9. A PCB label must be placed outside the premises;
10. A PCB alarm must be in operation on the appliance as well as inside and outside the workshop;

11. The volume of the catch basin must be greater than the quantity of PCB contained in the transformer (PCB density: 1.5 - vol = wt/density);
12. A catch basin must be installed below the transformer;
13. The period of time between inspections should be reduced for safety reasons;
14. Inspections should be carried out in accordance with the age of the transformer;
15. The level should be checked during each inspection;
16. The insulation should be checked during each inspection;
17. Regular analysis is recommended to ascertain the dielectric properties of the fluid;
18. This safety device is strongly recommended for PCB transformers;
19. If the PCB concentration is greater than 50 ppm, the transformer must be declared to the competent authorities as a PCB transformer;
20. The dielectric must be sampled to ascertain its PCB content;
21. Test recommended to ascertain the dielectric properties of the fluid;
22. Either the PCB transformer is replaced by a mineral oil transformer or a fire-wall must be erected between the two appliances;
23. Connections to the air conditioning system must be sealed;
24. Ventilation of the workshop must be sufficient to cope with the release of toxic gas should the need arise;
25. It is recommended that access be restricted to authorized personnel;
26. Repair work to the transformer is necessary;
27. Contaminated material must be removed and a decontamination inspection carried out and a report submitted to the competent authorities;

3.7 Regulatory policy

The plan must be underpinned by the regulatory framework of national and international obligations. For the most part, implementation of the plan will be driven by international agreements and obligations. PCB management, for example, including the monitoring of any possible transboundary movements, must be carried out in accordance with recognized international norms and obligations, especially the control systems set up by the Basel Convention. The possession and use of PCB transformers and capacitors at the national level must be subject to regulations that will control their impact on the environment. These regulations shall stipulate:

1. The obligation to declare possession to the relevant authorities;
2. The obligation to ensure their elimination in authorized facilities;
3. The obligation to declare any accidents;
4. The retrofitting of existing installations;
5. The security of existing installations;
6. Giving priority to installations at risk;
7. Emergency plans;
8. Other measures.

Certain countries feel that a system of regulations is the best long-term guarantee of the gradual phasing out of PCBs. It gives a shared sense of responsibility to everyone involved as well as defining their individual areas of responsibility. It also

ultimately allows for recourse to measures. Regulations, however, can only be effective to the extent that the parties involved have the capacity to implement them. In some cases they can even produce negative results as when, for example, they bring a given problem to the awareness of the owners without offering any real solutions

The first of these is the “proximity principle”, according to which the elimination of hazardous wastes must be carried out at a location as close as possible to the production site of the said wastes, even though it may be more economical and environmentally friendly to treat certain wastes in specialized centres situated some distance from the waste production site.

Another is the “self-sufficiency principle”, according to which each country has to ensure that the elimination of wastes produced on its territory must be carried out using environmentally sound management methods, again while conceding that it may be more economical and environmentally friendly to treat certain wastes abroad. This principle should be applied with due regard for the principle of the development and transfer of the technology referred to above. The third is the “principle of least transboundary movement”, according to which the transboundary movement of hazardous wastes is kept to a bare minimum, while the efficient and environmentally sound management of these wastes is still ensured. In applying these principles to PCB management it must be recognized that the current infrastructure of PCB management in developing countries has some bearing on decision making. With few exceptions, these countries do not possess the necessary infrastructure either for the treatment of contaminated equipment or for the destruction of PCBs. In any event, PCB stocks in most of the countries concerned are relatively small, and below the critical volume that would justify the creation of national infrastructures for treatment and elimination. In view of these considerations, the responsible national officials are encouraged to explore the different technical and technological choices, in accordance with the principles cited above, at both regional and sub-regional levels.

Under certain circumstances the principle of regional (or sub-regional) integration presents certain advantages in technical, regulatory and financial terms for the group of countries involved in such integration. As for the PCB management methods in use within the regions, it should be noted that the PCB-containing wastes are limited in quantity and in lifespan. Consequently, the needs for a PCB management infrastructure must be weighed within the overall framework of hazardous waste management. There are also grounds to expect that, if those areas that lack the necessary technology delay the implementation of PCB-containing waste management until they obtain that technology, the consequent risks to health and the environment could be perpetuated.

3.8 Guiding principles of PCB management plan

Below we list the guiding principles referred to above as applied to the development of a national PCB management plan:

Stocktaking:

- Compulsory declaration of possession of PCBs;
- Ensuring that PCBs and equipment can be tracked until the point of treatment and final elimination;

Maintenance of equipment:

- Monitoring of PCB-containing equipment until the end of its natural life;
- Retrofitting of existing installations;
- Temporary safe storage of equipment awaiting adequate a satisfactory technical means of decontamination or final elimination;

Technical aspects:

- Exploring domestic solutions for the decontamination of PCB-containing Equipment;

Financial aspects:

- Implementation of the polluter pays principle and the shared responsibility Principle;
- Giving priority to high-risk installations.

3.9 Regulatory framework for the national PCB management plan

An initial and vital step in the national strategy will be the preparation and implementation of national regulations covering the whole body of issues referred to previously namely, the management of PCB-containing equipment in use up to final elimination on the basis of the lifecycle principle. For the purpose of designing and implementing such regulations, a working group must be set up to ensure that the regulation modalities take due account of the various technical and financial constraints affecting those involved, particularly in the public and the private sector.

Draft regulations are proposed in Chapter VII of the present manual. These regulations will cover all the environmental aspects related to the possession and use of PCBs:

1. Area of application;
2. Definitions;
3. Inventories;
4. Maintenance of PCB-containing equipment and accident prevention;
5. Prevention;
6. Final elimination of PCBs and decontamination of scrapped appliances;
7. Emergency plan in case of accidents;
8. Norms and standards of management, analysis and treatment;
9. Monitoring and decontamination of sites.

The following section briefly describes the different regulatory phases of a national PCB management plan and suggests scenarios for a regulatory approach.

3.10 PCB phase-out plan

Using the quantity of existing supplies and the date at which the appliances are to be scrapped, a destruction graph for the period in question can be worked out as things stand, the destruction period will last until 2028.

Using data from the laboratory analysis of PCBs and contaminated oils, a more focused study will establish the distribution of known PCBs by concentration levels. This information will be particularly useful in deciding priorities and identifying the most suitable technologies in accordance with known quantities and concentrations at the national level. The implementation of concentration measures for the stock as a whole will, however, be an expensive exercise.

3.11 Creation and maintenance of a data base

The database is designed to be brought up-to-date using information which the owners' are required by law to provide, including:

1. Identification of appliances and the obligation to declare possession of PCBs;
2. Declaration of transformers to be scrapped, and the mandatory presentation of certificates of destruction.

Accredited organizations are required to manage the national stock of PCB-containing equipment, by ensuring follow-up throughout their service life. It is therefore possible:

1. To coordinate the preparation of a national inventory of PCBs;
2. To ensure the personalized follow-up of appliances and batches of PCBs (and listed establishments), to send leaflets to the owners concerning the retrofitting of their listed installations, and to update them on information about these installations;
3. To ensure the follow-up of PCBs at all stages, from the point when they are put to use, to their storage and final elimination;
4. To compile a body of local or national statistics on PCBs;
5. To provide useful information for the preparation of National PCB management plan

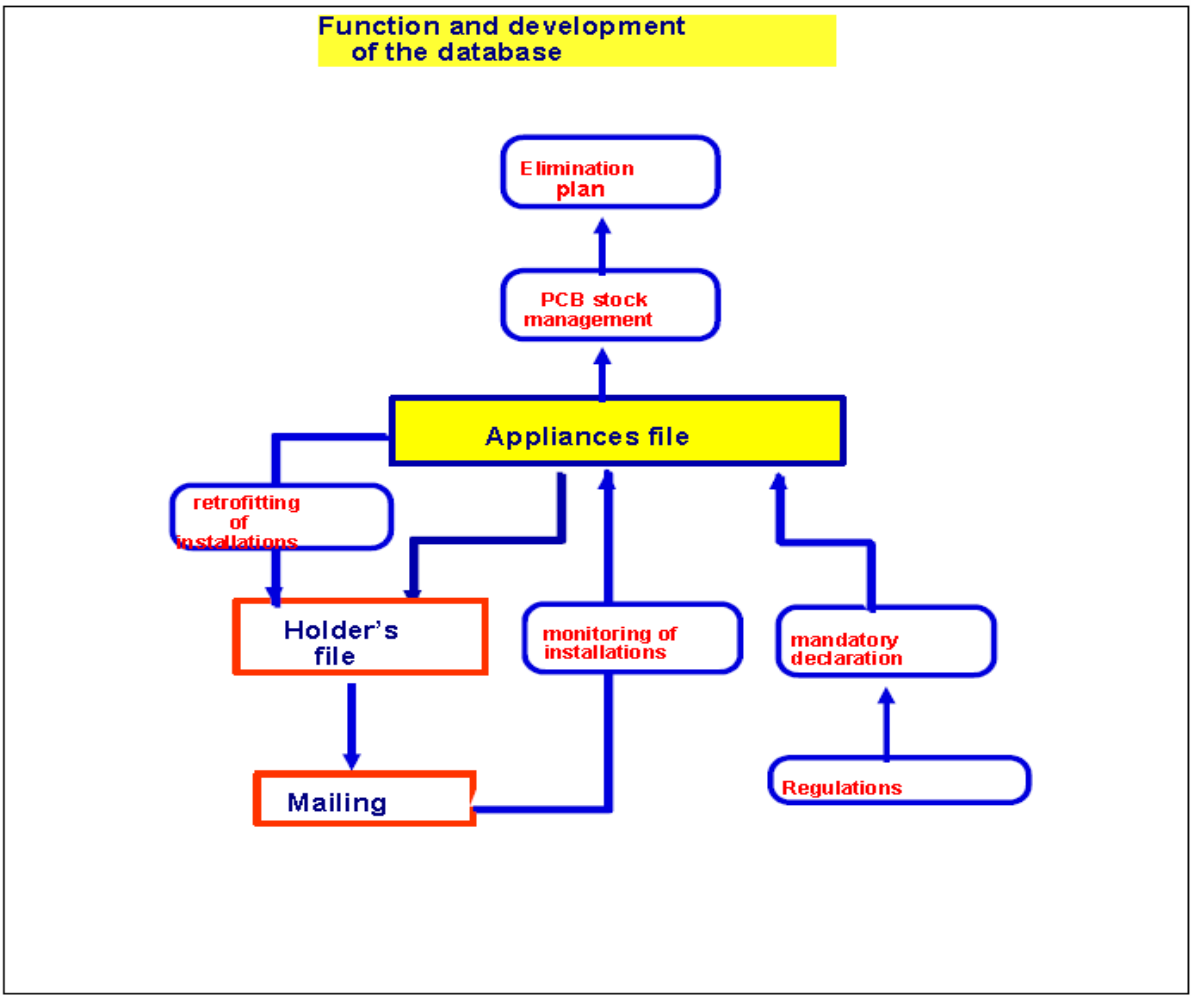


Figure 3: Flow chart of PCB Stock Management

3.12 Basic Principles of PCB Management

The data gathered in the inventory will help in the elaboration of a national plan for the environmentally sound management of PCBs. This plan will define government policy on the issue and will deal with the following aspects:

1. Implementation or maintenance of the national inventory;
2. Conditions for labelling and analysing PCBs and PCB-containing equipment, and general technical prevention measures;
3. Technical plan for the management of PCBs and PCB-containing equipment (storage, transport, final elimination etc.);
4. Parties involved;
5. Financial plan

3.13 National objectives

A national PCB management strategy will pursue the following basic objectives:

1. *PCB phase-out:*

   Eliminate all measurable discharges of PCBs into the environment, starting with enclosed areas, and work steadily towards the suppression of all PCB use likely to cause a discharge that might be impossible to contain. A PCB phase-out strategy must take into account risks to human health and the environment, as well as economic and technical factors.

2. *Environmentally sound management of PCBs throughout their life-cycle:*

   This covers the use, storage, and domestic and transboundary movement, as well as the treatment and elimination of PCBs. It also includes preventative aspects at all stages of the lifecycle, as well as the maintenance and retrofitting of PCB-containing equipment. The notion of environmentally sound management of PCBs, as developed in the Basel Convention, will be applied in its totality.

3. *Integration of PCB management into the national environmental management programme:*

   Decisions on PCB management will be taken in accordance with the overall objectives of environmental management at the national level, in particular the management of chemicals and hazardous wastes, as well as within the framework of the relevant environmental conventions (the Basel, Rotterdam and Stockholm conventions). PCB management objectives must not ignore the industrial context of environmental management and should aim to reinforce environmental management policies at the level of individual owners or companies.

Guiding principles for a national strategy

There are important principles guiding not only the implementation of a national management plan for PCBs but also its preparation. These principles apply to all the issues arising from PCB management.

Principle of life-cycle management

The environmentally sound management of hazardous wastes, as defined by the Basel Convention, is not confined to the environmentally sound management of the processing and elimination of such wastes. The national plan must apply to the total life-cycle of PCBs: in other words, it must ensure that they are only used in optimal conditions and that such use is phased out in a gradual and appropriate manner and it must also deal with the transport, storage and processing or elimination of PCB-containing wastes. This principle will be applied in accordance with the directives laid down by the Basel Convention together with additional

considerations drawn from such international environmental agreements as the Stockholm

3.14 Principle of safety and prevention of pollution: Rotterdam Convention:

One of the essential prerequisites for sound PCB management is the prevention of pollution caused by the release of PCBs into the environment. Pollution prevention involves the application of procedures, methods, materials and products at every stage of the PCB life-cycle, as a way of avoiding completely or reducing to an absolute minimum the production of pollutants and wastes, as well as reducing the general risks posed to human health and the environment. Since their manufacture was banned the total mass of PCBs has not increased. To ensure that this given mass is further diminished and to protect the environment and human health it is important to create conditions for environmentally sound management of existing PCBs to avoid any risk of inadvertent or careless release of PCBs.

The national plan will apply the safety principle, as strictly as is necessary, according to available resources and the national capacity for implementation. Too strict an application of the safety principle could contribute to the failure of the national plan.

An environmentally sound plan for the management of PCBs does not have to centre on their destruction. The presence of PCBs in electrical installations is actually a safety factor from the technical viewpoint. The exceptional dielectric qualities of this fluid, particularly its thermal and chemical stability, have helped provide ways of dealing with inflammable fluids. Consequently, a gradual phase-out of PCBs is proposed, backed up by administrative and technical monitoring of PCB-containing equipment, to be carried out by duly authorized bodies. The management plan must take account of the need for storage of scrapped appliances that are awaiting elimination. Such systems as the recycling of ferrous and non-ferrous metals and the collecting of used oil have traditionally been key links in the re-processing chain of these products without, however, any consideration being given to the environmental repercussions of their PCBs. The “market value” of these products is another contributory factor in the release of PCBs into the environment. A case in point is the production of copper through the open-air burning, fuelled by used tyres, of magnetic circuits from transformers. Up to 20% of a transformer can consist of copper, worth Rs. 8 Lakhs per ton. Potential problems are posed by the recycling of PCB liquids, for example, for use as a fuel substitute. This would mean mixing PCBs with motor oil. The level of dilution in such cases could mean that concentrations were kept below 50 ppm, but the PCB mass would remain the same and combustion would bring about the production of dioxins (PCDD) and furans (PCDF).

The management plan should also prioritize pollution risks. Several countries have included priority criteria in their regulations applicable to the elimination of transformers that are more than 35 years old and need replacing immediately. Another risk factor concerns the location of the transformer. There are certain public locations where measures should be taken to remove transformers.

Locations where elimination is of a high priority include:

Hospitals and clinics;
Medical centres;
Commercial centres;
Schools and universities;
Agro-food industries and manufacturers of food products;
Water and sanitation services;
Government offices;
Buildings frequented by the public.

3.15 Declaration procedure

The owners of any appliance with a volume of PCBs in excess of 5 dm3 are required to declare their possession of it to the competent authorities of the administrative region in which the appliance is located within X months of the publication of the decree. With electrical capacitors the threshold of 5 dm3 is relative to the aggregate PCB volume of an entire plant.

The declaration must contain the following information:

1. Owner's name and address;
2. Location and description of appliance;
3. Amount of PCBs contained in the appliance;
4. Date and type of treatment or substitution carried out or planned;
5. Date of declaration.

Preparation of the national inventory

The competent regional authority, working on the basis of the declarations referred to in Article 1 above, shall draw up, within X months of the publication of the decree, local inventories of scrapped appliances to be forwarded to the competent national authorities with a view to the establishment of a national inventory of stocks. This national inventory will be kept up-to-date by the competent national authority so as to ensure that the whole body of PCB-containing appliances can undergo regular follow-up inspections in accordance with the plan set out in Section 4.3.8

Labelling of appliances

Appliances itemized in the course of the inventory exercise referred to in Section 4.3.2 above must be labelled by their owner. A similar label should be attached to the doors of the site where the appliance is kept (see details in Annex III).

Dispensation arrangements for mineral oil transformers

Dispensation from the provisions based on regulatory frame work, can be made in the cases of appliances containing a liquid volume of between 500 ppm and 50 ppm of the substances. These appliances will be labelled "PCB contamination less than 500 ppm". Specific provisions must be made for the presence of PCB-

containing appliances within a range of mineral oil appliances as this situation presents increased risk.

Drawing up the technical plan

On the basis of the national inventory exercise referred to above, the ministry in charge of PCB management (e.g. the focal point of the Basel Convention) must draw up a draft technical plan for the decontamination and elimination of listed appliances within a designated period of X months from the publication of the decree. This draft plan provides a timetable for the elimination of PCBs and the elimination or decontamination of listed PCB-containing appliances, which would guarantee elimination or decontamination by a designated date (before 2005 at the latest), with the exception of transformers that have a liquid content of between 500 ppm and 50 ppm of the substances in question, which are to be eliminated at the end of their working life. It also makes provision for ways of keeping to the timetable. Furthermore, it lists the methods for collecting and eliminating other, non-listed PCB-containing appliances reaching the end of their working lives, including household appliances. Possible technical solutions (procedures and technologies) to the problem of waste management should be systematically and comprehensively explored, taking into account economic, social and environmental criteria (prevention of toxic emissions, controlled management of discharges, etc.). In this context, the technical directives developed under the various international bodies (e.g., Basel and Stockholm conventions) can provide methodological tools that will be useful in selecting procedures and technologies.

3.16 Technological Options for PCB final disposal

World over the various countries have disposed PCB's using different technologies. Based on the experience gained various remediation technologies for PCB destruction are being looked for assessment of the available technologies, Adoptability to Indian conditions is important to make the project successful. The document "Non Combustion Technologies for POPs Destruction Review and Evaluation" authored by Sergey Zinoviev, Paolo Fornasiero, Andrea Lodola, and Stanislav Miertus and published by International Centre for Science and High Technology, UNIDO, March 2007 and various other documents have been used to make a comparative evaluation of technological options.

Incineration

Incineration of POPs has been the widely used practiced around the world. The drawbacks of the incineration, generation of oxidation products like dioxins and furans which are highly toxic have been the matter of concern of the international organisations. It has been felt that Non-combustion technologies are to be favoured in view of the overall environmental impact of destruction of PCBs.

In the Indian Scenario, incineration as an option for PCB destruction has always been available and country has incinerators established for incineration of various hazardous wastes. Having such an option having an alternative or additional

option will always be of advantage as our country is very large and needs such options in view of geographic proximity and convenience and acceptance.

Among the available Non Combustion technologies of the 15 technologies listed and described in the UNIDO document only four technologies have been considered as established technologies.

These technologies are:

1. Base Catalysed Destruction, BCD
2. Sodium Reduction, SR
3. Gas Phase Chemical Reduction, GPCR
4. Plasma Arc Incineration, PLASCON

Out of these four technologies, the committee wished to go in to the details of each of these technologies and had comparative evaluation of these technologies with an Indian perceptive of adoption and suitability of the technology.

Individual technology was evaluated based on the scores out of 10 the technology was evaluated and ranked. The scoring was maximum of 10 means the technology is best for that criteria.

Important criteria selected were

- Destructive and Removal Efficiency
- Maximum POP strength
- Potential Gaseous emissions
- Commercial experience (number of plants installed / operational)
- Ease of operation
- Containment requirements
- Capital costs
- Operational costs
- Energy input
- Reagent inputs
- Water requirement
- Secondary waste generated and ease of disposal

Comparative Ranking of the Technologies was as under.

The scoring of marks out of ten was based on the international data available with the international agencies. The criteria used in the process (the aforementioned document) were accepted by the committee and were used without change for the present evaluation.

Comparative Evaluation of Established Technologies

Sl.No	Technology	Scoring for each technology 0-10, 10 being highest for best performance				
Sl.No	**Technology**	**BCD**	**SR**	**PLASCON**	**GPCR**	
1	Established technology	10	10	10	10	
2	Destructive & Removal Efficiency	10	10	10	10	
3	Maximum POP strength	10	2	10	10	
4	Gaseous emissions	10	10	2	6	
5	Commercial experience	10	10	10	8	
6	Ease of operation	2	10	2	2	
7	Containment	10	10	2	6	
8	Capital cost	6	10	6	2	
9	Operational cost	8	10	8	8	
10	Energy input	6	10	2	10	
11	Reagent, carrier, fuel requirement	6	10	6	6	
12	Water requirement	10	10	6	6	
13	Secondary waste disposability	6	10	8	10	
	Overall ranking	**104**	**122**	**82**	**94**	

Sodium reduction technology scores highest followed by Gas Phase Chemical Reduction and Base Catalysed Destruction technology. PLASCON technology scores lowest among the established technologies based on the listed criteria.

It was understood that though one CPRI scientist visiting Australia had recommended that PLASCON as a suitable technology, whereas another CPRI scientist's visit to Japan Kitakyushu recorded that Sodium de-chlorination is the technology used for PCB destruction and Plasma Incineration is used in Japan for incineration of cleaned waste which is having less than 2 ppm PCB in the waste. Engineers operating the plant (in Japan) maintained that the high concentration PCB is not recommended to be burnt in Plasma Incineration.

As CPRI scientists had the opportunity to visit working facilities on the two technologies SR and PLASCON, it was felt that these two technologies be described in detail.

PLASCON Technology

It is an in-flight plasma wherein waste mixes (with PCB waste) is directly combusted in an argon plasma column. Argon is used as plasma gas since it is inert and does not react with torch components. Waste is fed directly in to a plasma torch within the argon current, where it is rapidly heated (one millisecond)

up to about 12000^{o}C and passes into the flight tube where it is pyrolysed in about 20 ms at temperature of about 3000^{o}C. In the beginning limited amount of oxygen is also added to ensure that any carbon formed during the pyrolysis is then converted in to carbon dioxide. In the high temperatures of plasma, the compounds are dissociated in to elemental ions and atoms. Recombination of the atoms occurs in cooler zones and the quenched mixture is treated with alkali to scrub the acidic components. Such quenching prevents the formation of dioxins and furans.

The technology has been considered to be a good technology, which however, has few less desirable qualities such as high cost of establishment, very high operational costs, high cost of consumables, spares and accessories etc.,. Most of these spares and consumables need to be imported from the vendor on proprietary basis.

Further, it needs highly skilled manpower to run the system, rectify the system in case of any malfunction, and replace the spares and consumables whenever they complete their functional life. The life of some items may be as short as 1 year. All these factors increase the overall cost of operation and, therefore, are considered as a weakness for this technology

Sodium Reduction Technology

Sodium reduction technology involves carrying out the remediation in a contained closed reaction with dispersed sodium and halogenated aromatic compound in the temperature range of 125^{o}C to 150^{o}C. This reaction is very quick and complete at lower concentrations. Various technology suppliers claim that concentrations of the order of 15000 PPM can also be handled under this approach. The product of the reaction biphenyl, finds application elsewhere and cleaning up of the oils up to 2 ppm level has been established.

The technological developments have established stationary, mobile and larger scale and micro scale systems and these are available from various vendors. This technology is the most accepted one in the world and has about 20 years of commercial experience worldwide. Considering that the technology is available both as stationary and mobile models and can be scaled up easily, this is considered as an advantage of this technology.

The establishment cost and operating cost of the of the sodium reduction technologies is low as compared to other technologies.

Based on the evaluation criteria such as Destructive and Removal Efficiency, Maximum POP strength that can be destructed, Gaseous emissions, Commercial experience, Ease of operation, Containment, Capital costs, Operational costs, Energy input, Reagent inputs, Water requirement and Secondary waste generation and their disposal the SR technology has been found to perform better than other technologies and has scored 122 out of 130. Apart from weaknesses such as handling high concentrations of PCB de-chlorination and handling of sodium, the process is excellent in all other aspects.

In view of the comparative evaluation of technologies, experience of the country, experience of Japan, it is felt that sodium de-chlorination technology is the most suitable technology for the country. This technology would be environmentally compatible, easily adaptable and sustainable for the country activities on de-chlorination of PCBs. Further, it is also felt that the sodium based technology is very simple and the country can handle the requirement of spares, accessories, and operational requirements without having bulk dependence on import of spares and accessories. This will also avoid long shutdown period due to non- availability of spares. The analytical and monitoring tools can also be developed indigenously. The active consideration for a suitable technology is under consideration of MOEF and the best available technology would be opted for final disposal of PCB's in the country.

References

1. "Destruction Technologies for poly chlorinated biphenyls", MSM Mujeerbur Rahuman, Luigi Pistone, Ferrucio Trifiro and Stanislav Miertus, ICS-UNIDO Publications, Proceedings of expert group meetings on POP's and Pesticides contamination: Remediation technologies (April 200) and on clean technologies for reduction and elimination of POP's (May 2000) Published in November 200. UNEP document
2. Survey of currently available non-incineration PCB destruction technologies, United Nations Environment programme, First Issue August 2000.
3. "Non Combustion Technologies for POPs Destruction Review and Evaluation" Authored by Sergey Zinoviev, Paolo Fornasiero, Andrea Lodola, Stanislav Miertus and published by International Centre for Science and High Technology, ICS-UNIDO, March 2007.
4. BCD technologies web site home page and other details
5. PCB Destruction Services With Kinetics Mobile Processing Unit (MPU), Life cycle management solutions for electricity industry Kinetics home page and other details web page details
6. Destruction of PCB's SRL Plasma, PLASCON web site and details on PCB's
7. Alternative Technologies for Destruction of PCB and Other POPs Ian D. Rae
   Department of History and Philosophy of Science, The University of Melbourne, Parkville,
   Vic 3052,Australia, *E-mail: idrae@unimelb.edu.au, Chapter 16,* The Handbook of Environmental Chemistry Vol. 3, Part O Persistent Organic Pollutants © Springer-Verlag Berlin Heidelberg 2003
8. Inventory of World-wide PCB Destruction Capacity - December 2004 UNEP document on Chemical and PCB activities.

4.0 Regulations on Polychlorinated Biphenyls

4.1 Indian Legislation on POPs and Hazardous Waste

Conditions for the transportation, export and import of hazardous waste are also established under the Hazardous Waste Rules, Chapter IV. Under the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008, Schedule II, waste containing 50 ppm or more of PCBs is considered hazardous waste of class A.

Among other obligations, the Hazardous Waste rules requires that hazardous waste are packaged and labeled *"based on the composition in a manner suitable for safe handling, storage and transport as per the guidelines issued by the Central Pollution Control Board from time to time"* (Chapter VI, article 19). For the movement within the country, hazardous wastes are subjected to the Manifest System (Chapter VI, article 22).

Under rule Schedule VI of the Hazardous Waste rules, the import and export of waste, substances and articles containing, consisting of or contaminated with Polychlorinated Biphenyls (PCB) and/or polychlorinated terphenyls, (PCT) and/or polychlorinated naphthalenes (PCN) and/or polybrominated Biphenyls (PBB) or any other polybrominated analogues of these compounds is prohibited.

PCB uses to be considered during Identification and Inventory of PCBs.

Closed Applications

PCBs may be found in three classes of applications: closed, partially closed and open applications. Closed applications like transformers and capacitors are the ones which typically must be included in the PCBs inventory. However, identification of PCBs should also include partially closed or open applications, especially in all the cases where these applications can be easily associated with large industries or infrastructures.

Step up transformers	Power plants
Distribution transformers	Power plants, transformer substation, electricity distribution network, large industrial plants, railways, large ships, hospitals
Power capacitors	Electricity distribution network, large industrial plants
Lighting ballasts	Offices, large building, hospitals
Switches	Transformer substations, electricity distribution network, large industrial plants, railways, large ships

Typical closed applications are transformers, capacitors, switches and lighting ballasts. A closed application is defined as “an application in which the PCBs are held completely within the equipment”. In normal condition, therefore, the exposure of the environment or humans to PCBs contained in closed application is null. However, exposure may occur in circumstances like maintenance operations, and damage of the equipment due to the aging of the equipment or misuse.

Partially Closed Applications

Partially closed applications are heat transfer fluids and hydraulic fluids. In partially closed applications, PCBs is not directly in contact with the environment; however emission to the environment may occur in certain circumstances during typical use, leading in some cases to significant release. A typical example is the PCBs contamination of gas pipes due to the release of PCBs contained in the compressor oil from “compressor blow-by”. The two major PCBs accidents in the world (the Yusho accident in Japan in 1968, and the Yu Cheng accident in Taiwan ten years later) were caused by the contamination of rice oil due to an accidental release of PCBs after a leaking in the heater exchanger.

Heat transfer fluids	Chemical industry; petroleum refineries.
Hydraulic fluids	Any industrial process requiring hydraulic fluids. Mining equipment; ferrous and non ferrous metal industry.
Vacuum and compressors pumps	Natural gas transfer substations and pipes; any industrial facility requiring large compressors or vacuum pumps.

Open Applications

It is reported that PCBs has been used as additive in paint, flame retardant in surface coatings, plasticizers in chlorine based plastic and rubber like PVC and neoprene. PCBs have been also used as an additive to the paint of older ships.

Lubricants:	Immersion oil for microscopes; brake linings; cutting oils; lubricating oils
Casting waxes	Pattern waxes for casting
Surface coatings:	Paints (including the ones used for ship painting); surface treatment for textiles; carbonless copy paper; flame retardants;
Plasticizers;	Gasket sealers; filling materials; PVC; rubber sealers

4.2 Brand Name and Production Year of PCB Contaminated Transformers.

In the table below the list of trade name of PCBs containing transformers as from the first PCBs inventory in India is reported. In extending and updating the inventory, transformers produced by the manufacturers listed in the table should be considered as potentially PCBs contaminated.

In updating the PCBs inventory, it will be of interest to analyze the production year of the PCB contaminated transformers. In the percentage of PCB contaminated transformers by production year as from the first PCBs inventory is reported. More than 95% of the contaminated transformers were produced before the year 1990.

It is then reasonable to assign to the transformers produced before 1990 the highest priority, even though it cannot be excluded that transformers produced later on may still be cross contaminated by PCBs.

Table 1 PCB contaminated transformers by Brand and production year in India

Transformer Brand Name	Produced from	Produced until
A.C.E.C Belgium	1939	1939
Ambarnath X"mers	1988	1988
ANDREW YULE	1985	1985
APEX	1977	1977
APEX	1988	1999
APEX Electrical	1974	1974
Ashok TRF	1977	1978
ASKAREL	1985	1985
BBL/INDIA	1987	1991
BHARAT BIJILEE	1960	1986
BHEL	1977	1992
BHEL/INDIA	1985	2003
Canadian Gl. Ele	1966	1966
CEM	1968	1968
CEM France	1968	1968
CG India	1972	1972
CGL	1975	1981
Crompton	N.A.	N.A.
Crompton Greaves	1966	1988
Crompton Parkinson	1966	1966
CZECH	1980	1980
EARCS	1979	1979
ECE	N.A.	N.A.
Economy	1968	1968
Electric Factory TRF S.E.C	1939	1939
EL-TRA	1977	1979
EMCO	1962	1996
EMCO TRF	1980	1980
ETE	1975	1986
ETEA	1977	1977
GANZ Hungary	1967	1967
GCE	1971	1993
GEC Alstom	1997	1997
HACKBRIDGE-HEWTTIC & EASUN (HHE)	1960	1992
HBB	1968	1972

Table 1 PCB contaminated transformers by Brand and production year in India

Transformer Brand Name	Produced from	Produced until
HEL	1968	1968
HHE Madras	1968	1968
Hind Rectifiers	1961	1961
Hindustan Electric	1964	1976
IMP	1998	1998
IND Coil	1979	1985
Indian	1973	1973
INDOTECH	2006	2006
Johnson & Philips	1955	1966
Johnson Elect Co	1972	1972
KAVIKA	N.A.	N.A.
KEC	1984	1984
KEC India	1977	1984
KEL	1986	1986
Kirloskar	1962	1962
KIRLOSKAR/INDIA	1983	1984
M/S Bharat	1972	1972
M/s Bharat Bijlee	1983	1996
M/s BHEL	1984	1985
M/S BHEL Bhopal	1989	1989
M/s NGEF	1983	1990
M/s TELK	1984	1984
Marsons Electricals	N.A.	N.A.
MERLIN GERIN ELECTRO/FRANCE	1980	1980
Metro Pollition Vickers, England	1932	1937
Mitsubishi	1962	1962
National elec Ind	1967	1967
Nelson Electricals Bombay	1981	1981
NGEF	1973	1984
NGEF Licence AEG,India	1974	1974
NGEF/INDIA	1991	1991
P&CT L,	1971	1971
PARCS	1980	1980
Power Lite	1979	1980
Radio & Electricals Ltd	1969	1969
RUSSIAN	1957	1981
Star Delta Electrical	1977	1977
T&R	2004	2004
TELK	1970	1980

Table 1 PCB contaminated transformers by Brand and production year in India

Transformer Brand Name	Produced from	Produced until
TELK/INDIA	1983	1989
Thane Electric Supply	1981	1981
The National Electrical Industries Ltd, Bombay	1975	1975
TR & SWITCH GEAR Ltd	1962	1977
Volt Amp	1972	1984
VOLTAS	1977	1984

4.3 Ministry of Environment: Notification

Ministry of Environment and Forests (MOEF) has notified the draft regulations pertaining to Hazardous Materials in which PCB and PCT's are also included. Actual notification deals as under.

[To be published in the Gazette of India, Extraordinary, Part-II, Section-3, Sub-section (ii) dated the 28 September 2007] Government of India, MINISTRY OF ENVIRONMENT AND FORESTS, New Delhi, the 28 September 2007, S.O. 1676 (E) WHEREAS by notification of the Government of India in the Ministry of Environment and Forests Hazardous Wastes (Management and Handling)

Rules, 1989, vide, S.O. 594(E) dated the 28th July 1989 as amended from time to time imposed restrictions and prescribed procedures for management, handling and disposal of hazardous wastes.

AND WHEREAS, the Central Government considers it necessary in the public interest and to address sustainable development concerns, to review the rules published earlier, to enable the recovery and/or reuse of useful materials from hazardous materials generated from a process, thereby, reducing the hazardous wastes destined for final disposal and to ensure the environmentally sound management of all hazardous materials.

DRAFT RULES

AND WHERESAS the following draft rules, which the Central Government proposes to make in exercise of the powers conferred in clause (c) and (d) of sub-section (2) of sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the Hazardous Wastes (Management and Handling) Rules, 1989, is hereby published for information of the public likely to be affected thereby; and notice is hereby given that the said draft rules will be taken into consideration by the Central Government after expiry of a period of sixty days form the date of publication of this notification in the Official Gazette; The objections or suggestions which may be received from any person in respect of the said draft rules before the period specified will be taken into consideration by the Central Government. Any person desirous of making any objection or suggestion with

respect to the said draft rules may forward the same within the period so specified to the Secretary, Ministry of Environment and Forests, Paryavaran Bhawan, Central Government Offices Complex, New Delhi-110003.

Schedule I of the notification limits the values of Hazardous material to 1-50 ppm

SCHEDULE - I

[See rule 3(k), (l) & (za)]

Hazardous materials are materials possessing any one or more of the following characteristics:

(i) **Toxicity**

Materials having the following values of acute toxicity and which, owing to their physical and chemical properties, are capable of producing major risk to human health and other living organisms.

SNo.	Degree of Toxicity	Medium lethal dose by the oral route (oral toxicity) LD_{50} (mg/kg) body weight of test animals	Medium lethal dose by the dermal route (dermal toxicity) LD_{50} (mg/kg) body weight of test animals	Medium lethal concentration by inhalation route (four hours) LD_{50} (mg/kg) body weight of test animals
1.	Extremely toxic	1-50	1-200	0.1-0.5
2.	Highly toxic	51-500	201-2000	0.5-2.0

Poly Chlorinated Biphenyls have been classified under Schedule II under the category of Halogenated Aromatic groups at A16.

SCHEDULE – II

[See rule 3(k) & (l)]

List of hazardous materials Constituents with Concentration Limits*
[Hazardous materials having constituents of or contaminated with any of the following]

Class A

Concentration limit: ≥ 50 mg/kg

A1	Antimony and antimony compounds
A2	Arsenic and arsenic compounds
A3	Beryllium and beryllium compounds
A4	Cadmium and cadmium compounds
A5	Chromium (VI) compounds
A6	Mercury and mercury compounds
A7	Selenium and selenium compounds
A8	Tellurium and tellurium compounds
A9	Thallium and thallium compounds
A10	Inorganic cyanide compounds
A11	Metal carbonyls
A12	Napthalene
A13	Anthracene
A14	Phenanthrene
A15	Chrysene, benzo (a) anthracene, fluoranthene, benzo (a) pyrene, benzo (K) fluoranthene, indeno (1, 2, 3-cd) pyrene and benzo (ghi) perylene
A16	halogenated compounds of aromatic rings, e.g. polychlorinated biphenyls, polychloroterphenyls and their derivatives
A17	Halogenated aromatic compounds
A18	Benzene
A19	Organo-chlorine pesticides
A20	Organo-tin Compounds

Hazardous material related information and authorities to be contacted as per the notification are as under.

Schedule - VI

[*See* rule 12]

LIST OF AUTHORITIES AND CORRESPONDING DUTIES

S.No.	Authority	Corresponding Duties
1.	Ministry of Environment and Forests under the Environment (Protection) Act, 1986	(i) Identification of hazardous materials/wastes (ii) Permission to exporters (iii) Permission to importers (iv) Permission for transit of hazardous materials/wastes through India
2.	Central Pollution Control Board constituted under the Water (Prevention and Control of Pollution) Act, 1974	(i) Co-ordination of activities of State Pollution Control Boards/Committees (ii) Conduct training courses for authorities dealing with management of hazardous wastes (iii) Recommend standards and specifications for treatment and disposal of wastes and leachates Recommend procedures for characterization of hazardous wastes. (iv) Sector specific documentation to identify waste streams(s) for inclusion in Hazardous materials/wastes Rules (v) Prepare guidelines to prevent/reduce/minimize the generation and handling of hazardous wastes (vi) Registration and renewal of registration of Recyclers/Re-refiners of non-ferrous metal wastes and used oil/waste oil (vii)Any other function under Rules delegated by the Ministry of Environment and Forests
3.	State Government/Union Territory Government/ Administration	(i) Identification of site(s) for common treatment, storage and disposal facility (TSDF) (ii) Assess EIA reports and convey the decision of approval of site or otherwise (iii) Acquire the site or inform operator of facility or occupier or association of occupiers to acquire the site (iv) Notification of sites (v) Publish periodically an inventory of all disposal sites in the State/Union territory
4.	State Pollution Control Boards or Pollution Control Committees constituted under the Water (Prevention and Control of Pollution) Act, 1974	(i) Inventorisation of hazardous materials/wastes (ii) Grant and renewal of authorisation (iii) Monitoring of compliance of various provisions and conditions of authorisation including exports and imports (iv) Issue of public notice and conduct public hearing (v) Examining the applications for imports submitted by the importers and forwarding the same to Ministry of Environment and Forests (vi) Implementation of programmes to prevent/reduce/minimise the generation of hazardous materials/wastes (vii) Action against violations of Hazardous materials/wastes (Management and Handling) Rules, 1989

Various formats for Transboundary Movement, Form 1, Form 2, Formats for recyclers, importers and other necessary documentation is included in the notification and copies are enclosed for reference.

FORM - 1

[See rules 8, 9 & 10]

Transboundary Movement – NOTIFICATION DOCUMENT

1. Exporter (Name & Address):		3. Notification concerning (1):- Notification	N2
		A. (i) Single movement	Recovery operation
Contact person: Tel.:		(ii) General notification (multiple movements)	
Fax/Telex:			
Reason for export:		C. Pre-authorized recovery facility - Yes/No	
2. Importer/Recyler (Name & Address):		4. Total intended number of shipments:	5. Estimated quantity (3):
			Kg
			Liters
Contact person: Tel.:		6. Intended date(s) or period of time for shipment(s)	
Fax/Telex:		9. Method(s) of recycling(4)	
		R Code	
		Technology employed	
7. Intended carrier(s) (name, address(2):		10. Means of transport (4):	
Contact person: Tel.:		11. Packaging type(s) (4):	
Fax/Telex:			
8. Waste generator (s)(Name, address) (2):		12. (i) Designation and complete chemical composition o f waste(attach details)	
Contact Person Tel.:		(it) Special handling requirements	
Fax/Telex			
Site of generation & Process:		13. Physical characteristics (4):	
14. Material identification code			16. Y-number (4):
Basel No:	OECD No.:		
UN No. :	ITC (HS)		17. H-number (4):
Customs code (H.S.):	Other (specify): I		
15, OECD classification (1): amber. E]	Red [ ] and number:	18.(i) UN identification N[2]	(ii) UN class (4):

Other [ ]		UN shipping name:	
* (attach details)			
19. Concerned states, code number of competent authorities, and specific points of entry and exit:			
State of export	States of transit State of import		
20. Customs Aces of entry and/or departure		2 1. Exporter's/Generator's declaration:	
Entry:		I certify that the information is complete and	
		Correct to my best knowledge. I also certify that	
Departure		Legal y-enforceable written contractual obligations	
		have been entered into and that any applicable	
		insurance or other financial guarantees are or shall be	
		in force covering the transboundary movement.	
22. Number of annexes attached		Name: Signature:	
		Date:	
FOR USE BY COMPETENT AUTHORITIES			
23. To be completed by competent authority of- import		24. Consent to the movement provided by the competent authority	
Notification received on:	- transit (Basel)	of(country):	
Acknowledgement sent on:		Consent given on: Consent expires on:	
		Specific conditions (1): [ ] Yes, see block 24 overleaf annex	
Name of competent authority, stamp		[ ] No	
And/or signature:		Name of competent authority,	
		Stamp and/or signature:	

(1) Enter X in appropriate box (2) Attach list if more than one (3) Attach detailed list of multiple shipment (4) See codes on the reverse

List of abbreviations used in the Movement Document

RECOVERY OPERATIONS (Block 9)
R I Use as a fuel (other than in direct incineration) or other means to generate energy
R2 Solvent reclamation/regenerationR3 Recycling/reclamation of organic substances which are not used as solvents
R4 Recycling/reclamation of metals and metal compounds
R5 Recycling/reclamation *of* other inorganic materials
R6 Regeneration *of* acids or bases
R7 Recovery of components used for pollution abatement
R8 Recovery *of* components from catalysts
R9 Used oil re-refining or other reuses of previously used oil
RIO Land treatment resulting in benefit to agriculture or ecological improvement
R11 Uses of residual materials obtained from any of the operations numbered R I to 10
R12 Exchange of wastes for submission to any of the operations numbered RI to R I I
R13 Accumulation of material intended for any operation numbered RI to RI 2

MEANS OF TRANSPORT	PACKAGING TYPES (Block 16)	H NUMBER AND LIN CLASS (Block 17)
(Block 8-10)		
R = Road	1. Drum	LIN Class H No. Designation
	2. Wooden barrel	
T = Train/Rail	3. Jerrican	I H I Explosive
	4. Box	3 H3 Inflammable liquids
S = Sea	5. Bag	4.1 H4.1 Inflammable solids
	6. Composite packaging	4.2 H4.2 Substances or wastes liable to Air

A= Air	7. Pressure receptacle	spontaneous combustion
	8. Bulk	4.3 H4.3 Substances or wastes which, in W
W= Inland Waterways	9. Other (specify)	contact with water emit
		inflammable gases
PHYSICAL CHARACTERISTICS (Block 12)		5.1 H5.1 Oxidizing
		5.2 H5.2 Organic peroxides
1. Powdery/powder 5. Liquid		6.1 H6.1 Poisanous (acute)
2. Solid 6. Gaseous		6.2 H6.2 Infectious substances
3. Viscous/paste 7.Other (specify)		8 H8 Corrosives
4. **Sludge**		9 H10 Liberation *of* toxic gases in
		Contact with air or water
		9 H11 Toxic (delayed or chronic)
		9 H12 Ecotoxic
		9 H13 Capable, by any means, after disposal *of* yielding another material e.g. leachate, which
		Possesses any *of* the characteristics listed above

FOR USE BY CUSTOMS OFFICES				
2~. COUNTRY OF EXPORT/DISPATCH OR	27. STAMPS OF CUSTOMS OFFICES OF TRANSIT COUNTRIES			
CUSTOMS OFFICE OF EIXIT	Name *of* country:		Name *of* Country:	
The waste described overleaf has left the country				
on:	Entry	Departure	Entry	Departure
Stamp:				

Signature:				
26. COUNTRY OF IMPORT/DESTINATION	Name of Country		Name of Country	
described overleaf has entered the				
The wase country on:				
	Entry	Departure	Entry	Departure
Stamp:				
Signature:				

FORM - 2

[See rules 8,9 & 10]

Transboundary Movement - MOVEMENT DOCUMENT

I.A Exporter (name, address):		3. Corresponding to	4. Serial Number
		Notification N'	of shipment:
Contact person: Tel.:		Movement subject of(2) single notification	
Fax/Telex:			general notification
ii) Waste Generator (name, address)(1):		8. Disposer (name, address):	
Contact person Tel		Contact person	Tel.:
Fax/Telex:			Fax/Telex:
Site of' generation:		Actual site of disposal:	
2. Importer recycler (name, address):		9. Method(s) of recovery (4):	
		R code:	
		Technology employed:	
Contact person Tel.:			
Fax/Telex:		*(Attach details if necessary	
5. Ist Carrier (Name, address):	6. 2"d Carrier (name, address)(4):		7. Last Carrier (name, address):
Registration N2:	Registration N':		Registration N2:
lei: Fax/Telex: Tel.:	Fax/Telex: Tel.:		Fax/Telex:
8. Identity of means of transport (3)	9. Identity of means of transport (3)		10. Identity of means of transport (3)
Date of transfer:	Date of transfer:		Date of transfer:

Signature of Carrier's representative	Signature of Carrier's representative	Signature of Carrier's representative
11. Designation and chemical composition of the waste		12. Physical characteristics (3):
		13. Actual quantity
		Kg. Liter
14. Waste identification code		16. Packaging
		Type (3): Number:
Bales No: OECD No.		
	UN No. : ITC (HS)	17. UN Classification:
Customs code (H.S.):	Other (specify):	UN shipping name:
		LIN Identification No.:
15. OECD Classification (2): amber	Red EJ and Number:	UN class (3):
Other		H Number (3): Y No.:
	(attach details)	
18. Special handling requirements	20. Exporter's declaration,	
	I certify that the information in blocks I to 19 above is complete and correct to my best knowledge. I also certify that legally-enforceable written contractual obligations have been entered into, that any applicable insurance or other financial guarantees are in force covering the transboundary movement and that all necessary authorizations have been received from the competent authorities of the States concerned.	
	Date :	Signature:
19. Actual date of shipment	Name:	

TO BE COMPLETED BV IMPORTER/RECYCLER		
2 1. Shipment received by Importer/Recy1cer		23. 1 certify that the Recycling of the
Quantity received:	Kg. Liters accepted	waste described above has been
Date :		completed.
Name: Signature: rejected (x)		
		Date:
		Name:
22. Shipment received at Recycler		
Quantity received:	Kg. Liters accepted 0	Signature & stamp-
Date:	C3	
Name Signature:	rejected (x)	
Approximate date of recycler		
Method of recycling		

(1) Attach list, if more than one (2) Enter X in appropriate box (3) See codes on the reverse (x) Immediately contact Competent Authority.

(4) If more than three carriers, attach information as required in blocks 6 and 11.

List of abbreviations used in the notification

RECOVERY OPERATIONS (Block 9)	
R1 Use as a fuel (other than in direct incineration) or other means to generate energy	
R2 Solvent reclamation/regeneration	
R3 Recycling/reclamation of organic substances Which are not used as solvents	
R4 Recycling/reclamation of metals and metal compounds	

R5 Recycling/reclamation of other inorganic materials	
R6 Regeneration of acids or bases R7 Recovery of components used for pollution abatement R8 Recovery of components from catalysts R9 Used oil re-refining or other reuses of previously used oil	
R10 Land treatment resulting in benefit to agriculture w ecological improvement	
R11 Uses of residual materials obtained from any of the operations numbered RI to RIO	
R12 Exchange of wastes for submission to any of the operations numbered RI to RI I	
R13 Accumulation of material intended for any operation numbered RI to PL12	

MEANS OF TRANSPORT (Block 10)	PACKAGING TYPES (Block 11)	H NUMBER (Block 17) & UN CLASS (Block 18)	
R = Road	1. Drum	UN Class H Number	Designation
	2. Wooden barrel		
T = Train/Rail	3. Jerrican	I H I	Explosive
	4. Box	3 143	Inflammable Liquids
S = Sea	5. Bag	4.1 H4.1	Inflammable solids
	6. Composite packaging	4.2 H4.2	Substances or wastes liable
A Air	7. Pressure **receptacle**		to spontaneous combustion-
	8. Bulk	4.3 H4.3	Substances or wastes
W Inland Waterways	9. Other (specify)		which, in contact with
			Water, emit inflammable
			Gases
		5.1 H5.1	Oxidizing
PHYSICL CHARACTERISTICS (Block 13)		5.2 H5.2	Organic peroxides

	6.1 H6.1	Poisonous (acute)
1. Powdery/ powder 7. Other (specify)	6.2 H6.2	Infectious substances
2. Solid	8 H8	Corrosives
3. Viscaus/paste	9 HIO	Liberation of toxic gases in
4. Sludgry		contact with air or water
5. Liquid	9 HII	Toxic (delayed or hronic).
6. Gaseous	9 H12	Ecotoxic
	9 H13	Capable by any
		means after
		disposal of yielding
		another material e.g.
		leachate, which
		possesses any of the
		characteristics listed
		above.
Y numbers (block 16) refer to categories of waste listed in Annex I and II of the Basel Convention, as *well as more detailed information can be found in* anlinstruction Manual *available from the* *Secretariat of the Basel Convention. ,*		
25. SPECIFIC CONDITIONS ON CONSENTING TO THE MOVEMENT		

FORM – 3

[See rule 10]

Application for importing hazardous materials for recycling

From: .....
To : **TO BE MAILED BY IMPORTER**

The Member Secretary,
State Pollution Control Board
_____

Sir,

I/we apply for 'No Objection' under sub-rule 5.3 of rule 5 of the Hazardous Materials Management, Handling and Transboundary Movement Rules, 2007, for importing hazardous materials for recycling.

FOR OFFICE USE ONLY

1. Code No. :
2. Whether the unit is situated in a critically polluted area as identified by the Ministry of Environment and Forests :

TO BE FILLED IN BY APPLICANT

PART 1 :

(To be filled by Exporter or a person authorized by the exporter)

1. Name and Address of the Exporter
2. Details of material (hazardous materials in the form of raw material) to be exported.

S.No.	Particulars	Six digit Code No.*	Concentration(s) expected	Quantity	Whether any special handling requirement?

The material permitted shall be fully insured for transit as well as for any accidental occurrence and its cleanup operation.

4. The exported material shall be taken back, if it creates a genuine Environmental hazard or shall take all such measures to treat and dispose in an environmentally benign manner upto the satisfaction of concerned SPCB. All such costs involved in such operation shall be borne by Exporter and/or Importer.

PART 2:

(To be filled in by Importer)

Name and Address :

1. Details of material to be imported

S.No.	Particulars	Six digit Code No.*	Concentration(s) expected	Quantity	Whether any special handling requirement?

* (Here enter as reference nomenclature, the equivalent six digit code no. from European Waste Catalogue EWC, issued pursuant to the Article 1(a) of Council Directive 75/442/EEC on waste or its equivalent as the case may be)

Whether you have received such imported hazardous materials in the form of raw materials in the past and if yes give details

S.No.	Name of Material	Country of Export	Year	Quantity in tonnes

Whether the importer has :

5. Adequate facility to handle imported hazardous waste in the form of his raw material **if yes furnish details.** Yes / No

a. Adequate facility to handle the hazardous wastes generated by the use of such imported hazardous materials in the form of his raw material Yes / No
b. Requisite laboratory testing facility Yes / No

6. Break-up of the imported material

    a. The total quantity applied for ..... T
    b. Out of (a) above, how much quantity after initial in-situ purification, will be available as raw material ..... T
    c. Out of (b) above, how much quantity will be converted to be the useful product or co-product ..... T

7. Means of Transport (Road, Rail, inland waterway, sea, air) including country of export, transit and import, also point of entry and exit where these have been designated.

8. Information on special handling requirements including emergency provision in case of accident.

(Attach separate sheet)

9. Undertaking :

I hereby solemnly undertake that :

1. the full consignment shall be cleared in one lot by arranging authorised transporter under my supervision with due prior intimation to the Board, District Collector and Police station and the imported material shall be admitted in an enclosure especially provided in the premises.
2. The material permitted shall be fully insured for transit as well as for any accidental occurrence and its clean-up operation.
3. The record of consumption and fate of the imported material shall be monitored and report sent to the Board every fortnight.
4. At every step of consumption of 25, 50, 75 and 100% of the imported material, the situation in the store shall be shown to the Board authority at our cost.
5. The hazardous wastes which gets generated in our premises by the use of imported hazardous wastes in the form of raw material, shall be treated and disposed of and only as per conditions of authorisation.
6. I/We agree to share the cost and joint to exporter in undertaking the measures as per undertaking given by Exporter at Part A column No.12(3) of this Form 6.<
7. I am aware that there are significant penalties for submitting a false certificate/ undertaking/ disobedience of the rules and lawful orders including the possibility of fine and imprisonment.

Exporter

Date ..... Signature

Place ..... Designation

Importer

Date ..... Signature

Place ..... Designation

FORM - 4

[See rule 10]

(Format for maintaining records of hazardous material imported and exported)

1. Name and address of the importer:
2. Date and reference number of issuance of permission to import hazardous material:
3. Description of hazardous material:

    a. Physical form:
    b. Chemical form:
    c. Total volume and weight (in kilograms):
    d. Test report as per Rule 13(6):

4. Description of storage, treatment and reuse of hazardous material:

    a. Date:
    b. Method of Storage:
    c. Method of treatment and reuse (give details):

FORM - 5

[See rules 13 & 14]

Form of application for Grant of license of Industrial Units Possessing Environmentally Sound Management Facilities for Recycling

{To be submitted to the Central Pollution Control Board in triplicate}

1	Name and Address of the unit		
2	Name of the occupier or owner of the unit with designation, Tel / Fax		
3	Date of commissioning of the unit		
4.	No. of workers (including contract labourers)		
5	Consent Validity	Air (Prevention & Control of Pollution) Act, 1981 Valid up to..... Water (Prevention & Control of Pollution) Act, 1974 Valid up to.....	
6.	Product Manufactured during the last three years (Tonnes / Year)	Name a) b)	Quantity a) b)
7.	Raw material consumption during last three years (Tonnes/ year)	Name a) b)	Quantity a) b)
8.	Manufacturing Process	Please attach manufacturing process flow diagram for each product (s)	
9.	Water Consumption	Industrial .....m3/ day Domestic.....m3/day	
10	Water Cess paid up to (date)	.....	
11	Waste water generation as per consent.....m^3/day	Industrial Domestic Actual.....m^3/day (avg of last 3 months)	
12	Waste water treatment (provide flow diagram of the treatment scheme)	Industrial Domestic	
13	Waste water discharge	Quantity..... m^3/day Location..... Analysis of treated waste water pH, BOD, COD, SS, O&G Any other	
14.	Air Pollution Control a. Flow diagram for emission control system (s) installed for each process unit, utilities etc. b. Details of facilities provided control of fugitive emission due to material handling, process, utilities etc. c. Fuel consumption d. Stack emission monitoring results e. Ambient air quality	Name..... quantity .....D/M Stack Emission.....mg/Nm Attach to PM SO_2 Metals (pb. Zn.) Location parameter mg/m SO_2, NO_x ,SPM, Pb, any others	

15.	Hazardous waste management a. Waste generation b. Details on collection , treatment and transport c. Disposal (i) Please attach Details of the disposal facilities (ii) Please attach analysis report of characterisation of hazardous waste generated (including leachate test if applicable)	S.No. Name Category Quantity (last 3 years)
17	Details of hazardous material proposed to be acquired through sale/negotiation/ contract or import as the case may be for use as raw material.	1. Name 2. Quantity required per year 3. Waste listing & No. in Annex VIII (List A)/ Annex IX (List B) of Basel Convention 4. Hazard Characteristic as per Annex III of BC
18	Occupational safety and Health aspects	Please provide details of facilities provided
19	Remarks (i) whether industry has provided adequate pollution control system/ equipment to meet the standards of emission/effluent. (iii) whether HW collection and Treatment , Storage and Disposal Facility (TSDF) are operating satisfactorily (iv) Whether conditions exists or likely to exists of the material being handled /processed of posing immediate or delayed adverse impacts on the Environment. (V) Whether conditions exists or is likely to exists of the material being handled / processed by any means capable of yielding another material eg , leachate which may possess eco-toxicity.	Yes / No. Yes / No Yes / No Yes / No Yes / No
20	Any other Information i) ii) iii)	
21	List of enclosures as per rule	

Signature of applicant

Designation:

Date:.....

Place:.....

52

FORM – 6

[see rules 14]

Form for Filing Returns and Records by Recyclers

[To be submitted by recyclers to State Pollution Control Board/Committee by 30th June of every year for the preceding period April to March]

1.	Name and address of the generator/recycler	
2.	Name of the authorized person and full address with telephone and fax number	
3.	Installed annual capacity to recycle hazardous materials or dispose hazardous waste (in MTA)	
4.	Quantity hazardous materials (in MTA) purchased/sold (i) Source	
5.	Quantity of hazardous materials processed	.
6.	Quantity and type of material recovered (in MTA)	(i) (ii)
7.	Quantity of recyclable materials sent back to the manufacturers* and others#	(i)
8.	Quantity of hazardous waste generated (in MTA) and its disposal methods.	(i) (ii)

* delete whichever is not applicable

\# enclose list of other agencies

Signature:

Designation:

Place : .....

Date : .....

FORM – 7

[See rule 17]

Marking of Hazardous Material and Waste Containers

HAZARDOUS MATERIAL / WASTE *

Handle with Care

Waste Category No	Compatible Group .....
Total Quantity	Date of Storage
Contents and State of the Waste:	
Sender's Name & Address	Receiver's Name & Address
Phone	Phone .....
Telefax No	Telefax No .....
Telex No	Telex No .....
Contact Person	Contact Person .....
In case of emergency please contact	

Note :

1. Background colour of lab I fluorescent yellow.

2. The words 'HAZARDOUS MATERIALS / WASTES' & 'HANDLE WITH CARE' to be prominent and written in red

3. Label should be of non-washable material.

* delete which ever is not applicable

FORM-8

[See rule 19]

Transport Emergency (TREM) Card

1. Characteristics of hazardous material :

S.No.	Type of Waste	Physical Properties/	Chemical Constituents	Exposure Hazards	First Aid Requirements

2. Procedure to be followed in case of fire :

3. Procedure to be followed in case of spill age/accident/explosion :

4. For expert services, please contact :

i) Name & Address:

ii) Telephone No.:

(Name and Signature of Occupier)

FORM – 9

[See rule 20]

<table>
<tr><th colspan="6">Hazardous Materials/Waste Manifest</th></tr>
<tr><td colspan="3">1. Occupier's Name & Mailing Address:

(including Phone No.)</td><td colspan="3">2. Occupier's Registration No.

3. Manifest Document No.</td></tr>
<tr><td colspan="2">4. Transporter's Name & Address:

(including Phone No.)</td><td>5. Type of Vehicle:

Truck

Tanker

Special Vehicle</td><td colspan="3">.6. Transporter's Registration No.

7. Vehicle Registration No.</td></tr>
<tr><td colspan="3">8. Desiqnated Facility Name &Site Address:</td><td colspan="3">9. Facility's Reqistration No.</td></tr>
<tr><td colspan="3"></td><td colspan="3">10. Facility's Phone</td></tr>
<tr><td colspan="3">11. Material Description:</td><td colspan="3">12. Total Quantity</td></tr>
<tr><td colspan="3"></td><td>m^3</td><td colspan="2">t</td></tr>
<tr><td colspan="3"></td><td colspan="3">13. Consistency

Solid Oily

Semi-Solid Tarry

Sludge Slurry</td></tr>
<tr><td>14. Transport Description of Waste</td><td colspan="2">15. Containers</td><td>16. Total Quantity</td><td>17. Unit Wt/Vol.</td><td>18. Waste Categqory</td></tr>
<tr><td></td><td>No.</td><td>Type</td><td></td><td></td><td>No.</td></tr>
<tr><td colspan="6">18. Special Handlinq Instructions & Additional Information</td></tr>
<tr><td colspan="6">20. OCCUPIER'S CERTIFICATE: I hereby declare that the contents of the consignment are fully and accurately described above by proper shipping name and are categorised, packed, marked, and labeled, and arc in all respects in proper condition for transport by road accordinq to applicable national qovernment requlations.</td></tr>
<tr><td colspan="3">Typed Name & Stamp Signature Month Day Year</td><td colspan="3">Month/Day/Year</td></tr>
<tr><td colspan="6">2 1. 'Transporter Acknowledqement of Receipt of Materials</td></tr>
<tr><td colspan="6">Typed Name & Stamp Signature Month Day Year</td></tr>
<tr><td colspan="6">22. Discrepancy Note Spacep</td></tr>
<tr><td colspan="6">23. Facility Owner or Operator's Certification of Receipt of Hazardous Waste</td></tr>
<tr><td colspan="2">Typed Name & Stamp Signature Month Day Year</td><td colspan="2">Signature</td><td colspan="2">Month/Day/Year</td></tr>
</table>

FORM – 10

[see rule 21]

Form for Filing Returns and Records by Occupier/Operator of Facility

[To be submitted by occupier/operator of disposal facility to State Pollution Control Board/ Committee by 30th June of every year for the preceding period April to March]

1.	Name and address of the generator/ operator of facility				
2.	Name of the authorised person and full address with telephone and fax number				
3.	Description of hazardous materials/waste	Physical form with description		Chemical form	
4.	Quantity hazardous materials/ wastes (in MTA)				
5.	Description of Storage				
6.	Description of Treatment				
7.	Details of transportation	Name & address of consignee	Mode Of packing	Mode of transport ation	Date of transport ation
8.	Details of disposal of hazardous waste	Name & address of Operator	Disposal Site	Disposal Method	Date of disposal
9.	Environmental surveillance Data (Date of measurement)	Ground water analysis	Soil Analysis	Air analysis	Other analysis
9.	Quantity of recyclable materials sent back to the manufacturers* and others#	(ii)			

* delete whichever is not applicable

\# enclose list of other agencies

Signature:

Designation:

Place : .....

Date : .....

FORM – 11

[see rule 23]

Application for filing appeal against order passed by Central Pollution Control Board/State Pollution Control Board/Pollution Control Committee of the Union Territories b

1. Name and address of the person making the appeal.
2. Number, date of order and address of the authority which passed the order, against which appeal is being made (certified copy of the order to be attached) .
3. Ground on which the appeal is being made.
4. Relief sought for.
5. List of enclosures other than the order referred in para 2 against which the appeal is being filed.

Signature.....

Date: Name and address .....

[F No. 23-17/2006-HSMD]

(R.K.Vaish)

Joint Secretary to Government of India

Note- Principal rules were published in the Gazette of India vide S.O. 549(E), dated 28th July,1989 and subsequently amended vide S.O. 24(E), dated 6th January, 2000, S.O. 593(E), dated 20th May, 2003, S.O. 826(E), dated 19th July, 2004 S.O. 897(E), dated 6th August, 2004 and S.O. 914(E), dated 12th August, 2004.

5.0 International Draft regulations pertaining to PCBs

5.1 Details of Articles on the draft regulations in Stockholm Convention

Stockholm Convention Draft regulations on the use and destruction of PCBs are given here by way of example. These have been based on current regulations in several developed countries and are tailored to the specific PCB-management conditions, at the various stages of the PCB life-cycle, in a "pilot" developing country. The draft is supplemented by a list of comments pertaining to each article and explaining its purpose

Article I definitions

(a) "**PCBs**": "Wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (**PCB),** polychlorinated terphenyls **(PCT),** polychlorinated naphthalene **(PCN)** or polybrominated biphenyl (**PBB),** or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more."

(Category **A 3180** of classification A of the Basel Convention)
Polychlorinated biphenyls,
Polychlorinated terphenyls
All mixtures in which the total volume of the aforementioned substances exceeds 0.005% (50 ppm) in weight:

(b) "**PCB-containing appliances":** all appliances containing or having contained PCBs (transformers, capacitors, receptacles containing residual stocks, etc.) and which have not been decontaminated. Appliances capable of containing PCBs are considered to

(c) Used PCB's all PCB's are considered to be wastes

(d) **"Owner":** the person, who has physical possession of or moral responsibility for PCBs, used PCBs and/or appliances containing PCBs;

(e) **"decontamination":** the entire set of operations which enable appliances, objects, materials or liquids contaminated by PCBs to be reused, recycled or disposed of in secure facilities which can also include substitution, referring to the entire process in which PCBs are replaced by similar liquids that do not contain PCBs;

(f) **"disposal":** This refers to the processing of PCB-containing wastes, all stages of the destruction of PCB molecules, the decontamination of PCB-containing appliances, the replacing of PCB fluid in the appliances referred to in article 4 .1, the decontamination of other PCB-containing materials and objects and the recovery of PCB fluids;

(g) **"Retrofilling":** The replacing of PCB-containing dielectrics with non PCB-containing dielectrics.

Article 2: Implementation

The purpose of the present decree is to regulate the conditions surrounding the declaration, operation, use, handling, transport, storage and disposal of PCBs as defined in article 1 of the present decree

Article 3: Import and transfer of PCBs

On publication of the present decree in the official newspaper of [country], all import, manufacture, installation, purchase, sale or transfer, whether free or against a charge, of PCBs, PCB-containing electrical equipment or materials contaminated by PCBs shall be prohibited. The seller of a building containing a PCB appliance is subject to declaration in terms of the relevant legislation on classified installations must inform the buyer accordingly. Any person infringing the above regulations will be subject to penalties set out in act n° […] of [date], providing the Environmental Code.

Article 4: Declaration of PCBs

PCB owners, as defined in article 1, must declare such ownership to the technical section of the Ministry of the Environment, using the form provided in annex I to the present decree. This declaration must be made within a period of six (6) months from the publication of the present decree in the official newspaper of … [country]. All owners of appliances must inform the appropriate authorities of the quantities they contain and of any change in these quantities. All appliances declared must be labelled. The labelling, a description of which is provided in annex III to the present decree, must clearly state the presence of PCBs and the risks that could be caused by fire. The same type of labelling should also be used on the doors of the premises

Companies providing facilities for the storage, containment or disposal of PCBs must keep a register detailing the quantity, origin, nature and PCB content of the used PCBs delivered to them. This information is then transmitted to the appropriate authorities. Appliances that were retro filled before the present decree came into force must be declared as PCBs if PCB screening was not carried out on the dielectrics. Appliances whose dielectrics have not been marked on their identification disks and which have not undergone PCB screening must be declared as PCBs.

Article 5: Retrofilling of existing installations

All equipment in current use containing PCBs as defined in article 1 of the present decree is obliged to be retrofitted according to the methods defined in annex II.

Article 6: Repairs and Retrofilling

Repairs to PCB transformers in use, as defined in article 1 of the present decree, are authorized subject to the technical conditions defined in annex IV. Retrofilling of PCB transformers in use is forbidden.

Article 7: Technical inspection

The electrical equipment referred to in article 1 is subject to annual inspection performed by an authorized company and consisting of: Visual inspection, at minimum, of the water tightness or absence of leakage of the appliances and retention units; Check of the dielectric level; Check for the presence of inflammable liquids or solids on the same premises. This inspection must be carried out by an authorized company and the results forwarded to the classified installations inspectorate. The first inspection must be carried out no later than 12 months after the entry into force of the present decree. The authorized company will use the results of the first inspection to decide on the subsequent timetable of inspections. The technical visit reports must be forwarded to the Ministry of the Environment.

Article 8: Accidents and pollution

In the event of an accident (breakage, explosion, fire, etc.), the owner must immediately inform the appropriate services, which will explain the protective measures to be taken, including the initial steps to minimize the consequences of the accident. The inspector may require the conduct of the necessary analyses to determine the extent of PCB-contamination of the installation and the environment, or, where appropriate, contamination by decomposed products. In the light of the results of these analyses the technical services of the Ministry of the Environment may require the owner to carry out whatever work is necessary for the decontamination of the areas concerned. Further specification of these analyses and operations will be provided (by ministerial order) where justified by the scale of the accident. The operator must keep the inspectorate informed as to the progress of the work and other measures required. Rubble, earth and other contaminated materials must be disposed of in approved premises. The conditions under which action is to be taken in the event of PCB pollution are defined in annex VI.

Article 13: Transboundary movements of PCBs

The import of the PCBs defined in article 1 is prohibited. Equipment that could potentially contain PCBs may only be imported subject to the results of an analysis to be carried out by an independent, duly accredited laboratory at the expense of the exporter. This analysis must show a PCB content of less than 3 ppm. Transit operations may only be authorized if there is no other viable solution that does not involve a risk of pollution.PCB exports are only authorized in operations involving the final treatment of PCBs and the decontamination of PCB-containing equipment. Exports must be carried out in compliance with the provisions of the Basel Convention on the Transboundary Movements of Hazardous Wastes and ratified by … [country].

Article 14: PCB analyses

The Ministry of the Environment shall establish the benchmark methods to be used in determining the PCB content of contaminated materials. Measures implemented prior to the determination of such reference methods remain valid.

Article 15:

The present decree will be published in the **Official Gazette** of [country]…….
Done at……. on the …….

5.2 Comments on the draft regulations

Article 1: It is important to work out an exact definition of PCBs for those products that are not 100% PCB but have a greater than 50 ppm contamination level. This applies, for example, to mineral oil transformers with a dielectric content greater than 50 ppm.

Article 3: This fundamental article regulates commercial transactions, including those at no charge, of PCB-containing equipment. The example given proposes an import ban on PCB containing equipment. The article suggests retaliatory methods to be used against those contravening the terms of the said article.

Article 4: This article obliges all PCB owners to declare themselves to the appropriate authorities to ensure the traceability of all PCB installations in the country in question and to implement a projected elimination plan ending in 2013.

Article 5: The purpose of retrofitting existing installations is to prevent pollution that can be caused by active transformers.

Catch basin	To prevent the release of liquid PCBs
Fire-wall	To limit the dispersal of toxic substances
Disconnection mechanism for use if there is any malfunctioning of the appliance	To prevent the risk of any thermal decomposition of the dielectrics and production of toxic gases (PCDD and PCDF).
Sealing of ventilation shafts	To avert the dispersal of toxic gas into the air-conditioning system

Article 6: Retrofilling is forbidden because of the attendant risks of uncontrolled contamination, resulting from the leaching of PCBs impregnated as residues in the operating parts of the transformer. In any event, Retrofilling has no significant effect on the initial PCB content of the transformer.

Article 7: Technical inspection is a legal precondition for the use of PCB transformers, in environmentally sound management conditions, up to the end of their service life.

Article 8: 2013 has been set as the final date for disposal of all PCBs within the country in question. This date has taken into account the 1984 ban on the production and distribution of PCBs in producing countries. Bearing in mind that 1984 would be the last year of PCB imports and that the average working life of a transformer is 30 years, then the year 2013 would in fact be the end of the time span allowed for the replacement of these appliances.

Article 9: This article, on PCB disposal, is designed to prevent non-controlled procedures for the elimination of hazardous wastes. The specific procedures concerned are scrapping, burning, dumping and dilution, the last of which is already covered in some detail in, for example, the environmental code of Côte d'Ivoire (used as the model here).

Article 10: Although already mentioned in the Ivorian regulations on the transport of hazardous materials, the transport conditions for PCBs must be spelled out in more detail because of the risks arising from their toxicity.

Article 11: It is essential that transfers and deliberate spills designed to evade regulatory constraints should be banned, to prevent the growth of PCBs in ecosystems, not least because of the way they bio-accumulate and are not bio-degradable in the natural environment.

Article 12: The purpose of this article is to define the technical operations to be implemented in order: To contain the contaminated area; to decontaminate the affected areas, both surface and below surface.

Article 13: These regulatory constraints on the export of PCBs are specifically designed to prevent the illegal transfer for commercial purposes of PCB-containing electrical equipment into the countries of the sub region

5.3 Financial tools for the management and destruction of PCBs

Responsibility for meeting the costs of destroying PCBs should be shared by various stakeholders, including those owning and manufacturing the PCBs. In this context, in developing countries, the electricity production and distribution networks account for a large part, up to 40%, of the national stock of PCBs, because of the level of industrial activity and the consumption of low-voltage electricity. There is no hard and fast rule about how these costs should be shared among the various economic sectors mentioned above. These networks may be completely public, completely private or a combination of the two. Moreover, by reason of their activities, it is the electricity production and distribution companies which hold most of the obsolete PCB stocks. Any analysis of this problem must also take into account the different attitudes to industrial waste management as seen by the public and the private sectors. Looked at in this way, economic activity can be divided into three different sectors, each showing differing attitudes to the problem of the environmentally sustainable management of PCB-containing equipment:

The public sector (electricity production, water resources, public transport, telecommunications etc.);
The national private sector and the private sector dependent on multi-nationals;
The informal sector.

5.4 Various economic sectors owning PCB equipment:

Public sector

Despite the enormous difficulties which it faces, the public sector in developing countries is, by its very nature, open to environmental controls and willing to apply them with care. This is because it is not under as much pressure to show results as the private sector. Managers in the public sector are also receptive to the need to develop clean technology and its associated systems. The PCB problem is a good example, as it was very quickly taken on board in the environmental management of their activities. The public sector's enhanced sensitivity to environmental issues is facilitated by the dissemination of a wide range of information. The problem, however, will remain unresolved as long as the funding made available to the sector for the management of PCBs remains confidential (for the Retrofilling of existing fillings, the replacement of obsolete appliances, the destruction of scrapped appliances). Stocktaking exercises carried out in Africa show that there are stocks of scrapped PCB transformers that have been stored for several years with no special precautions, and these have caused significant levels of soil pollution. The position taken by the public sector on the funding of PCB management operations is clear: management programmes must be implemented with the support of important bilateral or multilateral financial mechanisms. This does not apply to capacity enhancing alone but also to the whole management of PCBs right up to their final elimination.

Private sector

(a) The national private sector, inasmuch as it is obliged to produce profits in a competitive context, takes a different approach to the question of hazardous industrial waste. This particular situation encourages lobbying and even economic "blackmail" as a way to environmental obligations. The problem they have is not with the concept of control itself but with the financial impact it has on production costs and competitiveness. The national private sector is therefore not inclined to support the additional financial costs incurred by PCB management, and PCB transformers are only replaced for reasons of technical efficiency (obsolescence, increased capacity, modernization).

(b)The multinational private sector applies environmental management standards generally supervised by an environmental official and expressed in strict directives laid down by the parent company. This company policy has to be seen within the general context of multinational activity, in which the multinationals are at times called to task for their social and environmental management. The extensive media coverage given to PCBs in industrialized countries has made the relevant officials within the multi-nationals more aware of the significant environmental impact of their industrial activity on developing countries and of its repercussions. In consequence, many multi-nationals are implementing plans for the elimination of PCB transformers and taking responsibility for the cost of these programmes in both financial and human terms.

Informal sector

The informal sector, although not as directly concerned with the problem of PCB management, must also be taken into consideration when analysing the way PCBs are handled. In the majority of cases businesses within the informal sector buy low-voltage power and rarely use high-voltage electrical fittings. It is unusual for this sector to buy medium-voltage power and transform it down to low-voltage using its own transformers. In such cases step-down transformers are administered by the public or private companies which produce and distribute electricity. Moreover the informal sector is especially concerned with the recycling of electrical transformers, including the recycling of metals and oil from transformers.

An electrical transformer can contain up to 20% of its total weight in copper, and this represents significant market value for a business in the informal sector. The copper is generally reprocessed by open air burning with used tyres so as to produce a resin-less copper. This copper is then sold for recycling, to be used in the production of new equipment. Another method is to recycle the copper as copper wire, using a simple unwinding process. This process can also be applied to magnetic sheets. While these methods are environmentally sound for mineral oil transformers, this does not apply to PCB-containing equipment, where there are extremely negative impacts on health and environment. Thus, during the burning process, the thermal decomposition of the PCBs at a low temperature produces carbon monoxide, chlorine, dioxins and furans. The oil from transformers can also be recycled as a fuel substitute, hydraulic fluid, moulding oil or for phytosanitary use.

PCB oils are thus 100% recycled or else mixed with used oil to be re-sold as fuel or as chemical products for various uses. In the informal sector, the management of PCB transformers while they are in industrial use causes the problem as the recycling of used electrical transformers. Future financial mechanisms will therefore have to take into consideration the specific nature of these recycling procedures. In this case, to be effective, financial compensation would have to match the returns from the existing recycling process.

PCBs and hazardous industrial waste in the private industrial sector

Several factors must be taken into consideration when the concept of hazardous industrial waste is applied to PCBs. These factors underline the difficulties of regulating the use of PCBs in the private industrial sector:

When these types of equipment were first put on the market, before they were banned, there were no restrictions placed on industries regarding their use or requirements for them to be scrapped. Private sector users are therefore reluctant to accept responsibility for the consequences of regulations laid down subsequent to their acquisition of this equipment. The sector is naturally anxious to avoid having to bear the financial costs of the sound environmental management of this equipment while it is in industrial use until its final elimination.

The positions taken by the international community, based on the precautionary principle, in, on the one hand, the environmental management of chemical products such as CFCs (Montreal Protocol) and, on the other, the legal campaigns to make asbestos manufacturers retroactively responsible for environmental consequences, lend further weight to the position taken by the private sector in developing countries in ascribing historical responsibility to the industrialized countries. As such, it is difficult to justify the setting up of compensatory financial mechanisms in the industrialized countries if the same is not applied to developing countries.

Electrical fittings containing PCBs are considered primarily as industrial products and not as hazardous industrial wastes. The concept of industrial waste is part of the development of chemical industries.

Even if the PCBs contained in electrical appliances are identified as being a hazardous chemical substance, this does not necessarily hold true for the appliance itself. The phenomenon of PCB impregnation into the porous parts of transformers (about 5% of the initial quantity of PCBs) is generally ignored, thus opening up the possibility of trade in second-hand transformers.

The processing of industrial waste in developing countries is rarely "internalized" and integrated into production costs. If PCBs were to be included on the list of hazardous industrial wastes then financial mechanisms would need to be implemented based on the 'polluter pays' principle and, for example, the contribution of funding bodies to the redistribution of the compensatory pollution taxes which would need to be collected. If the cost of destroying the appliance is imposed unilaterally on its possessor, some of these appliances will not be dealt with in an "environmentally sound" manner. There would be a great risk of a situation where significant numbers of PCBs would be released unofficially into the environment. Industrialized countries have noted during the preparation of inventories that, at the time when PCBs were introduced into environmental law, a significant quantity of appliances with PCBs "disappeared". These appliances are sometimes exported and re-sold as second-hand transformers in non-industrialized countries. The export of fittings containing PCBs under the label "second-hand transformer" will follow the path of least resistance in countries where the law is incomplete or not implemented, border controls are non-existent, standards of public health are low and also where regulations to enforce responsibility are barely developed. These factors, associated with the high costs of elimination, are the driving force behind such cases of illegal trafficking as defined by the Basel Convention.

The meaningful discussions that have already taken place in certain countries that are party to the Basel Convention have brought to light the necessity for countries to develop targeted approaches, taking into account the aforementioned factors. With this in mind, the reluctance of manufacturers and of non-industrialized countries to finance the destruction of products imported several decades ago on the basis of their excellent physio-chemical qualities compels us to look for financial solutions that will involve a combination of the public sector, the private sector and external sources. Accordingly, the national PCB management policy should be a process that involves the owner from the

very first stage of the inventory process and allows for the product concerned to be followed and its movements to be tracked by the authorized bodies up to the end of its natural life and its destruction.

5.5 Possible financial mechanisms

1 – Full implementation of the polluter pays principle

This is the position generally adopted by the multinationals that support the whole financial burden of PCB management on their industrial sites. This situation explains, to a large extent but not completely, the transboundary movements of PCBs from developing countries to industrialized countries11. This mechanism, however, cannot be implemented in the private sector at the national level without at the same time causing the emergence of informal recycling procedures that are inexpensive and not controlled (informal).

2 – Enforcement of the historical responsibility of the manufacturer

The 'polluter pays' principle cannot be clearly established in this case because it applies more to the user of the chemical product than to its manufacturer. For example, the treatment of perchloroethylene sludge used in dry cleaning is the responsibility of the user. Recent market developments allow businesses to include in their services the recovery of perchloroethylene sediment, with the cost of elimination provided for in the selling price. As for PCBs, the manufacturers claim that this substance has made for a considerable increase in the fire safety of mineral oil transformers in an urban environment, thereby contributing to the environmental protection of the urban habitat.

3 – Levying an eco-tax on new transformers

This mechanism is increasingly being used for widely distributed industrial products such as tyres and batteries of various kinds. It could be applied to all production and distribution businesses importing electrical fittings in developing countries.

4 – Levying an eco-tax on KWh

If a long period, e.g., 20 years, is anticipated for the total elimination of PCBs, this financial mechanism would be of some interest as it would allow for a return in the costs of PCB management to be recouped over the same period. There is the possibility that fees could be charged at the municipal level by the company distributing energy, and funds provided to support the costs of managing municipal waste.

5 – Multilateral financing

The principle of multilateral financing has been introduced into the financial mechanisms of the Stockholm Convention. The amount of time needed for their implementation could be detrimental to the sound management of PCBs, leading

to the existence of obsolete and, in many cases, orphan stocks, necessitating short-term action.

6 –Tied loans

These mechanisms are widely used in industrialized countries and link the 'polluter pays' principle with environmental responsibility on the part of the industries that generate industrial waste. Under an agreement between the producer or owner of industrial waste and a national environmental agency, the industry can benefit from financial mechanisms for the processing of its industrial waste in return for an undertaking to ensure the proper environmental management of its industrial activity. These mechanisms can be implemented as loans or in the form of participation in financing the costs of processing hazardous industrial waste. They have the advantage of creating awareness within the industry generating the industrial waste by the implementation of environmentally sound waste management When applied to PCBs, this type of financial mechanism can also have an educational effect insofar as it allows the concept of environmentally sound management to be introduced into industrial activity and extends this sense of responsibility beyond PCBs alone. Seen in this light, a financial agreement could be envisaged, managed by a governmental agency, which would commit the owner to certain obligations throughout the industrial life of the appliance until its final destruction:

- Obligation to declare ownership of a PCB appliance
- Obligation to install it properly
- Obligation to have the appliance destroyed at an authorized installation when it is time
- for it to be scrapped The 'polluter pays' principle has already been introduced into the
- Environmental law of many countries.
- The difficulty of classifying an industrial product such as a transformer as a hazardous waste;
- A working transformer does not become waste until it is scrapped.

5.6 Estimate of the costs of managing and eliminating PCBs

The evaluation of these costs covers all operations involving PCB transformers from declaration of ownership to final elimination.

Technical control:
Dielectric analysis (water content, breakdown voltage, etc.);
PCB screening of mineral oils;
Site evaluation (inflammable products, ventilation, lying of cables, presence of PCBs and mineral oil - see inventory questionnaire).

Retrofitting:
Physio-chemical treatment of the dielectrics or replacement;
Installation of holding tanks, gas detection and temperature and pressure control systems, installation of firewalls or removal and replacement of the PCB.

Evaluation of the costs of management, treatment and elimination

Evaluation of costs for a transformer - average weight 2,200 kg - estimated amount of PCBs (30%). 660 kg	US $
Technical control of an existing installation	350
Retrofitting (catch basin, DGPT9)	800
Servicing costs (four inspections every 12 years)	600
Handling and transport to the storage area	100
Storage costs (max. 1 year)	250
Costs of the transport and elimination of PCB liquids (660 kg at 2.5 US$ per kg)[12]	1 650
Costs of the decontamination of contaminated equipment shells (1,540 kg at 0.8 US$ per kg)[13]	1 232
Total	4 982
Total/tonnage of fittings	2 270

The replacement of the appliance is not taken into consideration since this depends purely on its age and has nothing to do with whether or not it contains any PCBs.

5.7 Financial Mechanisms for PCB management

When applying for partial or total financing of the costs of management and elimination, the eligibility of owners would be subject to the mandatory requirements set out in the regulations:

1. To declare all PCB-containing appliances in or out of use;
2. To retrofit all installations in use, according to the requirements set out in the regulations;
3. To ensure that servicing is carried out up to the time of scrapping;
4. To make sure that fittings containing PCBs are eliminated at the due date for scrapping.

Funding of this agreement could be of a mixed nature, as follows:

1. One part self-financing on the part of the owner, at the level of 20% (…);
2. Eco-tax imposed on the consumption of electricity;
3. Contribution by multilateral funding mechanisms;
4. Contribution by the equipment manufacturer

Operational modalities for tied loans

- The loan agreement is to be signed by the owner and the funding body;
- This agreement cannot enter into force until the owner has complied with the technical obligations of making a declaration and retrofitting following the initial technical inspection;
- The expenses involved are to be submitted to the funding body in the form of a quotation which will be included in the financing agreement;

- The body designated to manage these agreements will receive for each signed agreement the corresponding pollution compensation fees and financial support from GEF;
- The owner will pay the agency its share of the self-financing over a period of five years, per appliance and per year (scaled according to weight);
- The expenses to be incurred under this agreement are to be paid by the funding body to the various suppliers involved in this agreement, which should enable the funding body to issue calls for tender in major markets.

  As part of the approval process, the funding arrangements should be subjected to a specific study which would take account of different scenarios such as:
- The distribution of pollution compensation fees levied for the overall consumption or the industrial consumption of electricity;
- Self-financing contribution by the owners;
- Financial support contributed by GEF.

5.8 Annex I – PCB declaration form : INFORMATION ON THE COMPANY

Date of declaration
Name of company
Address 1
Address 2
Town or city
Postal code
Contact
Position
Type of business
Tel.
Fax
Email

TECHNICAL INFORMATION ABOUT THE APPLIANCE
(Tick the relevant box)

Transformer
Capacitor
Drums
Manufacturers
Power (kVA)
Date of manufacture
Age of transformer
Dielectrics identified as 100% PCB
Dielectrics identified as mineral oil > 50 ppm
Dielectrics identified as mineral oil < 50 ppm
Retrofilled transformer
Dry transformer
Not determined
Serial number
Total weight in kg

Dielectric weight
Commercial name of the dielectric
In use
Stand-by
In storage prior to destruction

Annex I – PCB declaration form

INFORMATION ON THE COMPANY

Date of declaration	
Name of company	
Address 1	
Address 2	
Town or city	
Postal code	
Contact	
Position	
Type of business	
Tel.	
Fax	
Email	

TECHNICAL INFORMATION ABOUT THE APPLIANCE	Tick the relevant box
Transformer	
Capacitor	
Drums	
Manufacturers	
Power (kVA)	
Date of manufacture	
Age of transformer	
Dielectrics identified as 100% PCB	
Dielectrics identified as mineral oil > 50 ppm	
Dielectrics identified as mineral oil < 50 ppm	
Retrofilled transformer	
Dry transformer	
Not determined	
Serial number	
Total weight in kg	
Dielectrical weight	
Commercial name of the dielectric	
In use	
Stand-by	
In storage prior to destruction	

5.9 Annex II – Retrofitting

Every precautionary measure should be taken to avoid even the slightest risk of fire. To this end, the PCBs should be stored far away from any inflammable substance. All deposits of pollutants and appliances impregnated with PCBs should be fitted with watertight devices to prevent discharges, with a capacity greater than, or at least equal to the highest of the following values: Existing installations: the existing retention system can be retained if it is watertight and if its overflow is not likely to seep into the natural environment or the public sanitation network; New installations: the device must have a capacity which is at least equal to the highest of the 100% of the capacity of the largest container; 50% of the total stored volume (a site containing a transformer holding 400 litres of Pyralene and two other transformers with a capacity of 300 litres must have a retention capacity of at least 500 litres).

Stocks should be kept in hard-wearing receptacles and should be clearly marked. All PCB containing appliances should be labelled. For existing installations which have mineral oil appliances and PCB-containing appliances at the same site, a two-hour rating firewall must be erected (high ceilings, vertical partitions, etc.); potential communication channels with other sites must be fire-proofed to at least one-hour rating. As the opening faces the exit the doors must be strengthened.

Preventative measures must be taken to minimize the probability and the consequences of accidents that might cause a release of toxic substances (one of the main causes of these accidents is a fault in the electrical protection of individual pieces of equipment upstream or downstream of the appliance. Thus excessive internal pressure on the equipment, possibly produced by an electrical fault, can cause a breach that then leads to a release of PCBs: it is essential to prevent arcing which might start a fire).

Electrical equipment containing PCBs must conform to the standards in force at the time of installation. Arrangements for the protection of individual appliances must also ensure that the appliances cannot be automatically switched back on. Instructions must also be given to prevent the equipment being manually re-started before the fault has been identified. A trouble-shooting mechanism for the detection of gas, temperature and pressure faults must be installed in every appliance in use. The user must take all the constructive precautions available on site to avoid the circulation into offices or inhabited areas of any accidental release of vapours from the dielectric. Above all these vapours must not be allowed to reach any waste-removal or ventilation pipes or shafts not exclusively used by the workshop. When the shafts used by the workshop provide access to other areas, such as those mentioned above, and then they must be equipped, at the connection points, with a watertight, pressure-resistant plug.

When the workshop is accessible from a private, enclosed space that itself leads to the abovementioned pipes or areas, then it is especially important that the connecting door be watertight and pressure-resistant. Thus, transformers containing PCBs are considered to be properly protected when one of the following measures is implemented:

Basic protection, provided by power-calibrated fuses; Instant voltage shut-off in the event of excess pressure, the detection of gaseous bubbles or a drop in the dielectric level.
The user is permitted a designated period of X months in which to complete the necessary inspections of the equipment and X years from the designated date to finish retrofitting the equipment according to the standards set out above.

5.10 Annex III – Labelling

Labelling of PCB appliances: All appliances containing or having once contained PCBs must be marked with labels carrying the following information: This appliance contains PCBs which can contaminate the environment and which by law have to be eliminated.

Labelling of decontaminated appliances that have contained PCBs

Each unit of the decontaminated appliance must be clearly and indelibly marked by embossing or stamping with the following information Decontaminated PCB-containing appliance PCB-containing liquid has been replaced by:

By ..... (name of substitute)

On ..... (date)

By ..... (company)

PCB concentration:

In the former liquid content..... % by weight

In the current liquid content..... % by weight

5.11 Annex IV: Declaration of PCBs

- PCB owners, as defined in article 1, must declare such ownership to the technical section of the Ministry of the Environment, using the form provided in annex I to the present decree.

- This declaration must be made within a period of six (6) months from the publication of the present decree in the official newspaper of … [country].

- All owners of appliances must inform the appropriate authorities of the quantities they contain and of any change in these quantities.

- All appliances declared must be labelled. The labelling, a description of which is provided in annex III to the present decree, must clearly state the presence of PCBs and the risks that could be caused by fire. The same type of labelling should also be used on the doors of the premises where the appliance is kept.

5.12 Annex V – Instructions on the handling and transport of equipment and materials:

PCB wastes as defined by this decree and designated for elimination are subject to certain standards with regard to packaging and transportation. Liquid wastes must be placed in closed drums and solid wastes in open-top drums.

Specifications for drums: 2001: closed drums

Filling level: 90% ; Marking of drums as per UN specifications;
1: containers /A: Steel
1: non-detachable (sealed) –2: detachable
Y: packing group II et III
For liquids: density: 1.5
For solids: maximum gross weight

Value in kPa of hydraulic test pressure: (> 100 kPa)
Year of manufacture of packaging:
Sample of liquid PCBs in sealed containers: 1A1 Y/1,5/150/83

PCB liquid wastes must be packed in sealed containers and PCB solid wastes in completely open containers. The containers must be palleted and secured on the pallets. The containers and metal cases must be labelled so as to show the relevant UN category and code UN Code Safety sheet information

Group N°: 90 201
UN Code: 2315
IMO class: 9 9

Packaging group II
Parcel labelling: 9
IMDG code PCB
Chlorine content: from 42 to 60%
Melting point: -19
Evaporation temperature: 325°
Flash point: 176°:
Density. 1.5

Transport

The transporter must be given an itinerary form which should indicate the nature and quantity of the products being transported. The vehicle must be provided with the regulation signs (hazardous materials plates) No inflammable product should be transported The drivers of the specially equipped vehicle must be informed of the nature of the goods being transported and their associated hazards The drivers must have at their disposal the regulation signs and protection equipment, a 9 kg dry-powder fire-extinguisher, sufficient quantities of absorbents to soak up any PCB leakage The drivers must know exactly what they are carrying and trained so that, in the event of an accident or incident, they will be able to avoid

the danger of fire, heat pollution, spillages, the dispersion of PCBs into the environment, and cold pollution;
The driver must be familiar with the first-aid procedures applicable to PCBs: A safety disk must be affixed to the vehicle. The owner should deal solely with specialized companies duly authorized to carry out transport operations of this type

Required protection equipment for the handling and transport of PCBs:
Disposable overalls
PVC glasses and gloves
Overshoes

Preventative materials:

Breathing mask with a special cartridge for chlorinated products
Inert absorbent bags
Signalling tape

PCB TRANSPORT FORM MANUFACTURER

Company
Address
Person in charge
Position
Tel/fax/e-mail
Designation of waste
Quantity
Packaging
Number of appliances
Number of containers

TRANSPORTER

Company
Address
Person in charge
Position
Tel/fax/e-mail
Date of shipping
Delivery date

CONSIGNEE

Company
Address
Person in charge
Position
Tel/fax/e-mail
Delivery date
Signature of consignee

Five copies of the form are drawn up:

Copy no.1: for the manufacturer
Copy no.2: for the transporter
Copy no.3: for the consignee
Copy no.4: for the manufacturer, dated and signed by the consignee
Copy no.5: for the classified installations inspectorate (or equivalent service)

PCB-containing equipment destined for scrap must be carefully drained prior to being stored or transported.
The contents must be decanted into watertight receptacles.

5.13 Annex VI – Instructions on the storage of PCBs prior to their elimination

PCBs must be stored in accordance with the following conditions: The site must be adequately ventilated and sheltered from bad weather and the risk of fire Absolutely no inflammable products should be present either on the site itself or in the vicinity The floor must be watertight or equipped with a catch basin with a capacity greater than the volume of PCB liquid on the site The site must be locked and subject to regular, duly logged inspections Signs reading “Danger PCB” must be put up inside and outside the site A complete inventory must be made and regularly updated of all incoming and outgoing Items The person responsible for stocktaking must have the necessary qualifications Liquid waste must be kept in regulation containers. Prior authorization for the storage site must be obtained from the classified installations and civil protection inspectorate, or equivalent service. This authorization will specify, among other things:

- maximum amount of equipment that can be stored
- maximum time a consignment can be stored between admission and discharge inventory particulars (incoming to be provided by the manufacturers and outgoing by the consignees)

5.14 Annex VII – Instructions on hot and cold pollution

COLD POLLUTION WITHOUT THERMAL DECOMPOSITION

In the event of a release of PCBs and a risk of environmental contamination, alert the classified installation and civil protection inspectorate (or equivalent service) Alert the doctor on duty and provide the staff with PCB protective clothing: wrap-around glasses, gloves and/or overshoes, breathing mask fitted with a filter cartridge Mark out a safety perimeter and, where necessary, ventilate the site in every way possible Contain the PCB dispersion by sealing off the leak (with cloths, cling-film, etc.) and with the use of inert absorbents Clean the soil

Watertight flooring

Scrape down thoroughly using rags soaked in solvent. Under no circumstances use a naked flame. Do not use chlorinated solvent, but rather mild detergents such as washing-up liquid.

Non-watertight flooring

Remove the heavily contaminated layers: concrete, earth etc. If there is any risk of contamination to groundwater, urgent steps must be taken to limit, settle and eventually eliminate the pollution Gather up all the polluted products (washing water, earth with a more than 100 ppm level of pollution, clothes etc.) and store them in watertight containers for eventual incineration on an authorized site to be agreed.

Soil decontamination standards

Materials over 100 ppm must be treated Materials between 10 and 100 ppm can be disposed of in approved landfills or contained on site Materials under 10 ppm are considered uncontaminated Washing water cannot be thrown out unless it has a content of less than 0.5 µg per litre.

HEAT POLLUTION RESULTING FROM BREAKS IN THE TANK AND THERMAL DECOMPOSITION

Disconnect the power without entering the premises; Call the fire brigade, giving them details of the nature of the accident to ensure that they bring the appropriate equipment to gain entry to the premises and to fight the fire. (The use of water should be avoided because it might cause the catch basins to spill into the surrounding environment; CO2 or dry ice would be preferable); Inform the competent authorities immediately; Prohibit access to the polluted area to any persons not wearing protective clothing (waterproof overalls, glasses, mask, overshoes) and access must be allowed only when strictly necessary and for short periods of time; Limit the extent of the pollution by sealing off any possible channels of transmission between polluted and non-polluted areas;

Check the extent of contamination; On appraisal of the results of these analyses the classified installations inspectorate may order the manufacturer to carry out various procedures essential to the decontamination of the affected areas, namely: To dump rubble, objects of little value and contaminated clothing in a container for subsequent incineration at an approved site; With the use of steam or solvent, to clean fixed surfaces and objects of value so as to eliminate surface contamination and appreciably reduce the general level of contamination with a view to re-opening the site and eventually bringing it back into use.

5.15 Annex VIII – Toxicity levels of PCDDs and PCDFs

Although there is a large body of scientific literature on the subject of the experimental toxicity of PCDDs and PCDFs, it is still difficult to say exactly how long the effects of such contamination remain in the human body. Essentially it is the knowledge acquired after the Seveso accident of 1976 or the contamination of Times Beach (Missouri) in 1971 that makes it possible, with hindsight, to understand the consequences of acute or prolonged contamination by 2.3.7.8 TCDD, but it would be arbitrary to extrapolate from this, with no adjustment, the consequences of risks from thermal deterioration of PCBs. Indeed, when it was possible to measure it, 2.3.7.8 TCDD was present in minuscule quantities. It is

true that some authors, seeking to establish the exposure threshold values as guides to decontamination, have put forward the idea of a *2.3.7.8 TCDD equivalent* for the different isomers of PCDD and PCDF, but this is still only a theory, based on the comparative level of DL 50 with laboratory animals. Thus, 2.3.7.8 TCDF would be three times less toxic than 2,3,7,8 TCDD. Much higher toxicity levels can be seen among quite close isomers: (ratios above 10,000 between DL 50 of 1.2.3.8 TCDD and 2.3.7.8 TCDD.) As a general rule the most toxic derivatives are isomers containing 4-6 atoms of chlorine with lateral positions 2.3.7.8 substituted. Despite its usefulness for the purposes of taking decisions, the notion of *2.3.7.8 TCDD equivalence* remains questionable as the ratio between DL 50 of two derivatives such as 2.3.7.8 TCDD and 2.3.7.8 TCDF differs depending on the species in question. Humans, like other species, absorb contamination mainly through the skin and the digestive system. The bio-accumulation of different PCDDs and PCDFs in the fatty tissues of an organism is evidence of the cumulative quality of toxic effects. Using epidemiological data taken from different instances of human contamination, compared with experimental data on animals, we can identify several possible areas of biological impact.

1. **Skin disorders**

Here we are dealing essentially with chloracne, which reproduce easily in animals. Chloracne have been found in humans after brief but intense periods of contamination; the best example of this is in Seveso where several observations have been made: The effect of chloracne on children is greater than on adults, at the same level of contamination; There can be a delay of up to 10 months before the effects appear; The intensity of the chloracne and the speed with which it takes hold are directly related to the levels of contamination. Additional cutaneous symptoms (rashes, hyperpigmentation, oedemas,) and mucous conditions (conjunctivitis) are present in Yusho disease. Chloracne can last for a particularly long time: after an instance of industrial exposure where 79 employees developed chloracne, follow-up tests 10 years later showed that cutaneous symptoms still persisted among half the victims.

2. **Liver disorders**

Experiments on animals and massive levels of industrial contamination in the case of humans lead us to expect the dioxins will have a toxic effect on the liver. In Seveso enlargement of the liver (hepatomegalia) was observed in 7-8% of adults in the most exposed area. The exact nature of the liver disorders has not been clearly defined and there has been no systematic research into enzyme induction. A case-study of 427 persons in the exposed area and 563 persons in a neighbouring town did not show any significant difference in the number of hepatic changes in those who had been exposed.

Few experimental studies demonstrate the likelihood of any neurological or muscular effects. Some forms of myalgia, ataxia and swelling of the joints have, however been noted in occupational exposures. The interpretation of clinical data and electro-physiological tests carried out in Seveso has given rise to some controversy: it appears that the slowing down of the motor nervous system observed in some subjects who had been exposed was no more than an acceptable variation within the normal range.

3. Other visceral disorders

Some haemorrhagic cysts were observed in studies carried out of the contamination in Times Beach, Missouri. The statistics have neither been explained nor confirmed but they do warrant systematic research into microscopic haematoria in persons exposed to such products. A range of functional symptoms including asthenia, insomnia, headaches and digestive troubles have also been noted, in particular in Yusho disease.

4. Immune system disorders

Experiments on animals have drawn attention to immuno-depression linked to 2.3.7.8 TCDD, which in certain colonies of mice has caused both hormonal and cellular depression with atrophy of the thymus; 2.3.7.8 TCDF appears to have a 30 times lower immuno-depressive effect on the mice. As for humans, both qualitative and quantitative lymphocytic tests were carried out on a subgroup of children exposed to the contamination at Seveso without any evidence being found of the anomalies expected from the animal studies on toxicity. There was no increased susceptibility to infection among the exposed group in the months following the contamination. In the study carried out at Times Beach, cellular immunity was measured by cutaneous tests of delayed sensitivity, lymphocytic subgroups and reaction to lymphocytic proliferation in mitogenes. No significant changes were noted.

5. Metabolic disorders

Changes in the lipid metabolism with a heightened level of whole lipids and triglycerides were reported in the first studies published of human occupational exposure. They were not encountered at Seveso or Times Beach. Experiments show PCDDs to be powerful enzyme conductors, especially in terms of their aryl hydrocarbon hydroxalyse (AHH) inducing potential. The liver enlargement effects noted after the Seveso accident could perhaps be linked to this mechanism but, in the absence of biochemical induction tests that are reliable and easy to implement, this must remain in the realm of conjecture. The level of urinary D-glucanic acid as an indication of enzyme induction is still being appraised. Disturbances of porphyrin metabolism by PCDDs are well known in animals, with a rise in the urinary heptacarboxyporphyrin. Cases of cutaneous porphyria in humans have been noted after significant occupational exposure. Among those of the Seveso group who had a chloracne, however, no anomalies were noted in the urinary excretion of porphyrin. There is a particular interest in the identification of heptacarboxyl porphyrin among the urinary uroporphyrins.

6. Reproductive problems and foetal abnormalities

Experimental studies on animals suggest that TCDD can be foeto-toxic and teratogenic: in the case of monkeys, for example, a species highly sensitive to TCDD, the rate of spontaneous abortion was higher in the group receiving 1 microgram per kg of TCDD than in the control group, although the evidence is not definitive. Among humans, a study of miscarriages did not show any abnormal increase in the six months following the Seveso exposure. Perinatal mortality also appears not to have increased as a result of the toxic accident. Another epidemiological study on the rate of miscarriages after a leakage of herbicide 2.4.5.1 – containing 2.3.7.8 TCDD impurities – into a forested region of Canada does show, on the contrary, a much higher figure in the exposed region than in the

control area. Congenital abnormalities linked to TCDD administered in doses of from 1 to 3 micrograms per kg have been found in experiments: cleft palates in mice, kidney deformities in mice and rabbits, cardiac deformities in chicken embryos. The epidemiological surveys carried out in Seveso have not demonstrated any increase in congenital deformities, as compared with normal statistics gathered by the same methodology.

7. Carcinogenic and cytogenetic effects

Short-term tests in vitro and in vivo have produced conflicting results concerning the genotoxicity of TCDD, and cytogenetic studies of the lymphocytes of workers exposed to TCDD show no increase in the frequency of chromosomic aberrations. Carcinogenetic experiments on rats and mice show that, after being given mild doses of TCDD, they suffer an increased incidence of thyroid nodules and liver tumours. TCDD is the main cause. Many epidemiological studies have been carried out on human beings exposed to TCDD. Out of seven studies published on employees subject to occupational exposure only one shows a rise in deaths from cancer, particularly of the gastric kind. The increase in deaths from liver cancer observed by Vietnamese doctors in the civilian population exposed to Agent Orange (a mixture of herbicides: 2.4 D and 2.4.5 T, containing TCDD impurities) has not been proved epidemiologically.

Swedish studies have pointed an increase in the frequency of soft tissue sarcomas among railway workers handling the same type of herbicides. These results are contested, as subsequent studies have not found this association. The long term follow-up of the population that was exposed in Seveso has not shown any increase in the cancer mortality rate, but it is still only nine years since the incident. For the time being, there is still no real proof that TCDDs have a carcinogenic effect on humans. Accordingly, it would seem that, apart from chloracne, metabolic induction and perhaps certain types of cutaneous porphyria, TCDD has not resulted in any really worrying pathology in people subjected to occupational or environmental exposure, of either an organ failure or involving medium or long-term effects. In particular, there is no evidence of ill-effects on offspring of the induction of cancer. In the absence of any definite appraisal of the risks to humans of this kind of product and according to the published statistics from experiments carried out, it would be as well to establish a medical surveillance system, to examine people exposed to PCDD and PCDF. This system must employ epidemiological methods by introducing a control group, which will facilitate the subsequent interpretation of results:

1. Attribution of exposure levels by synthesizing data from the questionnaire based on the criteria for exposure and the data on toxicology (at the very least, the serum PCB levels; at best, the relative blood and fat levels of PCDDs and PCDFs);

2. Initial clinical examination, repeated at 6 and 12 months intervals and then annually, concentrating on the outer skin, neurological tests, measurements of the liver and the frequency of recurring infections;

3. Complete medical history: Gamma-Glutamyl-transpeptidase (Gamma GT), serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvic

transaminase (SGPT) (± urinary glucaric acid), lipid profile, tests for microscopic haematoria, urinary porphyrin, And examination of the immune system: delayed immunity tests, lymphocyte typing, functional study of lymphocytes.

5.16 Annex IX –Stockholm Convention: Relevant Articles and annexes

Article 3

Measures to reduce or eliminate releases from intentional production and use

1. Each Party shall:
(a) Prohibit and/or take the legal and administrative measures necessary to eliminate:
(i) Its production and use of the chemicals listed in Annex A subject to the provisions of that Annex; and
(ii) Its import and export of the chemicals listed in Annex A in accordance with the provisions of paragraph 2; and
(b) Restrict its production and use of the chemicals listed in Annex B in accordance with the provisions of that Annex.

2. Each Party shall take measures to ensure:
(a) That a chemical listed in Annex A or Annex B is imported only:
(i) For the purpose of environmentally sound disposal as set forth in paragraph 1 (d) of Article 6; or
(ii) For a use or purpose which is permitted for that Party under Annex A or B;
(b) That chemical listed in Annex A for which any production or use specific exemption is in effect or a chemical listed in Annex B for which any production or use specific exemption or acceptable purpose is in effect, taking into account any relevant provisions in existing international prior informed consent instruments, is exported only:
(i) For the purpose of environmentally sound disposal as set forth in paragraph 1(d) of Article 6;
(ii) To a Party which is permitted to use that chemical under Annex A or B;
(iii)To a State not Party to this Convention which has provided an annual certification to the exporting Party. Such certification shall specify the intended use of the chemical and include a statement that, with respect to that chemical, the importing State is committed to:
a. Protect human health and the environment by taking the necessary measures to minimize or prevent releases;
b. Comply with the provisions of paragraph 1 of Article 6; and Comply, where appropriate, with the provisions of paragraph 2 of Part II of Annex B. The certification shall also include any appropriate supporting documentation, such as legislation, regulatory instruments, or administrative or policy guide-lines. The exporting Party shall transmit the certification to the Secretariat within sixty days of receipt.
(c) That chemical listed in Annex A, for which production and use specific exemptions are no longer in effect for any Party, is not exported from it except for the purpose of environmentally sound disposal as set forth in paragraph 1 (d) of Article 6;

(d) For the purposes of this paragraph, the term "State not Party to this Convention" shall include, with respect to a particular chemical, a State or regional economic integration organization that has not agreed to be bound by the Convention with respect to that chemical.

3. Each Party that has one or more regulatory and assessment schemes for new pesticides or new industrial chemicals shall take measures to regulate with the aim of preventing the production and use of new pesticides or new industrial chemicals which, taking into consideration the criteria in paragraph 1 of Annex D, exhibit the characteristics of persistent organic pollutants.

4. Each Party that has one or more regulatory and assessment schemes for pesticides or industrial chemicals shall, where appropriate, take into consideration within these schemes the criteria in paragraph 1 of Annex D when conducting assessments of pesticides or industrial chemicals currently in use.

5. Except as otherwise provided in this Convention, paragraphs 1 and 2 shall not apply to quantities of a chemical to be used for laboratory-scale research or as a reference standard.

6. Any Party that has a specific exemption in accordance with Annex A or a specific exemption or an acceptable purpose in accordance with Annex B shall take appropriate measures to ensure that any production or use under such exemption or purpose is carried out in a manner that prevents or minimizes human exposure and release into the environment. For exempted uses or acceptable purposes that involve intentional release into the environment under conditions of normal use, such release shall be to the minimum extent necessary, taking into account any applicable standards and guidelines.

Article 5

Measures to reduce or eliminate releases from unintentional production

Each Party shall at a minimum take the following measures to reduce the total releases derived from anthropogenic sources of each of the chemicals listed in Annex C, with the goal of their continuing minimization and, where feasible, ultimate elimination:

(a) Develop an action plan or, where appropriate, a regional or sub-regional action plan within two years of the date of entry into force of this Convention for it, & subsequently implement it as part of its implementation plan specified in Article 7, designed to identify, characterize and address the release of the chemicals listed in Annex C and to facilitate implementation of subparagraphs (b) to (e). The action plan shall include the following:
(i) An evaluation of current and projected releases, including the development and maintenance of source inventories and release estimates, taking into consideration the source categories identified in Annex C;

(ii) An evaluation of the efficacy of the laws and policies of the Party relating to the management of such releases;
(iii) Strategies to meet the obligations of this paragraph, taking into account the evaluations in (i) and (ii);
(iv) Steps to promote education and training with regard to, and awareness of, those strategies;
(v) A review every five years of those strategies and of their success in meeting the obligations of this paragraph; such reviews shall be included in reports submitted pursuant to Article 15;
(vi) A schedule for implementation of the action plan, including for the strategies and measures identified therein;

(b) Promote the application of available, feasible and practical measures that can expeditiously achieve a realistic and meaningful level of release reduction or source elimination;

(c) Promote the development and, where it deems appropriate, require the use of substitute or modified materials, products and processes to prevent the formation and release of the chemicals listed in Annex C, taking into consideration the general guidance on prevention and release reduction measures in Annex C and guidelines to be adopted by decision of the Conference of the Parties;

(d) Promote and, in accordance with the implementation schedule of its action plan, require the use of best available techniques for new sources within source categories which a Party has identified as warranting such action in its action plan, with a particular initial focus on source categories identified in Part II of Annex C. In any case, the requirement to use best available techniques for new sources in the categories listed in Part II of that Annex shall be phased in as soon as practicable but no later than four years after the entry into force of the Convention for that Party. For the identified categories, Parties shall promote the use of best environmental practices. When applying best available techniques and best environmental practices, Parties should take into consideration the general guidance on prevention and release reduction measures in that Annex and guidelines on best available techniques and best environmental practices to be adopted by decision of the Conference of the Parties;

(e) Promote, in accordance with its action plan, the use of best available techniques and best environmental practices:
(i) For existing sources, within the source categories listed in Part II of Annex C and within source categories such as those in Part III of that Annex; and
(ii) For new sources, within source categories such as those listed in Part III of Annex C which a Party has not addressed under subparagraph (d).
When applying best available techniques and best environmental practices, Parties should take into consideration the general guidance on prevention and release reduction measures in Annex C and guidelines on best available techniques and best environmental practices to be adopted by decision of the Conference of the Parties;

(f) For the purposes of this paragraph and Annex C:

(i) "Best available techniques" means the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for release limitations designed to prevent and, where that is not practicable, generally to reduce releases of chemicals listed in Part I of Annex C and their impact on the environment as a whole. In this regard:

(ii) "Techniques" includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;

(iii) "Available" techniques means those techniques that are accessible to the operator and that are developed on a scale that allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages; and

(iv) "Best" means most effective in achieving a high general level of protection of the environment as a whole;

(v) "Best environmental practices" means the application of the most appropriate combination of environmental control measures and strategies;

(vi) "New source" means any source of which the construction or substantial modification is commenced at least one year after the date of: a. Entry into force of this Convention for the Party concerned; or b. Entry into force for the Party concerned of an amendment to Annex C where the source becomes subject to the provisions of this Convention only by virtue of that amendment.

(g) Release limit values or performance standards may be used by a Party to fulfil its commitments for best available techniques under this paragraph.

Article 6

Measures to reduce or eliminate releases from stockpiles and wastes

1. In order to ensure that stockpiles consisting of or containing chemicals listed either in Annex A or Annex B and wastes, including products and articles upon becoming wastes, consisting of, containing or contaminated with a chemical listed in Annex A, B or C, are managed in a manner protective of human health and the environment, each Party shall:

(a) Develop appropriate strategies for identifying:

(i) Stockpiles consisting of or containing chemicals listed either in Annex A or Annex B; and

(ii) Products and articles in use and wastes consisting of, containing or contaminated with a chemical listed in Annex A, B or C;

(b) Identify, to the extent practicable, stockpiles consisting of or containing chemicals listed either in Annex A or Annex B on the basis of the strategies referred to in subparagraph (a);

(c) Manage stockpiles, as appropriate, in a safe, efficient and environmentally sound manner. Stockpiles of chemicals listed either in Annex A or Annex B, after they are no longer allowed to be used according to any specific exemption specified in Annex A or any specific exemption or acceptable purpose specified in Annex B, except stockpiles which are allowed to be exported according to paragraph 2 of Article 3, shall be deemed to be waste and shall be managed in accordance with subparagraph (d);

(d) Take appropriate measures so that such wastes, including products and articles. Upon becoming wastes, are:

(i) Handled, collected, transported and stored in an environmentally sound manner;

(ii) Disposed of in such a way that the persistent organic pollutant content is destroyed or irreversibly transformed so that they do not exhibit the characteristics of persistent organic pollutants or otherwise disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option or the persistent organic pollutant content is low, taking into account international rules, standards, and guidelines, including those that may be developed pursuant to paragraph 2, and relevant global and regional regimes governing the management of hazardous wastes;

(iii) Not permitted to be subjected to disposal operations that may lead to recovery, recycling, reclamation, direct reuse or alternative uses of persistent organic pollutants; and (iv) Not transported across international boundaries without taking into account relevant international rules, standards and guidelines;

(e) Endeavour to develop appropriate strategies for identifying sites contaminated by chemicals listed in Annex A, B or C; if remediation of those sites is undertaken it shall be performed in an environmentally sound manner.

2. The Conference of the Parties shall cooperate closely with the appropriate bodies of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal to, inter alia:

(a) Establish levels of destruction and irreversible transformation necessary to ensure that the characteristics of persistent organic pollutants as specified in paragraph 1 of Annex D are not exhibited;

(b) Determine what they consider to be the methods that constitute environmentally Sound disposal referred to above; and

(C) Work to establish, as appropriate, the concentration levels of the chemicals listed in Annexes A, B and C in order to define the low persistent organic pollutant content referred to in paragraph 1 (d) (ii).

Annex A, part II

Polychlorinated biphenyls

Each Party shall:

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

(i) Make determined efforts to identify, label and remove from use equipment containing greater than 10 per cent polychlorinated biphenyls and volumes greater than 5 litres;
(ii) Make determined efforts to identify, label and remove from use equipment containing greater than 0.05 per cent polychlorinated biphenyls and volumes greater than 5 litres;
(iii) Endeavour to identify and remove from use equipment containing greater than 0.005 percent polychlorinated biphenyls and volumes greater than 0.05 litres;

(b) Consistent with the priorities in subparagraph promote the following measures to reduce exposures and risk to control the use of polychlorinated biphenyls:
(i) Use only in intact and non-leaking equipment and only in areas where the risk from environmental release can be minimized and quickly remedied;
(ii) Not use in equipment in areas associated with the production or processing of food or feed;
(iii) When used in populated areas, including schools and hospitals, all reasonable measures to protect from electrical failure which could result in a fire, and regular inspection of equipment for leaks;

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

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

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

(f) In lieu of note (ii) in Part I of this Annex, endeavour to identify other articles containing more than 0.005 per cent polychlorinated biphenyls (e.g. cable-

sheaths, cured caulk and painted objects) and manage them in accordance with paragraph 1 of Article 6;

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

(h) The reports described in subparagraph (g) shall, as appropriate, be considered by the Conference of the Parties in its reviews relating to polychlorinated biphenyls. The Conference of the Parties shall review progress towards elimination of polychlorinated biphenyls at five-year intervals or other period, as appropriate, taking into account such reports.