PCB—Open Applications

Identification and Environmentally Sound Management

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This *Photo Booklet* provides an overview of open applications of PCB. Their uses, as well as the materials and objects where such PCB applications can typically be found, are briefly described.

A short risk evaluation of possible leakage, evaporation or other kind of uncontrolled release shall help to set priorities and take actions.

Guidance material on the identification, environmentally sound handling and disposal of PCB in open applications is being developed. For instance, factsheets on open applications are available at: http://chm.pops.int/Implementation/PCBs/DocumentsPublications/tabid/665/Default.aspx

A dedicated inventory of open applications should be developed. Until then, it is recommended to investigate and gather information about open applications of PCB as soon as possible in the frame of inventory activities for closed applications and any further national PCB assessments.

ETI Environmental Technology Ltd.

This booklet has been prepared in collaboration with Environmental Technology Ltd. All photos courtesy of Environmental Technology Ltd.

PCB used in other open applications:

Below is a short summary of some further minor and not well documented open applications of PCB.

Summary of uncommon uses of PCB
PCB in Insulation: Used in wool felt, foam rubber and fibreglass insulation.
PCB in Carbonless Copy Paper and Inks: Used as ink pigment carrier and transfer agent in carbonless copy paper.
PCB in Cast Waxes: Used as filler/extender for investment casting waxes.
PCB as Polymerisation Catalyst: Used as catalysts in the chemical industry.
PCB as Carrier for Insecticides and Bactericides: Used as carrier substances for insecticides and bactericides.
PCB Pesticide Extenders: Added to pesticides to dilute and/or extend the life of the sub-stances.
and many more

Serious information, data, pictures or even samples of other applications of PCBs in open applications are very welcome. Contributions can be made by contacting the PEN: pen@pops.int

What are PCB?

Polychlorinated biphenyls (PCB) are chlorinated, often colourless compounds that occur as liquids or solids. Depending on the number and position of the chlorine atoms in the molecule, the physical and chemical properties vary. This variation is pronounced also for the toxicological properties of the different molecules. PCB have toxicological properties similar to the polychlorinated dibenzo-*p*-dioxins and dibenzofurans (like 2,3,7,8-TCDD) and are named "dioxin-like PCB" (dl-PCB). Once in the environment, PCB enter the food chain. More than 90% of human exposure to PCB is through food, mainly meat, dairy products and fish.

PCB can cause serious health effects in humans and wildlife. Health effects include carcinogenicity, reproductive impairment, and immune system dysfunctions. In the environment, top predators are the most affected. For a substantial part of the human population current exposure to PCB and to dl-PCB is close to the value of the tolerable daily intakes. It is therefore important to minimise any additional human exposure to PCB.

PCB were manufactured worldwide by a small number of companies in mostly industrialised countries and often used as cooling and isolating agents in transformers and capacitors. As the characteristics of PCB are quite advantageous from a technical point of view, they were found in a wide range of applications. Globally, the PCB production peaked in the 1960s and 1970s. Between 1983 and 1993, the production of PCB was stopped in many countries. In some countries it had already been regulated since the early 1970s.

PCB were included in the initial list of the twelve POPs (persistent organic pollutants) under the Stockholm Convention. It bans the production and new uses of PCB and requires international action to eliminate the use of PCB in equipment by 2025 and to manage PCB waste in an environmentally sound manner by 2028.

Applications of PCB

Due to their chemical characteristics and physical stability, PCB commercial products were widely used in open and partially open applications, for example in caulks (sealants), paints, anti-corrosion coatings, small capacitors, and flame retardants (see Figure 1). It is generally believed that PCB were used in open applications between the 1950s and the early 1980s. However, the time of usage of PCB in the different applications may vary from across countries.

The percentage of PCB in the materials highly depends on the type of application, the product itself, and the manufacturer. PCB concentrations can vary considerably and may reach up to 80 %.

PCB from open applications can be released into the environment by weathering and inappropriate removal of PCB containing materials. However, wastes generated from use in open applications are usually not defined as hazardous waste. Current national PCB inventory activities mainly focus on closed systems, such as cooling fluids in electrical equipment, e.g. transformers, capacitors, and switches. It is however important to be aware of the fact PCB applications can be found throughout industrial facilities and other buildings. It is therefore important to consider these applications as inventories are carried out.

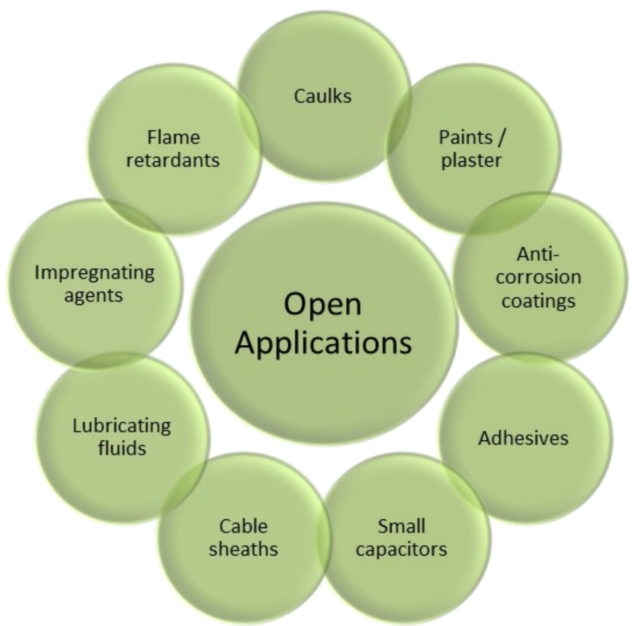


Figure 1: Open applications of PCB

PCB and Asbestos

PCB applications were often installed together with Asbestos materials. Typical examples are fluorescent lights (PCB ballast), with an Asbestos cardboard used as flame-retardant. Furthermore, plaster as well as adhesives can contain and release PCB and Asbestos fibres.

Materials: Fluorescent light ballasts, plaster on walls and façades, floor adhesives etc.

Objects: Houses, residential and public buildings (schools, kindergartens, theatres, universities, hospitals, shopping malls, sports and leisure centres, hotels, swimming pools, car parks, etc.), industries, power plants, military bases etc.

Special: Materials also contain and release asbestos fibres

No immediate risk:
⇒ Ballasts with mark saying “No PCB”
⇒ Objects built after 1979 (US) or 1985 (worldwide)

Potential risk:
⇒ Non-labelled ballasts manufactured before 1980
⇒ Material in good and poor condition may cause diffusion into air, soils and water

High risk:
⇒ Materials in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Flaking coating accessible to public
⇒ Inexpert removal and inappropriate disposal

PCB and Asbestos 'Galbestos' in roofing and siding materials

PCB were used in galvanised steel applications called 'Galbestos'. Theses applications were coated with Asbestos. Galbestos is a type of asbestos-protected metal.

Materials: Galvanised steel sheeting, galvanised corrugated siding panels etc.

Objects: Airlines, railroads, chemical plants, steel mills, mines, industries, military bases etc.

Special: Products also contain and release asbestos fibres

No immediate risk:

⇒ Objects and installations built after 1985

⇒ Objects in good condition

Potential risk:

⇒ Coating in good and poor condition may cause depletion into soils and waters

High risk:

⇒ Coating in fire (formation of dibenzo-p-dioxins and dibenzofurans)

⇒ Flaking coating accessible to public

⇒ Inexpert removal and inappropriate disposal

PCB cross-contamination and back-diffusion

PCB may diffuse from open applications into other materials. PCB-containing caulks, for example, contaminate the surrounding materials (concrete, brick, wood, *etc.*) as well as the caulk backing materials. Analyses in Switzerland revealed that PCB contamination in the caulk concrete edges (3 mm from caulk) is often >1,000 mg/kg. Depending on material type and porosity, paints containing PCB may also greatly diffuse into upper/lower coatings and substances.

Given the fact that PCB spread into other materials, a removal or replacement of the source is not sufficient and cannot be considered sustainable. Trials in Switzerland clearly showed that PCB diffuse back into new materials.

PCB do not only diffuse into materials, but also emit into (indoor) air (see Figure 2 on page 4). Concentrations in indoor air greatly depend on the type of PCB application, the PCB percentage, composition of the PCB product and external conditions (temperatures). Buildings frequented by many people (schools, hospitals etc.) or with long duration of stay (flats) should be given extra consideration.

Example: A joint containing PCB at a concentration of 203,000 mg/kg had been removed. The surrounding structures were left unchanged. Due to back diffusion, the new caulking material was contaminated with PCB within one month. Analysis showed a very high PCB content in the caulk greater than 20,000 mg/kg (on average).

Indoor air concentration is influenced by both primary and secondary sources of PCB. A primary source of PCB is a product to which PCB was intentionally added to improve its characteristics. A secondary source of PCB is a product to which PCB was not intentionally added but that was later contaminated by PCB from other sources (e.g. fogging effect). Both primary and secondary sources continuously emit PCB and must therefore be considered when planning a clean-up.

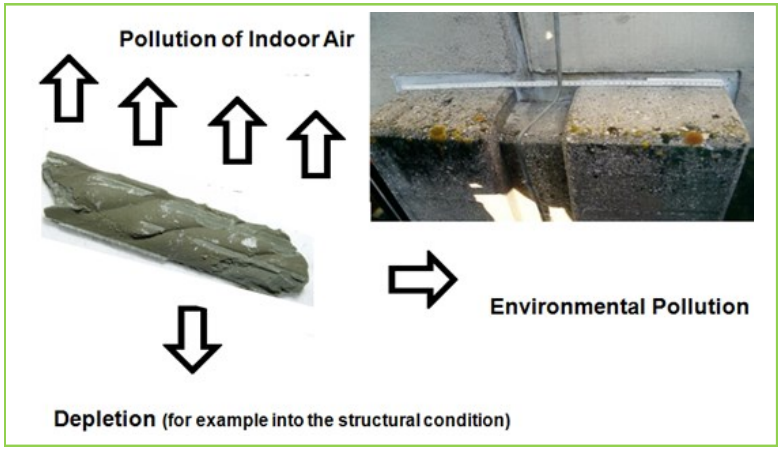


Figure 2: Diffusion of PCB in open applications

In addition to the before-mentioned secondarily contaminated surrounding materials, completely independent items and substances can be affected by PCB. For example, elevated concentrations of PCB were detected in furniture, dirt and dust.

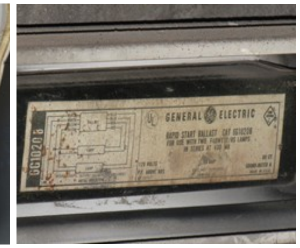
Chemical substitutes

In the 1980s, various PCB applications, such as like flame retardants and plasticisers, were replaced by short-chained chlorinated paraffins (SCCP). However, the risk for humans and the environment from SCCPs is similar to that posed by PCB. When screening a building, object or installation for PCB, the possibility of SCCP contamination should always be considered.

Ballasts manufactured after 1978 may contain another PCB replacement called DEHP (bis(2-ethylhexyl)phthalate). This chemical is suspected to be a human carcinogen.

Generally, screenings of sites, plants and buildings should not only focus on one particular substance, but provide an overall status of the situation. Hazardous chemicals and materials such as asbestos, polcyclic aromatic hydrocarbons (PAH), SCCP, flame retardants, wood impregnation and heavy metals could be found in basically every building, both public and private as well as on industrial sites, in various applications and materials.

PCB in small capacitors (ballasts) and small sized transformers


Typical fluorescent light ballasts contain a small capacitor. The PCB are found in the capacitor oil, the starter and often in the tar-like epoxy resin. The ballasts are normally mounted on the light fixture. Also, small motors often require starting devices that can contain PCB.

Applications: Fluorescent light ballasts, small motors (for example in washing machines, televisions, dishwashers, fridges, and other household machines), street lamps, electro locomotives in industries, specifically in underground mines etc.

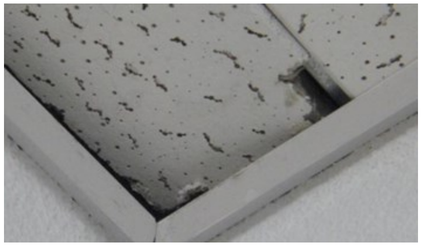
Objects: Residential, public and industrial buildings, mining and other industries, military bases, manufacturing plants, storage halls etc.

No immediate risk:
⇒ Mark saying “No PCB”
⇒ Manufacture after 1979 (US) or 1985 (worldwide)

Potential risk:
⇒ Non-labelled ballasts manufactured before 1980
⇒ Capacitors marked “PCB” in good condition

High risk:
⇒ Capacitors in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Leaking capacitors
⇒ Inexpert removal and inappropriate disposal

PCB as flame retardant and impregnating agent



PCB were often used as flame retardants for wood and cardboard in indoor applications. Another application of PCB was textile coatings. Furthermore, PCB were often used for impregnating wood in outdoor as well as indoor applications.

Materials: Acoustic ceiling tiles, door and floor panels, treated timber, textile coatings (ironing board covers, polyamide yarns), wooden (telephone) poles, pallets, railway tracks, treated timber etc.

Objects: Houses, residential and public buildings (schools, kindergartens, universities, hospitals, shopping centres, hotels, sports halls, theatres, concert halls), outdoor installations etc.

No immediate risk:
⇒ Objects built and installations erected after 1985

Potential risk:
⇒ Flame retardant in good condition, but high PCB content may cause indoor air pollution
⇒ Impregnation in good and poor condition may cause depletion into soils and waters

High risk:
⇒ Materials in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Flaking coating/impregnation accessible to public
⇒ Inexpert removal and inappropriate disposal

PCB in combination with other hazardous substances

PCB were also mixed and combined with other hazardous substances and materials, in order to enhance the properties of a product.

On one hand, PCB were mixed with other hazardous substances, for example, 'Galbestos' metals were coated with a mix of Asbestos and PCB. On the other hand, PCB materials were used in combination with other hazardous products. A parallel installation of PCB containing small capacitors and Asbestos cardboard for fire protection reasons was very common.

Only experienced specialists may screen a site or a building professionally. Although some applications can be identified by visual inspection, random samples and analysis are usually necessary in order to correctly assess the situation.

Read next:

PCB in open applications

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description and risks

PCB in caulks (sealants)

Caulk is a flexible material used to seal gaps. PCB were added to caulk because PCB imparted flexibility. Objects constructed between the 1950s and the early 1980s often contain PCB in their caulks. Old caulks have often lost their flexibility and can therefore be more or less stiff.

Applications: Joints in buildings and other structures, caulks between prefabricated concrete panels, dilatation joints for large brick façades, sealants around windows, door frames and vents, sealants in insulating glazing etc.

Objects: Houses, residential and public buildings (schools, kindergartens, theatres, universities, hospitals, shopping malls, sports and leisure centres, hotels, swimming pools, car parks, etc.), industries, power plants, water reservoirs, military bases etc.

No immediate risk:
⇒ Objects built after 1985
⇒ Silicone and rubber sealants do not contain PCB (unless secondarily polluted)

Potential risk:
⇒ Interior: caulk in good condition, but high PCB content may cause indoor air pollution
⇒ Exterior: caulk in good and poor condition may cause depletion into soils and waters

High risk:
⇒ Caulks in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Deteriorating caulks accessible to public
⇒ Inexpert removal and inappropriate disposal

PCB as lubricating fluid in oils and grease

Prior to 1976 PCB were widely used in lubricating oils for electrical equipment and hydraulic systems because of their exceptional heat transfer characteristics.

Materials: Electrical equipment, air/gas compressors, natural gas turbine compressors, heat transfer, hydraulic systems, vacuum pumps, oil-impregnated gaskets/filters, brake linings, cutting oils, lubricating oils, optical oils, immersion oils etc.

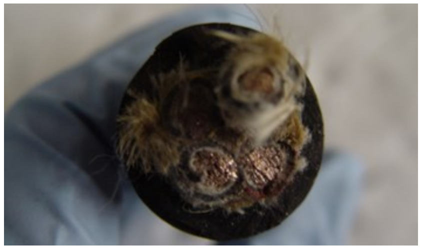
Objects: Industries, power plants, waste water treatment plants, mines, private and public buildings, natural gas pipelines, hospitals, laboratories, research departments etc.

No immediate risk:
⇒ Devices manufactured after 1985

Potential risk:
⇒ Devices contain viscous liquids and may cross-contaminate when released or leaking

High risk:
⇒ Devices in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Leaking devices
⇒ Inexpert removal and inappropriate disposal

PCB in cables and cable sheaths




PCB were added to cable sheaths as flame retardants, plasticisers and impregnation, for example in lead cables. The electrical cable itself can also contain PCB.

Materials: Electrical cables, both PVC and lead jacket, any kind of cable sheaths.

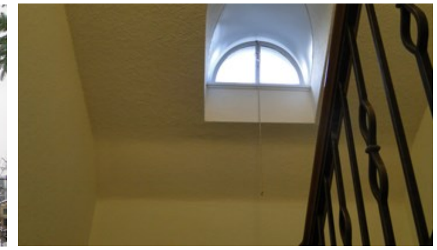
Objects: Harbours, airports, military bases, auto salvage yards, auto crushing, recycling sites (shredders), scrap dealers, landfills, industrial sites etc.

No immediate risk:
⇒ Cables manufactured after 1985

Potential risk:
⇒ Electric cable contains liquids or damp insulation

High risk:
⇒ Cables in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Leaking cables
⇒ Inexpert removal and inappropriate disposal

PCB in paints and plaster

From 1947 to the end of the 1970s, PCB were used as plasticizers, and added to different formulas of paint to enhance the physical and chemical resistance of the paint.

Applications: Paint and plaster on facades and walls, emulsion priming and top coats for use on concrete or plasterwork, for both indoor and outdoor applications.

Objects: Houses, residential and public buildings (schools, kindergartens, theatres, universities, hospitals, shopping malls, sports and leisure centres, hotels, swimming pools, car parks), dams, industries, power plants, military bases etc.

Special: Plasters may contain and release Asbestos fibres

No immediate risk:
⇒ Objects built after 1985

Potential risk:
⇒ Interior: paint in good condition, but high PCB content may cause indoor air pollution
⇒ Exterior: paint in good and poor condition may cause depletion into soils and waters

High risk:
⇒ Paint in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Flaking paint/plaster accessible to public
⇒ Inexpert removal and inappropriate disposal

PCB in paints — Indoor applications

Until the end of the 1970s, PCB were used as plasticisers and flame retardants in paints and varnishes. Products containing PCB were used to coat a very wide variety of surfaces.

Applications: Window frames, doors, radiators, pipes, steel constructions etc.

Objects: Houses, residential and public buildings (schools, kindergartens, theatres, universities, hospitals, shopping malls, sports and leisure centres, hotels, swimming pools, car parks etc.), industrial plants, power plants, military bases etc.

No immediate risk:
⇒ Objects built after 1985
⇒ Objects in good condition

Potential risk:
⇒ Interior: paint in good condition, but high PCB content may cause indoor air pollution

High risk:
⇒ Paint in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Flaking paint accessible to public
⇒ Inexpert removal and inappropriate disposal

PCB in adhesives

PCB were used as plasticisers in adhesives. In case of exposed concrete, PCB were added as adhesives.

Applications: Floor adhesives, adhesive in exposed concrete etc.

Objects*:* Houses, residential and public buildings (schools, kindergartens, theatres, universities, hospitals, shopping malls, sports and leisure centres, hotels, swimming pools, car parks, etc.), industries, power plants, military bases etc.

No immediate risk:
⇒ Objects built after 1985
⇒ Objects in good condition

Potential risk:
⇒ Interior: coating in good condition, but high PCB content may cause indoor air pollution
⇒ Exterior: coating in good and poor condition may cause depletion into soils and waters

High risk:
⇒ Coating in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Flaking coating accessible to public
⇒ Inexpert removal and inappropriate disposal

PCB in anti-corrosion coatings and ASR — other industries

From 1947 to the end of the 1970s, PCB were used as plasticisers in a variety of adhesives. A content of up to 25 % pure PCB was added to some paints, and for example used for military, maritime, and aviation purposes. PCB were also used in the automotive industry, and can often be found in auto shredder residues (ASR).

Applications: Vessels, submarines, aeroplanes, cars, grain silos, window frames, valves, flanges etc.

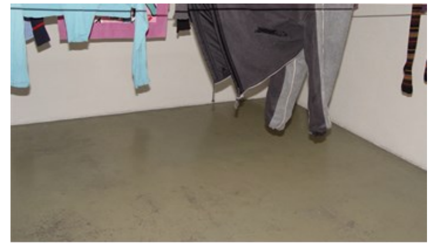
Objects: Harbours, airports, military bases, auto salvage yards, auto crushing, recycling sites (shredders), scrap dealers, landfills, industrial sites etc.

No immediate risk:
⇒ Devices and vehicles built after 1985

Potential risk:
⇒ Interior: paint in good condition, but high PCB content may cause indoor air pollution

High risk:
⇒ Coating in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Flaking coating accessible to public
⇒ Inexpert removal and inappropriate disposal

PCB in surface coatings — floors



Until the end of the 1970s, PCB were used as plasticisers and flame retardants in paints and varnishes. Products containing PCB were used to coat a very wide variety of surfaces.

Applications: Concrete paints and coatings, emulsion priming and top coats for use on concrete or plasterwork, resistant industrial floors, highway marking paints etc.

Objects*:* Houses, residential and public buildings (schools, kindergartens, universities, hospitals, shopping centres, hotels, laundries, swimming pools, sports halls, car parks etc.), industrial plants, power plants, military bases, motorways etc.

No immediate risk:
⇒ Objects built after 1985

Potential risk:
⇒ Interior: paint in good condition, but high PCB content may cause indoor air pollution
⇒ Exterior: paint in good and poor condition may cause depletion into soils and waters

High risk:
⇒ Paint in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Flaking paint/plaster accessible to public
⇒ Inexpert removal and inappropriate disposal

PCB in anti-corrosion coatings — indoor

From 1947 to the end of the 1970s PCB were used as plasticisers in a variety of adhesives. Chlorinated rubber paints were primarily used in anti-corrosion coatings. Products containing PCB were used not only in priming coats but also in middle and top coats.

Applications: Steel supports, steel structures, radiators, pipes, oil fuel tanks, machines, devices etc.

Objects: Houses, residential and public buildings (schools, kindergartens, theatres, universities, hospitals, shopping malls, sports and leisure centres, hotels, swimming pools, car parks, etc.), industries, power plants, military bases etc.

No immediate risk:
⇒ Objects built after 1985

Potential risk:
⇒ Interior: coating in good condition, but high PCB content may cause indoor air pollution
⇒ Exterior: coating in good and poor condition may cause depletion into soils and waters

High risk:
⇒ Coating in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Flaking coating accessible to public
⇒ Inexpert removal and inappropriate disposal

PCB in anti-corrosion coatings — power plants and pipelines

From 1947 to the end of the 1970s, PCB were used as plasticisers in a variety of adhesives. Chlorinated rubber paints were primarily used in anti-corrosion coatings. Products containing PCB were used not only in priming coats but also in middle and top coats.

Applications: Natural gas pipelines, oil pipelines, high pressure water pipelines, turbines, motors, weirs, sluice gates, bridges, steel supports, steel structures, oil tanks, gas tanks, water storage tanks, transformers, machines and devices etc.

Objects: Industrial plants, power plants, nuclear power plants, waste water treatment plants, dam lakes, mines, military bases etc.

No immediate risk:
⇒ Objects built after 1985

Potential risk:
⇒ Interior: material in good condition, but high PCB content may cause indoor air pollution
⇒ Exterior: material in good and poor condition may cause depletion into soils and waters

High risk:
⇒ Coating in fire (formation of dibenzo-p-dioxins and dibenzofurans)
⇒ Flaking coating accessible to public
⇒ Inexpert removal and inappropriate disposal