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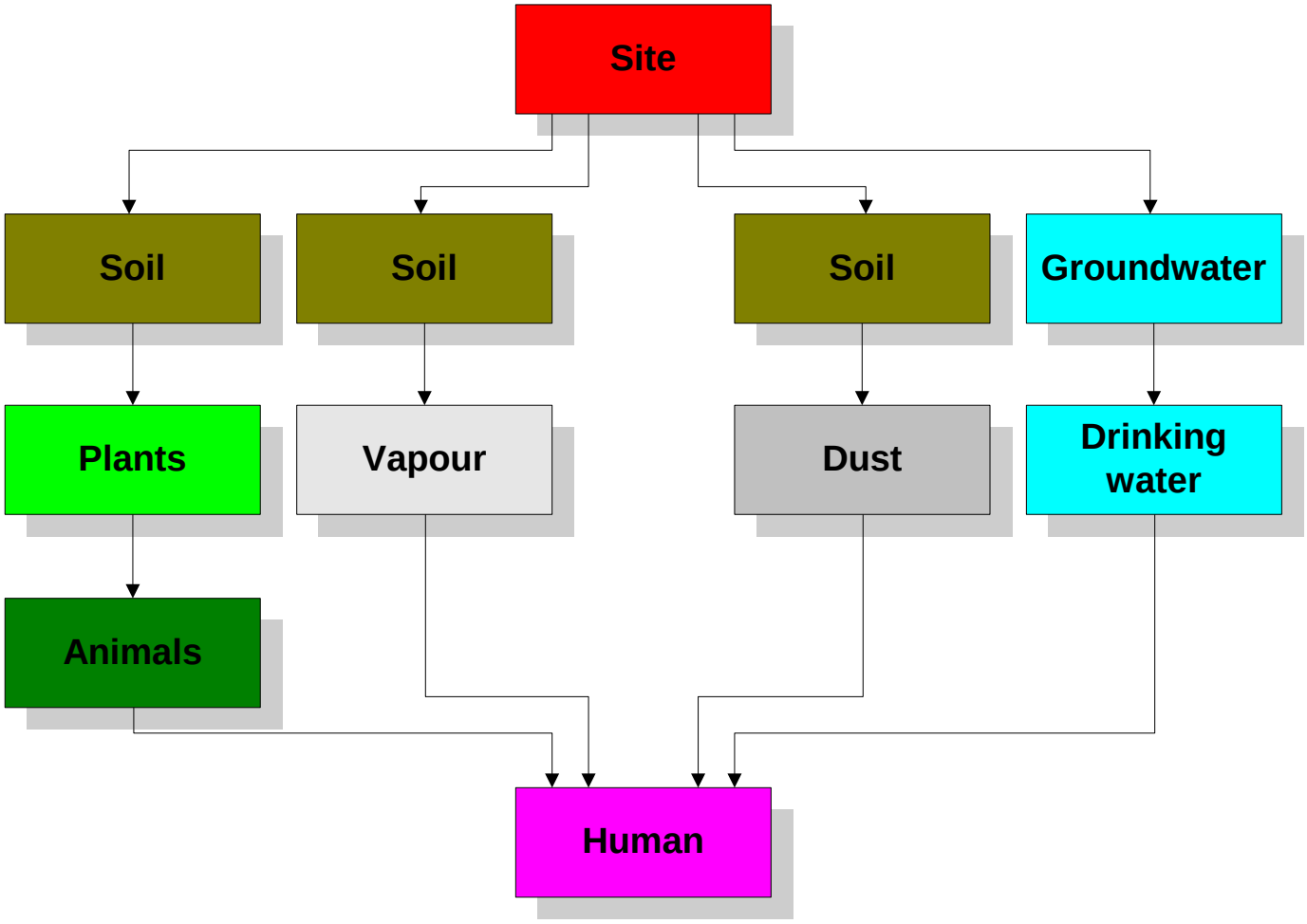
For more on the IARC Monographs see http://monographs.iarc.fr/

Upcoming meetings
June 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 Cogliano (USA)–Chair; K Ayrsmen, H Tryphonas (Canada); Y L Guo (Taiwan, China); M Machala (Czech Republic); E C Bonefeld-Jørgensen, K Vorkamp (Denmark); J P Cravedi, B Le Bizec, J F Narbonne (France); H Esch (Germany); P Cocco, F Merletti (Italy); B Vermeulen (Unable to attend, Netherlands); A Agudo (Spain); N Johansson (Sweden); H Fiedler, N Hopf

* International Agency for Research on Cancer

Environmental impacts of POPs

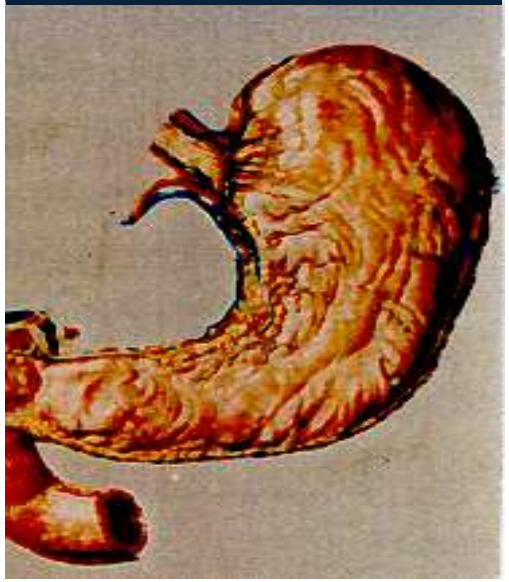


Primary Ways of Exposition

Skin

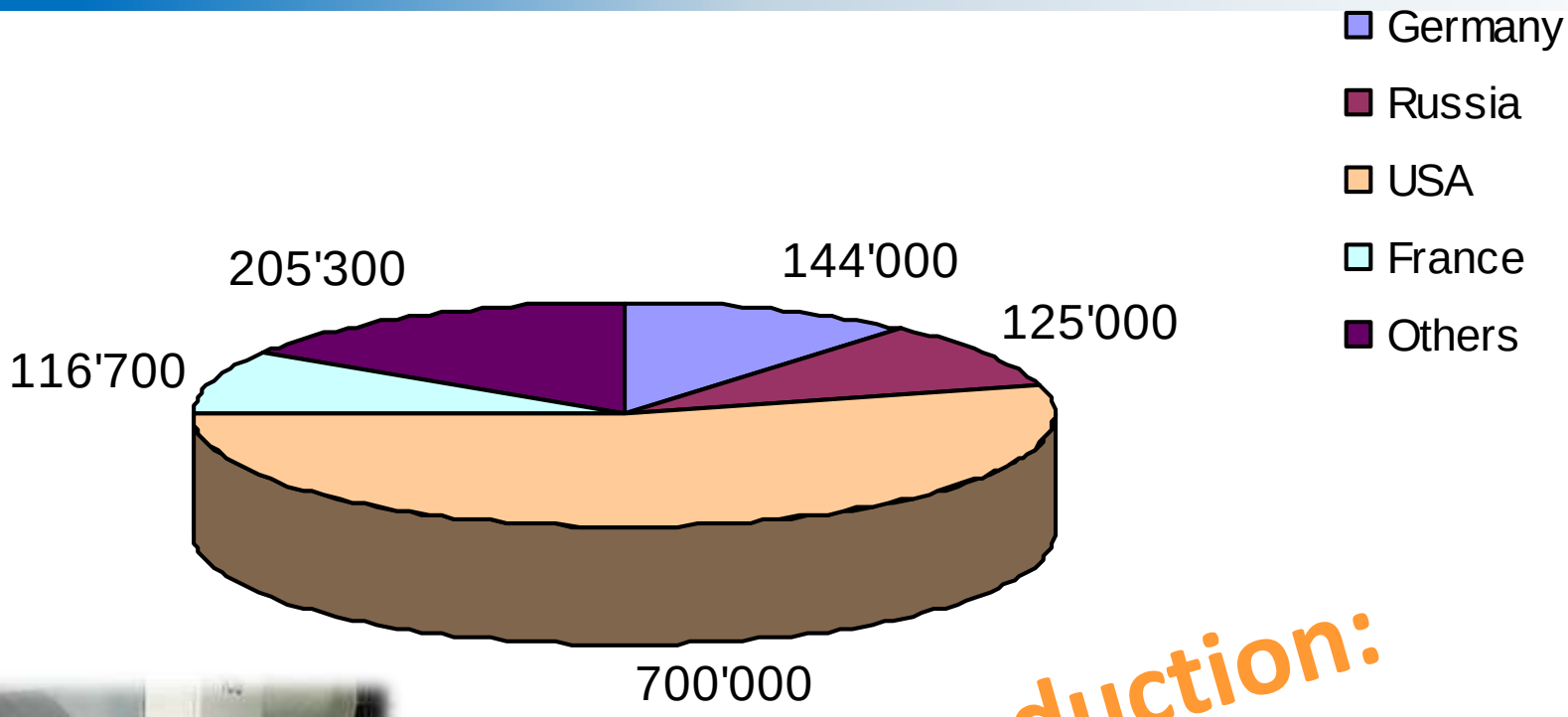
Respiration

Stomach



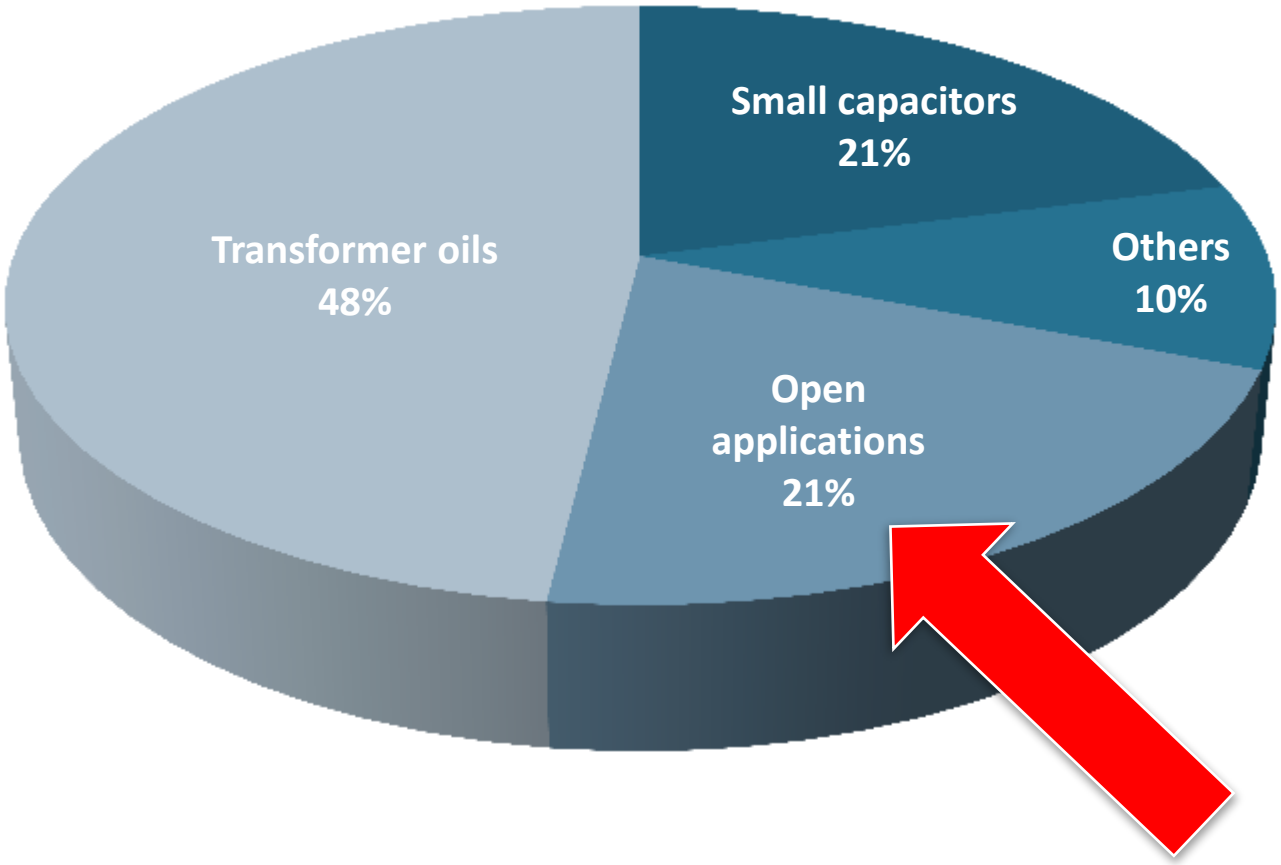
Exposure PCB closed vs open applications?

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

Assessments and inver
for any environmental

Stockholm Convention Text:

In lieu of note (ii) in Part I of this Anne aining more than 0.005 % PCB (**e.g. cable-sheat** and manage them in accordance with paragraph

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

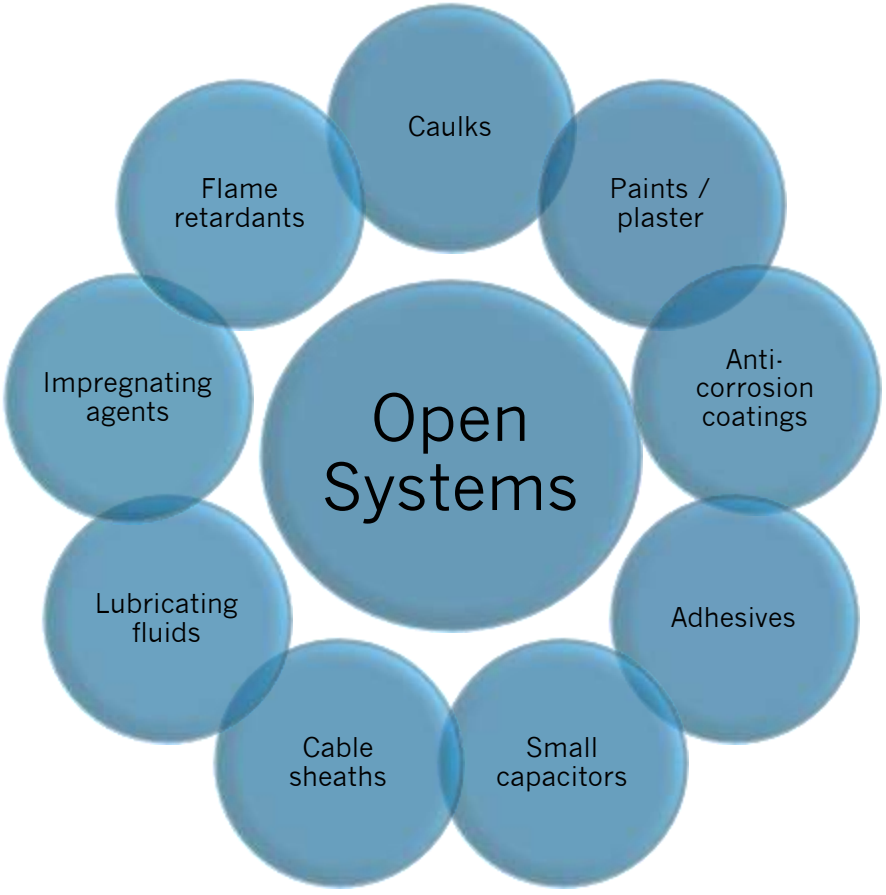
PCBs are ubiquitous in the environment:

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

Persistency

Advantage = Disadvantage…

Partially and Open applications of PCBs



PCB in open applications …

Where can PCB containing materials be found— indoors?

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

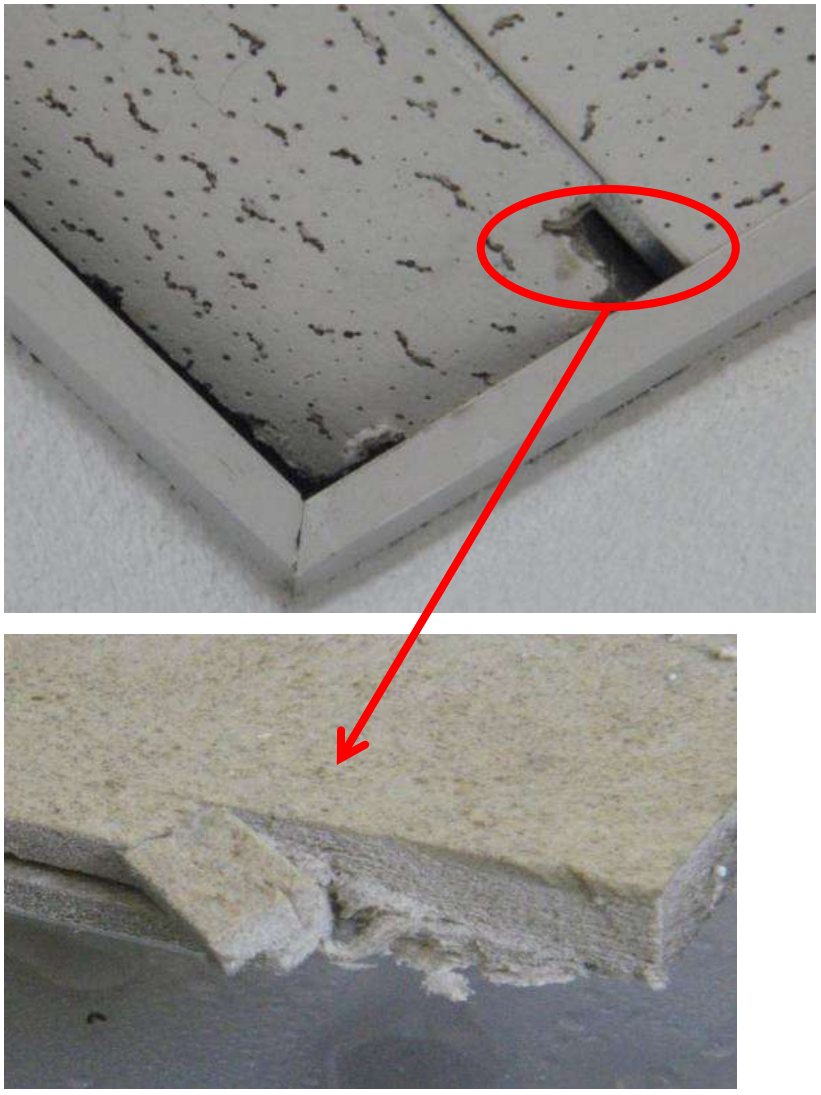
Where can PCB containing materials be found— outdoors?

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

Caulks: Exterior

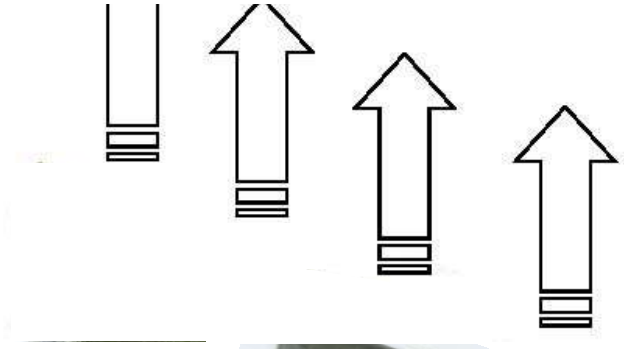
Paints and coatings residential and school buildings

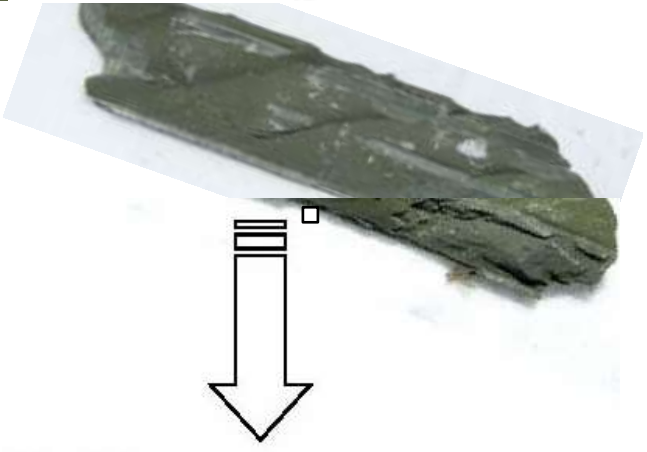
Flame retardants in Ceiling tiles: PCBs or Asbestos?

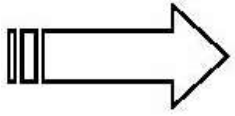


Paths of emission

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/m^3 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

↓

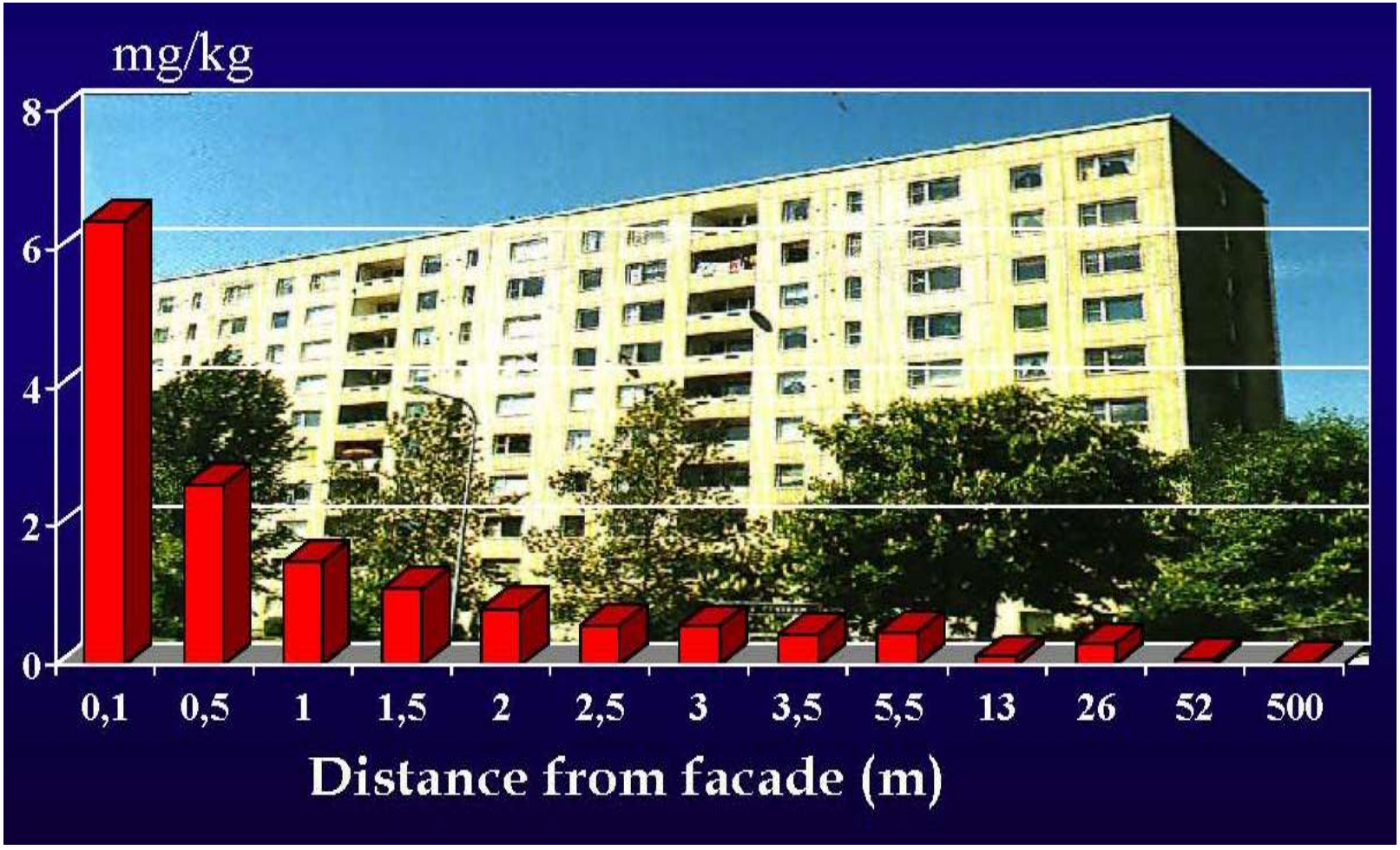
approx. 1.1 t PCB

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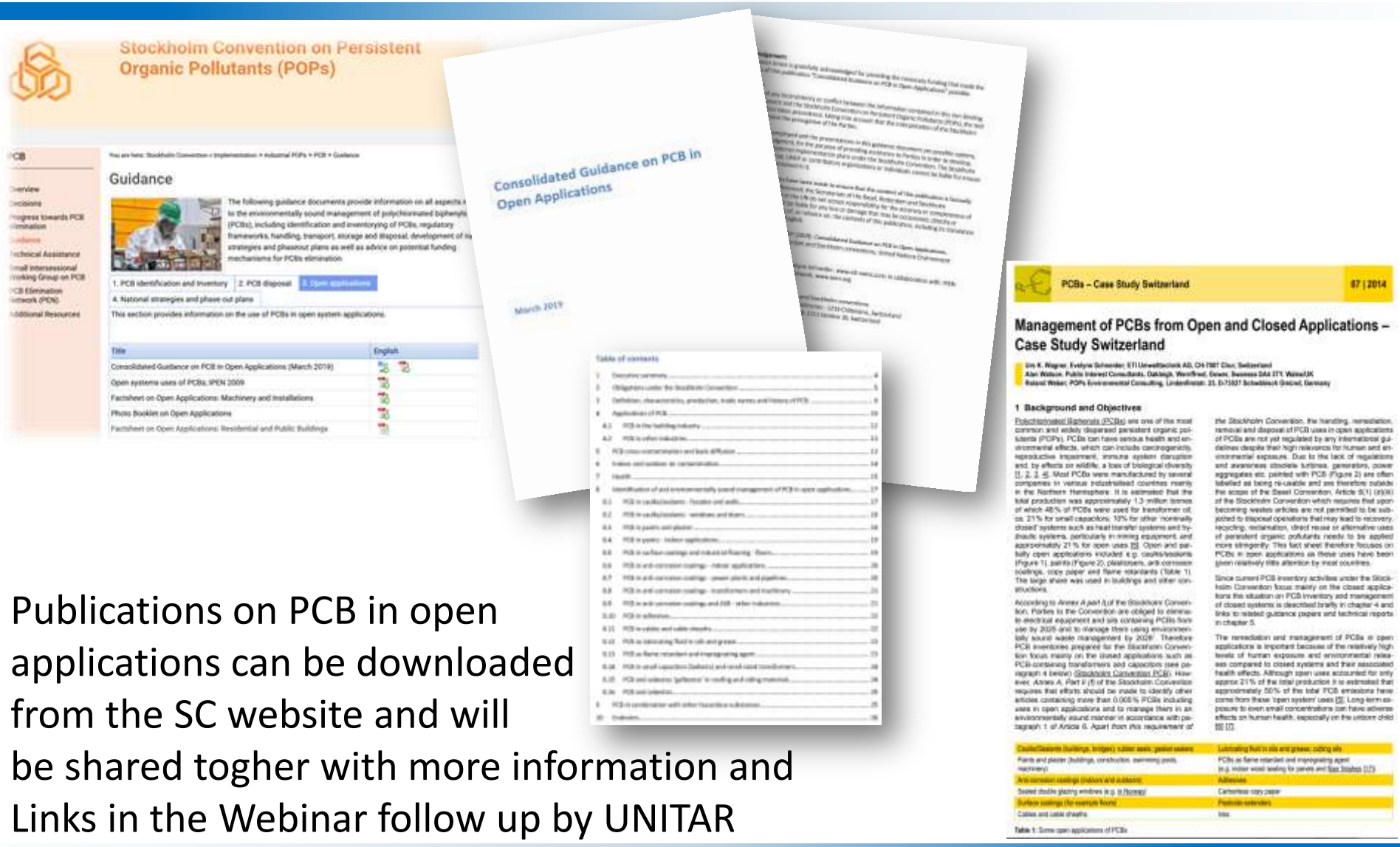
Publications as e.g. Consolidated Guidance PCB in OA 2019



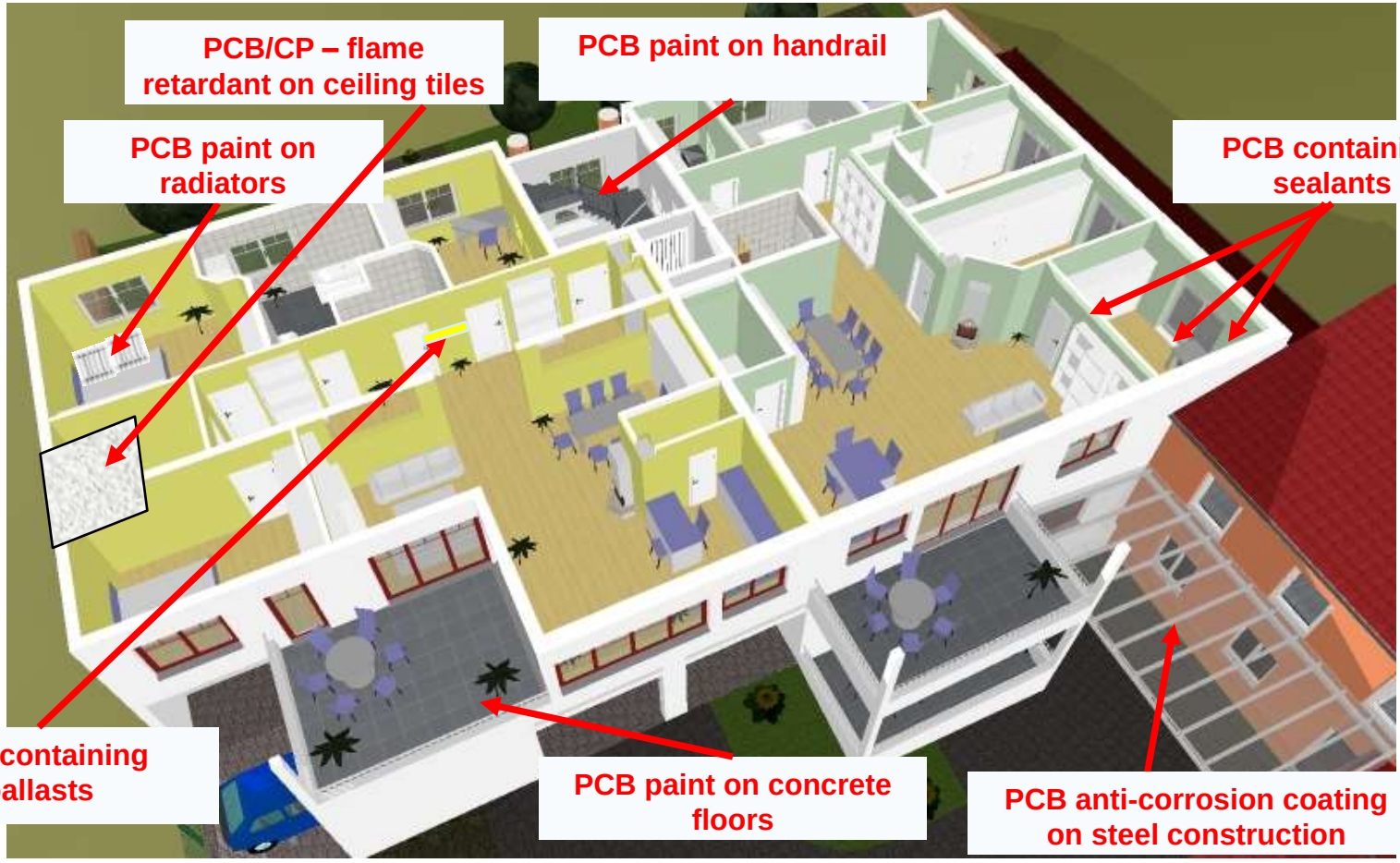
Publications on PCB in open applications can be downloaded from the SC website and will be shared togher with more information and Links in the Webinar follow up by UNITAR

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



Guide Values for PCB in Indoor Air

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 µg/m^3 (80 ng/m^3) and health hazard value (indoor air guide value II) of 0.80 µg/m^3 (800 ng/m^3) for the PCB substance group.

Bundesgesundheitsblatt January 14th 2025.

PCB-Guideline

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/m^3) and the precautionary value (target value or remediation guideline value of 300 ng total PCB/m^3) 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/m³]	100	100	200	300	500	600	500

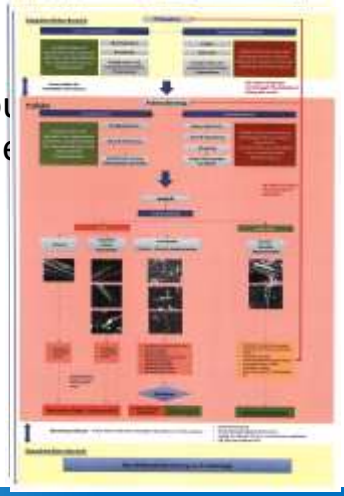
Duration of Stay: *8 hours/day for 185 days per year; **6.5 hours/day for 180 days per year

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 cou
=> (SC)CP were a replacement product of PCBs, mainly used from the Eighties to the Ninetie
=> 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!