Inventory and clearance of PCBs in buildings and facilities

GUNILLA BERNEVI REX

REPORT 6885 • MARS 2019

Inventory and clearance of PCBs in buildings and facilities

Author Gunilla Bernevi Rex

SWEDISH ENVIRONMENTAL
PROTECTION AGENCY

Orders
Phone: + 46 (0)8-505 933 40
E-mail: natur@cm.se
Address: Arkitektkopia AB, Box 110 93, SE-161 11 Bromma
Internet: www.naturvardsverket.se/publikationer

The Swedish Environmental Protection Agency
Phone: + 46 (0)10-698 10 00 Fax:+ 46 (0)10-698 16 00
E-mail: registrator@naturvardsverket.se
Address: Naturvårdsverket, SE-106 48 Stockholm, Sweden
Internet: www.naturvardsverket.se

ISBN 978-91-620-6885-1
ISSN 0282-7298

Tryck: Arkitektkopia AB, Bromma 2019
Cover photo: Miljökonsultgruppen i Stockholm HB

Preface

Though the use of PCBs is prohibited since long time products containing PCBs are still present in society. Since the Swedish Environmental Protection Agency in the mid 1990´s drew attention to the problems of PCB in buildings several measures to investigate and clear up buildings from PCBs has been taken. With this report we wish to share experiences from the work in Sweden and contribute to the development of strategies for identifying products that contain PCBs that still can occur in buildings and facilities. By investigating PCB occurrence, relevant waste streams can be identified, which can create conditions for environmentally sound waste management. In 1998 in Sweden, a comprehensive initiative to provide information about PCBs in Swedish buildings was started as a project within the Ecocycle Council of the Building Sector. The Ecocycle Council was an organisation that consisted of representatives for four groups of stakeholders within the building sector – developers and property owners, architect firms and technical consultancy firms, construction and installation companies, and the building material industry. The Ecocycle Council worked to promote active environmental measures within the various areas of the building sector, and it carried out a number of projects aimed at generating knowledge, developing aids and disseminating information about how environmental measures could be implemented. In order to make the most of all this knowledge and all these measures, and to continue the task of spreading information, Miljökonsultgruppen i Stockholm HB was formed by Bengt Gustafsson, Per Lilliehorn and Gunilla Rex in 2003. They had all been actively involved in the earlier PCB project as well as the dissemination of information about PCBs and projects for other companies and organisations. Miljökonsultgruppen still runs the website about PCBs and provides information about PCBs in other ways, for example through courses, advice via email and through a handbook about the clearance of PCBs.

This report contains a description, in summary form, of the Swedish knowledge and experiences. Much of the material contained in this report has been obtained from the website www.sanerapcb.nu. Information has also been obtained from the websites of the Swedish Environmental Protection Agency, Karolinska Institutet and the Swedish National Food Agency. Gunilla Bernevi Rex has compiled the material in consultation with Bengt Gustafsson and Per Lilliehorn. The authors are responsible alone for the content, conclusions and recommendations. Unless otherwise stated, all images and diagrams reproduced in the report have been produced by Miljökonsultgruppen. When an image or a diagram is used or reproduced, the photographer’s name (which can be found next to the image) and Miljökonsultgruppen’s name must be stated.

Stockholm 14 February 2019
Ingela Hiltula
Assistant director Sustainability Department

Contents

1 Summary

Sweden has worked actively to remove PCBs from buildings for 20 years. In 1997, the Swedish Environmental Protection Agency published a report on a study demonstrating that polychlorinated biphenyls (PCBs) from sealants in buildings contaminate the surrounding environment. PCBs spread to the ground surrounding buildings, into the air both outside and inside the building and to materials that are in contact with PCB-containing sealants. The spread of PCBs from existing sealants in facade joints showed the urgency of removing PCB-containing sealants and flooring compounds, known as open applications.

In 1998, Sweden began an extensive information campaign regarding PCBs in buildings. Work to inventory and decontaminate the country's buildings and installations has been ongoing to various extents since then. PCBs can be found in four different products in Swedish buildings namely sealants, flooring compounds, sealed window units and small condensers. Since 2007, there have been requirements in place regarding the decontamination of PCB-containing sealants and flooring compounds pursuant to the Swedish PCB Ordinance (SFS 2007:19).

This report has been written to summarise the current state of knowledge in Sweden and to inform of our experiences. The report provides a written and illustrated description of how inventory and sampling can be achieved and methods for successfully decontaminating sealants with regard to people and the environment. We offer examples of suitable equipment and machinery for decontamination and describe situations in which various tools and methods are good to use.

This report only deals with PCBs in buildings. Whenever the term *buildings* is used, it also encompasses facilities. The term *PCBs in buildings* refers to building materials and equipment that contain or are suspected of containing PCBs.

Measures taken in Sweden and the effects of these

The open use of PCBs was prohibited in 1972. In Sweden, we can see one effect of this prohibition in the form of a sharp reduction in PCBs in birds studied since 1969 on Stora Karlsö, a small island off the coast of Gotland.

Information campaigns regarding PCBs in buildings – where they can be found and how they should be handled – as well as legislative requirements, have been effective in increasing the scope of inventory and decontamination. Today, it is calculated that at least 70 – 85% of affected buildings dating from the period 1956 – 1973 have been decontaminated.

Sealants

Although polysulphide sealants may have a PCB additive, not all polysulphide sealants contain PCBs. The dominant use of polysulphide sealants in Sweden was in the form of exterior sealants between facade elements, in dilation joints (moving joints, for example on facades) and exterior connecting joints around windows, doors and the like. They can also be found indoors as joint seals for example in entrances and stairwells. Sealants containing PCBs was used in Sweden between 1956 – 1973, although mainly during the years 1965 – 1972.

It is also possible to find secondary PCB contamination among other, non-polysulphide-based types of sealants. These may contain over 0.005% (= 50 mg/kg or 50 ppm) PCB, the amount over which sealants are considered to be PCB-containing and should therefore be treated as hazardous waste.

Flooring compounds

PCBs are also found in plastic-based flooring compounds for seamless floors, especially in non-slip floors laid between 1956-1973 in facilities such as factories. Most of these floors were laid from the mid-1960s onwards. This flooring compound was sold under the Acrydur brand. Many of these floor surfaces have been replaced, although there may still be PCB-containing flooring compounds in place, for example under later surfaces.

Insulating windows

PCBs can be found in insulating windows manufactured in Sweden from 1956-1973 as well as in imported windows up until 1980. Insulating windows are primarily used in public buildings, office blocks, etc., but where not used to any great extent in residential buildings. Insulating windows consist of two pieces of glass with a spacer strip and a seal for which a sealing compound has been used.

Condensers

PCBs can also be found in Swedish buildings in small condensers, for example in fluorescent tube fittings or fans and pumps installed up until the 1980s. Condensers in imported equipment installed during the 1980s may also contain PCBs. Inventories should be conducted by someone with sufficient knowledge to carry out the work.

Inventories of PCBs

Inventories of sealants and flooring compounds in buildings and installations must be conducted in accordance with the Swedish PCB Ordinance. This requirement extends to hidden sealants. Insulating windows and condensers suspected of containing PCBs must be inventoried and labelled in situ. According to the Swedish PCB Ordinance, all inventories should have been completed by 2008.

Those carrying out an inventory of PCBs should have technical building knowledge and know where PCB-laden sealants and other products containing PCBs could exist. Careful preparation is a prerequisite for a thorough inventory; for example, knowledge of building plans and testing equipment. Inventories must be thoroughly documented.

Laboratory analysis is required to confirm whether a sealant or flooring compound contains PCBs. In some cases, it may be possible to identify insulating windows by labels stating the manufacturer and year on the spacer. Small condensers in electrical equipment installed up until the early 1980s should be suspected of containing PCBs.

Decontamination and removal

Pursuant to the Swedish PCB Ordinance, sealants and flooring compounds containing PCB levels over 500 mg/kg must be decontaminated. Decontamination requires that the PCB-containing sealants and parts of the edging around it be removed and handled as hazardous waste. Certain dispensations may be possible. Sealants containing a PCB level between 50 and 500 mg/kg must be decontaminated no later than in conjunction with renovation, rebuilding or demolition. There is no requirement for the removal of PCB-containing insulating windows and condensers, as long as they are intact.

The property owner is responsible for his or her property and must ensure that clearance measures are implemented if it has been shown that the property contains PCBs in sealants or flooring compounds. Those undertaking decontamination should have the necessary knowledge, through training in decontamination techniques, environmental protection and work environment.

Great care is required when decontaminating sealants in order to avoid PCBs spreading to the surrounding environment. Specific protective measures must be in place and effective tools and working methods employed. Waste must be handled in accordance with applicable legislation in a manner that avoids the spread of PCBs and a number of work environment measures must be taken to protect those performing the decontamination.

Insulating windows containing or suspected of containing PCBs must be handled carefully and there is legislation in place regarding how waste should be handled. Condensers in electrical products that are to be uninstalled must be left in situ and the electrical product should be handed over intact to an approved pre-processor of electrical waste.

Those carrying out demolition and renovations in buildings from the period 1956 – 1973 must remain acutely aware of the possibility of previously undiscovered PCB contamination!

2 Introduction

2.1 Background

Since 1998, active measures have been undertaken in Sweden to remove PCBs from our buildings. In 1997 the Swedish Environmental Protection Agency published a report from a survey that showed that PCBs leach from sealants in a facade. The PCBs then spread to the ground outside the building, to the air outside the building and indoors, and to materials that are adjacent to the PCB-laden sealants (Jansson, B, Sandberg, J, Johansson, N, Åstebro, 1997). In the autumn of 1997, the Swedish Environmental Protection Agency summoned representatives for the building and property sector to a meeting, in order to hear how the industry intended to deal with the problem of PCBs in existing buildings.

This became the start of a comprehensive initiative to remove PCBs from Swedish buildings and facilities. The work has focused on finding and removing all PCBs in open use in buildings and facilities, in other words sealants and flooring compounds. The clearance of these compounds prevents the continued spread of PCBs to the environment and also reduces the PCB levels in the air indoors.

Initially the work was performed voluntarily, with no support from legislation. Information was sent out to property owners, consultants, entrepreneurs etc. about PCBs and how they should be dealt with, and many property owners were quick to make an inventory and clear their buildings of PCBs (more information about this voluntary work is contained in section 5). In 2007, a new ordinance was introduced in Sweden containing requirements on inventory and clearance of PCBs in sealants and flooring compounds. According to the new ordinance, the clearance work was supposed to be completed by 30 June 2016, but there is still a little work remaining.

During the twenty years the work has been going on, knowledge has been gathered and a lot of information has been provided to Sweden's property owners, consultants, entrepreneurs, supervisory authorities, etc. Methods have been developed in relation to how to make an inventory of, and how to clear, sealants in buildings.

2.2 Purpose and aim

This report has been written as a summary of the level of knowledge in Sweden at the present time, and to provide information about our experiences. The report uses text and images to describe and illustrate how inventory can be made and samples can be taken, and how (primarily) sealants can be cleared in a good way with regard to people and the environment. We show examples of equipment and machinery that is suitable for the clearance work, and we describe situations in which various tools and methods are good to use.

The aim of this report is to enable the Swedish Environmental Protection Agency to disseminate information about these experiences internationally, in order to increase knowledge about PCBs in buildings. The report is intended to form a basis for the further development of competence within the area of inventory and clearance of PCBs in buildings, and to contribute to the achievement of the goals set in the Stockholm Convention.

2.3 Demarcations

This report only addresses the issue of PCBs in buildings. In this context the term buildings also encompasses facilities. When reference is made in this report to PCBs in buildings, such reference refers to building materials and equipment that contain or are suspected of containing PCBs. The materials and equipment on which Sweden is focused are sealants, flooring compounds, sealed window units and small condensers, for example of the type found in light fittings. Larger transformers and condensers > 2 kVA are not addressed.

2.4 Method

The information in this report has primarily been obtained from the website www.sanerapcb.nu, the PCB Handbook (Miljökonsultgruppen i Stockholm, 2016), the Swedish Environmental Protection Agency's report on PCBs in selants 1997 (Jansson, B, Sandberg, J, Johansson, N, Åstebro, A, 1997), and the websites of the Swedish Environmental Protection Agency, Karolinska Institutet and the Swedish National Food Agency. The summary of destroyed PCB waste from joint clearance measures has been obtained from the report Monitoring the clearance of PCBs in sealants and flooring compounds (Rex Hus & Miljökonsult and Lilliehorn Konsult AB, 2015) , with supplementary statistics from 2015 – 2017.

A box with the heading "Please note:" has been inserted into many sections of the report with the aim of highlighting important facts and experiences and/or to provide concise summaries/descriptions.

3 PCBs in the environment and in our food

3.1 Polychlorinated biphenyls

The abbreviation PCB stands for polychlorinated biphenyls which consist, chemically, of two benzene rings in which hydrogen has been substituted with chlorine to a varying extent. In theory there could be 209 different polychlorinated biphenyls, or congeners, but only slightly less than 150 such congeners have actually been found in technical products, and even fewer in samples that have been taken in the environment.

3.2 Technical properties and use

Most PCB compounds are viscous oily liquids. PCBs have a number of valuable technical properties, such as heat-resistance, stability and insulation capability. PCBs started to be used in the 1920s as dielectric fluids in electrical components such as condensers, transformers and cables. The area of use was subsequently expanded, and during the 1950s PCBs also started to be used in certain building products. 1956 is usually named as the year PCBs started to be used within Swedish construction.

PCBs were used in Sweden for, among other things, the major initiative involving the production of housing during the 1960s (the “Million Programme”), where PCBs were added as plasticizers in the sealants that were used, for example, in facades of concrete elements.

3.3 PCBs are persistent

In 1966 the chemist Sören Jensen found high levels of an unknown substance in a dead sea-eagle from the Stockholm archipelago. The substance was identified as PCB.

PCBs are stable and degrade very slowly, which means that they accumulate in the food chain when they leach into the environment. PCBs can also spread over large distances and will remain in the environment for a long time. This means that animals and people will be exposed to PCBs for a long time to come. It also takes a long time before the limitation of emissions and other measures take effect.

PCBs can be photochemically degraded in a relatively short amount of time, but the degradation of PCBs in the ground, for example, can take hundreds of years or more.

PCBs are soluble in fats and are therefore stored in the fat tissue of animals and human beings. PCBs are bioaccumulated, which means that there is a higher level

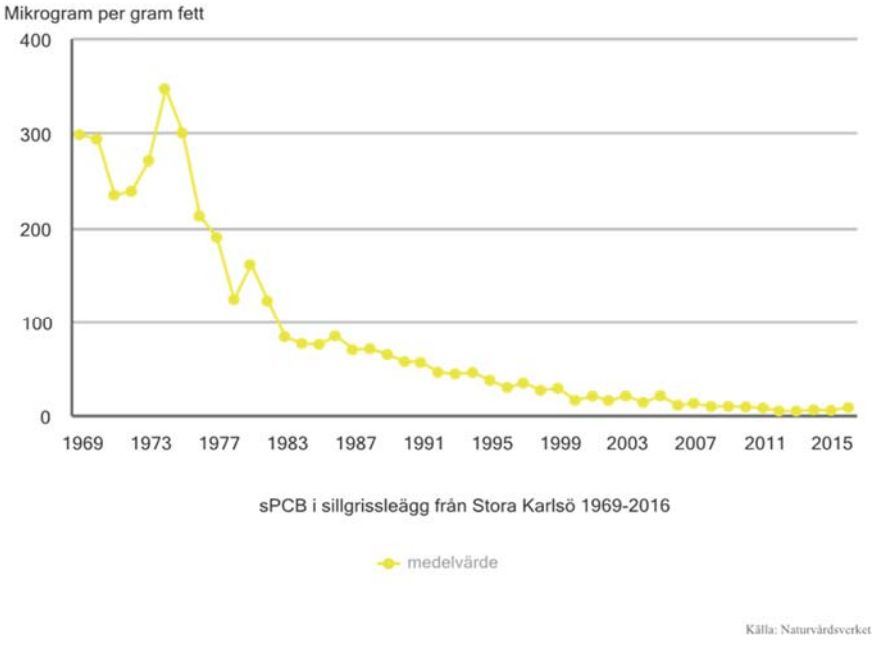
of PCBs in living organisms than in the surrounding environment. PCBs are also biomagnified, which means that the higher up the food chain one looks, the higher the PCB levels that can be found.

PCBs are included in the list of POPs (persistent organic pollutants) that are to be eliminated according to the Stockholm Convention – an international agreement that came into effect in 2004. There is an EU directive on POP substances that applies in all EU member states. The reduction of dioxins and dioxin-like PCBs in foods is also a highly prioritised area, including within the Swedish environmental objective "A Non-Toxic Environment".

3.4 Impact on health and the environment

3.4.1 PCBs in the environment

PCBs impair the ability of animals to reproduce, which led to a reduction in the numbers of e.g. seals, otters, guillemots and sea-eagles during the 1970s. Studies into PCB levels have included a study of guillemot eggs from Stora Karlsö, a small island off the coast of Gotland in the Baltic Sea. The current PCB levels in the eggs on that island are only about one-tenth of the levels that existed in the 1970s. Below is a diagram from the Swedish Environmental Protection Agency's website that shows the changes in the PCB levels that have occurred over the years.



The above diagram has been obtained from the Swedish Environmental Protection Agency's website

PCBs are to be found everywhere in the environment, and our food also contains PCBs. The substances exist in fatty animal-based foods like fish, meat and dairy products. Particularly high PCB levels are to be found in fatty fish types like herring and salmon caught in the wild, which come from contaminated areas such as the Baltic Sea, the Gulf of Bothnia, and the Vänern and Vättern lakes (the Swedish National Food Agency).

3.4.2 PCBs and dioxins

Certain PCB congeners are dioxin-like, i.e. they have a structure that is very similar to that of dioxins, and work via the same mechanisms as dioxins in the body. Consequently, the combined effects of dioxins and dioxin-like PCBs are calculated when performing risk assessments. The total level of dioxins and dioxin-like PCBs is often stated in the form of dioxin equivalents (TEQ; 'toxic equivalents') (the Swedish National Food Agency).

3.4.3 Health effects

Population studies have shown an increased risk for metabolic diseases, such as diabetes and cardiovascular disease, as well as symptoms of such diseases. Dioxin is also classified as carcinogenic for human beings (. Sensitivity to dioxins and PCBs is greatest during the period as a foetus and breastfeeding infant. Studies have shown that dioxins and PCBs during a human being's period as a foetus and breastfeeding infant can affect the sperm quality of males in adult age. Other studies indicate that exposure to dioxins and PCBs during the period as a foetus can affect the new-born baby's hormone levels, the baby's birth weight and the development of the child's motor skills and cognitive abilities, and can also have effects on tooth enamel (the Swedish National Food Agency).

3.4.4 Regulation

Within the EU, a tolerable weekly intake (TWI) has been determined for dioxins and dioxin-like PCBs. TWI means the quantity of dioxin-like substances that a person can ingest each week throughout his or her entire life without risking any negative health effects. The European Food Safety Authority (EFSA) has now (November 2018) performed a new comprehensive risk evaluation of the dioxins and PCBs we ingest via our food, and has lowered the maximum limit for what we should ingest to one-seventh of the previous limit. The new limit is two picograms TEQ per kilo of bodyweight per week (the Swedish National Food Agency).

Since measurements were started in 1999, the levels of dioxin-like substances in foods have been clearly reduced. However, individuals who eat a lot of fatty fish from contaminated areas and breastfeeding infants can have an intake of dioxin-like substances that is several times higher than the TWI. On average, the intake of dioxins and dioxin-like PCBs by adults in the Swedish population is 0.5 picograms TEQ per kilo of bodyweight per day (equivalent to 3.5 picograms TEQ per kilo of bodyweight per week), and children have an even higher intake. This means that

the safety margin is small or non-existent for parts of the Swedish population, despite the fact that the exposure has continuously been reduced (Karolinska Institutet).

The Swedish National Food Agency now intends to review its national dietary recommendations, in particular in relation to fish. The dietary recommendations apply to fatty fish from the Baltic Sea and a couple of large inland lakes in Sweden, which have high PCB levels. Sweden may sell such fish domestically but may not export it, since the EU has established limits for levels of dioxins and dioxin-like PCBs. An exception was granted subject to the requirement that Sweden must issue dietary recommendations and inform consumers about the risk of eating such fish.

4 PCBs in buildings and facilities in Sweden

In Sweden, PCBs in buildings may exist in sealants and flooring compounds, sealed window units and components used in equipment that could exist in buildings, for example condensers for light fittings.

In Sweden we search for PCBs in the following contexts (relevant years stated):

- Sealants used 1956 – 1973
- Flooring compounds of the make Acrydur from 1956 – 1973
- Sealed window units installed 1956 – 1973 (or later if they are imported)
- Condensers, primarily small condensers from the early 1950s until the early-mid 1980s.

The majority of the relevant sealants were used during the years 1965 – 1972 and were used on larger apartment buildings, office buildings, industrial buildings and public buildings such as schools, hospitals, etc. The use of products with PCBs has been less common in one and two apartment buildings.

The use of PCBs in open systems (for example as plasticizers in sealants and flooring compounds) was prohibited in Sweden in 1972. However, it is possible that some sealants that were in stock at that time could have been sold and used at a later date. Consequently, when checking sealants, installations performed during 1973 should also be included in the examination.

4.1 Sealants

Please note:

Sealants with PCBs were used in Sweden between 1956 and 1973, and primarily during the years 1965 – 1972.

They were used, for example, between facade elements of concrete, in expansion joints, around doors and windows, between prefabricated elements indoors (for example stairs) and adjacent parts of buildings.

Large quantities could exist in buildings with concrete elements from the mid-1960s until 1973.

Only elastic sealants based on polysulfide have received PCBs as a primary additive, although not all polysulfide-based sealants contain PCBs.

Compounds may also have been secondarily contaminated, and all types of sealants in buildings from 1956 – 1973 may therefore contain PCBs. This also applies to sealants that contain asbestos.

4.1.1 Types of sealants

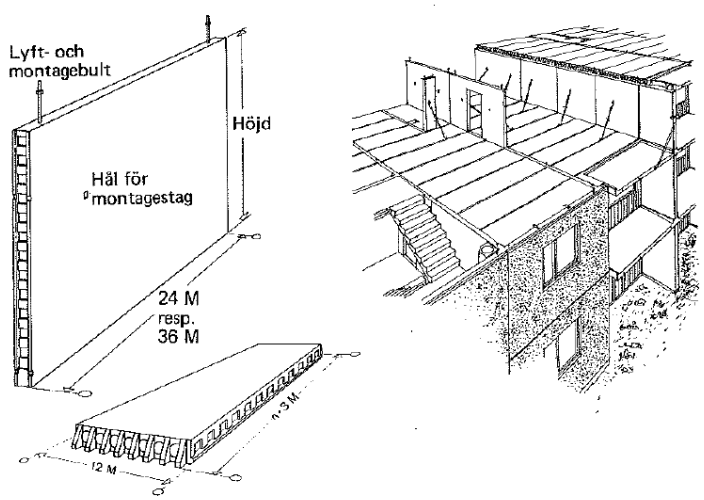
During the 1950s and 1960s, polysulfide rubber was the most important raw material for elastic sealants. PCBs were used in some of these as a plasticizing component, sometimes in combination with other plasticizers. During the 1960s and 1970s, new types of elastic sealants were developed, primarily of the type polyurethane and silicone sealants. PCBs were not used in these new types of compounds. Only polysulfide compounds have received PCBs as a primary additive, but not all polysulfide-based sealants contain PCBs.

4.1.2 Where might sealants with PCBs be found?

The dominant area of use for polysulfide compounds was for the external sealing of expansion joints, among other things. Consequently, PCB-laden sealants can primarily be found between facade elements, in expansion joints and in external connection joints to windows and doors. Not only concrete elements but even facade panels/slabs of e.g. natural stone may have had PCB-laden compounds used on them. PCB-laden sealants may also exist indoors where they have been used to seal joints, for example in entranceways and stairwells.

4.1.3 Which buildings could have large quantities of PCBs?

The issue of PCBs in buildings is connected to the industrialisation of the construction industry during the 1960s and the "Million Programme" (Swedish housing programme) of that time, for which new methods and materials were tested. The core of the programme was a plan to build one million apartments in ten years, although the programme also involved a modernisation of the entire infrastructure – roads, sewage systems, electricity, schools, etc. 1970 was the year in which the largest number of apartments were produced – 110,000 in total.



About ten per cent of the Million Programme's apartments were in buildings constructed from prefabricated concrete elements (about 150,000 apartments in total). The construction with concrete elements meant that sealants were used to a great extent. This means that there could be large quantities of PCB-laden sealants

in buildings that were built using concrete elements from the mid-1960s until 1973, although not all these buildings contain PCB-laden sealants.

4.1.4 Pictures that exemplify sealants in buildings

Cracked sealant between concrete facade elements

A sealant has been used by the glass section

Photo: Igor Kecskés Maconkai

Sealant used on prefabricated stair elements

Photo: Igor Kecskés Maconkai

Sealant used on the base of a building. The joint continues in under the balcony

Sealant between a window and natural stone

Sealant in an expansion joint in a brick wall and exterior passageway

The sealant is concealed behind the panel

4.1.5 Sealants secondarily contaminated by PCBs

In many cases the original sealants have been replaced with new material, since the old sealant has technically served out its useful life.

There are also examples of PCB-laden sealants that remain in the joints, but over which a new compound has been applied. PCBs may also have found their way into a replacement sealant from existing sealant residues that have been left behind and from adjacent material. The contractor may not have been aware that there were PCBs in the sealant that was being removed, and may therefore not have been particularly careful to remove 100% of the existing sealant. It is therefore also possible to find sealants (of types other than polysulfide-based compounds) that have been secondarily contaminated with PCBs. They could contain more than 0.005% (= 50 mg/kg or 50 ppm) PCBs, which is the level at which the sealant is deemed to be PCB-laden and must be managed as hazardous waste.

4.2 Flooring compounds

Please note:
In Sweden, PCBs may exist in plastic-based flooring compounds, of the make Acrydur, used on jointless floors 1956 – 1973.

PCBs may exist in plastic-based flooring compounds for jointless floors, in particular for non-slip floors that were laid, for example, in catering kitchens and industrial premises from 1956 – 1973. Most such floors were laid from the mid-1960s using a compound of the make Acrydur. The binder in the floor covering contained approx. 20% PCBs, and the level in the finished floor covering was approx. 12% PCBs. (Öberg, T, 1994). Many of these floor coverings have since been replaced, but there could still be PCB-laden flooring compounds remaining, for example concealed under a later floor covering.

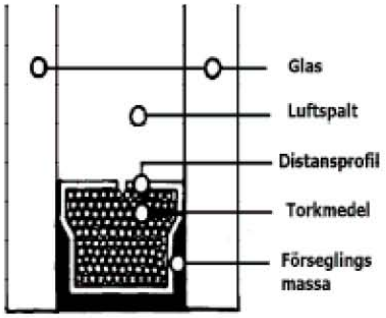
A piece of removed floor covering with PCBs

4.3 Sealed window units

Please note:
In Sweden there could be PCBs in the sealing compound used on sealed window units, in Swedish-manufactured windows from 1956 – 1973, and in imported windows up to and including 1980.

PCBs may exist in Swedish-manufactured sealed window units from 1956–1973 and in imported windows up to and including 1980. These types of sealed window units were primarily used in public buildings, office buildings, etc. but were not used in residential buildings to any great extent.

The sealed window units consist of two panes of glass with a spacer strip and a seal for which a sealing compound has been used. The year and month of manufacture is usually written in the spacer strip between the panes, and this can be used to determine whether or not the sealing compound may contain PCBs or can be cleared of suspicion.



Organiskt förseglad isolerruta i genomskärning

Image from Svensk Planglasförening

This is the structure of a sealed window unit with PCBs

Photo: Karin Markeryd

The year and month of manufacture is imprinted in the sealed window unit's spacer strip.

On the website of Svensk Planglasförening there is a list of sealed window units that have (or do not have) PCBs in the sealing compound.

4.4 Condensers

Please note:

In Sweden there could be PCBs in small condensers used in e.g. light fittings or in fans and pumps until the 1980s. Condensers in imported equipment that has been installed during the early to mid-1980s may also contain PCBs.

PCBs may exist in small condensers in electric motors and light fittings as well as in larger condensers and transformers. An inventory of such condensers should be performed by a person who possesses sufficient knowledge for the work in question.

PCB oil or mineral oil has been used in small paper condensers since the start of the 1950s. The quantity of PCB oil in a condenser is approx. 50 grams. The PCB condenser was most commonly used in light fittings that were manufactured during the 1960s and 1970s.

Small condensers with PCBs may also exist as starter condensers in single-phase motors in, for example, fans for oil burners, and in circulation pumps, washing machines, centrifuges, spin dryers and kitchen fans.

After the prohibition of PCBs in Sweden in 1972, the Swedish PCB condensers were replaced with types based on metal paper and plastic foil. In other countries, however, PCB condensers continued to be used until the early to mid-1980s. Consequently there is a risk that PCB condensers could exist in imported equipment in Swedish buildings, for example in fans and pumps, installed as late as the 1980s.

5 Risks associated with PCBs in buildings

Please note:

The spread of PCBs from sealants and flooring compounds to adjacent material means that, even when sealants and flooring compounds have been cleared from the site, a certain amount of PCBs will still remain. A building that has contained PCBs at some time can never be completely free of PCBs!

This means that, in conjunction with demolition work, further surveys should be performed to identify whether additional clearance work is needed, and to ensure that the waste is managed in a correct and appropriate manner.

Knowledge about PCBs prior to demolition work is also necessary to ensure a good work environment.

5.1 The spread of PCBs from buildings

As has already been mentioned, PCBs can leach from existing joints. See the image below.

- PCBs in sealants are released in gas form and spread to the surrounding environment via the air.
- When the sealant ages and is degraded, particles come loose and are transported via water and wind to the ground, from where they then spread further to adjacent ground and out into waterways.
- PCBs in sealants spread into adjacent material, for example concrete or brick, and into the underlying material.
- PCBs in demolition waste can end up being deposited in an ordinary landfill, from where they can leach into the environment.
- PCBs are also degraded by UV light.

As of today, the spread of PCBs has taken place on such a large scale that we can find traces of PCBs everywhere around us. We have the possibility to prevent the leaching that occurs from building materials by clearing such sites of sealants and flooring compounds with PCBs.

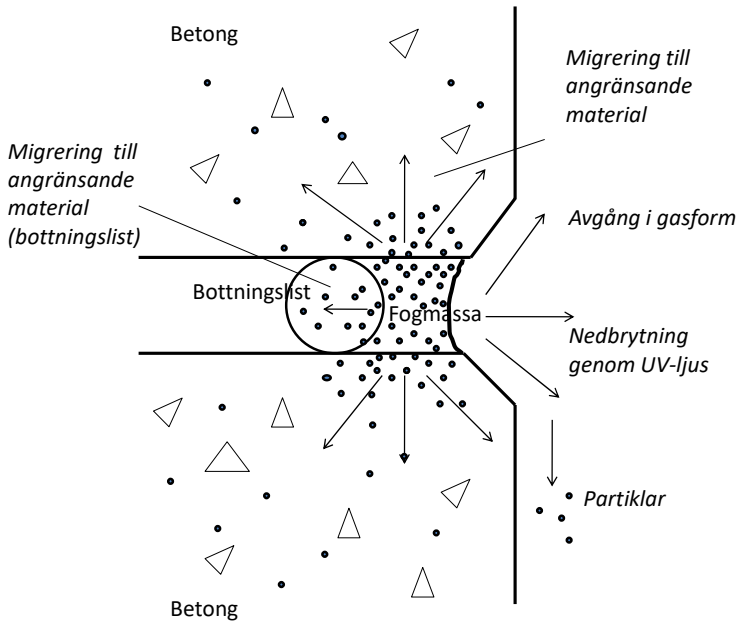


Image: Miljökonsultgruppen i Stockholm

The above image illustrates the principle of how PCBs spread from sealants to adjacent materials, the air and ground.

5.1.1 Spread of PCBs to the external environment

The aforementioned study from 1997 showed that PCBs leach from sealants in a facade to (among other things) the ground outside the building. The highest levels were found close to the facade, and the levels then quickly diminished when samples were taken further away from the building. However, PCBs of the same technical mixture as in the sealant were found as far as 500 m from the building. Once the PCBs have leached into the ground in this manner, they then spread further until they make their way into our waterways and to the fish in our lakes, and thus finally end up in the food eaten by people.

5.1.2 Spread of PCBs to the internal environment

One example of a survey of PCBs in the internal environment was conducted in 2001 in Swedish apartment buildings and schools with PCB-laden joints in the facade (Miljöförvaltningen i Stockholm and SP, 2001). The PCB levels in the air varied from low to moderately high. More or less all levels were under 300 ng/m^3, "Guideline level" (benchmark level for clearance measures) in Germany's guidelines for PCBs in indoor air (Katalyse e. V., Institut für angewandte Umweltforschung, 1995).

In this study, the contribution from the air of the most toxic PCB contaminants was assessed to be less than 1% of the total intake via food. The average level in the dust samples was of such a size that 1 g of dust equates to the daily intake of PCB

via food. This highlights the importance of cleaning in buildings with PCB-laden joints, and that small children should not be exposed to this dust.
Both the air samples and the dust samples provide justification that the PCB sources in the buildings should be removed and managed as waste in an appropriate manner.

5.1.3 Spread of PCBs to adjacent materials

The fact that PCBs spread from sealants into adjacent materials has been noted, among other things, in the aforementioned study from 1997 (Jansson, B, Sandberg, J, Johansson, N, Åstebro, A, 1997).

5.1.4 PCBs remain in the joint edges after clearance work

The spread of PCBs to adjacent materials means that even buildings that have been cleared of PCB-laden sealants and flooring compounds still have some PCBs left in joint edges of, for example, concrete or brick that have been adjacent to the cleared compounds. The level can in fact be so high that parts of the material should be classified as hazardous waste. The level can vary significantly, depending, among other things, on the original level in the sealant, the density of the adjacent material, and how well the clearance work has been carried out.

A supplementary clearance of such joint edges can be performed in conjunction with demolition work, in order to make it possible to recover the mineral compounds in some form. If the sealant has contained about 10% PCBs, it could be appropriate to remove about 2 cm of the joint edge prior to demolition. Flooring material that has previously had an outer layer of PCB-laden compound can be decontaminated in an equivalent fashion prior to demolition.

5.1.5 Remaining PCBs are a problem in connection with demolition

Sealants and flooring compounds with PCBs, or sealed window units with PCBs, which have not been identified prior to demolition could end up in a waste fraction that is not managed in an appropriate manner for waste that contains PCBs. If the waste is deposited as landfill or is combusted at the wrong temperature and without the correct management of the fumes, PCBs will be spread to the environment. The demolition and waste management work thus also becomes a work environment problem, since those who are performing the demolition work are not aware of the PCB content in the materials, and therefore do not use the correct protective equipment.

PCB condensers that have not previously been identified, but which are managed as electrical waste prior to demolition and are therefore sent to an approved pre-processor of electrical waste, should be discovered and identified by the party that is pre-processing the waste, and should therefore be able to be managed in the correct manner.

6 PCB work in Sweden

Historical PCB overview in Sweden:

1956 – 1972	The building sector is industrialised, and PCBs start to be used in building materials
1965 (approx.)	PCBs start to be used on a large scale
1972	Use of PCBs in open systems is prohibited (sealants and flooring compounds)
1978	All new use of PCBs is prohibited
1997	Report “PCBs in sealants – a major or minor problem?”
1998 – 2002	The Ecocycle Council’s project “PCBs in Buildings” – a voluntary undertaking
2002	The Swedish Environmental Protection Agency evaluates the project and proposes that an ordinance should be issued
2007	The PCB Ordinance comes into effect
2016	The final year (according to the ordinance) for clearance of sealants and flooring compounds

6.1 The Ecocycle Council’s project and the building sector’s undertaking

The Ecocycle Council of the Building Sector was an organisation that consisted of representatives for four groups of stakeholders within the Swedish building sector – developers and property owners, architect firms and technical consultancy firms, construction and installation companies, and the building material industry. The Ecocycle Council adopted a programme for the sector’s environmental work and carried out a number of projects aimed at generating knowledge, developing aids and disseminating information about how environmental work could be performed within the various areas of the sector.

As has already been mentioned, in 1997 the results of a study were presented that showed that PCBs from PCB-laden sealants in facade joints spread to the environment (Jansson, B, Sandberg, J, Johansson, N, Åstebro, A, 1997).

In the spring of 1998, a working group was established within the Ecocycle Council with the aim of coordinating the building sector’s work with PCB-related issues, and the project ”PCBs in Buildings” was started and involved a voluntary undertaking from parties active within the building and property sector (The Swedish Environmental Protection Agency, 2002, appendix 4). The aim was to map the problem with PCBs in buildings, to gather knowledge about technical methods for identification, analysis and clearance measures, and to evaluate these and investigate suitable management of PCB-laden waste products. The intention was that information would be disseminated to the construction and property sector

so that property owners would be able, in a correct manner, to make an inventory of and clear PCBs from their buildings, and thus prevent PCB in buildings from spreading to nature. The goal was that most of the PCBs in the country's buildings would have been cleared by the end of the project, i.e. by the turn of the year 2002/2003.

In the project, the PCB level of 500 mg/kg was chosen as the limit above which sealants should be cleared as quickly as possible. It had been shown in a study of sealants in 22 buildings that there were certain sealants with a PCB level that was clearly below 500 mg/kg, and these were assessed as compounds that had been secondarily contaminated, perhaps by remaining PCBs after previous resealing work. Other sealants had a significantly higher PCB level, and these were assessed as original joints on which PCB-laden compounds had been used. There was a large discrepancy between PCB levels at these two levels where no sealant had been found. By choosing 500 mg/kg as the limit above which clearance measures must be taken, all sealants with PCBs as a primary additive were comfortably included, and the secondarily contaminated compounds with levels below 500 mg/kg would not require clearance measures. The PCB project also held discussions with the Swedish Environmental Protection Agency about the level that could be appropriate to select, and it was perceived that the Swedish Environmental Protection Agency accepted the level of 500 mg/kg as an appropriate level above which clearance measures should be taken.

The Ecocycle Council's project was managed in close collaboration with the Swedish Environmental Protection Agency. The work involved the technical development of site clearance methods and techniques, the development of aids to assist inventory of PCBs and the procurement of clearance contracts, and comprehensive measures aimed at disseminating information. Many courses and conferences were held, and a large number of people contributed to the knowledge that was compiled on the website www.sanerapcb.nu.

6.2 The work of local government and property owners

Many municipalities in Sweden were active in promoting the work and sent out information aimed at property owners who had buildings that had been built during the period 1956 – 1973. Many large professional property companies began the work of making an inventory and clearing PCBs in their buildings.

However, the clearance work progressed relatively slowly. The Swedish Environmental Protection Agency, which monitored and evaluated the project, did not feel that the practical results in the form of inventory and clearance of buildings and facilities had reached a sufficient level through the voluntary undertaking, and it was therefore proposed that an ordinance should be introduced to regulate the work with PCBs.

6.3 The PCB Ordinance

In 2007 a new ordinance came into effect (the PCB Ordinance, 2007) which imposes requirements on making an inventory of PCBs and requirements on the clearance of PCBs in open use, if the PCB level is higher than 500 mg/kg. The property owner is responsible for making an inventory and clearing his property of PCBs. The ordinance applies to all buildings and facilities apart from one and two apartment buildings that are owned by natural persons.

The inventory relates to PCBs in sealants and flooring compounds in buildings and facilities from 1956 – 1973, and sealed window units and condensers that are suspected of containing PCBs are to be inventoried and labelled. According to the ordinance, the inventory was to have been completed for all relevant properties – and reported to the supervisory authority – by 30 June 2008. The clearance work was to have been completed by 30 June 2016.

The ordinance also imposes requirements that sealants and flooring compounds with PCB levels between 50 mg/kg (which is the limit for hazardous waste) and 500 mg/kg must be removed no later than in connection with renovation, redevelopment or demolition.

Certain possibilities exist for the supervisory authority to grant an exemption from the clearance requirement, for example if redevelopment, renovation or demolition is planned during the next few years, if the compound is in a location that is very difficult to access, or if it is necessary to delay the clearance work to ensure that an activity that is of importance to society is not obstructed in a significant manner. An example of the latter situation could be a hospital at which clearance work would entail comprehensive difficulties and temporary changes to the activities undertaken at the hospital.

No later than three weeks prior to the commencement of clearance work, an application regarding the clearance measures must be submitted to the supervisory authority, whereupon the authority will assess whether the clearance measures will be implemented in a good manner with regard to people’s health and the environment. Such an application must also be submitted in relation to the clearance of sealants with PCB levels between 50 and 500 mg/kg.

The Swedish legislation also contains rules about the waste generated from the clearance work and how that waste is to be managed, labelled and transported, and where it may be discarded. Fortum Waste Solutions in Kumla (formerly SAKAB) is the only company that may “dispose of” such waste, in other words destroy PCB-laden material, which involves combustion at a high temperature in a controlled process.

6.4 How much has been cleared?

Please note:

Information campaigns (primarily 1998 – 2002) to property owners and others within the building sector about the undertaking, on a voluntary basis, to clear buildings of PCBs, led to an increase in the extent of clearance work being performed. However, the new legislation (2007) has had an even greater and clearer effect.

Both the information campaigns and regulation by way of legislation are needed to drive the work regarding inventory and clearance of PCBs!

In 2015, Per Lilliehorn and Gunilla Rex performed a survey, on behalf of the Swedish Environmental Protection Agency, to find out how much PCBs had been cleared in the country (Rex Hus & Miljökonsult and Lilliehorn Konsult AB, 2015). By that stage the inventory work had more or less been completed, and the results of the inventory have shown that around 25% of the inventoried properties contained PCBs. That figure relates to all types of properties that have been inventoried. For buildings that have been built with elements, the percentage containing PCB is significantly higher.

The assessment of the clearance situation was that by 30 June 2016 (the final date for clearance work according to the ordinance), it was likely that 70 – 85% of the relevant properties from 1956 – 1973 would be finished in terms of having been cleared of PCBs. A rough estimate was made that this would mean that between 20 -50 tonnes of PCBs would remain in buildings that had not yet been cleared. There is also the matter of PCB-laden buildings that haven't been identified or reported by their owners, a figure that is extremely difficult to assess.

Waste statistics from Fortum Waste Solutions in Kumla state that thereafter, during the years 2015, 2016 and 2017, a further (approximately) 25-30 tonnes of PCBs from joint clearance have been delivered for destruction.

The diagram below shows the quantities of PCB-laden waste from clearance of joints that have been delivered to Fortum Waste Solutions, previously SAKAB. The following diagram shows the estimated quantity of PCBs in the waste. During the years 1998 – 2002 the PCB project within the Ecocycle Council was ongoing and the amount of clearance work increased, which can be seen from the increased quantities of waste that were delivered for destruction during the period 1999 – 2003. In other words, the information provided by the project had an effect! When a decision was then announced that Sweden was to have new legislation with requirements on inventory and clearance, the level of work clearly reduced as people decided to wait for the introduction of the legislation, and then increased again in connection with the introduction of the PCB Ordinance (2007: 19) in March 2007. The ordinance has since had a major effect on the level of clearance work.

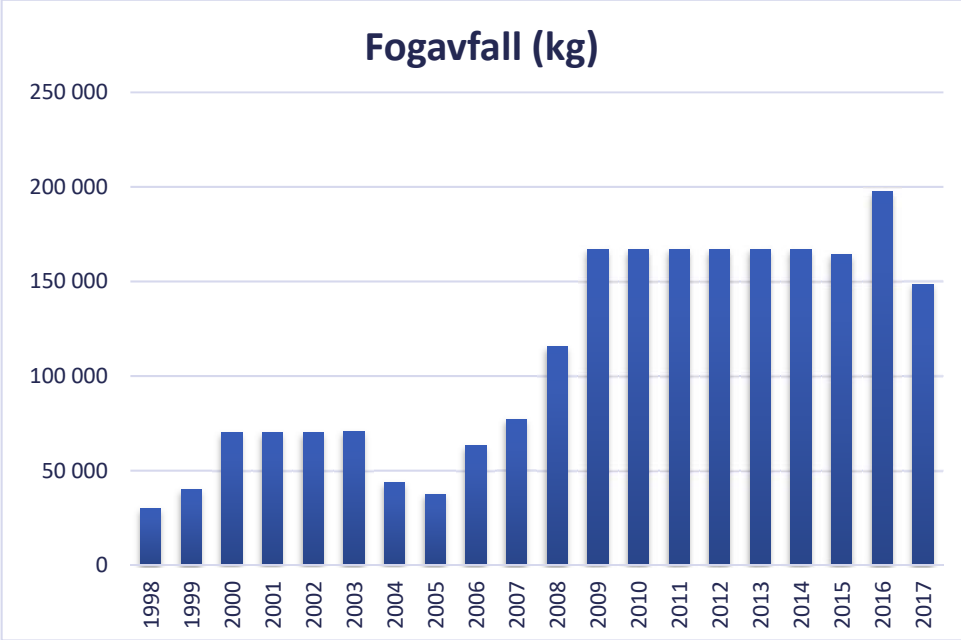


Diagram: Miljökonsultgruppen i Stockholm

Destroyed quantities of waste from joints with PCB-laden compounds 1998-2017 (kg)

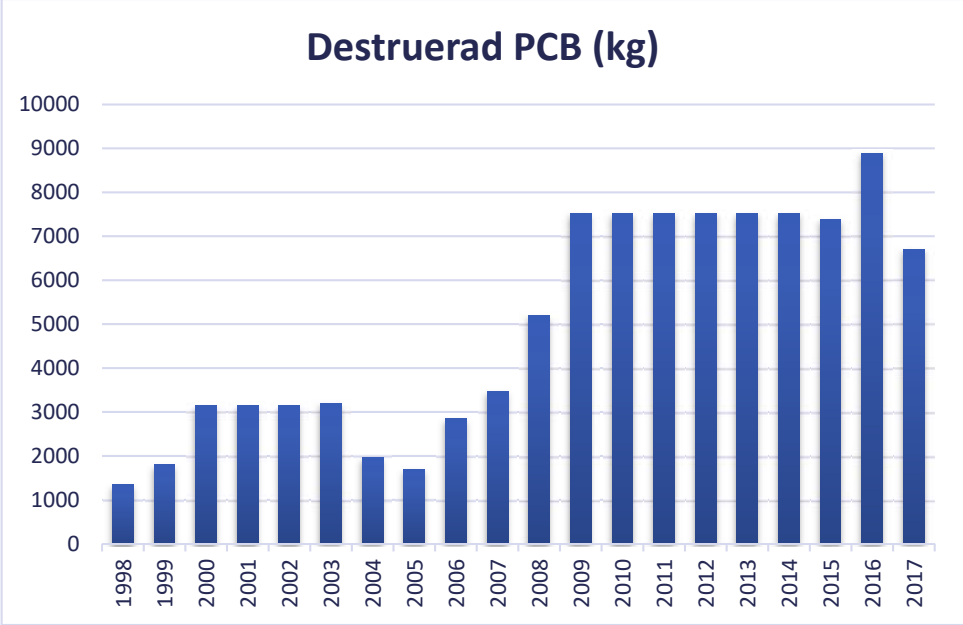


Diagram: Miljökonsultgruppen i Stockholm

Destroyed quantities of PCB 1998-2017 (kg).

Based on the quantity of sealants waste destroyed the quantities of destroyed PCBs are calculated on the basis of an average content of PCBs in the waste of 5.25%. However, the calculation is based on several uncertain factors.

7 Inventory – Swedish experiences

Please note:
The person who intends to make an inventory should possess technical building knowledge and should know where there could be sealants and other products with PCBs.

7.1 Better inventories today

The knowledge and thoroughness regarding inventory of PCBs has improved since the active work to remove PCBs was started 20 years ago.

Inventories that were performed 15 – 20 years ago could be poorly documented and perhaps even poorly executed. They could lack information about where samples had been taken of sealants, and whether all the sealants in a building had been inspected, and how much sealant (total length) there was in total. Information about other products with PCBs could also be lacking. Such an inventory must be redone in order for the property owner to be able to gain information about all the PCBs that exists in the building, and to be able to submit this information to the supervisory authority. A good inventory is also a necessary piece of documentation when it comes to procuring the services of a contractor for the clearance of PCBs in sealants or flooring compounds for a building that is to be decontaminated.

Aids for how to make an inventory have been produced in the form of forms for the compilation of the inventory results and for the submission of the results to the local supervisory authority (in practice this matter is administered by the environmental department of the local municipal government). Many people who are responsible for performing inventories have attended courses on how to make an inventory of PCBs, and information about how to perform an inventory is also available on the website www.sanerapcb.nu. These days, the municipal environmental departments have greater knowledge and are more aware that sufficient and reliable information from inventories is being submitted.

7.2 Knowledge requirements on those who perform an inventory

There are no formal requirements on the knowledge that needs to be possessed by a person who is to perform a PCB inventory, although it is good if such a person has technical building knowledge and knows where PCB-laden sealants and flooring compounds could exist. Ideally, the person who is to perform an inventory should have experience of previous PCB inventories, in order to be able to assess where the various products with PCBs might exist, and how many samples should be taken on sealants and (where applicable) flooring compounds.

A person who wishes to make a PCB inventory but does not have previous experience can increase his or her knowledge by reading relevant information and preparing thoroughly for the task, by attending a course on how to perform an inventory, or by working together with an experienced person. The person who performs the inventory could be a consultant, or perhaps a property owner can carry out the inventory with his or her own personnel. Certain entrepreneurs have also undertaken training in how to make a PCB inventory.

7.3 Preparations for the inventory

Please note:

A good inventory requires thorough preparations, for example knowledge about the building and drawings thereof, and suitable equipment for taking samples.

An inventory should cover all building products that could contain PCB, and should be thoroughly documented.

There are a number of important points to consider and prepare for prior to an inventory.

- Allocate sufficient time to the inventory work, so that products with PCBs are not missed, and/or the documentation is not rushed or inadequate.
- If possible, allocate at least two people to the inventory work so that they can help one another. There is a lot to manage during the inventory – above all else the samples that need to be taken of sealants and flooring compounds.
- Consider in advance whether aids will be needed in the form of ladders and/or other equipment.
- Consider the work environment aspects of the inventory work.
  - Is there a risk of suffering a fall during the work?
  - Could it be dangerous to enter areas that have not been used in a long time, or to enter operating areas where there could be loose asbestos?

  The person who is responsible for the inventory should make all necessary arrangements to avoid the risk of injury.
- Investigate and reach agreement prior to the inventory about what applies in relation to destructive samples. (By destructive samples we mean that taking the sample involves a measure that damages the outer surface or building parts and therefore requires special measures to return the damaged area to its original condition).

  If samples are not taken (whatever the reason), the inventory is not complete. In such case a new inventory must be performed at a later date, for example in connection with a redevelopment project.
- Use drawings (plans, facade drawings) and other documentation about the building as supporting documentation for the inventory.
- Investigate the history of the building. Perhaps there is someone who can remember the types of businesses that were operated in the building in the past? All such information facilitates the performance of the inventory.

- Make sure of the availability of all the equipment that is needed to take samples of sealants and (where applicable) flooring compounds.
- Plan the inventory work on the basis of the different products that are to be examined (both indoors and out).
- Investigate any potential access issues, and arrange for access to the relevant premises (for example by obtaining keys), and access to a couple of the apartments in an apartment building.
- Provide advance information to local residents and other local users that could be affected by the inventory.
- Try to ensure that a caretaker/janitor or some other person with in-depth knowledge of the premises is able to participate in the inventory.

7.4 Equipment for inventory work

The following equipment is needed or is good to have as an aid during the inventory work:

- Drawings
- Inventory form/report and a pen
- Measuring tool (to assess the length of joints)
- Camera
- Respiratory equipment or other protective equipment (as applicable, in accordance with the risk assessment that has been performed prior to the inventory)
- Any other equipment that may be needed e.g. a ladder

For labelling of condensers and sealed window units that are identified as PCB-laden or are suspected of containing PCBs:

- Labels that can be affixed to the products on site.

The following equipment could be required when taking samples:

- A sharp knife (a pair of pliers, a screwdriver, a chisel and a hammer could also be useful to have)
- Aluminium foil
- Plastic bags or key bags and a pen to label them
- Disposable gloves that can be changed between each sample
- Acetone and paper towels, paper wipes or the like for cleaning
- Large bags for the collection of samples and waste
- Caulking gun with sealant for resealing, in several colours (our suggestion is definitely one grey and one white, and also one brown if possible)

Example of equipment needed for taking samples of sealants

7.5 Sealants

Please note:

It is not possible to see whether or not a sealant contains PCBs; in order to find out, a sample must be taken and sent to a laboratory for analysis. An experienced person can often determine whether or not a sealant is polysulfide-based, but that knowledge alone is not sufficient to determine whether it contains PCBs.

Please refer to section 5.1 for information about the types of sealants that could contain PCB as a primary additive and where PCB-laden compounds are likely to be found (we have also provided a number of pictures as examples).

All sealants from the relevant period should be examined. Since sealants may have been secondarily contaminated, samples must be taken of all types of sealants in buildings from the period 1956 – 1973, and sent to the laboratory for analysis.

Sealant in exterior passageway

Sealant adjacent to window

Sealant adjacent to steel door

7.5.1 Taking samples of sealants

Please note:

When taking a sample:

- *Make sure you bring good tools for taking the sample*
- *Be careful that the samples do not ”contaminate” each other*
- *Use disposable plastic gloves and change gloves between each sample*
- *Document the process thoroughly*
- *Reseal the area you have sampled so that you don’t leave a hole in the seal*

Samples must be taken of sealants in buildings from 1956–1973 as well as in older buildings if the sealant has been used during this period. Samples must be taken of all types of sealants, in other words all sealants that look different than each other or that have been used in joints between different types of materials or products. Samples must also be taken of new sealants in buildings from the period in question, since they could have been contaminated due to e.g. residues of a previous sealant with PCBs.

Samples must be taken both indoors and out. If the sealants look different than one another, it could be due to the fact that they have a different composition or have suffered a different level of exposure to weather and wind; for example, certain sections on the southwards-facing facade may have been replaced.

When it comes to e.g. larger residential areas that have been built up during a lengthy period of time, several different types of sealants may have been used. It is also possible that sealants with PCBs and sealants without PCBs may have been used on the same facade.

Sealant is cut out. Only the hand with the plastic glove may touch the sealant.

THE SCOPE OF THE SAMPLING PROCESS

How many samples that need to be taken is a matter of judgement. It depends on how big the building is, how many joints it contains and what the joints look like. All types of sealants must be examined. In order to assess a sealant as one and the same type of sealant (and therefore only requiring one sample to be taken), not only must it look the same, it must also have the same properties as the sealant from which the first sample was taken.

As a general recommendation, at least two samples should be taken of each type of sealant. It is often appropriate, for example, to take one sample of each expansion joint of a certain type. If sealant has been used adjacent to the entranceways, it could be appropriate to take samples of several of these if the sealants on all entranceways are of the same type. If there are sealants that look the same on the building's various facades, and the compounds have the same consistency, one sample can be taken on each facade.

Bear in mind that it is more cost-effective to gain more knowledge about where the PCB-laden compounds are by taking samples, than it is to arrange for the clearance of compounds that do not contain PCB.

INDIVIDUAL SAMPLES

When performing an inventory, some people prefer to just take one sample at each location, in which case a sample of about 3 cm should suffice. Bear in mind, however, that if you only take one sample at each location, it could mean that you

have to go back and take a new sample at that location at a later date if e.g. the original sample does not arrive at the laboratory for some reason, or if the results from the laboratory are deemed to be unreasonable and the analysis needs to be performed again.

Otherwise, take a 5 – 6 cm piece of sealant and divide it up into two samples – one of which is sent to the laboratory, while you keep the other one until the lab results from the first sample have been produced without any problems.

Remember that the "reserve" samples retained by the person who has performed the inventory must be managed as hazardous PCB waste if the lab results show that the compound in question contains PCBs. It is usually possible to give such sample pieces to a contractor who works with PCB clearance.

COLLECTIVE SAMPLES

An option is to take collective samples (mixed samples) from each type of joint. It has been shown that the PCB level can vary a great deal at lower levels of PCBs, even with only a distance of 0.5 metres between the sampling locations. A collective sample is prepared by taking several sub-samples from each type of joint. Collective samples can be taken if there are a lot of joints of the same type on a building or if there are several buildings that appear to have the same type of sealant.

If it turns out that one type of sealant does not contain PCBs, it is a lab result that applies to all the joints sampled in the same collective sample. If, however, the sample contains PCBs, it could be justification enough to go back and take several more samples, to see if some joints might possibly be free from PCBs, or how the PCB level varies. Based on the results, the clearance work can then be limited to the joints that have actually been shown to contain PCBs.

THE SAMPLING PROCESS STEP BY STEP

1. Put on a clean pair of disposable gloves
2. Cut out the length of sealant that has been selected for the samples. Make sure that you get the entire piece of sealant (the cross-section)
3. Divide up each sample into two pieces (if applicable – see explanation above), wrap the pieces in aluminium foil and place each of the pieces in its own bag, so that one of them can be saved as a reference (reserve) sample. The pieces are wrapped in aluminium foil to ensure that the PCB does not start to transfer to the plastic. When taking collective samples, the sub-samples from each type of joint can be collectively placed in one bag that is to be sent to the laboratory and in one other bag that is to be saved in reserve until the lab results have been reported.
4. Remove the disposable gloves and throw them away.

5. Label the sample bag with the designation you have chosen for that sample (the bag can also be labelled before you start to take the sample). It is important that the bags and the sampling report are labelled so that each sampling location can be identified.
6. Mark the sampling location on a drawing or sketch with the sample's designation, and ideally also with a description of what the joints look like. Pictures of the sampling location and joints are always a valuable reference material.
7. Thoroughly clean the knife and any other tools you have used after each sample.
8. Apply new sealant to the area where the sample was taken.
9. Measure the length, width and depth of the sealants as a basis for being able to calculate the quantity of PCBs in the building.
10. Wash your hands thoroughly after the sampling work, especially if you are going to take a food break.
11. Send the sample pieces to the laboratory. The labelling of the samples should contain the property designation.
12. Alternatively, this can be stated in a list of the samples that can then be submitted together with the samples when they are sent to the laboratory. Request that the property designation also be recorded in the lab's analysis report.

Remember to clearly document where the samples have been taken! The labelling should make it possible for the samples that are sent to the laboratory to be unequivocally identified at a later stage. It should be possible to see exactly where each sample has been taken.

Photo: Igor Kecskés Maconkai

The quantity of PCB is calculated by referring to the width of the joint! In this case the joint is about 3 cm wide.
Assistance in how to perform the calculation is available on the sampling report form.

Inventeringsprotokoll
Fogmassor

Byggnadens adress		Fastighetsbeteckning	
Byggnadsnummer	Bruttoarea (m²)	Byggnadsår	Ombyggnadsår
Inventerad av	Telefon	E-post	Datum för inventering

Byggnadens användning (ange ett eller flera alternativ)

Byggnadens användning (ange ett eller flera alternativ)

☐ Bostäder
☐ Skola, daghem
☐ Sjukhus eller vårdcentral
☐ Industribyggnad (byggnad som taxeras som industribyggnad)
☐ Annat, ange vad

Konstruktion

Hus med fasadelement av betong	Byggnaden har fogats om	Om ja, ange år
☐ Ja ☐ Nej	☐ Ja ☐ Nej	

Omgivning

Lekplats med sandlåda eller lekredskap inom 50 m från huset	Odlingslott eller kolonilott inom 50 m från huset
☐ Ja ☐ Nej	☐ Ja ☐ Nej

Provnr	Provtagningsplats (Även hänvisning till ritning e d)	Fogmassa typ[1]	Halt mg/kg	Foglängd m	PCB[2] kg
		Summa >500 mg/kg			
		Summa 50-500 mg/kg			
		Summa totalt			
Kommentarer					

1 Välj egen beteckning för varje typ av fogmassa som ser annorlunda ut än övriga.

2 Mängden PCB (kg) räknas ut med formeln $\frac{Halt\ (mg/kg)}{1\,000\,000} \times Foglängd\ (m) \times 0{,}25\ (kg/m)$.

Formeln bygger på att fogbredden är ca 15 mm och fogdjupet 6 – 7 mm.

7.5.2 Analysis and calculation of total level of PCBs

It is important that the laboratory used has documented experience of analysing PCBs in sealants. Certain laboratories are accredited for analysis of PCBs in sealants. In Sweden the GC-MS (Gas Chromatography Mass Spectrometry) analysis method is primarily used.

The analysis results are usually expressed in mg/kg, and the total PCB level is usually calculated on the basis of a certain number (usually seven) of individual PCB contaminants (congeners). The total for the seven congeners is then multiplied by a factor that varies depending on the technical mixture that the laboratory assesses is in the sealant.

The total PCB level expressed in mg/kg can easily be converted to a percentage – you just have to remember that a PCB content of 10,000 mg/kg of sealant is equivalent to 1% PCBs in the sealant. (1 mg/kg is the same as 1 ppm, i.e. one-millionth).

If the analysis results do not give any clear answers regarding where PCB-laden joints are located (mixed positive and negative results), additional samples should be taken.

7.6 Flooring compounds

Please note:
Analysis at a laboratory is required in order to identify flooring compounds with PCBs.

Please read section 5.2 for information about where flooring compounds with PCBs might exist.

In order to know where to look for flooring compounds with PCBs, it is good to know how the premises were used during the period 1956 – 1973. The property owner should investigate whether there is any existing technical documentation available, and can also ask any “witnesses” about the floor-laying techniques that were used in the premises during the above period.

If it is possible that flooring compounds could exist under another (more recent) floor covering, the PCB Ordinance requires that samples be taken of the underlying flooring compound. It is also likely that, for example, a PVC floor that has been laid on top of an old Acrydur floor will accumulate PCBs and thus have PCB levels that mean the floor must be managed as hazardous waste when it is removed.

If the old Acrydur floor has been removed and a new floor covering has been laid on top, there is still a risk that PCBs remaining in the underlying layer may have made their way into the new flooring material.

All types of flooring compounds from the named period must be examined. The identification of flooring compounds with PCB requires the taking of samples for analysis at a laboratory.

7.6.1 Taking samples of flooring compounds

Samples must be taken of flooring compounds that are suspected of possibly containing PCBs, even if they exist under a new floor covering. If there is flooring where it is known or possible that the flooring material in the relevant types of premises has been replaced, a sample should also be taken from these floors.

Samples can be taken as follows:

- If the premises are in use: Try to take the sample in such a way that the waterproofness in the floor covering is not damaged.
- Break off small pieces, for example from the pulled-up base.
- Use a drill to take samples in certain cases.If it is necessary to reseal the sampled area with sealant – check with a sealant supplier about the appropriate type of sealant to use.

7.6.2 Analysis

Check that the laboratory you intend to use has documented experience of analysing PCBs in flooring compounds.

If the person who has performed the inventory has sample pieces remaining and it turns out that they contain PCBs, they must be managed as hazardous PCB waste.

7.7 Sealed window units and condensers

Please note:

In certain cases, sealed window units can be identified by checking for a label in the spacer strip between the panes with details of the manufacturer and the year of manufacture. Svensk Planglasförening maintains a list of sealed window units that contain (and do not contain) PCBs.

Small condensers in electrical equipment installed up to the early to mid-1980s should be suspected of containing PCBs.

According to the PCB Ordinance, if the person who is performing the inventory finds sealed window units or equipment with a condenser that contains or is suspected of containing PCBs, the product must be labelled in such a way that it is clearly visible that it might contain PCBs. Sealed window units with a label showing the manufacturer's name and the year of manufacture can be checked against Svensk Planglasförening's list (Svensk Planglasförening, 2017).

7.8 Documentation

Please note:

The inventory must be well documented.
It must include:

- *Details of where sealants and flooring compounds are located and where samples have been taken.*
- *PCB levels for sealants and flooring compounds must be stated (even PCB-free compounds are reported).*
- *State where and how many sealed window units and condensers with PCBs (or suspected of containing PCBs) have been found.*
- *Include an assessment of the total quantity of PCBs in each type of product.*

The documentation must be saved as supporting documentation for future measures.

The inventory must be well documented, and the inventory report should contain details of the sealants and (where applicable) flooring compounds that have been sampled and where they are located. Document the scope of windows and condensers that contain (or are suspected of containing) PCBs and where these are located in the building. Forms for reporting the inventory results are available at www.sanerapcb.nu. The places where the samples have been taken of sealings and (where applicable) flooring compounds should be marked on drawings or sketches, as well as the location of sealed window units and condensers that contain (or are suspected of containing) PCBs. It is good if your drawings and inventory report can be supplemented with photos. Make a note in the inventory report of the joint length for each type of sealant as well as the area of the sampled floor.

If the analysis has indicated that the compounds contain PCBs, the PCB levels should then be stated in the report. Even sampled compounds that are PCB-free should be reported. The analysis report from the laboratory should be included with other documentation. Details of any sealings and/or other products that are suspected of possibly containing PCBs but which have not been able to be examined, as well as any areas to which access has not been available, should also be included in the report, along with the reasons why these have not been able to be examined. A supplementary inventory of such products/areas will need to be performed when the building parts in question are subject to renovation, redevelopment or demolition work.

By stating the property designation on the inventory report and the laboratory's analysis report, it is made clear to the property owner and the supervisory authority (the municipal environmental department) which property has been examined. This also reduces the risk of cheating in relation to the analysis results.

If PCBs have been found in sealants or flooring compounds, the inventory documentation will form part of the supporting documentation for the procurement/ordering of clearance measures. The documentation should also be saved as supporting documentation when it comes to assessing future measures that involve sealings and flooring compounds. This applies to the compounds for which the property owner has been granted an exemption from the need to implement clearance measures, as well as to the compounds that have PCB levels below 500 mg/kg and thus do not need to be cleared until the building is subject to renovation, redevelopment or demolition. The information is also needed for the assessment of measures where PCBs could still remain, for example, in joint edges after clearance.

7.8.1 Calculation of PCB quantities

The quantity of PCBs in various products in a building can be roughly calculated in order to enable an assessment of the total quantity of PCBs in the building. For example, in Sweden the quantity of PCBs in sealants (kg) is calculated with the formula:

$$\frac{\text{PCB level (mg/kg)} \times \text{joint length (m)} \times 0.25 \text{ (kg/m)}}{1{,}000{,}000}$$

The formula is based on the assumption that the width of the joint is approx. 15 mm and the depth of the sealing 6 – 7 mm. If the dimensions of the sealants differ significantly from these figures, the formula should be changed accordingly. For flooring compounds the quantity of PCBs (kg) is calculated with the formula:

$$\frac{\text{PCB level (mg/kg)} \times \text{area (m}^2\text{)} \times 2.2 \text{ (kg/m}^2\text{)}}{1{,}000{,}000}$$

A condenser for e.g. a light fitting is estimated to contain approx. 50 g PCBs. For sealed window units the circumference is calculated, and the sealing compound is assumed to have a PCB content of approx. 0.04 kg/m.

The calculations of PCB quantities may only be rough, but they are still helpful when it comes to procuring/ordering clearance measures or other measures.

7.9 Reporting to the supervisory authority

In Sweden the inventory results must not only be reported to the client (the property owner) but also to the local supervisory authority (the municipal environmental department) in the form of a summary of the results and an action plan if there are PCB-laden compounds that must be cleared pursuant to the requirements in the PCB Ordinance.

7.10 PCBs in the ground

Please note:
After clearance of PCB-laden joints, the property owner should replace the sand in sandpits as well as the top layer of soil in playgrounds and allotments near the building.

We have a background level of PCBs in the ground, but the PCB levels are higher in the ground underneath facades that contain or have contained PCB-laden sealings.

The Swedish Environmental Protection Agency has issued benchmark values for levels of contaminants for sensitive use of land, such as e.g. land used for residential housing, and for less sensitive use of land. The benchmark values have been set on the basis of the risks that are posed to people's health and to the environment. The benchmark values are a tool for assessing whether a contamination situation exists and whether after-treatment measures are needed. Contaminants in the ground are not covered by the provisions of the PCB Ordinance but rather by chapter 10 of the Swedish Environmental Code (1998:808), and clearance measures may not be commenced in the ground until the supervisory authority has approved the measures. Consequently, prior to the clearance of PCB-laden joints, it is important to consult with the supervisory authority regarding the measures that are to be performed in relation to clearance of the joints and the need for ground decontamination that may exist. Otherwise, if the contamination damage in the ground lacks set corrective measure objectives and/or clear demarcations, there is a risk for major unforeseen costs.

The supervisory authority (the municipal environmental department) may request samples and a risk assessment in order to be able to assess the measures that are necessary.

After the clearance of PCB-laden sealants in facades, the PCB levels in the ground close to the building may have increased, and it may therefore be necessary to also undertake decontamination of the ground close to the building as an extra safety precaution, in particular in relation to the ground close to apartment buildings, schools, nurseries, etc. In such cases the top layer (approx. 10 cm) of soil within a few metres from the building can be replaced for surfaces/areas that are not sealed. The sand in sandpits should be replaced, as should the top layer of soil in playgrounds and allotments near the building. It may also be relevant to consider adding new soil on top of the existing soil where applicable.

The supervisory authority (the municipal environmental department) should be contacted for consultation about appropriate measures and how the removed top layers should be dealt with.

7.11 Negligent property owners

A property owner who has not performed an inventory or arranged for clearance measures in accordance with the requirements of the PCB Ordinance (PCB Ordinance, 2007) may be subject to an order from the authority. In certain cases an order to undertake such measures may also be subject to a fine.

There are no environmental sanctions connected to the PCB Ordinance. However, performing clearance measures without first having submitted the appropriate application could constitute prohibited environmental activities pursuant to the Swedish Environmental Code.

7.12 The cost of performing an inventory

The cost of performing an inventory can vary significantly, depending, for example, on the size of the object that is to be examined, the amount of sealants contained in the object and how easy (or difficult) these are to find and examine, and how good the available supporting documentation is in the form of drawings etc. For example, performing an inventory of a building could take 8 hours, including preparations, but when you also consider the time required to summarise the results as well as any travelling time (if applicable), the total time taken could perhaps be 20 hours. In addition, there is the cost of having the samples analysed by a laboratory. When all factors are considered, the total cost could be in the region of SEK 30,000 – 40,000.

7.13 Training in how to perform a PCB inventory

Miljökonsultgruppen i Stockholm arranges a course that deals solely with how to perform a PCB inventory. Training in how to perform a PCB inventory can also be included as part of a course on “Environmental Inventory” or “Material Inventory”. The PCB inventory can also be included in a course on clearance of joints, or perhaps as part of internal training courses arranged by e.g. site clearance companies.

A course in how to perform a PCB inventory should cover:

- General information about what PCBs are, the environmental and health effects of PCBs, and where PCBs might exist in buildings.
- Information about the Swedish PCB Ordinance and the property owner’s responsibilities pursuant to the ordinance.
- How the inventory should be performed, including the practical preparations and the practical inventory work, how to take samples and the documentation that is required.
- Some information about the supervisory authority’s role and activities, and the requirements the authority can impose on the reporting of the inventory.

8 Clearance of sealants – how we work in Sweden

Please note:

During the clearance work, the spread of PCBs must be prevented through a number of measures:

- *Collection of dust and particles close to the tool, which requires good equipment.*
- *Collection containers for waste must be located adjacent to the worksite.*
- *Using a sealed/enclosed work platform when working on a facade, and sealing/enclosing the area between the work platform and the facade, prevents pieces of joint from falling down.*
- *The work scaffolding should also be covered all the way to the top edge of the railing.*
- *Geotextile fabric to cover the ground: from the facade and about four metres out, although even more when working on high buildings.*
- *Tenants/residents and other local users must be informed in advance. It is the responsibility of the property owner to ensure the provision of such information, although the contractor can be requested to also attend an information meeting. Tenants/residents should keep their windows and balcony doors closed during the work.*
- *Ventilation openings must be closed or covered.*
- *If possible, the building's ventilation system should be shut off if it is extraction ventilation.*
- *When performing clearance measures indoors, safety measures should be taken in the equivalent manner as for clearance of asbestos.*

Clearance involves removing the PCB-laden sealant and a small amount of the joint edges, and managing the removed material as hazardous waste. The property owner must specify requirements on the quality of the clearance work and is responsible for ensuring that the work is performed in a good way. The individuals who perform the actual clearance work should have good knowledge and training regarding clearance techniques, environmental safety and protection, and work environment issues.

8.1 Training in site clearance measures

Courses in PCB clearance are arranged by a number of companies and organisations in Sweden. The training is not a specific requirement in the legislation in order to be able to perform clearance work, although property owners are encouraged to specify a requirement during the procurement process that clearance personnel must have undertaken appropriate training.

Guidelines for the content and scope of the training have been agreed by a number of training organisations together with Miljökonsultgruppen. The Swedish Environmental Protection Agency, the Swedish Work Environment Authority and the environmental departments in Stockholm and Gothenburg also took part in the discussion regarding the training guidelines. Individuals who have completed the training course in PCB clearance should be able to provide a valid approved course certificate.

A training course in PCB clearance should cover

- General information about what PCBs are and their environmental and health effects
- Where PCBs might exist in buildings
- Clearance techniques
- Clearance measures during demolition work
- Environmental safety and protection measures
- Work environment issues
- Waste management
- Quality assurance
- Applicable legislation

8.2 Help for the clearance work

There are a number of documents available that describe methods, equipment, procedures, etc. that can be used for clearance of joints:

- During the Ecocycle Council's PCB project (1998 – 2002), the Swedish Sealant Association (SFR) studied clearance methods and produced a guidance document for the clearance of PCB-laden sealants, "Sanera PCB-haltiga fogar" (Removal of sealants containing PCBs), Guidance for sealing contractors (Folkesson, I et al., 1999). When procuring the services of clearance contractors, it can be stated in the requirements specification that the clearance work is to be performed in accordance with this guidance document.
- The PCB Handbook from Miljökonsultgruppen i Stockholm (Miljökonsultgruppen i Stockholm, 2016) contains information about clearance of joints, and the same information is also largely available on the website www.sanerapcb.nu (in Swedish only).
- During 2005 – 2006, the Swedish Demolition and Site Clearance Contractors Association performed a study of the air contaminants that arise during the clearance of PCB-laden sealants, as well as the protective measures that need to be taken. A recommendation (based on a summary of the results from the study) is set out in the document Clearance of PCB-laden sealants in buildings – Operating guidelines recommended by the trade associations (The Swedish Demolition and Site Clearance Contractors Association, 2006). When procuring the services of a contractor and during the actual clearance work, this recommendation can be referred to as a complement to the books mentioned under the first two points.

8.3 Responsibility for the clearance work under Swedish legislation

Please note:

The property owner is responsible for his or her property and must ensure that clearance measures are implemented if it has been shown that the property contains PCBs in sealants or flooring compounds.

The property owner must submit an application regarding the clearance work to the supervisory authority (the municipal environmental department) at least three weeks prior to the planned commencement of the work.

The property owner has the overall responsibility for ensuring that the clearance work is performed in the best possible manner with regard to the environment and people's health, and is also ultimately responsible for the work environment during the clearance work.

The contractor is responsible for ensuring that the work is performed in the best possible way from a technical perspective, and for ensuring that the necessary measures are taken to minimise the spread of PCBs to the surrounding area and to protect people's health and the environment.

It is the role of the municipal environmental department to exercise supervision in order to check that PCBs do not spread to the environment.

8.3.1 Responsibility for the environmental impact

The Swedish Environmental Code (1998:808) and its ordinances apply to PCB clearance measures and include, among other things, requirements on the use of the best available techniques and technology for the work, protective measures that prevent the spread of PCBs, and an environmentally appropriate management of waste in accordance with the Swedish Waste Ordinance (2011:927). PCBs are also classified as POPs (persistent organic pollutants), and special requirements apply to how such waste is to be managed. For PCB levels above 50 mg/kg, the PCB waste must be destroyed in accordance with EU Regulation (EC) 850/2004 on persistent organic pollutants.

The contractor is responsible for ensuring that the clearance work is performed in accordance with the requirements specified in applicable legislation. The contractor must continuously check that the work is being performed with good quality.

The property owner must ensure that the work is being performed in the agreed manner. The property owner can check this by making repeat unannounced visits to the worksite. If the property owner has engaged the services of a consultant for the inventory, it could be appropriate to ask the same person for assistance when it comes to checking the way the clearance work is being performed by the contractor. The inspection of the clearance work should also cover a review of the contractor's self-checks/self-inspections and the reporting of waste management.

The property owner must request and file documentation from the contractor regarding waste management, and must report such information to the supervisory authority after completion of the clearance work.

8.3.2 The role and work of the supervisory authority

The role of the supervisory authority (the environmental department) to exercise supervision means that the environmental department processes the application and assesses whether it is likely that the clearance work will be performed in an environmentally appropriate manner, i.e. with the use of an appropriate method and competent personnel. The authority may also deem it appropriate to follow up the application by performing a supervisory visit to the workplace. Once the clearance work has been completed, it is important that the property owner submits a report about the completed clearance measures to the environmental department. As part of its supervisory work, the environmental department may also, after completion of the clearance work, request documentation about how the waste generated by the work has been transported and where it has been delivered/deposited (if this information is not already included in the property owner's report).

8.3.3 Responsibility for the work environment

THE CONTRACTOR (THE SITE CLEARANCE COMPANY)

Every employer always has a work environment responsibility for its own employees. It is important that all employees know who is responsible for the work environment at the worksite and who they should turn to concerning various work environment issues.

The employer has the primary responsibility and must produce, together with the employees and the health and safety officer, procedures that ensure the achievement of a good work environment. The employer must undertake the measures necessary to prevent the risk of employees suffering injury or ill-health.

THE CLIENT'S WORK ENVIRONMENT RESPONSIBILITY

Client is a term that is often used in Swedish legislation in reference to the person or party that arranges/orders building or civil engineering work. In relation to site clearance contracts and work, the client is usually the property owner. Under the Swedish Work Environment Authority's provisions on Building and Civil Engineering Work (The Swedish Work Environment Authority, 1999), the client has the fundamental responsibility for ensuring that everyone involved gives consideration to the work environment at different stages of a building project.

8.4 Procurement of joint clearance services

Please note:
In connection with the procurement process, it is the person who is procuring/ordering the clearance work (i.e. the property owner or other client) who can specify requirements on the contractor and the clearance measures.

The property owner should engage the services of a contractor who works in accordance with a tried and proven method, and who uses equipment and procedures that minimise the spread of PCBs. One concrete recommendation is to specify a requirement that those who are to perform the clearance work have undertaken appropriate training in accordance with the guidelines described above.

When procuring the services of a contractor, the client can refer to the description of the work in the PCB Handbook (Miljökonsultgruppen i Stockholm, 2016) or to the Swedish Sealant Association's guidance document "Sanera PCB-haltiga fogar" (Removal of sealants containing PCBs) (Folkesson, I et al., 1999). The document Clearance of PCB-laden sealants in buildings – Operating guidelines recommended by the trade associations (The Swedish Demolition and Site Clearance Contractors Association, 2006) can also be referred to as complementary information.

As assistance during the procurement process, the website www.sanerapcb.nu contains a proposal (only in Swedish) regarding Administrative Regulations in accordance with the Swedish industry agreement AMA AF 12 (Svensk Byggtjänst, 2015). An English version of AMA AF 12 is available.

The request-for-tender documentation should contain drawings of the building with markings of what needs to be cleared and where, a description of the building's design and construction, a description of the joint types involved, the calculated quantities (joint lengths, floor areas) that need to be cleared, and the analysis results from the inventory, with a description (and indication on a drawing or sketch) of where the samples were taken.

In its tender, the contractor should provide details of its work environment measures, safety and protection measures and daily procedures for protecting the environment and ensuring the safety of tenants/residents/local users and other relevant persons and parties.

8.5 Preparations for the work

9.5.1 Meeting between the client and the contractor

The client (and the property owner if he/she is not also the client) should hold a meeting with the contractor prior to commencement of the work, at which the contractor should present the work methods and equipment it has chosen for the work. The supervisory authority (the environmental department) and the Swedish

Work Environment Authority's inspector should be given the possibility to attend this meeting.

8.5.2 Test clearance

It can be of value to first carry out a test clearance if the project concerns comprehensive clearance work or if the sealant is very difficult to access. It is also recommended to carry out a test clearance prior to clearance measures on panels/slabs of natural stone, since it is important in such cases to ensure that the work will not damage the stone. Please see more information under the heading 9.8 Clearance measures in special cases.

During a test clearance, it is possible to see how the work is to be performed and to reach agreement on the degree of cleaning required and what the results of the cleaning work may look like. The supervisory authority (the environmental department) should be included in the discussion about the degree of cleaning required, if the proposed measures mean that PCB residues will remain to a greater extent than is normally the case after joint clearance work.

Carefully cleaned surface prior to resealing. Cracks and other damage to the joint edges that already existed prior to commencement of the clearance work should be documented to avoid disputes at a later time. Damage that arises during the work should be noted by the contractor and reported to the client.

8.5.3 The contractor's preparations

- The contractor must provide the client with documents that show that the work will be performed as described in the contract with the client, for example a work environment plan, an environment and quality plan, and copies of training certificates for personnel who will be performing the clearance work.
- Everyone who is to work with the clearance measures needs to receive relevant information from the PCB inventory about where the PCB-laden sealants are located and the PCB levels they contain, about the clearance techniques that are intended to be used, requirements on tools and equipment, safety and protective measures, personal protection equipment, etc.
- Scaffolding and all machines, tools, protective equipment and containers for waste that are appropriate for the purpose and will be used during the clearance work must be in place prior to commencement of the work.
- As mentioned above, the property owner must have submitted an application for the clearance work to the supervisory authority (the municipal

environmental department). The contractor should check that the application has in fact been submitted and approved in order to be able to start the work as planned.

- If the supervisory authority has imposed requirements on how the work is to be performed, in addition to the work measures described in the application, the contractor should make preparations so that the work can be performed in accordance with such requirements.
- The worksite must be cordoned off so that unauthorised persons cannot gain access to the worksite, and signs must be erected with information about the work that is being done, and the fact that entry to the work area is prohibited. Containers for waste should be lockable and should be located inside the cordoned-off work area.

Photo: Igor Kecskés Maconkai

Signs must be erected while the work is ongoing. At the end of each working day, signs and machines etc. must be removed, and exterior passageways must be thoroughly cleaned if tenants/residents are to have access to them.

The work area is cordoned off from the street. An additional worker is on site and makes sure that passers-by do not come too close to the work area. Everything is removed and thoroughly cleaned at the end of each working day. During breaks, someone must always remain behind and supervise the work area.

For work on a facade, appropriate scaffolding must be assembled if scaffolding is not already in place on the site. The scaffolding should have sufficient space for the personnel who will be performing the clearance work as well as all necessary vacuum cleaners, waste containers and tools. Scaffolding must provide a good and safe work environment, and a type of scaffolding that can be adjusted height-wise provides better ergonomics for the person who is performing the clearance work, for example suspended scaffolding, climbing scaffolding or lifts.

Photo: Igor Kecskés Maconkai

Working from a lift. Installing a lining in the lift basket (for example with fabric, as shown in the picture to the right) provides more protection against falling pieces of sealings. Some form of seal/enclosure against the facade is required. The ground close to the facade must be covered.

Hanging scaffolding lined with “summer fabric” that allows the air to circulate. Note the rollers, which provide space for the awning boxes on the facade. It is difficult to achieve a seal/enclosure against the facade in this instance. The ground must be covered.

Photo: Igor Kecskés Maconkai

Climbing scaffolding

8.6 Clearance methods

Please note:

Different methods can be used to remove the sealant:

- *Cutting and then grinding*
- *Sawing with a blade on one side at a time*
- *Cutting grooves*
- *Chiselling*

A powerful vacuum cleaner must be connected to the tools for collection of dust and gases.

When clearing sealants, a common method is cutting followed by grinding of the joint edges. Another method is sawing, which is performed in the joint edge so that both the sealant and a piece of the edge are removed during one and the same work procedure. In certain cases the sealant and joint edges can be chiselled away.

8.6.1 Cutting with an oscillating (vibrating) knife

The sealant is cut out with an incision on each side, as close to the joint edge as possible.

In this case an older model of knife from Fein is being used. The vibrations mean that oscillating knives should be equipped with a vibration-reducing handle.
Note that a bendable hose end is pointed towards the tool to collect dust and gases from the cutting operation.

Example of a tool used to cut out sealant.

Motor-driven oscillating knife from Fein with vibration-reducing handle. A pipe has been assembled onto the knife to such up dust and gases, and is connected to a powerful vacuum cleaner.

8.6.2 Manual cutting of sealant

The sealant can also be cut out manually.

In this case the sealant is being cut out with an ordinary knife. A carpet knife can also be used.

The sealant and all underlying material behind it must be carefully removed.

The waste must be placed directly into the designated sack.

8.6.3 Collection of waste from clearance of joints

Waste must be collected as close to the source as possible. Larger pieces of sealing and underlying material are collected by hand as they are removed. The waste must be placed directly into a sack or other container designated for the hazardous waste.

Care must be taken to collect the particles and larger pieces of sealing that fall down onto the work platform; the simplest way to do this is by vacuuming. The platform should be thoroughly cleaned at regular intervals, and at least as often as when the work area changes or when a pause is taken during the work.

8.6.4 Grinding of the joint edges

Normally the joint edges are processed with a grinder after the sealant has been cut out. For easily accessible joints, an angle grinder with diamond blades is usually used. If the joint is recessed, it is necessary to use a blade that is at least 180 mm in diameter. If the sealant is situated closer to the surface of the facade, smaller blades can be used.

Angle grinders can be equipped with dust collection attachments from the manufacturer. A die grinder with grinding pin can be connected to a bendable hose that is aimed at the work area.

Grinder with metal attachment for dust collection

A die grinder with grinding pin can be a good tool to use on joints that are difficult to access. A dust-collecting nozzle has been attached to the tool. The nozzle is bendable and can be aimed at the work area.

Grinding with a grinding pin and dust collection close to the tool.

8.6.5 Sawing with a cutting blade

By sawing, the sealant and adjacent contaminated material is all removed in one and the same work procedure. Sawing can be performed with a diamond blade on one side at a time or by cutting grooves with the use of two blades, whereby the sealant and the joint edges are all removed in one and the same procedure.

Photo: Svensk Kvalitetssanering AB

Cutting grooves with two blades

The joint often becomes clearly wider than the original joint, which can be a disadvantage if the building is not to be demolished.

This method is primarily used on horizontal surfaces, for example floors and exterior passageways. For vertical sawing a supporting aid is required – the method can then be used prior to demolition.

8.6.6 Dust collection

An effective vacuum cleaner is required for the collection of particles and gases. Air flow and air velocity next to the tools are factors that determine the capacity required. The hose for the vacuum cleaner must not be too long and narrow. Ideally it should not be longer 10 m, with a diameter of 63 – 75 mm, plus 2 m with diameter 50 mm closest to the tool.

The vacuum cleaner's air flow should be high enough to ensure that no visible dust is forming – sometimes 400 m^3/h nominal flow is sufficient. The flow reduces with use and when the hose and tool are connected. A higher air flow is often desirable, i.e. 600 m^3/h or 800 m^3/h nominal flow.
The vacuum cleaner must have filters for three-step dust separation:

- Pre-filter for pre-separation
- Fine filter
- Micro filter

Use a Hepa filter 99.95%, class H13 according to standard SSEN 1822-1, together with an appropriate pre-filter.

In order for the vacuum cleaner to work well, the filters must be cleaned (on site in the vacuum cleaner) in accordance with the manufacturer's instructions. Filters must be changed in accordance with the manufacturer's directions, in a location that is well protected from the wind, or indoors in a cordoned-off area with an air purifier. The plastic sacks must be removed every day after the work is finished.

A vacuum cleaner that sits on the ground may need to have a longer hose.

Note the carbon filter that can be seen behind the vacuum cleaner. A carbon filter can be connected to the vacuum cleaner to collect PCBs in gas form.

If clearance work is to be performed indoors and the exhaust air from the vacuum cleaner cannot be released outdoors, a carbon filter should be connected to the vacuum cleaner.

8.7 Safety and protective measures

Please note:
When performing clearance work, it is necessary to implement safety and protective measures for tenants, residents and local users, the external environment and people in the surrounding area, as well as for the workers themselves.

8.7.1 Protection for tenants, residents and local users

In order to protect the tenants, residents and local users of the building when the clearance work is being performed, the most important thing is to ensure that dust and particles are collected at source, and that the contractor has good procedures for cleaning and waste management.

The tenants/residents should not open windows or use balconies on the facade where the clearance work is being performed. The air supply valves should also be sealed in the facade where the clearance measures are planned. If necessary, a seal

can also be applied around windows and doors to prevent air leakage. If possible, extract air ventilation that creates under-pressure indoors, and where the air is taken in close to the work area, should be shut off during the work.

Photo: Igor Kecskés Maconkai

Sealing of a door prior to clearance work in a stairwell

Photo: Igor Kecskés Maconkai

Sealing of a valve in the facade

8.7.2 Protection for the external environment and people in the surrounding area

The most important thing when it comes to protecting the environment is to ensure that the best known clearance technique is used, with good dust collection at source, and that the contractor has good cleaning and control procedures. The measures that are described above under the heading Protection for tenants, residents and local users also apply to protection of the environment and people in the surrounding area.

The ground next to the building must be covered with geotextile. The area covered should be about four metres out from the building and around the work scaffolding. If it is a high building, the ground may need to be covered even further out from the facade.

The protective covering on the ground must be cleaned of pieces of sealant and other material that falls down from the scaffolding/work platform. The protective covering must be gathered up each day and stored in a secure location.

The ground covering is vacuumed clean before the work moves to the next part of the facade.

Picture to the right:
Protection against falling particles has been laid on a mobile scaffold under the suspended scaffolding. If the work was being performed higher up the facade, this protection would need to be wider and longer.

When working in the inner city, access may be required to e.g. shops during the clearance work. This imposes great demands on creativity when it comes to finding a good solution for protection against falling particles. A mobile scaffold with a sealed ceiling (so that people can walk under it) could work as a form of ground covering.

8.7.3 Safety and protective measures when performing clearance work indoors

- If possible when performing clearance work indoors, the premises in which the work is ongoing should be demarcated and sealed off from adjacent premises.
- The premises should be emptied of their normal business activities, and ideally even of their furniture and fittings.
- There should also be under-pressure in the work premises.
- Areas/surfaces within the premises may also need to be covered to protect them from PCB contamination.

Photo: Igor Kecskés Maconkai

Clearance work indoors around a door is prepared with a protective “box” against the door and protective covering on the floor. The protective “box” must be thoroughly vacuumed before it is removed.

Photo: Igor Kecskés Maconkai

Sealing of a door opening

- Grinding should be performed with a die grinder with grinding pin, since such a tool creates less spread of dust than an angle grinder (The Swedish Demolition and Site Clearance Contractors Association, 2006).
- If possible, the vacuum cleaner should be placed outdoors. If this is not possible, a duct fan and evacuation hose should be connected to the vacuum cleaner to facilitate the release of the exhaust air outdoors. By leading the exhaust air away for release outdoors, under-pressure is created in the premises where the clearance work is being performed.
- Make sure that the exhaust air from the vacuum cleaner does not contaminate someone else’s work zone! When working with a grinding pin, the quantity of PCBs in gas form that comes out of the vacuum cleaner is increased! The vacuum cleaner only separates particles.
- If the area in which the clearance work is planned is of such a character that the exhaust air from the vacuum cleaner cannot be released outdoors, the vacuum cleaner should be equipped with a carbon filter to capture PCBs in gas form.
- Access to the work area should be arranged via an airlock. Clearance workers in their PCB dust-laden work clothes may not enter or walk through premises containing other people.

Photo: Per Karlsson

Clearance work indoors on the Stockholm Metro system, with demands on high capacity during the time the work can be performed (only for a few hours each night when the Metro trains are not running). The stringent requirements on collection of dust and gases have been met through the use of powerful vacuum cleaners and carbon filters.

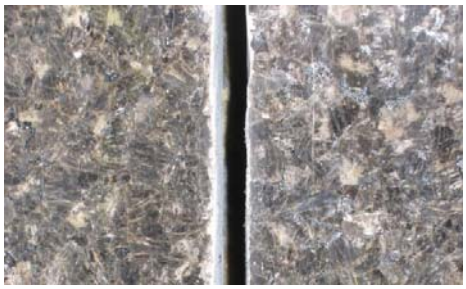
8.7.4 Cleaning and final clean-up

- Work clothes must be vacuumed during pauses in the work and at the end of each day.
- Machinery and equipment must be vacuumed daily.
- When performing clearance work outdoors, the work platform must be vacuumed at the end of each work day, as well as prior to moving to a new work area and during pauses in the work (for example lunchbreaks).
- When performing clearance work indoors, all areas and surfaces in a room must be vacuumed when the clearance measures in that room have been completed.

8.8 Clearance measures in special cases

If the sealant is very difficult to access, it may be difficult to perform clearance measures whereby the entire sealant is removed, without also causing damage to an adjacent part of the building. If the property owner assesses that the technical and financial consequences will be too great, the level/degree of clearance should be discussed with the supervisory authority, ideally in conjunction with a test clearance.

The way in which the clearance work is to be performed, and the level/degree of decontamination, should also be discussed with the supervisory authority if it is a matter of narrow joints that are located between panels/slabs of natural stone in a facade, and you do not wish to risk cracking or damage to the panels/slabs.



The sealant has been cleared in this natural stone facade. Perhaps a test clearance could have enabled the contractor to find a method causing less damage to the stone edges.

A property owner who has PCB-laden sealant adjacent to asbestos-laden panels should ideally arrange for the PCB-laden joints to be cleared as thoroughly as possible and should also remove the asbestos panels. When sealant that is adjacent to asbestos-laden panels is to be cleared, it is not possible to perform the clearance work without affecting the asbestos panels. Consequently, such work is deemed to be asbestos work, and the requirements that apply in Sweden on training, permits, etc. in conjunction with asbestos clearance are thus also applicable to such work. Furthermore, an application regarding the PCB clearance measures must be submitted in the usual manner to the supervisory authority (the environmental department). One suggestion regarding how the work can be performed is to remove the panel and make a groove and crack it to remove the edge. The edge is then managed as PCB waste, while the asbestos panel is classified as asbestos waste.

Under the heading “PCBs remain in the joint edges after clearance work” above, it is described how joint edges that have been situated adjacent to a PCB-laden sealant may require additional clearance measures prior to demolition work.

In connection with redevelopment or demolition work, sealants with levels between 50 and 500 mg/kg must be cleared, if this has not already been done earlier. An application to the supervisory authority must also be submitted for these types of clearance measures. Sealants with a PCB level lower than 50 mg/kg are not classified as hazardous PCB waste but rather as combustible waste, and the removal of such compounds is therefore not subject to PCB-clearance measures.

8.9 Waste management

Please note:

The property owner is the business practitioner and is responsible for waste that arises in his own properties.

All hazardous waste must be collected in approved containers and plastic sacks, which must be labelled.

The party that transports the waste must have a permit from the local county council.

If the waste is being taken to a facility for storage, the facility must have an appropriate permit.

It is the responsibility of the property owner to check that the transportation firm and receiving facility have appropriate and valid permits, and to ensure that the necessary transportation documents are prepared, with notes about the waste as applicable. The property owner can choose to assign these tasks to the contractor, in which case the property owner should request copies of all relevant information and documentation from the contractor.

The PCB-laden waste must ultimately be destroyed at the facility of Fortum Waste Solutions in Kumla, which is the only waste treatment facility in Sweden that is approved for destruction of such waste.

PCB-laden sealants or flooring compounds that contain more than 0.005 per cent PCB based on weight (= 50 mg/kg or 50 ppm) are classified as hazardous waste pursuant to the Swedish Waste Ordinance (2011:927), which follows the EU's waste directives. Waste with lower PCB content is not classified as hazardous waste.

All waste from PCB clearance work that is contaminated with PCBs must be managed as hazardous waste, for example sealants and the underlying material, concrete waste or other materials that have been situated adjacent to the sealant, as well as fabrics used as ground coverings and gloves used during the work.

Sealants that are cut away and the underlying material must be placed directly into the designated packaging or container, which could be a sack that is approved for hazardous waste. Dust that forms is collected by the vacuum cleaner. Care must be taken to ensure collection of all particles that fall down onto the scaffold or work platform. All PCB-laden waste from the clearance work may be collected in the same packaging or container.

The PCB waste may be stored temporarily on site, separately in a locked area. Such waste may not be mixed with or stored together with other waste. Each packaged unit of waste must be clearly labelled and placed in a lockable area, normally a container, which must also be labelled. The waste code for PCB waste is

17 09 02*.

PCB-laden waste may only be transported by a party with a valid permit for such activity from the local county council.

The ADR rules concerning transportation of dangerous goods are applicable to the transportation of PCB waste.

The party that hands over hazardous waste (the property owner) and the party that receives the hazardous waste (the transportation firm) must ensure that the necessary transportation documents are prepared. The transportation documents must contain information about the type of waste and quantity of waste being transported, as well as details of the party that has handed over the waste and the party that has received the waste. The transportation documents must be signed by the party that hands over the waste.

The recipient of the waste could be a facility for intermediate storage of the waste. In such case the facility must have an appropriate and valid permit or must have submitted an application regarding intermediate storage of the waste in accordance with chapter 29 of the Swedish Ordinance on Environmental Impact Assessment (2013:251).

The waste that contains PCBs must ultimately be dealt with by Fortum Waste Solutions in Kumla – the only approved facility in Sweden that deals with hazardous PCB waste. The waste is destroyed by way of incineration at 1,200 – 1,400°C, whereby it is degraded to less hazardous components in a controlled process.

The property owner is deemed to be the party conducting a professional business activity at the location where the waste arises, and is therefore responsible for ensuring that the necessary transportation documents are prepared (this responsibility is shared with the transportation firm) and for checking that the transportation firm and the receiving facility have the requisite valid permits. The property owner may assign these tasks to the contractor, in which case the contractor may also sign the transportation documents on behalf of the property owner, although the property owner always retains his legal management responsibility. If the contractor performs these tasks on behalf of the property owner, the contractor must provide the property owner with copies of all relevant information and documentation.

The property owner must also ensure that notes are recorded about the waste that arises, with details of the quantity of waste, the type of waste, and the facility to which the waste is being transported. The contractor who performs the clearance work may record these notes and give the information to the property owner. Notes must be recorded when the waste is handed over for transportation, and should also

be recorded when the recipient issues a receipt. The party that collects hazardous waste and the party that transports such waste must also record notes about the waste.

8.10 Quality assurance

The contractor must prepare a quality plan for the contract, a plan for how the environmental protection is to be arranged (an environmental plan), and a work environment plan. These can be coordinated to form one comprehensive environmental, quality and work environment plan (known in Sweden as a "KMA plan").

The contractor's quality assurance measures must ensure that:

- The clearance work performed is as complete and comprehensive as is reasonably possible from a technical and financial perspective
- The spread of PCBs is minimised
- The worker protection used is at least in compliance with the Swedish Work Environment Authority's provisions (this means that the Swedish Work Environment Authority's provisions must be followed, as described above under the heading Work environment)
- Waste is dealt with in accordance with applicable rules and regulations

A prerequisite for good control and management of the quality and environmental work is that the contractor has an adequate and appropriate quality system and environmental management system.

8.10.1 Environmental, quality and work environment plan ("KMA plan")

Please note:

The contractor must have individual plans or one comprehensive coordinated plan for the environment, quality and work environment, containing the various items that must be checked/inspected before the work is started and as part of the daily checks/inspections.

In an environmental, quality and work environment plan (or "KMA plan" as it is called in Sweden), the following information must be accounted for in relation to the safety and protection of people in the surrounding area and the external environment:

- Measures for protecting the adjacent/surrounding ground and land
- Measures for minimising the spread of dust and gas
- Design of scaffolding and work platforms to minimise the spread of waste
- Management and storage of waste
- Plan for the transportation of waste
- Measures for cordoning off the worksite
- Cleaning procedures

- Information to tenants, residents and local users

The plan or plans for the environment, quality and work environment must contain checkpoints for items that must be checked or inspected before the work is started, and for the items that must be checked/inspected as part of the mandatory daily procedure.

8.11 The client's checks and inspections

The client's checks and inspections can be performed visually, through a visit to the workplace by the client's representative or by the client himself to personally check how the work is being performed, and/or by auditing the protocols from the contractor's self-checks and self-inspections. The contractor's environmental, quality and work environment measures must always be checked and inspected.

Prior to final inspection, the following documents must be submitted by the contractor, in accordance with the proposed Administrative Regulations (according to the AMA AF 12 publication (Svensk Byggtjänst, 2012)):

- Documentation of self-checks and self-inspections that have been performed
- Summary of waste quantities
- Results of any measurements that have been performed
- Receipt regarding the PCB-laden material that has been handed over (such a receipt will be issued by Fortum Waste Solutions or by a receiving station that has been approved by the local county council)
- Copy of transportation documents.

8.12 The cost of joint clearance

The cost of replacing sealant can vary greatly, depending on the location of the building, the nature of the ground closest to the building, the height of the building, whether access is available to scaffolding or other appropriate types of work platforms, the scope of the sealants that are to be cleared, and how accessible the joints are. The cost can also vary depending on which part of the country the work is being performed in.

If the clearance of sealants is to be performed in a facade with easily accessible joints, the cost of the work could be in the region of SEK 250 – 350 per linear metre of joint. Clearance work indoors could cost around SEK 100 more. These figures do not include costs for scaffolding and work platforms or the transportation and destruction of waste, or the cost of resealing joints (where applicable). For transportation and destruction, the cost can vary from about SEK 10 to SEK 25 per linear metre of joint material. The actual cost depends, among other things, on how much material from the joint edge is removed and becomes waste.
If, during a procurement process, there is a large difference in the various tender

prices submitted, the client should check any low tender extra carefully to ensure that the contractor in question is a legitimate business practitioner and that all specified requirements are being met, before selecting the cheaper alternative/tender.

9 Clearance of PCB-laden flooring compounds

Please note:
Work involving clearance of PCB-laden flooring compounds requires use of the best techniques and technology, measures to ensure the safety and protection of the environment and people in the surrounding area, work environment measures, waste management procedures, etc. in the same manner as has already been described for clearance of sealants.

Clearance of flooring compounds should be managed in the same manner as for clearance of sealants when it comes to information to tenants and residents, requirements to be specified during the procurement process, and monitoring by the client.

During the procurement process, request a proposal from the contractor regarding the tools and work methods that could be appropriate for the specific work in question. An example of a specific suitable work method could be chiselling of the floor's top layer of PCB-laden sealant, followed by grinding.

The spread of dust during the work must be minimised. Equipment and techniques for dust collection should be proposed by the contractor. The work area in question should be cordoned off in an equivalent manner to work involving the clearance of sealants indoors.

10 Dealing with PCB-laden sealed window units

Please note:
Disassembled PCB-laden sealed window units represent hazardous waste and must therefore be dealt with in such a way that there is no risk of PCBs leaching into the environment. The Swedish Waste Ordinance imposes the same requirements on documentation and labelling, storage, transportation and destruction as apply to other PCB waste.

The disassembly of PCB-laden sealed window units in Sweden does not require a permit or the submission of an application, but the same rules apply to transportation and receipt of the waste as for waste from the clearance of sealants and flooring compounds.

PCB-laden sealed window units must be disassembled and dealt with as PCB waste in accordance with the Swedish Waste Ordinance (2011:927). Sealed window units must be disassembled and dealt with as whole units. It is not permitted to break up the actual pane; it may not be smashed or processed (unless the company has received a special permit for such processing). Any cracks in the glass should be taped over.

Protective gloves must be worn when working with windows. If broken/smashed panes must be dealt with indoors, it is recommended to wear a full respiratory mask with gas and particle filters.

How PCB-laden sealed window units (or units suspected of containing PCBs) should be disassembled and dealt with is described in a brochure issued by Svensk Planglasförening (Svensk Planglasförening b, 2013).

11 Dealing with electrical waste and PCB condensers

Please note:

Disassembled condensers that are suspected of containing PCBs must be treated as electrical waste and transported by a firm that has a permit for such waste. The waste must be taken to an approved pre-processor of electrical waste.

The Swedish Waste Ordinance imposes the same requirements on documentation and labelling, storage, transportation and destruction as apply to other PCB waste.

The condenser itself may not be disassembled by the person who removes the electrical equipment; instead, the equipment must be transported and handed over as a whole unit to an approved pre-processor of electrical waste.

According to the Swedish Waste Ordinance (2011:927), the party in possession of waste that contains or consists of electrical and electronic products must sort (separate) the electrical and electronic products and keep them separate from other waste.

The disassembly of products that are suspected of containing PCB-laden condensers does not require a permit or the submission of an application.

The actual PCB-laden condensers (or condensers suspected of containing PCBs) may only be disassembled by an approved pre-processor of electrical waste. The rules mean that the property owner or the contractor may not remove the condensers from the equipment themselves! Light fittings and other condenser-containing equipment must be handed over as whole units to the contractor with a permit for the transportation of electrical waste.

The facilities that will be receiving the electrical waste must be approved as pre-processors of electrical waste.

12 Pay careful attention during demolition or redevelopment work!

Please note:

Prior to demolition work, a material inventory must be performed that provides information about where possible PCB-laden sealants or flooring compounds are located, as well as whether (and if so, where) possible (suspected) PCB-laden sealed window units or condensers may exist.

The party that will be clearing, redeveloping or demolishing a building must know about the likely location of PCB-laden sealants and flooring compounds, and must pay careful attention prior to and during the work! There could be more PCBs than have been identified in earlier inventories!

If additional suspected PCB-laden compounds are found, the client must be contacted, so that the material can be more closely examined through samples and analysis.

The party that will be performing demolition work should also be aware of the possible existence of PCB-laden sealed window units and condensers.

13 References

Folkesson, I et al. (1999). “Sanera PCB-haltiga fogar” (Removal of sealants containing PCBs), Guidance for sealing contractors. Swedish Sealant Association (SFR). 8th edition, April 2012.

Jansson, B, Sandberg, J, Johansson, N, Åstebro, A (1997). PCBs in sealants – a major or minor problem? Report 4697 of the Swedish Environmental Protection Agency. Retrieved from www 01/12/2018, www.naturvardsverket.se/Om-Naturvardsverket/Publikationer/ISBN/4000/91-620-4697-7

Karolinska Institutet, Institute of Environmental Medicine, Dioxins and dioxin-like PCBs, retrieved from www 01/12/2018, ki.se/imm/dioxiner-och-dioxinlika-pcb?_ga=2.245913091.661874052.1543927599-1628329190.1540894760

Katalyse e. V., Institut für angewandte Umweltforschung (1995). PCB-Belastung in Gebäuden. Erkännen – Bewerten – Sanieren. Bauverlag GmbH. Wiesbaden, Berlin. ISBN 3-7625-3243-5.

Miljöförvaltningen i Stockholm and SP (Research Institutes of Sweden) (2001). PCBs in the indoor environment, retrieved from www 01/12/2018, foretag.stockholm.se/Regler-och-ansvar/Miljoregler/Kemikalier/PCB

Miljökonsultgruppen i Stockholm (2016). PCB Handbook, Clearance of PCBs in buildings.

The Ecocycle Council and Miljöförvaltningen i Stockholm (1999). Inventory report. Revised by Miljökonsultgruppen i Stockholm HB 2008, 2014. Retrieved from www 01/12/2018, www.sanerapcb.nu/web/page.aspx?refid=202

The Swedish Demolition and Site Clearance Contractors Association (2006). Clearance of PCB-laden sealants in buildings. Operating guidelines recommended by the trade associations. Retrieved from www 01/12/2018, www.sanerapcb.nu/web/page.aspx?refid=686

The Swedish Environmental Code (1998:808). Retrieved from www 01/12/2018, www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/miljobalk-1998808_sfs-1998-808

The Swedish Environmental Protection Agency (2002). Dealing with PCBs in buildings, Report ref. no. 643-2492-02, Appendix 4, PCBs in Buildings, A project within the Ecocycle Council. Retrieved from www 01/12/2018, www.naturvardsverket.se/upload/stod-i-miljoarbetet/vagledning/pcb/pcb-i-byggnader.pdf

The Swedish Environmental Protection Agency's website. PCBs in guillemot eggs, retrieved from www 01/12/2018, www.naturvardsverket.se/Sa-mar-miljon/Statistik-A-O/PCB-i-sillgrissleagg

The Swedish National Food Agency, Dioxins and PCBs, retrieved from www 01/12/2018, www.livsmedelsverket.se/en/food-and-content/oonskade-amnen/miljogifter/dioxiner-och-pcb

The Swedish Ordinance on Environmental Impact Assessment, chapter 29 (2013:251). Retrieved from www 01/12/2018, https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/miljoprovningsforordning-2013251_sfs-2013-251

The Swedish PCB Ordinance (2007). Ordinance (2007:19) on PCBs etc. Retrieved from www 01/12/2018, http://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-200719-om-pcb-mm_sfs-2007-19

The Swedish Waste Ordinance (2011:927). Retrieved from www 01/12/2018, www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/avfallsforordning-2011927_sfs-2011-927

The Swedish Work Environment Authority, 1999. Building and civil engineering work, (AFS1999:3Eng), provisions. Retrieved from www 01/12/2018, www.av.se/en/work-environment-work-and-inspections/publications/foreskrifter/building-and-civil-engineering-work-afs1999-3eng-provisions/

Rex Hus & Miljökonsult and Lilliehorn Konsult AB (2015). Monitoring the clearance of PCBs in sealants and flooring compounds, report for the Swedish Environmental Protection Agency. Retrieved from www 01/12/2018, www.naturvardsverket.se/upload/stod-i-miljoarbetet/vagledning/pcb/151027-nv-v-pcb-uppf%C3%B6ljning.pdf

Svensk Byggtjänst (2015). AMA AF 12: Guidance for the preparation of particular conditions for Building and Civil Engineering Works and Building Services Contracts. ISBN: 9789173337441. https://byggtjanst.se/bokhandel/kategorier/projektering-upphandling/program-projektering-beskrivning/ama-af-12-engelsk-utgava/

Svensk Planglasförening a (2017). PCBs in sealed window units. Retrieved from www 01/12/2018, www.svenskplanglas.se/files/2017/12/PCB-i-isolerrutor.pdf

Svensk Planglasförening b (2013). Disassembly and handling of PCB-laden sealed window units. Retrieved from www 01/12/2018, www.svenskplanglas.se/files/2015/01/isolerrutor_pcb_mars_2013.pdf

Öberg, T (1994). The occurrence of PCBs and PCNs in goods and chemical products in Sweden – The Chlorine Assignment, documentation report 5. Memorandum No. 18/94, The Swedish Chemicals Agency.

Inventory and clearance of PCBs in buildings and facilities

REPORT 6885

SWEDISH EPA
ISBN 978-91-620-6885-1
ISSN 0282-7298

GUNILLA BERNEVI REX

In Sweden, several initiatives and measures have been taken to identify and clean up buildings from PCBs. With this report we want to disseminate experiences from the work in Sweden. The purpose is to contribute to the development of strategies for identifying PCB products that still occur in buildings and facilities. By inventorying where PCBs still occur, relevant waste streams also can be identified, which can create conditions for environmentally sound management and that PCB waste is destroyed.

This report contains a summary description of the Swedish knowledge and experiences from work on PCB identification and decontamination.

Swedish EPA SE-106 48 Stockholm. Visiting address: Stockholm - Valhallavägen 195, Östersund - Forskarens väg 5 hus Ub, . Tel: +46 10 698 10 00, fax: +46 10 698 16 00, e-mail: registrator@swedishepa.se Internet: www.swedishepa.se **Orders** Ordertel: +46 8 505 933 40, e-mail: natur@cm.se Address: Arkitektkopia AB, Box 110 93, SE-161 11 Bromma. Internet: www.swedishepa.se/publications