12.4.10 Polychlorinated biphenyls (PCBs)

From around 1950, PCBs were often to be found as plasticisers in a number of open applications as well as in fluorescent lamp capacitors and other closed applications. Open applications using PCBs are particularly likely in buildings erected before the end of the 1970s. Based on current knowledge, open PCB applications are unlikely in buildings constructed after 1980.

In particular, open PCB applications can be contained in permanent elastic sealants in the form of

- building joints,
- expansion joints between precast concrete products,
- connecting joints (windows, door frames),
- connecting joints between glass and window frames and
- joints in sanitary facilities (rare).

In addition, PCBs can be contained in

- paints,
- adhesives,
- ceiling panels (as plasticisers or flame retardants),
- plastics and
- cable sheaths.

One of the most common applications in this area was PCB used as a plasticiser in polysulphide resin-based sealants. The products used for this purpose contained 30 to 60% chlorine by weight. They were marketed under names such as Clophen, Arodor, Kanechlor and Fenchlor.

The PCB products used in open applications up until around 1975 can still pollute indoor air today. The extent of that pollution depends on the type of PCB, the PCB content in the product concerned, the type of material contaminated, the quantity and nature of the PCP products in the room, the thermal environment in the room, the building's surface temperatures and the weather conditions. In such rooms, it is also possible for components and items that do not contain PCBs to be contaminated over time by substances that do contain PCBs and thus contribute to pollution in the indoor air themselves. A distinction must therefore be drawn between primary and secondary sources.

"Primary sources are products to which PCBs have specifically been added in order to change the product's characteristics. These products, e.g. sealants or coatings, usually contain more than 0.1% PCB by weight, and experience to date indicates that they can cause a significant increase in PCB indoor air pollution. Besides the PCB content, the ratio of contaminated surface to room volume and the type of PCB mixture have a major influence on the resultin pollution of the indoor air" [37].

According to VDI 4300, Part 2 [38], the following are possible primary sources of PCBs in indoor air:

- faulty capacitors, e.g. in lights,
- faulty transformers,
- paints and varnishes containing flame retardants,
- plasticisers used in plastics, e.g. sealants for expansion joints in precast concrete buildings,
- form oil used in concrete construction and
- dust ingress from emission sources and contaminated sites.

"Secondary sources are components (e.g. walls or ceilings) or items (e.g. furniture or furnishings such as carpets or curtains) that have usually absorbed PCBs from the polluted indoor air over a prolonged period. They can gradually release the PCBs that have accumulated on their surfaces back into the indoor air. Large-scale secondary contamination can cause indoor air PCB concentrations to remain high even after the primary sources have been completely removed" [37].

Primary sources that have not been removed to a sufficient depth and secondary sources that have not been sufficiently removed can cause heightened indoor air pollution levels years after remediation measures have been taken.

Investigation

When identifying potential PCB sources, the first step is to verify the age of the building product or electronic component suspected of containing PCBs (see Questionnaire G2 in Annex 3). It is usually possible to assume that the following points hold true:

- no open applications since 1978 (when the PCP Directive came into force),
- no PCBs in lamp capacitors or other capacitors since 1981,
- production stopped in 1983 and
- complete ban as of 1989 (PCB-Verbotsverordnung/Ordinance Banning PCBs [39]).

If this first step does not eliminate the possibility of PCB pollution in buildings, the following method should be employed:

- an inspection of the workplace should be carried out by people with relevant expertise, representative samples should be taken and any suspicious materials analysed (precise records should also be kept);
- representative indoor air samples should be taken (the sampling strategy should also be justified and documented); and
- a pollutant register should be drawn up (material samples, layer profiles, air samples) as a basis for a refurbishment

plan and for determining the pollution situation for the whole building.

The findings thus obtained must then be assessed.

Assessing PCB pollution and urgency of refurbishment measures

The health risk for users of PCB-polluted rooms rises as the PCB concentration in the indoor air increases and is influenced by the room's use and the duration of exposure.

The toxicological assessment of PCBs in the air in permanently used rooms carried out by the former Bundesgesundheitsamt (Federal Health Office) and the Arbeitsgemeinschaft der Leitenden Medizinalbeamten der Länder (hospital commission study group of governing medical officials) [37], is used to assess how urgently remediation is required:

- *"Indoor air concentrations below 300 ng PCB/m³ of air are deemed tolerable in the long term (precautionary value).*
- *Where indoor air concentrations lie between 300 and 3,000 ng PCB/m³ of air, the source of the indoor air contamination must be identified and eliminated in the medium term by means proportionate to the risk. In the interim, the rooms should be ventilated regularly, cleaned thoroughly and dust removed in an effort to reduce the PCB concentration level. The target is a value below 300 ng PCB/m³ of air (refurbishment guide value).*
- *Where the indoor air concentration level is higher than 3,000 ng PCB/m³ of air (intervention value for immediate action), acute health hazards cannot be ruled out. If such values are detected, control analyses should be carried out immediately. If they confirm the initial result, immediate action must be taken – in line with the pollution level – to reduce the PCB concentration levels in the indoor air in order to prevent health risks in the rooms concerned. Here too, the target is a value lower than 300 ng PCB/m³ of air."*

To date, it has not been possible to confirm any clear link between the PCB content of sealant materials and the PCB concentration in the indoor air. Nonetheless, approximate estimations of the PCB concentrations in indoor air are possible on the basis of data given in the literature (see Table 32) [40].

Table 32:
Guide values for indoor air PCB concentrations as a function of PCB content in sealant materials [40]

Clophen type[1]	Maximum PCB concentration in sealant (%)	Indoor air PCB concentration in µg/m³
A 40	21 maximum	Approx. 0.2 to 6.0
A 50	35 maximum	Approx. 0.2 to 2.5
A 60	47 maximum	0.55 maximum

[1] Technical-grade PCB mixture produced by Bayer

Where there are large-scale primary sources, e.g. (fire retardant) paints or ceiling panels, which often contain a highly chlorinated PCB mixture (Chlopen A 50/60), the possibility of direct cutaneous or oral absorption of contaminated particles resulting from abrasion must also be taken into account. A material's dioxin and furan content also usually increases as the PCB content increases [37].

Recommendations for building refurbishment

The aim of refurbishment measures for PCB-polluted buildings is to achieve a permanent reduction in the indoor air pollution caused by products containing PCBs. This can be done, for example, by removing, stripping or coating PCB products. However, coating primary sources has not proved successful so far.

Refurbishment of primary sources

Generally speaking, the only way to ensure permanent refurbishment of PCB-polluted rooms is to remove the primary sources, e.g. sealants, paints or ceiling panels. The methods described below have proved successful in practice but this does not mean that other procedures that yield equivalent results are not possible. However, heat-treating PCB materials, e.g. flame-cleaning, and methods that entail PCB materials being heated to > 100 °C are not suitable.

Permanent elastic sealants must only be removed using tools that generate little dust or by hand. They are then collected in containers suitable for disposal. Any backfill material should be removed. Dust should be collected where it occurs, using a suitable vacuum cleaner, e.g. of dust category H. The edges of seals should be removed, if possible, taking into account structural requirements and the depth of the PCB penetration. As with the sealants, they must be removed by hand or with the help of low-dust-emission tools and techniques with constant suction removal or in a self-contained system. If it is not possible to remove the edges, they must be completely freed of any remaining sealant and coated with a suitable diffusion-inhibiting material. Once the joint has been coated and new backfill material installed, the joint can be resealed.

Large-scale primary sources, such as paints or coatings, must be removed in a dust-free process with constant suction removal or in a self-contained system. If there is any residual contaminant, the approach to be taken is the same as that for handling secondary sources.

Removable primary sources, such as ceiling panels, must be cleaned and then removed without allowing any dust to escape, using suction if necessary.

Refurbishment of secondary sources

If the measures aimed at refurbishing primary sources do not reduce the indoor air PCB concentration to below the refurbishment guide value of 300 ng PCB/m³ of air, refurbishment of the secondary sources is also necessary.

As with primary sources, refurbishment of secondary sources should take the form of removal. If this method is not chosen, indoor air PCB pollution arising from contaminated components can also be adequately reduced by means of low-dust processes to remove the surfaces of these components, with constant suction removal or in self-contained systems, e.g. by stripping off paint layers and surface coatings. Based on current knowledge, products such as diffusion-inhibiting insulating wallpapers, emulsion paints with a high binding agent content, particularly those based on acrylate, and two-part epoxy resin and polyurethane coatings are suitable for this purpose.

Another option is to separate secondary sources from the indoor air using airtight methods, e.g. permanently sealed panelling. However, they must then be labelled and documented so that they can be disposed of separately later. This type of approach requires permanently sealed joints, including joints with ancillary building components, and must be carefully examined to determine the impact on the physics of the building and the thermal environment.

Contaminated items, such as furniture, carpets or curtains, should be cleaned thoroughly and checked for any residual contamination before being used again.

The long-term success of these measures must be documented by means of measurements.

Cleaning

Once refurbishment has been completed, the entire area that has been refurbished must be cleaned thoroughly, starting with all building component and furnishing surfaces, which must be cleaned using a suitable vacuum cleaner. This is followed by a wet clean of all surfaces that can be cleaned in this manner and any furniture that is to be reused. The cleaning must be done manually using conventional cleaning products. High pressure cleaners are not suitable as the cleaning fluid cannot be fully collected.

Monitoring

The PCB concentration in the indoor air must be measured using a strategy set out in the PCB Directive so as to document the success of the remediation process.

12.4.11 References

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