

PCB in Open Applications & other Building Contaminants – Part I

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Saludos desde los Alpes Suiza - la ciudad Chur



Aims of today

Learn about potentially harmful building contaminants and their uses



Learn about interfaces between PCBs in OA and other building contaminants



In case of interest: a future Webinar could focus on

Preliminary investigations of potential building contaminants



How to sample / analyse



Obtain an insight into removal and disposal of various building contaminants



PCB in closed and open applications

Polychlorinated biphenyls (PCB) are synthetic compounds whose production and use have been banned for decades.

However, PCB can still be found in the environment and in buildings today due to their former use, sometimes on a large scale, in technical construction applications in **closed applications** (e.g. electrical appliances, cooling devices, transformers, capacitors, hydraulic systems) **or open applications** (e.g. paints, coatings, sealants/fillers, plasticisers, adhesives, flame retardants).



PCB IARC* Re-Classification in 2013

- The IARC classified PCB as **carcinogenic to humans (Group 1)**
- Additionally, dioxin-like PCBs were also classified in Group 1

Carcinogenicity of polychlorinated biphenyls and polybrominated biphenyls

In February 2013, 26 experts from 12 countries met at the International Agency for Research on Cancer (IARC), Lyon, France, to reassess the carcinogenicity of polychlorinated biphenyls (PCBs) and polybrominated biphenyls (PBBs). These assessments will be published as volume 107 of the IARC Monographs.¹

PCBs are a class of aromatic compounds comprising 209 congeners, each containing one to ten chlorine atoms attached to a biphenyl nucleus. Technical PCB products, which were manufactured to obtain a specific level of chlorination, are mixtures of many PCB congeners. These products were widely used as dielectric fluid in capacitors and transformers, and to a lesser extent in building materials (eg. caulking, paints, and lighting ballasts). PCB production and new use were banned in most countries by the 1980s, but production has been reported recently in North Korea.

Earlier, occupational exposure was highest during manufacture of PCBs, transformers, and capacitors; today, exposure can come from demolition, dysfunction, or uncontrolled recycling of PCB-contaminated structures and

PCB congeners can be categorised by their degree of chlorination, substitution pattern, and binding affinity to receptors. 12 congeners with a strong affinity for the aryl hydrocarbon receptor (AHR) are referred to as dioxin-like PCBs. PCBs are readily absorbed and distributed in the body, and accumulate in adipose tissue. Biotransformation of all PCB congeners starts with cytochrome P450-dependent mono-oxygenation. Low-chlorinated PCBs are readily metabolised into highly reactive electrophilic species (ie. arene oxides, quinones) which, in addition to producing DNA adducts and reactive oxygen species, are directly genotoxic and mutagenic.² By contrast, highly chlorinated PCBs are poorly metabolised but, through induction of xenobiotic-metabolising enzymes, can also generate reactive oxygen species, lipid peroxidation, oxidative and alkylating DNA adducts, and can eventually cause genotoxic effects.

Individual PCBs activate numerous receptors, including AhR and the constitutive androstane and pregnane xenobiotic receptors (CAR/PXR). AhR activation is one of the key events linked to carcinogenesis mediated

via AhR-independent mechanisms, including metabolic activation. Both low-chlorinated and high-chlorinated PCBs are associated with chronic inflammatory responses. Non-dioxin-like PCBs can stimulate the production of inflammatory mediators, whereas dioxin-like PCBs can inhibit such reaction. By contrast, some dioxin-like PCBs, but not non-dioxin-like PCBs, can compromise the normal function of the vascular endothelium.

PCBs target the endocrine system. Several models have shown direct modulation of nuclear steroid hormone-dependent gene expression by PCBs. Furthermore, depending on their structure, monohydroxylated PCB metabolites can act as oestrogen agonists or antagonists. These disruptions might have reproductive, toxic, and carcinogenic consequences.

The Working Group considered more than 70 independent epidemiological studies with informative data for carcinogenicity of PCBs in human beings. Excess risks for melanoma were reported in several studies, mainly cohort studies of workers in the manufacture of capacitors and transformers, and



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[http://dx.doi.org/10.1038/S1470-2045\(13\)01044-9](http://dx.doi.org/10.1038/S1470-2045(13)01044-9)

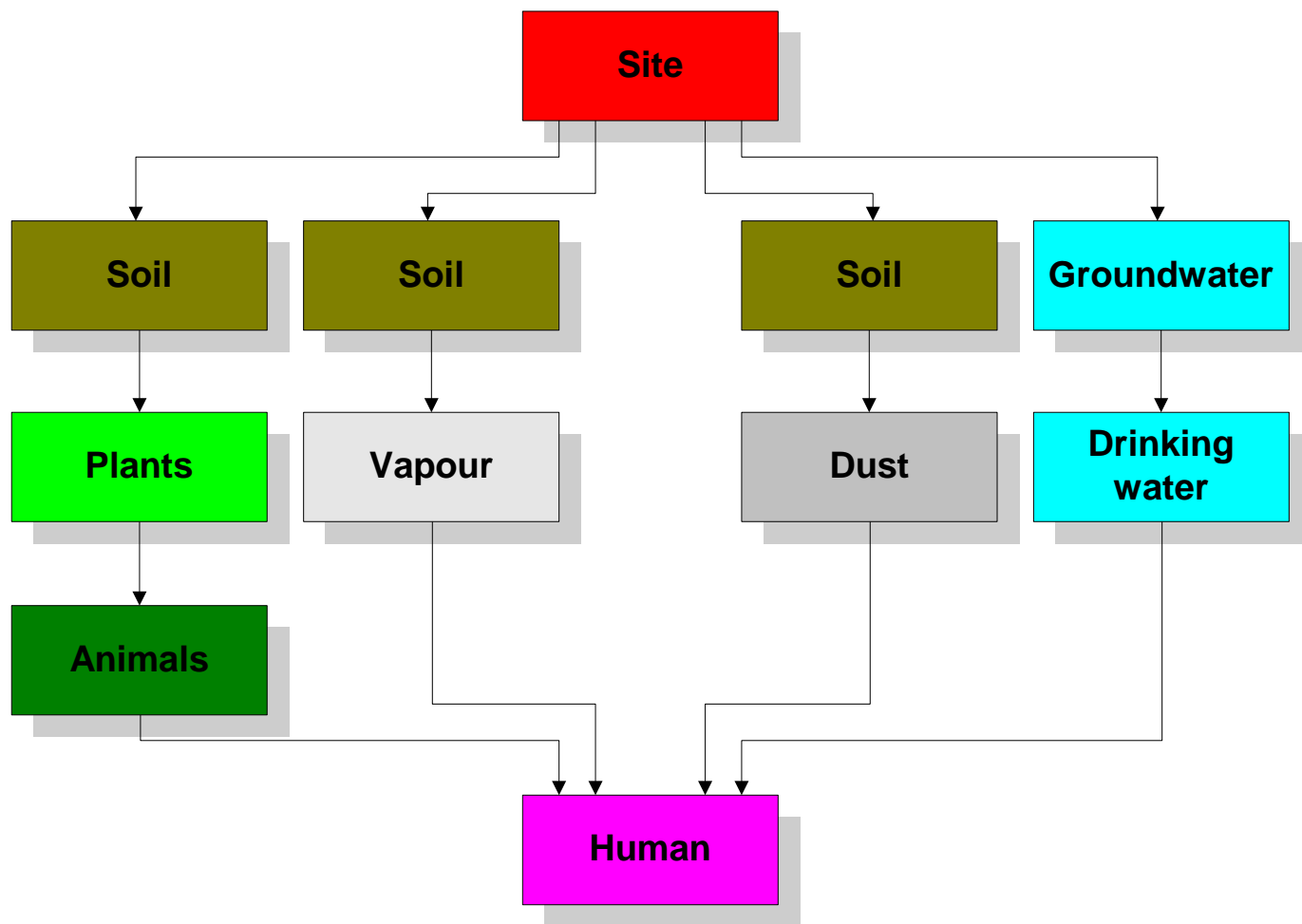
For more on the IARC Monographs see <http://monographs.iarc.fr/>

Upcoming meetings
IARC 4-11, 2013
Volume 108: Some drugs and herbal medicines
Oct 8-15, 2013
Volume 109: Ambient air pollution

Monograph Working Group Members
V J Costanzo (USA) - Chair
K Aronow, H Tophanes (Canada), Y L Guo (Taiwan, China), M Machala (Czech Republic),
E C Buserfeld-Jørgensen, E Skerfving (Denmark), J P Castejón, B Le Bosc, J F Narbonne (France), H Echi (Germany), P Cocchi, F Marconi (Italy), B Vermeulen (unable to attend, Netherlands), A Agudo (Spain), N Johnson (Sweden), H Foellmer, N Hogd

* International Agency for Research on Cancer

Environmental impacts of POPs



Primary Ways of Exposition

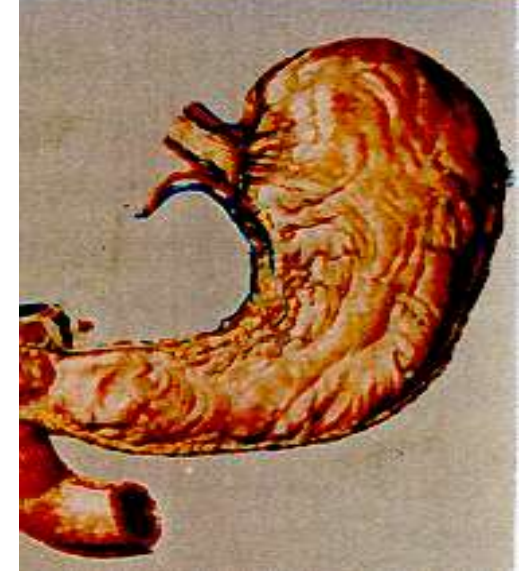
Skin



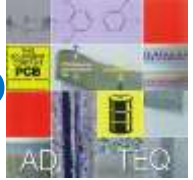
Respiration



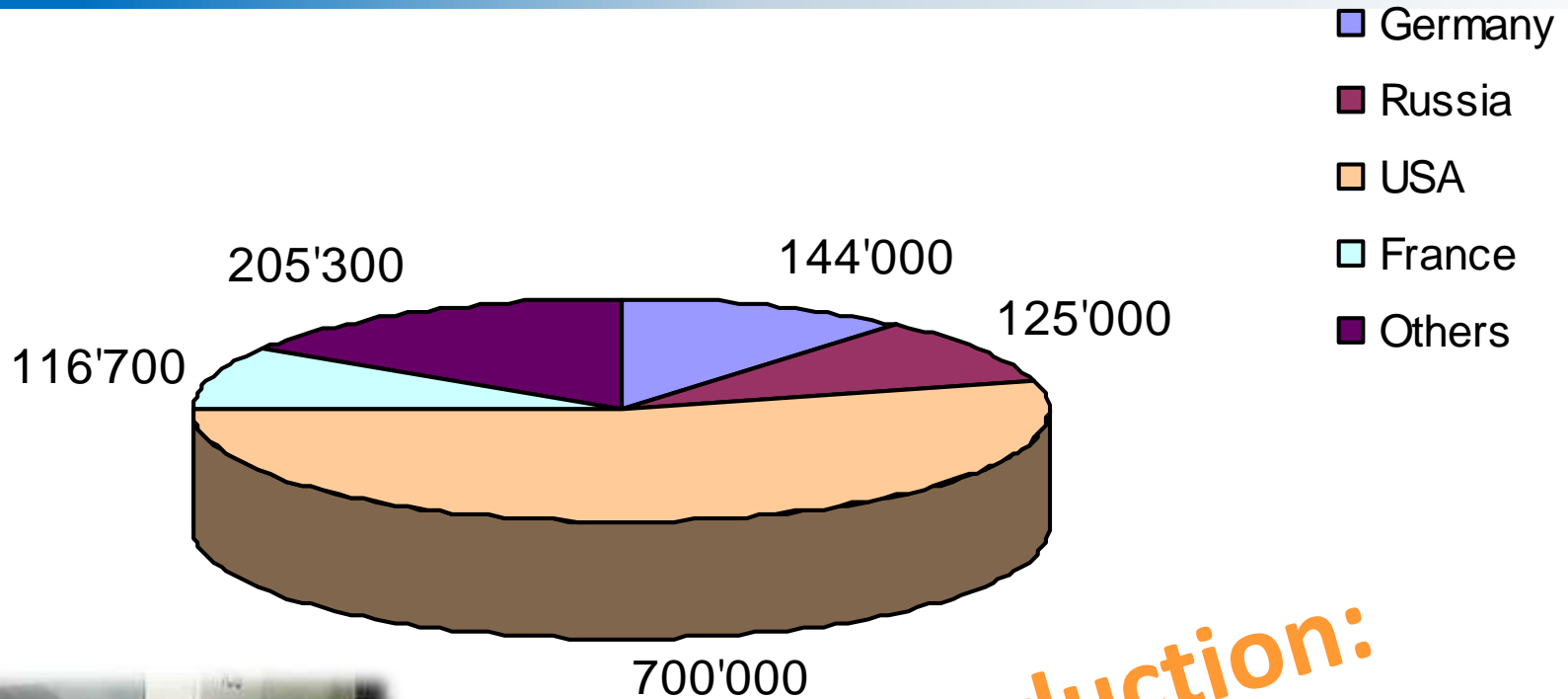
Stomach



Exposure PCB closed vs open applications?



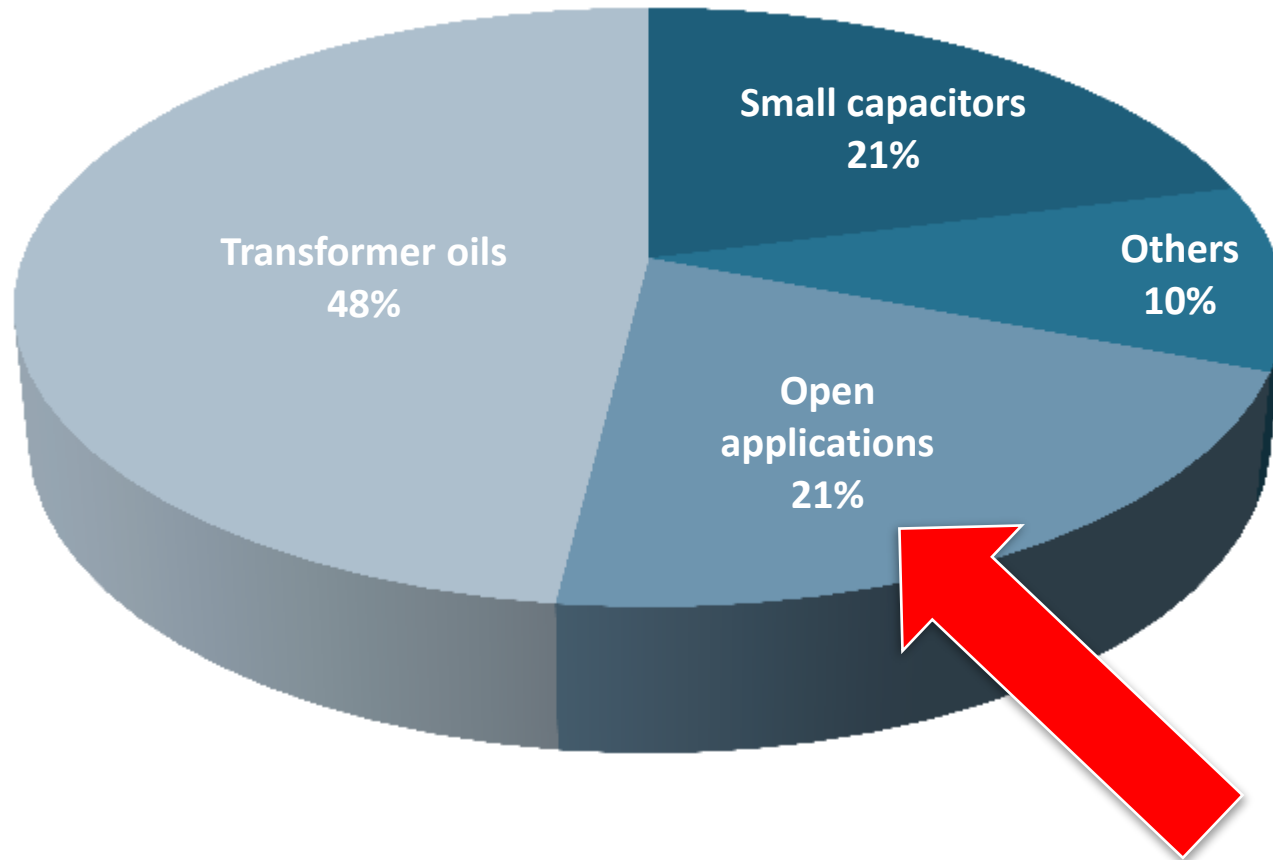
World production of PCBs



**Total world production:
1.3 - 2.0 million tons**



Applications of PCBs



Stockholm Convention (SC)

- PCBs are one of the original 12 POPs covered by the Stockholm Convention.
- PCB are listed in Annex A and C to the Stockholm Convention, including the following provisions for Parties to the Stockholm Convention:
 - › Parties to ban the production and new uses of PCB;
 - › Parties to make determined efforts to identify, label and remove from use equipment (e.g. transformers, capacitors or other receptacles containing liquid stocks) containing PCB by 2025;
 - › Parties to make determined efforts designed to lead to environmentally sound waste management of liquids containing PCB and equipment contaminated with PCB as soon as possible but no later than 2028;
 - › Parties to identify other articles containing PCB (open applications) and manage them in an environmentally sound manner; and
 - › Parties to allow export or import PCB only for the purpose of environmentally sound waste management.

SC, Annex A, Part II, PCB (f)

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



To be considered

Stockholm Convention
persistent organic
contaminants (POPs)

Assessments and inventories
for any environmental



COPS

BASEL / ROTTERDAM / STOCKHOLM
CONVENTIONS

Stockholm Convention Text:

In lieu of note (ii) in Part I of this Annex, equipment containing more than 0.005 % PCB (e.g. cable-sheathings) shall be managed in accordance with paragraph 2.

containing
and

Draft guidance for development of PCB inventories and analysis of PCB, May 2021:
The inventory for open application is **voluntary** according to decision SC-9/3.
The cut-off concentration is the same as for PCB in equipment, i.e., at or greater than 0.005% or 50 mg/kg.

Open applications of PCB can be found everywhere



Advantages = Disadvantages

PCBs are ubiquitous in the environment:

- Persistent in the environment
- **Stable to aging**
- Bio accumulating
- Harmful to wildlife and human beings

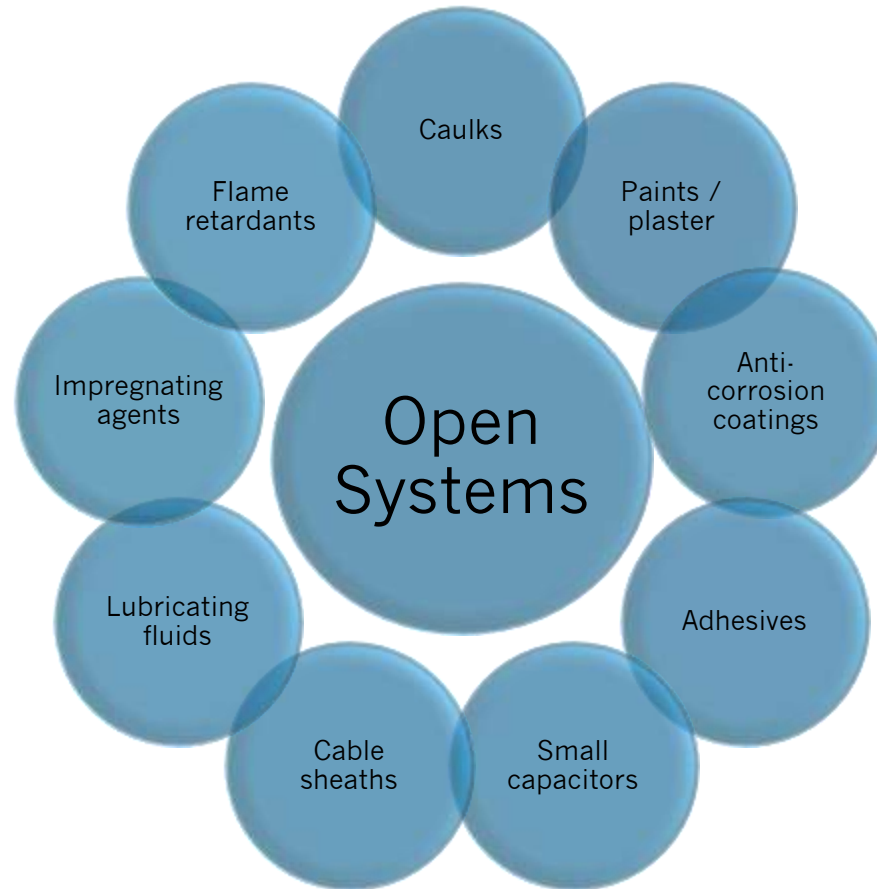
Persistence



Advantage = Disadvantage...



Partially and Open applications of PCBs














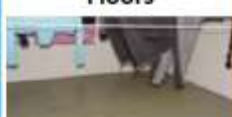
PCB in open applications ...

Polychlorinated Biphenyls (PCBs) in Building Materials

ENTER AT YOUR OWN RISK



Where can PCB containing materials be found— indoors?

Ceilings  ⇒ Caulks (sealants)	Acoustic ceiling tiles  ⇒ Paint ⇒ Flame retardant	Fluorescent lamps  ⇒ Small capacitors ⇒ Ballasts	Walls  ⇒ Caulks (sealants) ⇒ Paint
Windows  ⇒ Caulks (sealants) ⇒ Paint	Doors  ⇒ Caulks (sealant) ⇒ Paint	Radiators  ⇒ Paint	Pipes  ⇒ Paint
Fuel oil tanks  ⇒ Anti-corrosion coating	Steel constructions  ⇒ Paint	Floors  ⇒ Caulks (sealant)	Floors  ⇒ Paint

Where can PCB containing materials be found— outdoors?

Concrete facade  ⇒ Caulks (sealants)	Brick facade  ⇒ Caulks (sealants)	Plaster facade  ⇒ Plaster ⇒ Paint	Balconies  ⇒ Caulks (sealants) ⇒ Paint
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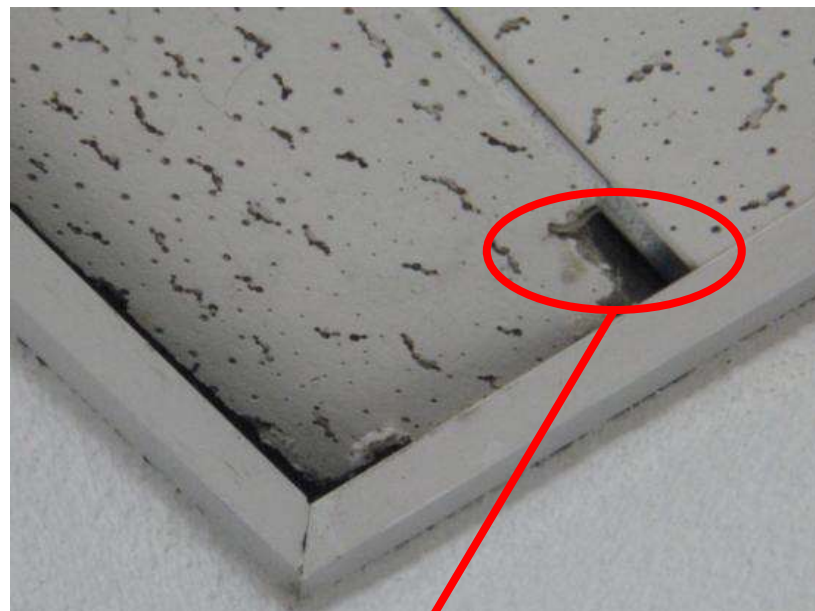
Caulks: Exterior



Paints and coatings residential and school buildings



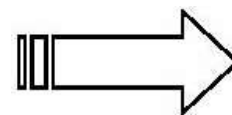
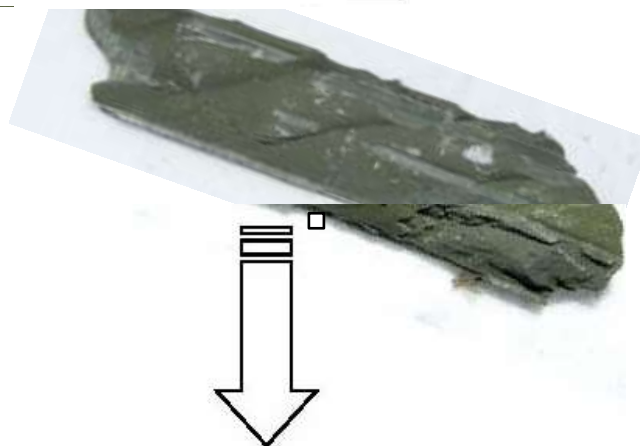
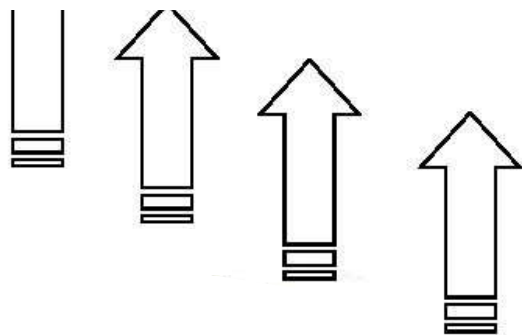
Flame retardants in Ceiling tiles: PCBs or Asbestos?



Paths of emission



Pollution of Indoor Air



**Environmental
Pollution**

Depletion (for example into the structural condition)

Guide Values for PCB in Indoor Air

The release of PCBs from open applications such as joint sealants and coatings into indoor air can still be significant today if buildings or rooms have not been renovated or have been renovated inadequately.

The German PCB-Guideline, which was introduced in the 1990s in most federal states of Germany as a technical rule, supports the assessment and remediation of existing harmful PCB concentrations in buildings.

Bundesgesundheitsblatt January 14th 2025.

Guide Values for PCB in Indoor Air

PCB in indoor air are analysed by determining the 6 indicator congeners PCB 28, 52, 101, 138, 153 and 180 multiplied by a factor of 5, called the LAGA Factor.

A precautionary value of 300 ng/m³ in indoor air are specified in the German PCB-Guideline for health assessment purposes.

The experimental animal data on which these values are based no longer correspond to the current state of knowledge on the effects of PCB on human health. Recent studies show that compliance with these values does not provide sufficient protection against the harmful effects of PCB.

Bundesgesundheitsblatt January 14th 2025.

Chur / Switzerland: High School



11'260 ng PCB per m³
in indoor air

Summary of PCB quantity in a Swiss high school

approx. 15 km of PCB containing caulks



PCB up to 30 %



approx. 0,25 kg caulks/m'



approx. 3.750 kg caulks



approx. 1.1 t PCB



2023-2025: Teachers College SCCP!

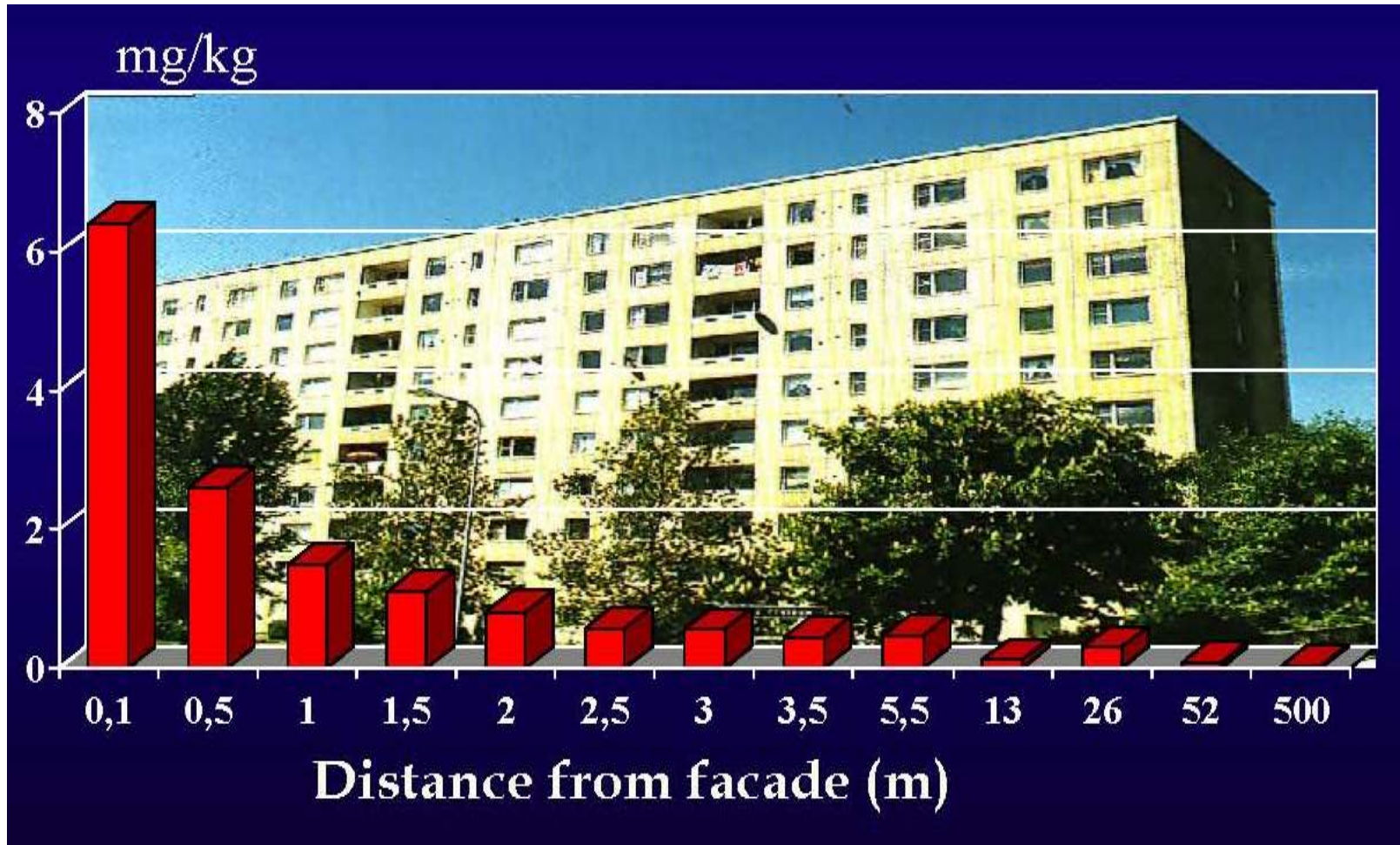


Gordon Hall Boston => «old building»



**Caulks/sealants:
337'256 ppm Aroclor 1254**

PCB in soil close to a “PCB Building”



Source: Niklas Johansson Swedish EPA and Karolinska Institute

How are the first experiences in Colombia?



Desarrollar un diagnóstico y un plan para la gestión de los PCB en aplicaciones abiertas.



Please find following additional slides for your information

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Publications as e.g. Consolidated Guidance PCB in OA 2019



Stockholm Convention on Persistent Organic Pollutants (POPs)

This site lists: Stockholm Convention > Implementation > National POPs > PCB > Guidance

Guidance

The following guidance documents provide information on all aspects of the environmentally sound management of polychlorinated biphenyls (PCBs), including identification and inventorying of PCBs, regulatory frameworks, handling, transport, storage and disposal, development of risk strategies and phase-out plans as well as advice on potential funding mechanisms for PCBs elimination.

1. PCB identification and inventory 2. PCB disposal 3. Open applications
4. National strategies and phase-out plans

This section provides information on the use of PCBs in open system applications.

Title	English
Consolidated Guidance on PCB in Open Applications (March 2019)	
Open systems uses of PCBs, SPEN 2009	
Factsheet on Open Applications: Machinery and Installations	
Photo Booklet on Open Applications	
Factsheet on Open Applications: Residential and Public Buildings	

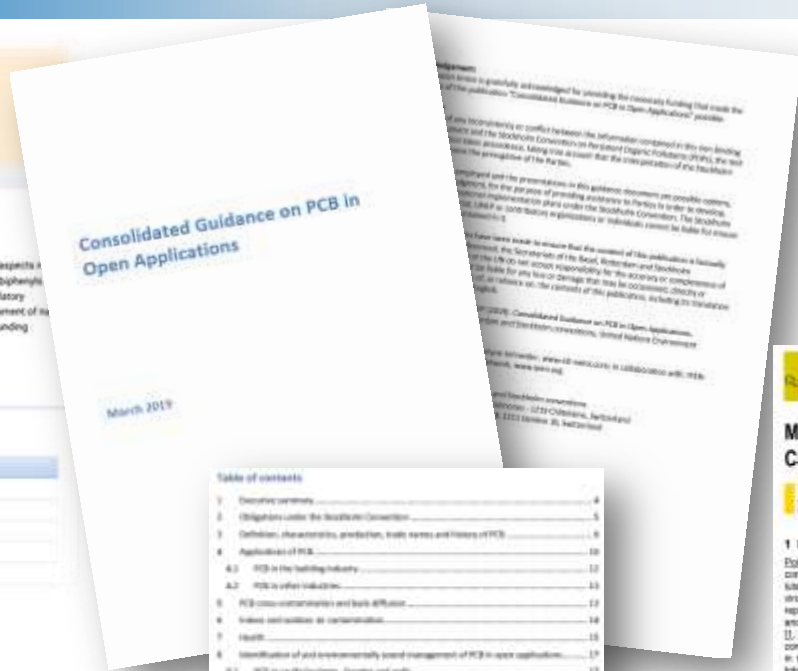


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PCBs – Case Study Switzerland 07 | 2014

Management of PCBs from Open and Closed Applications – Case Study Switzerland

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 Alan Wilson, Public Interest Consultants, Dulwich, Westford, Essex, Essex SA4 5TY, United Kingdom
 Roland Weber, POPs Environmental Consulting, Lindenstrasse 21, D-74337 Schönbuch (Baden), Germany

1 Background and Objectives

Polychlorinated biphenyls (PCBs) are one of the most common and widely dispersed persistent organic pollutants (POPs). PCBs can have serious health and environmental effects, which can include carcinogenicity, reproductive impairment, immune system disruption and effects on wildlife, a loss of biological diversity etc. (1, 2, 3, 4). Most PCBs were manufactured by several companies in various industrialised countries mainly in the Northern Hemisphere. It is estimated that the total production was approximately 1.2 million tonnes of which 40% of PCBs were used for transformer oil, ca. 21% for small capacitors, 10% for other non-metallic dielectric systems such as heat transfer systems and hydraulic systems, particularly in mining equipment, and approximately 21% for open uses (5). Open and partially open applications included e.g. caulks/sealants (Figure 1), paints (Figure 2), adhesives, air-conditioning, copy paper and flame retardants (Table 1). The latter share was used in buildings and other applications.

According to Annex A, Part 4 (f) of the Stockholm Convention, Parties to the Convention are obliged to eliminate electrical equipment and sets containing PCBs from use by 2028 and to manage them using environmentally sound waste management by 2028. Therefore PCB inventories prepared for the Stockholm Convention focus mainly on the closed applications such as PCB-containing transformers and capacitors (see paragraph 4 below) (Stockholm Convention PCBs). However, Annex A, Part 4 (f) of the Stockholm Convention requires that efforts should be made to identify other articles containing more than 0.005% PCBs including uses in open applications and to manage them in an environmentally sound manner in accordance with paragraph 1 of Article 6. Apart from this requirement of the Stockholm Convention, the handling, remediation, removal and disposal of PCBs uses in open applications of PCBs are not yet regulated by any international guidelines despite their high relevance for human and environmental exposure. Due to the lack of regulations and awareness, obsolete kettles, generators, power aggregates etc. painted with PCB (Figure 2) are often labelled as being re-usable and are therefore outside the scope of the Basel Convention, Article 5(1) (g)(ii) of the Stockholm Convention which requires that open-becoming wastes articles are not permitted to be subjected to disposal operations that may lead to recovery, recycling, reclamation, direct reuse or alternative uses of persistent organic pollutants needs to be applied more stringently. This fact sheet therefore focuses on PCBs in open applications as these uses have been given relatively little attention by most countries.

Since current PCB inventory activities under the Stockholm Convention focus mainly on the closed applications this situation on PCB inventory and management of closed systems is described briefly in chapter 4 and links to related guidance papers and technical reports in chapter 5.

The remediation and management of PCBs in open applications is important because of the relatively high levels of human exposure and environmental release compared to closed systems and their associated health effects. Although open uses accounted for only approx. 21% of the total production it is estimated that approximately 55% of the total PCB emissions here come from these open system uses (5). Long-term exposure to even small concentrations can have adverse effects on human health, especially on the unborn child (6, 7).

Chalk/Gypsum (buildings, bridges), stone walls, gravel sewers	Labelling fluid in oils and greases, cutting oils
Floors and plaster (buildings, construction, swimming pools, machinery)	PCBs as flame retardant and intumescent agent (e.g. motor wheel bearing for cars) and flux (tablets) (17)
Air emission coatings (ducts and chimneys)	Adhesives
Sealed double glazing windows (e.g. in floors)	Carbonless copy paper
Surface coatings (for example floor)	Protective sealants
Cables and cable sheaths	inks

Table 1: Some open applications of PCBs

Publications on PCB in open applications can be downloaded from the SC website and will be shared together with more information and Links in the Webinar follow up by UNITAR

Partially open applications

Heat transfer fluids

Hydraulic fluids (mining industry)

Vacuum pumps

Switches

Voltage regulators

Liquid filled electrical cables

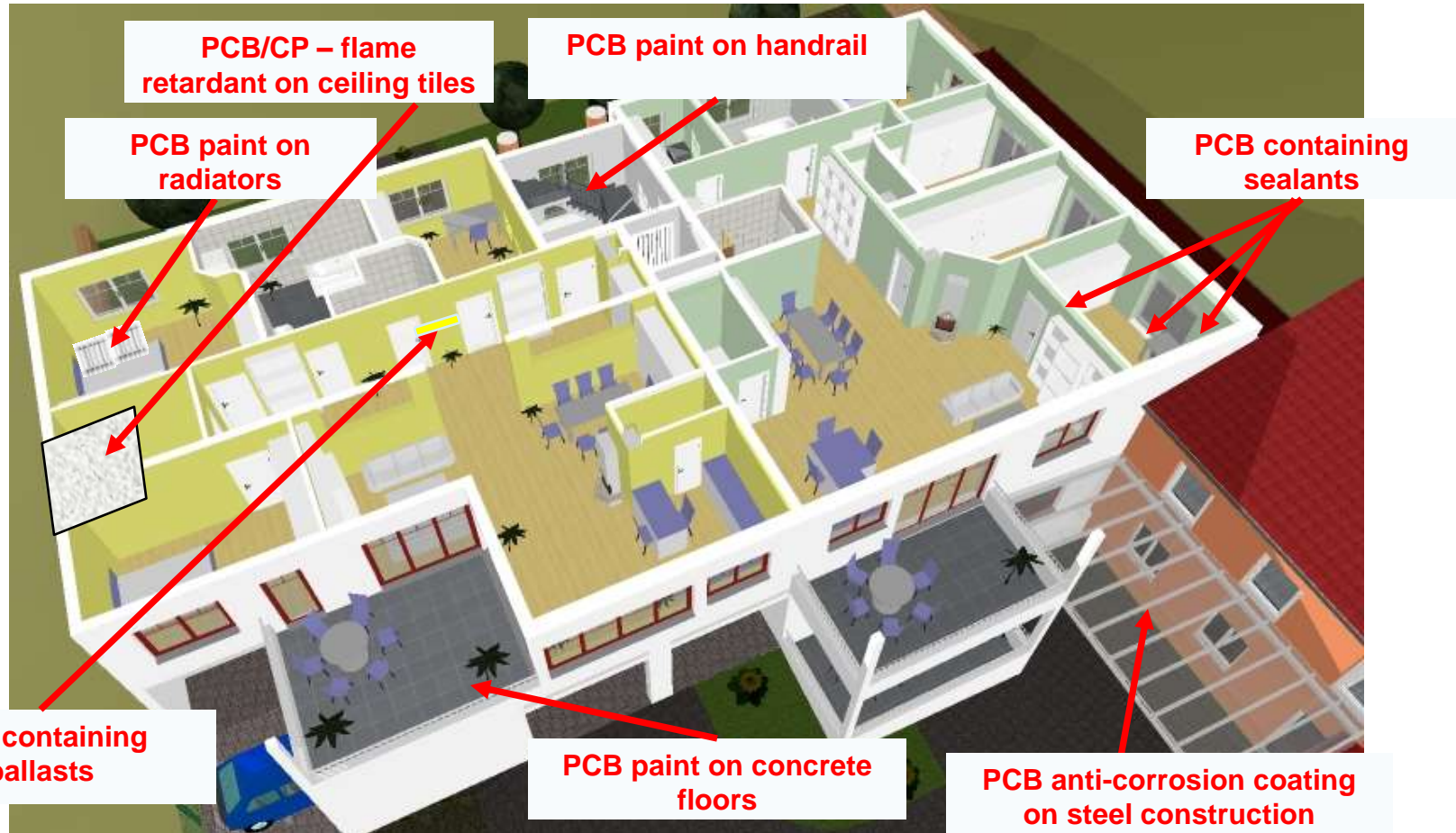
Liquid filled circuit breakers



Mining Sector: Sources of PCB suspected material; as well as confirmed use of PCB containing paint (and Asbestos)



PCBs: a few potential indoor sources



In recent exposure studies, the proportion of PCB inhaled via indoor air contaminated with PCB has been plausibly quantified for the first time. This means that it is now possible to evaluate the inhaled PCB levels collected under realistic exposure conditions in relation of the effect thresholds determined in animal studies.

Against this background, the AIR derives a precautionary value (indoor air guide value I) of $0.080 \mu\text{g}/\text{m}^3$ ($80 \text{ ng}/\text{m}^3$) and health hazard value (indoor air guide value II) of $0.80 \mu\text{g}/\text{m}^3$ ($800 \text{ ng}/\text{m}^3$) for the PCB substance group.

Bundesgesundheitsblatt January 14th 2025.

Guideline for the Assessment and Remediation of PCB-Contaminated Building Materials and Components in Buildings (PCB Guideline).

The PCB Guideline regulates the measurement, assessment, and remediation of PCBs in indoor spaces in Germany.

Both the intervention value (3,000 ng total PCB/m³) and the precautionary value (target value or remediation guideline value of 300 ng total PCB/m³) of the PCB Guideline are based on the derivation of a Tolerable Daily Intake (TDI).

Bundesgesundheitsblatt January 14th 2025.

Exposure Values of the US EPA for PCBs in Indoor Air of Schools



Permissible values between 100 and 600 ng/m³ have been derived for different age groups.

Age	1 - < 2 years*	2 - < 3 years*	3 - < 6 years**	6 - < 12 years**	12 - < 15 years**	15 - < 19 years**	> 19 years*
PCB-Concentration [ng/m ³]	100	100	200	300	500	600	500

Duration of Stay: *8 hours/day for 185 days per year; **6.5 hours/day for 180 days per year

How to proceed?

- Information - Awareness Raising
- Name the stakeholders
- Involve the public sector
- Good News: Many POPs are already regulated

- Investigate into Import and building history
- Focus on construction and Renovation years

=> PCBs have been mainly used from WW2 until mid Nineties; OA were banned in many countries
 => (SC)CP were a replacement product of PCBs, mainly used from the Eighties to the Nineties
 => Asbestos has been used from earlier, in some countries until today

- Where to find? How to sample? How to analyse?

=> Build a roster of experts
 => Develop national guidelines based on existing POPs and Waste regulations
 => Ensure professional deconstruction and controlled waste streams / recycling!



Schadstoffe im Bau Sanierung ohne Risiko

Asbest ist der tödlichste bekannte Bauschadstoff in der Schweiz. Aber auch bei anderen Stoffen ist bei Um- und Rückbauten Vorsicht geboten. Haben Sie zum Beispiel schon von «PCB» und «PAK» gehört? Bevor der Bagger auffährt, sind Abklärungen unerlässlich.

Von Schweizerischer Eidgenossenschaft - Eidgenössische Eidgenossenschaft

Sie sind für die Sanierung von Gebäuden im Bauwesen verantwortlich. Sie müssen wissen, dass es bei Um- und Rückbauten oft zu Schadstoffbelastungen durch Asbest, PCB und PAK kommen kann. Diese Schadstoffe sind gefährlich für die Gesundheit und die Umwelt. Sie müssen also wissen, wie Sie diese Schadstoffe erkennen und beseitigen können.

Das Wissen der Bevölkerung über PCB ist der wichtigste Bestandteil der schweizerischen Sanierungsrichtlinien für Gebäude und Bauteile. Es ist wichtig zu wissen, dass PCB in vielen Materialien verwendet werden, die in Gebäuden und Bauteilen verwendet werden. Sie müssen also wissen, wie Sie diese Materialien erkennen und beseitigen können.

! PAK und PCB werden nicht nur durch das Einatmen belasteter Stäube, sondern auch durch das Berühren von schadstoffhaltigen Materialien über die Haut aufgenommen.

