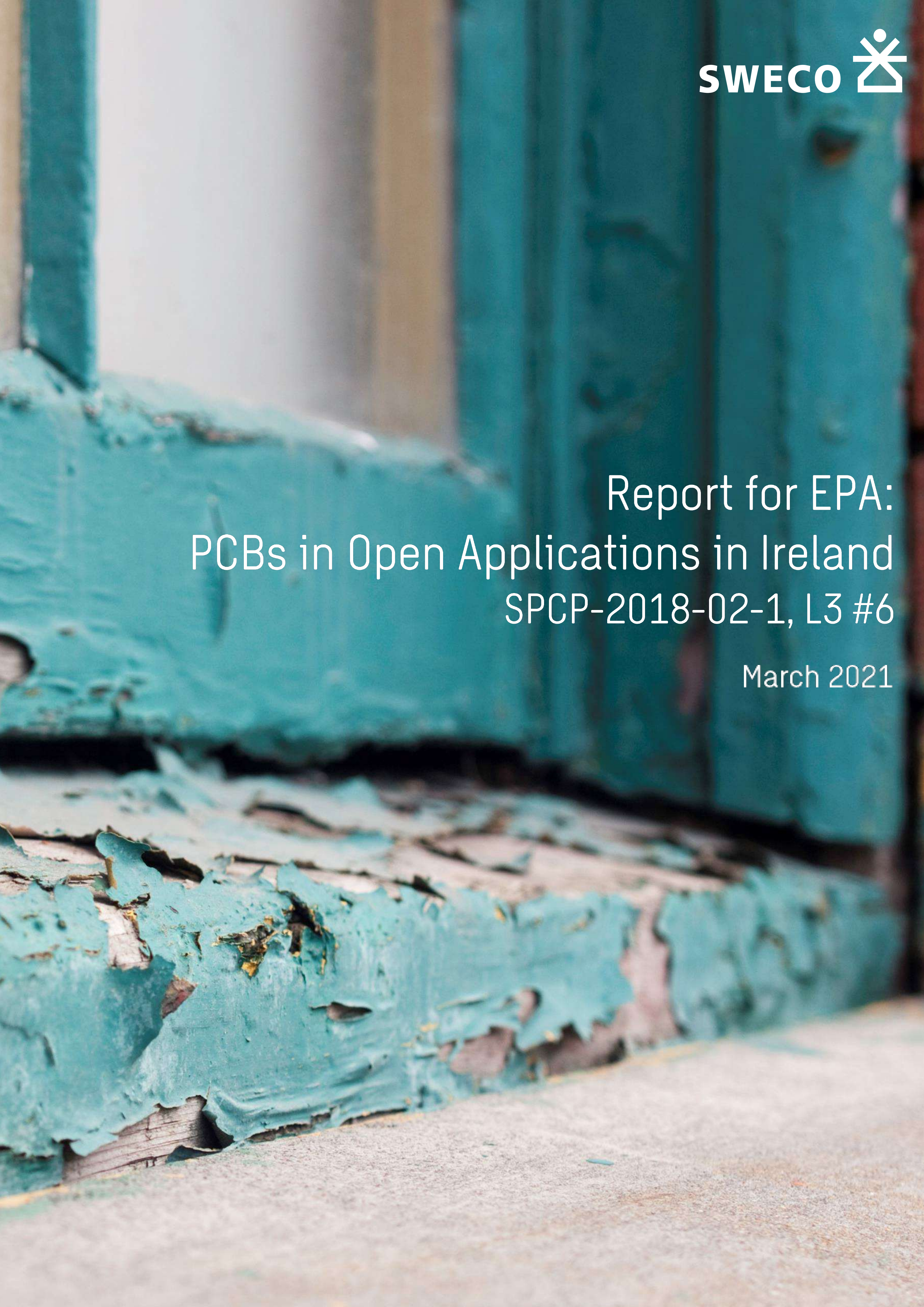

Report for EPA:
PCBs in Open Applications in Ireland

SPCP-2018-02-1, L3 #6

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List of Abbreviations

ACM	Asbestos Containing Material
Congener	Any single, unique well-defined chemical compound in the PCB category.
DL-PCB	Dioxin-like polychlorinated biphenyl
EPA	Environmental Protection Agency
EU	European Union
FOPH	Swiss Federal Office of Public Health
GC-ECD	Gas chromatography equipped with electron capture detector
GNI	Gas Networks Ireland
GSI	Geological Society of Ireland
IARC	International Agency for Research on Cancer
LOD	Limit of detection
NIP	National Implementation Plan
OSPAR	OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic (successor to Oslo and Paris Conventions) OS = Oslo, PAR = Paris
PCB	Polychlorinated biphenyl
PCT	Polychlorinated terphenyl
POPs	Persistent Organic Pollutants
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SPIN	Substances in Preparations In the Nordic countries (database)
UNEP	United Nations Environment Programme
WFD	Water Framework Directive
WHO	World Health Organisation
ΣPCB7	Sum of seven PCB congeners 28, 52, 101, 118, 153, 138 and 180

1 Executive Summary

This report has been prepared by Sweco to document the findings of a study, completed on behalf of the Environmental Protection Agency (EPA), on the potential historic uses of polychlorinated biphenyls (PCBs) in open applications in Ireland. PCBs are a group of man-made organic chemicals which were manufactured worldwide during the mid-20th century with potential for serious health and environmental effects. Production of PCBs peaked in the 1960s and 1970s and was stopped in many countries between 1983 and 1993 owing to greater recognition of their harmful effects. Within the European Union (EU), a ban on the use of PCBs as a raw material or chemical intermediate entered force in 1985.

PCBs are among a wider group of chemicals classified as Persistent Organic Pollutants (POP), characterised by their persistence in the environment and toxicity to both humans and wildlife. The Stockholm Convention on POPs is a global treaty dating from 2001, with the objective to protect human life and the environment from POPs, including PCBs. Over 170 countries, including Ireland, are parties to the Convention. Parties are required to take measures to eliminate or reduce the release of POPs into the environment.

The main uses of PCBs were as cooling and isolating agents in 'closed' systems or applications i.e. contained within equipment such as transformers and capacitors. As a result, international efforts to-date to eliminate and reduce the release of PCBs into the environment have been largely focused on closed applications. Since the Stockholm Convention entered force, National Management Plans for PCBs have been developed and inventories of PCB holdings prepared. In Ireland, equipment with PCB volumes of more than five litres was to be appropriately decontaminated or disposed of by the end of 2010.

In contrast to contained systems/equipment, 'open applications' comprise the uncontained use of PCBs in paints, sealants and other such materials which remain open to the environment following application. Open applications are believed to account for as much as 25% of PCBs produced globally (estimated quantity of 375,000 tonnes) and were mainly used in buildings and other construction. Further to progress achieved in the management of PCBs in closed applications, the Stockholm Convention requires additional measures to ensure the environmentally sound waste management of PCBs by 2028, which includes use in open applications.

Following the development of a project plan, this study has involved a desktop study to review available information on the management of PCBs in open applications, with a particular focus on the Nordic countries and Switzerland, where greater progress has been achieved in this area. Product registries with information on chemical substances in products were first reviewed for these countries, however this yielded limited data for products containing PCBs. A draft listing of product types and brands containing PCBs was compiled based on relevant experience in Scandinavia and findings from the desktop study.

Consultation was then carried out with key industry representatives in Ireland regarding possible knowledge of the use of PCBs generally and possible recognition of information within the draft product listing. Based on the feedback received, it was apparent that there was limited or no surviving knowledge of the use of PCBs among the stakeholders identified. This may be attributed to the significant time elapsed since PCBs were legally traded and the loss of knowledge over time. In the absence of detailed knowledge and relevant records within the Irish sector, it was not possible to establish a list of PCB-containing products used in open applications specific to Ireland. As a result, the study adopted a broader European focus, compiling relevant information on PCBs in open applications in Scandinavia, Switzerland and other countries where relevant. The listing of PCB-containing products was finalised based on data gathered including relevant information obtained on product types, brands and periods of use.

Further consultation was carried out with Swedish industry professionals experienced in the management of PCBs in open applications, specifically within the building sector. This included consultation with a laboratory active in the analysis of building materials and environmental samples for PCBs.

The remainder of the desktop study was focused on the investigation of PCB congener profiles of PCB-containing products, with the associated main findings summarised below:

(i) **Technical blends:** Though production processes were largely similar, there was a wide variation in the technical blends of PCBs used by different manufacturing companies. Common trade names included

Arochlor, Pyrochlor, Phenoclor and Clophen. The evolution of production processes also resulted in possible variations over time in the technical blends being used for the manufacture of the same product.

(ii) **Congener profiles:** Based on a review of available studies, information on congener profiles of specific technical blends has been compiled as an Appendix to this report.

(iii) **Technical blends and specific products:** Limited information was identified connecting a given technical blend to specific products. Making such a connection is considered difficult as the range of desired material properties for different products and open applications involved using a range of technical blends. In most cases a congener profile cannot be established for a product type due to differences in manufacturing processes used by different companies.

(iv) **PCB congener profiles from product samples:** Great care must be employed in the utilisation of any available data on PCB profiles to draw conclusions on links between certain congener profiles and particular products or product types. A given sets of results of PCB analysis may not reflect the full composition of PCBs present in the analysed material and must be considered together with the method and purpose of analysis. Any forensic analysis of PCBs will typically require the characterisation of a very large number of PCB congeners (50-100) and an appropriate limit of detection.

A number of other related findings on PCBs in open applications more generally were also documented. Best practice measures and approaches adopted in other countries for the management of PCBs in open applications were identified and are described. In Sweden and Switzerland, significant progress has been achieved with the implementation of regulations focused on PCBs in building materials, screening for PCBs based on year of construction or at the point of demolition/renovation and a mandatory requirement to remove and dispose of PCB-containing materials ensuring environmentally sound waste management.

Estimates of PCB quantities used in open applications reported for other European countries have been broadly evaluated to approximate the likely usage of PCBs in the Irish building sector, assuming some degree of equivalence between usage in Ireland and these countries, per head of population. A preliminary and high-level review of publicly available information on the Irish building stock has been documented which may be of interest for further investigation regarding PCB-containing materials.

As anticipated from the outset of the study, the availability of data, records, information and experience generally on the use of PCBs in open applications in Ireland is very limited. This is consistent with most other countries. The main knowledge gaps identified relate to (a) Irish stakeholder experience and knowledge within industry (b) low awareness of PCBs in open applications among building owners/occupiers, the construction and waste sectors and public generally (c) absence of monitoring programmes for PCBs in open applications (d) minor uses of PCBs and non-building sector applications such as plasticisers, rubber products and insecticides among others.

Finally, a number of recommendations have been included which may help to increase awareness and support the future management and control of PCBs in open applications in Ireland. These include:

(i) Pilot programme of sampling and analysis for PCBs in buildings

(ii) Review of the Irish building stock to better estimate the quantities of PCBs in open applications

(iii) Development of a programme of awareness and/or training considering the general public (non-technical), sector specific guidance (technical guidance for construction and waste professionals) and regulatory personnel

(iv) Consideration of steps required in advance of an enhanced legal / regulatory framework for the management of PCBs in open applications:

   a. Identification of relevant stakeholders and preliminary consultation
   b. Review of regulatory framework for asbestos and any measures potentially suitable for use in the regulation of PCB-containing materials in buildings
   c. Review availability and capacity of appropriate service providers to support the identification and investigation of PCB-containing materials i.e. laboratory facilities, authorised waste hauliers and treatment facilities, companies specialised in the handling/management of hazardous materials
   d. Consultation with the HSA regarding health impact.

2 Project Description

2.1 Introduction

Sweco was contracted by the Environmental Protection Agency (EPA) to deliver a study on the potential historic uses of polychlorinated biphenyls (PCBs) in open applications in Ireland. The study involved the compilation and technical review of information on the types of PCB-containing materials used, their period of use, their likely applications and, where available, relevant information pertaining to PCB congener profiles.

This report has been prepared to document the findings of the above study, including the knowledge gaps identified and recommendations arising.

2.2 Scope

The scope of work included the following tasks:

Task 1 Project Plan

This Plan outlined the methodologies proposed for completion of the tasks as set out in the EPA Specification of Requirements (EPA ref. SPCP-2018-02-1-L3#06, Section 2.3). This Plan was issued to the EPA on 14 October 2020.

Task 2 Identification of PCB-containing products potentially marketed within the State

The methods employed in the identification of relevant PCB-containing products are set out in Section 3.1 and the key project findings are described in Section 4 of this report. A list of relevant products is included in Appendix A. Noting the historic nature of the use of PCB-containing materials, knowledge gaps identified in the course of the study are further detailed in Section 5.

Task 3 Investigation of PCB congener profiles of PCB-containing products potentially marketed within the State

Relevant literary sources and selected European product registries were reviewed for information relating to PCB congener profiles of PCB-containing products. Discussion was also carried out with forensic laboratory personnel in Sweden experienced in the analysis of PCB-containing materials. Further details relating to the investigation methodology are set out in Section 3.2.

Task 4 Generation and submission of Project Report

This report comprises the output of Task 4.

2.3 Project Background

2.3.1 What are Polychlorinated Biphenyls (PCBs)?

PCBs are a group of man-made organic chemicals consisting of carbon, hydrogen and chlorine atoms and are one of the most common and widely dispersed Persistent Organic Pollutants (POPs)[1, 2]. PCBs have no known taste or smell, and range in consistency from thin, light-coloured liquids to yellow or black waxy solids. PCBs can have serious health and environmental effects, which can include carcinogenicity, reproductive impairment, immune system disruption and, by effects on wildlife, a loss of biological diversity.

PCB molecules consist of a biphenyl core with 1 to 10 chlorine atoms attached, resulting in 209 different congeners[3] characterised by different degrees of chlorination. Of the 209 PCB congeners, 13 exhibit a dioxin-like toxicity. Depending on the number and position of the chlorine atoms in the molecule, the physical and chemical properties vary. This variation is also reflected in the toxicological properties of the different molecules. The persistence of PCBs in the environment corresponds to the degree of chlorination, and half-lives can vary from 10 days to 1.5 years.

PCBs were manufactured worldwide by a small number of companies in mostly industrialised countries mainly in the Northern Hemisphere and often used as cooling and isolating agents in transformers and capacitors. PCBs are fire resistant, have a low electrical conductivity, high resistance to thermal breakdown and a high resistance to oxidants and other chemicals. Consequently, they are found in a wide range of applications.

The manufacturing processes have resulted in different complex mixtures of about 150 of the theoretical 209 individual congeners[4]. These mixtures, in this text referred to as technical blends, were tailored and manufactured with the aim of yielding a certain degree of chlorination to fulfil technical requirements, generally between 21% and 68% chlorine content (percentage weight). These commercial technical blends were given trade names such as “Arochlor” (or Aroclor). The Arochlor blends were manufactured by Monsanto in the US and are among the most well-known.

Globally, PCB production peaked in the 1960s and 1970s. Between 1983 and 1993, the production of PCB was stopped in many countries. According to UNEP[5], approx. 1.5 million tonnes of technical grade PCB are estimated to have been produced since the late 1920s. A case study on the management of PCBs in Switzerland[6] estimated that total production of PCBs equated to approximately 1.3 million tonnes of technical grade PCB.

While the Stockholm Convention on POPs[7] prohibits their production, PCBs remain present in various applications and stockpiled in many countries. Once released into the environment, PCBs remobilise and can enter the ecological food chain, eventually contributing to human exposure via food intake.

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1 Wagner, U., Schneider, E., Watson, A., Weber, R. (2013) Management of PCB from Open and Closed Applications – Case Study Switzerland, p.1

2 US EPA online information (https://www.epa.gov/pcbs/learn-about-polychlorinated-biphenyls-pcbs#what)

3 A PCB congener is any single, unique well-defined chemical compound in the PCB category. The name of a congener specifies the total number of chlorine substituents, and the position of each chlorine atom. For example: 4,4'-Dichlorobiphenyl is a congener comprising the biphenyl structure with two chlorine substituents - one on each of the #4 carbons of the two rings.

4 Frame, G., Cochran, J., Bøwadt, S. (1996). J High Resol Chromatogr 19:657

5 UNEP, Consolidated assessment of progress toward elimination of PCB, 2017, p.6

6 Wagner, U., et al., Management of PCB from Open and Closed Applications – Case Study Switzerland, p.1

7 http://www.pops.int/TheConvention/Overview/TextoftheConvention/tabid/2232/Default.aspx

According to World Health Organisation (WHO) studies, more than 90% of human exposure to PCBs is through food, mainly meat, dairy products and fish[8].

2.3.2 Regulation of PCBs

2.3.2.1 Stockholm Convention

The Stockholm Convention on POPs was adopted in 2001 and came into force in 2004. This global treaty requires its parties to take measures to eliminate or reduce the release of POPs into the environment. PCBs were one of the original twelve POPs covered by the Stockholm Convention.

The POPs and resulting actions for the Parties are categorised under three annexes:

- Annex A: Parties required to take measures to eliminate production and use. The specific exemptions for use or production as listed only apply to Parties that register for them.
- Annex B: Parties required to take measures to restrict the production and use of the listed chemicals, unless for acceptable purposes/ specific exemptions detailed in the Annex; and
- Annex C: Parties required to take measures to reduce the unintentional release of chemicals, with the goal of continuous minimisation and where feasible, ultimate elimination.

PCBs are listed in Annexes A and C to the Convention. Exemptions relating to PCBs are limited to existing equipment that contains or is contaminated with PCBs which may continue to be used until 2025.

2.3.2.2 EU Regulation

The use of PCBs as a raw material or chemical intermediate has been banned in the EU since 1985 further to European Directive 85/467/EEC[9], the 6th amendment to Directive 76/769/EEC. The original Directive 76/769/EEC controlled certain hazardous substances and preparations and preceded the current REACH Regulation[10], which entered into force in 2007 to further improve the protection of human health and the environment from the risks that can be posed by chemicals.

In 1996, the European Directive 96/59/EC[11] was introduced to advance the complete disposal of PCBs and equipment containing PCBs (in addition to provisions for polychlorinated terphenyls – PCTs). The Directive established harmonised requirements for the environmentally sound disposal of PCBs and required Member States to make an inventory of large equipment containing PCBs, adopt a plan for disposal of inventoried equipment and outlines requirements for collection and disposal of non-

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[8] UNEP, Consolidated Guidance on PCB in Open Applications, 2019, p.6

[9] Council Directive 85/467/EEC of 1 October 1985 amending for the sixth time (PCBs/PCTs) Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations

[10] Regulation No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC

[11] Council Directive 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCB/PCT)

inventoried equipment. Equipment with PCB volumes of more than five litres was to be appropriately decontaminated or disposed of by the end of 2010 at the latest.

The Stockholm Convention was first given effect in the EU by Regulation (EC) No. 850/2004, which was subject to several amendments subsequently. This Regulation has since been repealed and replaced by the current EU POPs Regulation (EC 2019/1021) that prohibits and restricts the use of POPs in both chemicals and products. The POPs Regulation complements earlier EU legislation on POPs and aligns with provisions of international agreements on POPs.

Annex I of the POPs Regulation lists those substances that are subject to prohibition on manufacturing, placing on the market and use (and incorporates the substances listed in Annex A to the Stockholm Convention). Annex III lists the substances subject to preparation of national inventories in accordance with the Stockholm Convention while Annex IV lists substances that are subject to waste management rules according to Annex V. PCBs are subject to the provisions contained in these Annexes I, III, IV and V.

Ireland

The EU legislative provisions (85/467/EEC) which originally banned the use of PCBs as a raw material or chemical intermediate were formally transposed in Ireland by means of the European Communities (Dangerous Substances and Preparations) (Marketing and Use) Regulations 2003, S.I. No. 220 of 2003. This preceded the introduction of the current EU REACH Regulation (1907/2006).

Prior to these Regulations, the Waste Management (Hazardous Waste) Regulations, S.I. No. 163 of 1998 gave effect to the requirements contained in Directive 96/59/EC for disposal of PCBs in Ireland.

The Stockholm Convention formally entered into force in Ireland in 2010, further to the enactment of the Persistent Organic Pollutants Regulations 2010, S.I. 235 of 2010. For the purposes of compliance with the latest EU POPs Regulation (EC 2019/1021), the aforementioned Irish Regulations of 2010 were revoked and replaced by the European Union (Persistent Organic Pollutants) Regulations 2020, S.I. 146 of 2020.

The EPA is the body responsible for the Irish national inventory of PCB holdings.

2.3.3 Uses of PCBs

In the examination of the use of PCBs and PCB-containing materials or products, a distinction is made between **‘closed’** and **‘open’** applications.

2.3.3.1 Closed Applications

A closed application means that, in principle, PCBs cannot be released to the environment during use. In a closed application, PCBs have been added into a closed container e.g. PCBs as dielectric fluid in transformers. Closed applications were dominant and the usage in dielectric fluids in capacitors and transformers constituted some 50-60% of total PCB use in the US during the 1960s (IARC 2013). According to Erickson and Kaley (2011), capacitor and transformer fluids dominated the sales even more with a combined 75% of US sales. Other important closed applications included hydraulic/lubricant/heat-transfer fluids in pumps, turbines and circulatory piping systems.

Of the 1.5 million tonnes of PCBs estimated to have been produced globally, approximately 79% of this quantity has been attributed to closed applications, including transformer oils (48%), small capacitors (21%) and other 'nominally closed' systems such as heat transfer / hydraulic systems, particularly in mining equipment (10%)[12].

According to Annex A, Part II of the Stockholm Convention, parties to the Convention are obliged to eliminate electrical equipment and oils containing PCBs from use by 2025 and to manage them using *"environmentally sound waste management"* by 2028. As a result, national PCB inventories prepared further to the Stockholm Convention have focused mainly on closed applications such as transformers and capacitors.

2.3.3.2 Open Applications

An open application refers to where PCBs exist or have been added as a component in a product that is open or partially open to release into the environment. United Nations Environment Programme (UNEP) has identified the following main examples:

- Caulks / sealants
- Paints / plaster
- Anti-corrosion coatings
- Cable sheaths and cable insulation
- Lubricating fluids
- Adhesives
- Flame retardants
- Flooring materials
- Carbonless copy paper (microencapsulation of dyes)
- Fluorescent light ballasts and small capacitors (ballasts)
- Asbestos 'galbestos' – roofing / siding materials.

In these applications, PCBs were mixed with a fluid or plastic polymer, in order to achieve the desired viscosity or elasticity for the final product that could be marketed as being flexible, durable and water resistant.

[12] UNEP, Consolidated Guidance on PCB in Open Applications, p.6

Open applications also include the following general and specific uses:

- Plasticisers
- Lamination and impregnating agents
- Additives in cement
- Dedusting agents
- Immersion oils
- Conveyor belts and rubber products.

Some open applications of PCBs are considered minor or not well documented:

- Insulation (in wool felt, foam rubber and fiberglass)
- Cast waxes (filler/extender for investment casting waxes)
- Polymerisation catalyst (chemical industry)
- Carrier for insecticides and bactericides
- Pesticide extenders (to dilute and/or extend the life of the active substances).

UNEP has identified that open applications account for as much as 25% of PCBs estimated to have been produced globally[13] corresponding to 375,000 tonnes. The predominant use of PCBs in open applications was in buildings and other construction.

Further to progress made in the inventory and disposal of PCBs in closed applications, Annex A, Part II (f) of the Stockholm Convention requires further efforts to identify articles containing more than 0.005% PCBs and to manage them in an environmentally sound manner. This includes PCBs in open applications. Apart from this requirement of the Stockholm Convention, the handling, remediation and removal of PCBs used in open applications are not yet subject to explicit regulation in Ireland or at EU level.

The remediation and management of PCBs in open applications is important because of potential for human exposure and dispersion in the wider environment. Although open uses accounted for only 25% of the total production, it is estimated that approximately 50% of the total PCB emissions may have come from these 'open system' uses[14].

To minimise potential PCB exposure risk for humans and the environment as a result of the degradation and/or the volatilisation of PCBs from materials it is necessary to identify and raise awareness on what products and product types need to be tested, removed and managed

[13] UNEP, Consolidated Guidance on PCB in Open Applications, p.6

[14] Breivik, K., et al. (2007), Towards a global historical emission inventory for selected PCB congeners -- A mass balance approach: 3, An update. Science of The Total Environment 377, 296-307

appropriately. This is important given that long-term exposure to even small concentrations of PCBs can have adverse effects on human health[15].

2.3.4 PCB Studies in Ireland

The Geological Survey of Ireland published a report in 2012 entitled '*Geochemical baseline for heavy metals and organic pollutants in topsoils in the greater Dublin area.* This report included an examination of PCBs in soil samples taken within the greater Dublin area. In relation to findings on PCBs the report concluded that "*Results for PCBs in soil indicate isolated, low level detections of PCBs in Dublin, mainly in the city centre. The PCB compositions in soils indicate that contamination is probably associated with historical industrial sources and old paint rather than modern, active sources".* This conclusion is explored further in the context of the key findings of this report in Section 4.4.3 of this report.

[15] Schantz SL, Widholm JJ, Rice DC (2003), Effects of PCB exposure on neuropsychological function in children, Environ Health Perspect. 111, 357–576.

3 Methodology

3.1 Task 2

3.1.1 Desktop Study

A desktop review of relevant publications was carried out with a particular focus on Swedish literary sources to identify PCB-containing products. Significant progress has been made in Sweden towards the removal of PCBs in open applications, with a specific focus on the building sector.

Experiences from inventories, investigations and remediation of PCBs in Sweden have been compiled in a report in English[16]. This report served as a starting point for a listing of PCB-containing products used in the building sector in Sweden. References provided in the report, and at the website (www.pcbsanera.nu) were reviewed. This website is run by a small consultancy firm (Miljökonsult-gruppen i Stockholm HB) and serves as an information hub related to PCB remediation in Sweden.

Internet searches were used to obtain additional reports and scientific publications. General key words were used e.g. PCB, chlorinated biphenyls, caulk, sealant, paint, glass, buildings, open source as well as specific searches when companies, brands etc. were encountered. Other key search words included aroclor, pattern, congener and environmental forensics.

Further to a broader and more general review of available literary and internet resources, no published resource or further information was identified pertaining to a review of PCBs in materials used in open applications specific to Ireland (i.e. building materials, construction and demolition waste etc.).

Similarly, it is understood that the research on PCBs in open applications in the United Kingdom is limited. In 2018, the UK Parliamentary Office of Science and Technology (POST) compiled a POST Note (briefing note reviewing emerging areas of research) on 'Persistent Chemical Pollutants'[17] which addressed regulatory challenges and emerging issues concerning POPs including PCBs. This briefing note highlighted the reduction in PCB emissions since 1980 and UK obligations (under the Stockholm Convention) to address 'closed' sources of PCBs by 2025. Relevant to PCBs in open applications, the briefing note stated that *"the UK has also committed to undertake research on the contribution of its unknown sources, such as PCBs from materials in buildings and landfilled waste"*, indicating an absence of existing research and detailed study in the area (until 2018 at least).

3.1.2 Review of Product Registries

A number of countries maintain publicly available product registers containing detailed information on the common use of chemical substances in different types of products and industrial areas. As part of the project plan, the product registries of the Nordic countries and Switzerland were identified for a review of product types possibly containing PCBs.

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[16] Swedish Environmental Protection Agency (2019). Gunilla Bernevi Rex, Inventory and clearance of PCBs in buildings and facilities. Report 6885. March 2019.
[17] UK Parliamentary Office of Science and Technology (2018). POST Note Number 579 (https://post.parliament.uk/research-briefings/post-pn-0579/)

Nordic Countries

Product registries of the Nordic countries (Norway, Sweden, Denmark and Finland) were searched in the SPIN database[18]. This SPIN (**S**ubstances in **P**reparations **I**n the **N**ordic countries) database is the result of a common Nordic initiative, financed by the Nordic Council of Ministers Group, to gather non-confidential, summary information from Nordic product registers on the common use of chemical substances in different types of products and industrial areas.

The database was searched using the following keywords for substances: PCB; aroclor, kanechlor, biphenyl.

Switzerland

The product register for chemicals maintained by the Swiss Federal Office of Public Health (FOPH) was similarly reviewed for any relevant information on product types containing PCBs[19].

3.1.3 Product Listing

Based on the desktop study of available information, an initial list of product types for PCB-containing materials in open applications was prepared including relevant details on product names, use and manufacturers where available.

The list of product types and information gathered on PCB-containing materials was then used as a basis for consultation with relevant stakeholders. Details of this consultation are included below.

3.1.4 Consultation

Sweden – PCBs in Building Materials

A telephone interview was conducted with the Swedish Consulting firm Miljökonsultgruppen i Stockholm HB who are experts in PCB remediation. This firm has produced guidance on the management of PCBs in building materials[20]. During this interview, feedback was obtained on the most appropriate sources for finding additional country-specific information on product types containing PCBs.

Consultation was also conducted with with:

- A consultant at Golvanalys i Sverige AB, who was formally engaged with the Swedish business association of plastic and chemicals, with expertise on flooring applications and knowledge of the Acrydur-brand and Ulfcar company.
- A representative of industry on the subject of production of sealants in Sweden under licence from the US company Tremco.

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[18] http://www.spin2000.net/spinmyphp/
[19] https://www.gate.bag.admin.ch/rpc/ui/home
[20] Swedish EPA, Inventory and clearance of PCBs in buildings and facilities

Ireland – Suppliers, Manufacturers & Representative Bodies

As set out in the Project Plan, efforts were made to engage with relevant Irish suppliers, manufacturers and representative bodies regarding the list of product types and information that may be known regarding historic use or production of PCB-containing materials in Ireland.

Through contact with the Building Materials Federation (a business association of Ibec), it was identified that a number of the relevant manufacturer and supplier companies of interest were affiliated and engaged in an existing Ibec BMF forum. The BMF facilitated enquiries to key contacts within the companies of interest which included Crown Paints, Dulux, Akzo-Nobel, FSW Coatings, Ronseal, PPG and General Paint who were listed as members of the Irish Decorative Surfaces Coating Association. Enquiries to these companies were submitted via the BMF forum to attempt to establish if identified product types were marketed in Ireland and if any relevant information remained available concerning the production or use of PCBs.

Enquiries were also made via telephone and e-mail with Carey Glass, a glass and window manufacturer operating in Ireland since 1965 and FloorTech, a Cork based company which develops and installs resin based flooring.

Enquiries by Sweco were supported by a written information letter issued by the EPA to set out the context for the study and associated enquiries.

The initial product listing (Section 3.1.3 above) was used as the basis for consultation. A long list of trade names for PCB-containing materials prepared by UNEP[21] in its consolidated guidance of 2019 was also used in support of the consultation.

3.2 Task 3

3.2.1 Desktop study

Once PCB-containing products in open sources had been identified from Task 2, a literature review was undertaken to investigate if there were common characteristics, in PCB congener profiles for particular product applications or product types.

The desktop study included a review of:

1. Available data on the technical blends of PCBs which were used during the production of specific product types
2. Available analytical data on profiles from congener analysis of samples of paints, sealants, flooring products etc.

A review of available analytical data from environmental (soil) samples, in the direct vicinity of a known product source was also completed.

It is important to note that not all data from chemical analysis of PCBs in products or environmental samples can be used for drawing definitive conclusions on a complete congener profile. Due to degradation over time, chemical analysis of materials in years after the original application, may not

[21] UNEP, Consolidated Guidance on PCB in Open Applications, pp. 8-10

accurately capture the technical blend of the material first applied. Key to the assessment of PCB profiles is the selection of appropriate laboratory analytical methods. This is examined with particular reference to the GSI Report referenced earlier in Section 2.3.4 of this report.

In the desktop study, internet searches were used to identify relevant reports and open source scientific publications. These publications were reviewed for key information regarding:

- Technical blends of PCBs that were preferred for different types of products used in open sources
- Progression of different industrial production lines for technical blends of PCBs (e.g. different technical blends such as Aroclors which were manufactured by Monsanto in the US but were supplied to the European market)
- Analytical methods for complete profiling and quantification of different technical blends of PCBs
- Environmental forensic methods for differentiation of PCB sources in the environment
- Analytical data from building materials during Swedish surveys and remediation measures.

3.2.2 Consultation

Telephone consultation was carried out with a representative of Synlab Laboratories in Linköping, Sweden regarding experience in the analysis of PCBs. Synlab Laboratories carries out analysis of PCBs in soil, water and building materials (including sealants). Synlab is accredited by SWEDAC (Swedish Board for Accreditation and Conformity Assessment).

Synlab in Linköping were responsible for the analysis of PCBs in soil (ΣPCB7) in the GSI report reviewed later (Section 4.4.3)[22].

3.3 Project Limitations

Further to initial discussions between the project team and EPA personnel, a number of limitations were anticipated from the outset of the study owing primarily to the historic nature of the use of PCBs in open applications globally.

Following the EU ban on the use of PCBs as a raw material or chemical intermediate in 1985 (and further to more general restriction on their use globally since the 1970s), it is now over 30 years since PCB-containing materials were legally traded.

This has meant the loss over time of experience and knowledge within companies who manufactured, imported, exported or used PCBs. As the period of PCB usage in open applications is known to have almost entirely pre-dated the mid-1980s, the likelihood of any relevant electronic records or surviving paper-based records is also low.

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[22] Geological Survey of Ireland, (2012). Geochemical baseline for heavy metals and organic pollutants in topsoils in the greater Dublin area.

The knowledge gaps identified are further described in Section 5.

As the project was progressed and further to consultation with stakeholders identified in the Project Plan, it was increasingly clear that information on PCB-containing products specific to the Irish market was either extremely limited in nature or unavailable. As a result, it was required to expand the identification of products containing PCBs (Task 2) and investigation of PCB congener profiles (Task 3) to consider products marketed within Europe (and beyond) more generally.

The project methodology was also broadened with an increased focus on the review of relevant literary sources and the experience of European countries where the management of PCBs in open applications has been further progressed. As identified previously (Section 2.3.3.2), the predominant use of PCBs in open applications was in buildings and other construction. The experience of other European countries in managing PCBs used historically in building materials has also been reviewed to inform the project findings and recommendations.

4 Project Findings

4.1 Task 2 - Identification of PCB-containing products

4.1.1 Findings from desktop study and experiences from Swedish inventory and removal of PCB-containing materials in buildings

In the mid-1990s the Swedish EPA highlighted the issue of PCB-containing materials used in the fabric of existing buildings. Various stakeholders within the building sector were brought together to address this issue under an initiative called *'The Ecocycle Council of the Building Sector'*.

Experience gained as a result of the Ecocycle Council initiative is summarised in a report prepared for the Swedish EPA (Naturvårdsverket) in 2019. This report describes the approach to identification and management of PCBs in building materials in Sweden, which primarily involves the mandatory preparation of inventories for buildings suspected of having PCB-containing materials. The key steps in the preparation of a building inventory includes:

- Identification of buildings that were constructed between 1956 and 1973
- Recording of suspected products/materials including sealants, flooring compounds and double-glazed windows
- Sampling and laboratory analysis of the materials to determine the PCB content.

Further to the preparation of these building inventories, some information was found on specific building materials, products and product names. This informed the development of an initial product list of PCB-containing materials. Further details on the product list are included in Section 4.1.3.

Telephone consultation was carried out with a senior member of the Miljökonsultgruppen i Stockholm HB consulting firm, a previous member of the Ecocycle Council initiative. The approach to the identification of PCB-containing materials was discussed and whether experience or learnings had emerged more generally regarding specific product, manufacturer or brand names.

Subsequently, the following limitations associated with investigation of materials by brand and trade names were identified:

- Brand names may have been used during an extensive time period including years of PCB-free product e.g. the Acrydur[23] plastic-based flooring compound
- Brand names are seldom visible on the building material, with limited exceptions such as certain types of isolated glass windows.

In general, it was advised that attempts to locate PCB-containing products in open applications by way of focus on specific manufacturers, products or brand names was likely to be ineffective. Based on the experience of the Ecocycle Council, the approach recommended for this study was to focus more broadly on the age of buildings and structures and likelihood of usage of PCB-containing materials.

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[23] PCBs were extensively used in plastic-based flooring of the brand Acrydur between 1956 and 1973. Finished floors constructed between 1965-1973 may contain as much as 12% PCBs (Naturvårdsverket 2019). Based on sales records from the manufacturer (Ulfcar AB, Sweden) a total of 53 tonnes of PCB were used for this application (KEMI 1994). However, the brand Acrydur has been used continuously up to date for non-PCB flooring material.

4.1.2 Findings from review of product registries

The SPIN database for the Nordic countries contained 12 relevant entries describing groups of chemicals (e.g. “PCB 1260”, “Aroclor 1268”, “Kanechlor 400”, “Chloreret Biphenyl (uspec.)”) and also some 40 individual congeners, but in most cases no use was reported. In the SPIN database, these entries were typically not linked to specific products or individual product names.

Use of PCBs has been reported in Denmark between 2005 and 2010 and in Sweden in 2003 and again between 2006 and 2015. Again, this database did not provide any information on what type of products contained PCBs before 2006. Where information on usage is available, it shows that PCBs were used in the paint industry. The reported use of PCBs in the paint industry after 2006 is probably referring to small quantities inadvertently generated during the production of certain pigments such as diarylides or azo pigments (Rodenburg 2015).

In the Swiss product register it is not possible to search for substances in order to find products or type of products in which the substances have been used. However, it was noted that several PCB blends (such as “Aroclor 1221”, “PCB 1254” and “Kanechlor 500”) and seven individual congeners were listed substances in the database.

4.1.3 Product Listing

An initial list of product types for PCB-containing materials in open applications was compiled from the desktop study.

The list of product types and information gathered on PCB-containing materials was then used as a basis for consultation and enquiry with companies and representative bodies known to be involved in the import, production or supply of the same product types in Ireland. A long list of trade names for PCB-containing materials was documented by UNEP in its consolidated guidance of 2019 was also referenced.

As described in Section 4.1.4 below, the engagement with Irish consultees of interest yielded no significant beneficial information to further refine this initial product listing for Ireland. Therefore, the final list for the purposes of this report draws more broadly on the experience identified in Sweden, where remediation of PCBs in the building sector has been progressively addressed since the late 1990s. Where the relevant information was available, this product list includes:

1. Application
2. Product name
3. Manufacturer
4. Period of usage

A copy is included in Appendix A. For reference, a copy of the long list of trade names for PCB-containing materials compiled by UNEP is included in Appendix B.

4.1.3.1 Summary of Common Product Types by Application

Based on a review of the product list compiled, the most commonly identified products may be grouped by application and period of use, where this has been identified for other countries. A similar period of use is considered likely in Ireland.

Table 1 – Most commonly identified products and period of use

Application (overall)	Application (detailed)	Reported years of usage	Reported peak years of usage	Comments
Sealants	Predominantly used in the exterior of buildings between facade elements, in dilation joints (moving joints, connecting joints around windows, doors etc.). Also used indoors for joint seals e.g. building entrances and stairwells.	1956-1973	1965-1972	Only in elastic polysulphide sealants, not in polyurethane and silicone sealants. Not all polysulphide sealants contain PCBs. Building sealants are a significant source of current emissions of PCB from open applications according to studies carried out in Germany and Switzerland.
Sealed window units	Seal between windowpanes in insulating windows, primarily found in public buildings, office blocks etc.	1956-1973*	Unknown	* until 1980 in windows imported to Sweden. Due to differences in climate, prevalence of double glazed windows in Ireland may be lower during this period.
Flooring compounds	Plastic-based flooring compounds for seamless floors, non-slip floors[#]	1956-1973	1965-1973	Acrydur was the product brand used for most floors of this type laid from the mid-1960s. The binder in the floor covering contained approx. 20% PCBs.
Paints and coatings	Plasticiser in paints, especially for corrosive environments. Used widely to coat water tanks, bridges and other infrastructural components. Also used in anti-corrosive coatings on transformers and machinery / industrial plant.	1947-1970s	Unknown	

[#] = While the method of installation of flooring materials may have differed, analysis carried out in Sweden has identified levels of PCBs in the binder materials used in laying floor coverings and the finished floor covering itself.

4.1.4 Consultation with Irish manufacturers/suppliers and representative bodies

Enquiries were made with Irish companies of interest as described in Section 3.1.4. From an early stage of enquiry, it was clear that there was limited or no knowledge surviving within these companies owing to the historic nature of the use of PCB-containing materials.

Prior to the widespread use of computer systems and electronic records, company records for the period are generally limited or no longer maintained. As such, any surviving knowledge is most likely limited to anecdotal accounts of retired personnel.

Based on the feedback received, no further engagement was pursued with the companies of interest identified and efforts were focused on the remaining study tasks and other related findings.

4.2 Task 3 – Investigation of PCB congener profiles of PCB-containing products

The investigation of PCB congener profiles of PCB-containing products considered the following aspects:

1. Technical blends (mixtures) of PCB
2. Identification of technical blends
3. Linking technical blends to specific products
4. Identifying PCB congener profiles using product samples

4.2.1 Technical blends (mixtures) of PCB

PCBs were manufactured in mixtures, with these mixtures tailored for the end product use/purpose. The manufacturing processes resulted in varying complex mixtures of some 150 of the theoretical 209 individual congeners[24]. These mixtures, generally referred to as technical blends, were tailored and manufactured to yield a degree of chlorination, generally between 21% and 68% chlorine content (percentage weight).

These commercial technical blends were given trade names such as “Arochlor”. The Arochlor blends were manufactured by Monsanto in the US and were among the most well-known having also been supplied to the European market. The individual technical blends of Arochlor were identified by a four-digit numbering system in which the last two digits indicate the approximate chlorine content. Other manufacturers adopted a similar coding system for specifying their trade name technical blends such as Clophen in Germany, Phenoclor in France and Kanechlor in Japan.

While the production processes used by manufacturers were similar, they were not identical, resulting in variations in technical blends between manufacturers. For example, the technical blends of Arochlor 1260 and Clophen A60 show similar but varying compositions[25]. Furthermore, the manufacturing processes for specific compounds evolved over the years resulting in the possibility of variations over

[24] Frame, G.,et al. J High Resol Chromatogr

[25] Johnson GW, Quensen JF 3rd, Chiarenzelli JR et al. (2000). Polychlorinated Biphenyls. In: Morrison RD, Murphy BL editors. Environmental Forensics: Contaminant Specific Guide. Academic Press; pp. 187–214.

time in the technical blends being used for the manufacture of the same product. In the case of Arochlor 1254, the manufacturing process evolved so that the early production of Arochlor 1254 had a different profile originally compared to its later production[26].

4.2.2 Identification of technical blends

Published data was reviewed from three separate studies whereby complete or near complete congener profiles of the following technical blends were investigated:

1. 17 different batches from 8 specific Arochlors technical blends [27] (US), with approximately 95 congeners quantified
2. 4 different Kanechlors (Japan) with approximately 140 congeners quantified [28]
3. 4 different Clophens (Germany) and 5 different Aroclors with approximately 130 congeners identified [29]

Information on the technical blend and congener profile for each of these has been included in Appendix C.

4.2.3 Linking technical blends to specific products

Linking technical blends to specific products is a difficult task for a number of reasons:

- The range of desired material properties for use in different open applications required the use of a range of technical blends
- In most cases a congener profile cannot be established for a product type due to differences between the manufacturing processes used by different organisations.

The original unweathered congener profile of a PCB containing product will vary depending on what technical blend was used for that specific product. For example, the Swedish company Göta Kemi manufactured sealants using the brand name Lasto-meric under licence from Tremco, USA. Sources suggest that for the manufacturing of these sealants, Aroclor 1254 along with other technical blends were used [30]. Therefore, it can only be assumed that a sealant in Sweden *might* contain a PCB profile similar to the technical blend Aroclor 1254. The reason being is that other manufacturers of sealant in Sweden might have imported other technical blends such as Clophen from Germany or Phenoclor from France, resulting in different PCB profiles.

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[26] Frame, G.,et al. J High Resol Chromatogr
[27] Frame, G.,et al. J High Resol Chromatogr
[28] Kyoung Soo Kim, Yusuke Hirai, Mika Kato, Kouhei Urano, Shigeki Masunaga. (2004) Detailed PCB congener patterns in incinerator flue gas and commercial PCB formulations (Kanechlor). Chemosphere 55[4] 539–553 (2004)
[29] Schulz, D., Petrick, G. Duinker, J. (1989). Commercial Aroclor and Clophen mixtures by multimimensional gas chromatography – electron capture detection. Environ Sci Technol 23:852.
[30] Erickson, M. and Kaley R. (2011) Environ Sci Pollut Res 18:135–151

From the literature review it appears that the historical use of different Aroclors in closed applications (e.g. capacitors, transformers) is well documented [31]. For open applications the situation is very different and the same reference states that:

> *The PCBs used for plasticizer applications, including those used in paints, were often sold to independent distributors who resold them to the manufacturers of the ultimate product, for which adhesion, chemical resistance, and/or flame resistance were deemed important. Therefore, product names and PCB composition are largely undocumented.*

For products groups such as plasticisers, paints, varnishes, lacquers, surface coatings, caulk and joint sealants, rubber products, insulation and other building materials, there is no information available on what Aroclors were used, or available information points to more than one type of Aroclor[32]. The IARC, an agency of the World Health Organisation (WHO), linked the following technical blends and product types:

- Aroclor 1242 for carbonless copy paper
- Aroclor 1254 for industrial cutting oils
- Aroclor 1268 for pipeline valve grease[33].

Similarly, when trying to establish PCB congener profiles using historical documents, information from patent records may provide information on PCB profiles and composition. However, it is difficult to determine whether a given patent application was successful and if the product associated with a particular patent was subsequently manufactured or supplied to the market.

4.2.4 PCB congener profiles from product samples

Data from product samples can be a way of establishing congener profiles for sealants or other product types. In Sweden for example, it is a requirement to sample building material prior to demolition where PCB-containing materials are suspected to occur within the building fabric. This contrasts with the current position in Ireland, where the fate of such building materials from demolition is not regulated as strictly. For large scale demolition projects requiring planning permission, Construction & Demolition (C&D) Waste Management Plans (WMPs) will typically be required as a condition of planning. The existing guidelines informing C&D WMPs[34] do not require or recommend the testing of suspect building materials for hazardous properties prior to demolition, though the preparation of an *"inventory of hazardous wastes"* is advised. Small scale demolition in Ireland may potentially occur in the absence of planning permission or without the preparation of a C&D WMP. In short, there is no established practice or norm in Ireland for testing (laboratory analysis) of building materials for the presence of PCBs prior to their demolition or removal/replacement.

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[31] Erickson, M. and Kaley R. (2011) Environ Sci Pollut Res 18:135–151

[32] Erickson, M. and Kaley R. (2011) Environ Sci Pollut Res 18:135–151

[33] IARC (2013). Polychlorinated Biphenyls and Polybrominated Biphenyls IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 107, p.73

[34] Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects, Department of the Environment, Heritage & Local Government, July 2006

In Sweden, there are a number of commercial laboratories (e.g. Synlab, Eurofins, ALS) providing specific analysis, with results being compared to guideline values[35]. Access to this data, however, is limited and therefore results for larger data sets for specific congener quantification beyond the standard seven congeners "ΣPCB7" methodology (Total of 7 PCBs) is not readily available for comparative purposes. Analysis of the "ΣPCB7" includes the following congeners, where the number of chlorine atoms per molecule is given in parentheses:

PCB 28 (3), 52 (4), 101 (6), 118 (6), 153 (6), 138 (6), and 180 (7).

This standard ΣPCB7 suite was initially selected for use in analysis by the International Council for the Exploration of the Sea (ICES) as a PCB screen for monitoring biota and sediment samples. Subsequently, this became the recommended suite by the European Union Community Bureau of Reference for monitoring PCBs[36].

Key reasons for using these seven congeners in environmental analysis include their relatively high concentrations in different technical mixtures of PCBs and the inclusion of congeners of both low and high chlorination range.

Some older publications have been found which indicate that different sealants can contain different types of chlorinated technical solutions. In a study from 1997, one sample of sealant from a house built in 1965 showed a dominance of more heavily chlorinated congeners and a profile resembling Arochlor 1260 while samples from other houses (year of construction unknown) showed less chlorination and patterns similar to Arochlor 1248[37]. In a study from 2001, samples from sealants were found to be either heavily chlorinated, similar to Clophen A60 or less chlorinated, similar to Clophen A40 [38].

Where congener profiling is the objective, careful consideration must be given to the analytical method selected. For example, the analysis of the *'sum seven'* PCB congeners "ΣPCB7", which is commonly used by commercial laboratories has very limited value for identifying a potential product source since these congeners are non-specific.

To illustrate this point, an example of how material samples are analysed for PCBs at Synlab Laboratories, Linköping, Sweden[39] is presented hereunder:

Material samples from old sealants in buildings are typically analysed for total mass of PCB by comparison to different Aroclor standard solutions retained by the laboratories. This procedure means the laboratory will have prepared different calibration curves based on diluted standards of the technical blends. The total chromatogram from GC-ECD (gas chromatography equipped with electron capture detector) of the sampled material is then compared to the different Aroclor standard solutions. The Aroclor standard solutions that shows a total chromatogram most similar to the sample is then chosen for quantification. According to the reference method (EN 16167:2018+AC2019) six individual PCB congeners are first quantified (PCB 28, PCB 52, PCB 101, PCB153, PCB138, PCB180). To obtain the

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35 Σ 7PCBs < 0,008 mg/kg DW in soil for "sensitive land use" such as housing.

36 Webster, L., Roose, P., Bersuder, B., Kotterman, M., Haarich, M. and Vorkamp. K. 2013. Determination of polychlorinated biphenyls (PCBs) in sediment and biota. ICES Techniques in Marine Environmental Sciences No. 53. 18 pp.

37 Naturvårdsverket (Swedish EPA) (1997). PCB i fogmassor, stort eller litet problem?

38 Miljöförvaltningen (Municipality) Stockholm and Sveriges Provnings- och Forskningsinstitut (SP) (2001), PCB i inomhusmiljön. Kartläggning av PCB-halter i inomhusluft och damm i utvalda lägenheter i Stockholm.

39 As described in a telephone interview with analytical chemist of Synlab Laboratories and according to the Swedish reference method SS-EN 16167:2018+AC2019

total content of PCBs, the sum of the six PCB congeners is multiplied by a specific factor for the specific Aroclor standard solution used. Examples of multiplication factors are as follows:

- Aroclor 1242 = 7.7
- Aroclor 1248 = 7.2
- Aroclor 1254 = 4.3 and
- Aroclor 1260 = 3.4.

The result is then reported as a PCB concentration of the specific Aroclor standard solution e.g. 50 µg/g of Aroclor 1254. It is important to note that this indicates similarities in the PCB congener pattern between the sample and the reference profile but does not identify the true technical blend or congener profile. It also does not indicate that Aroclor 1254 is the source of PCB contamination.

The method above includes quantification of six congeners for the estimation or total mass of PCBs in building material (and excludes PCB 118 which is part of the ΣPCB7 suite).

Complete characterisation of PCBs in seven commercial Aroclors has been presented by Frame et al. (1996) and characterisation of four Aroclors and four Clophen mixtures has been presented by Schulz et al. (1989). The latter showed that all seven of the ΣPCB7 congeners were present in the original technical mixtures Aroclor 1242, Aroclor 1254 and Aroclor 1260. Hence, it would be of little diagnostic value if some of these congeners are found in soil samples while others are absent, as this could easily be attributed to limitations in the analytical method (detection limit) or to weathering. Differences in the relative occurrence of PCB 180 in a sample however, could be used to distinguish between Aroclor 1242 and Aroclor 1260 as the relative occurrence differs from 0.05% to 7 % respectively.

The "Aroclor-methods" as described above are often highly unreliable for identifying the type or source of PCBs in environmental samples. The US EPA (2012) distinguishes between two general types of analytical methods for PCBs:

- *Rapid sediment characterisation technologies which provide for wide spatial coverage to delineate sediment contaminant heterogeneity and semi-quantitative characterisation in a cost-effective manner*
- *Advanced chemical fingerprinting (ACF) on a selected subset of samples to delineate sources. ACF includes both advanced laboratory chemical analysis of samples, along with the application of sophisticated data analysis and interpretation methods*.

A forensic analysis for PCBs will typically include the characterisation of more than 100 discrete PCB congeners (congeners that comprise >98% of the total and possible PCB contamination), or in some cases, a smaller set of 50 to 75 congeners (US EPA 2012).

To generate high quality data for fingerprinting of PCBs in soil samples, a substantial number of congeners needs to be included in the dataset and the detection limit must be sufficiently low to ensure that congeners present are captured. In an extensive survey of background levels of PCBs in Norway and the UK, soil samples were sampled between 1998 and 2008[40] to establish any change in loading

[40] Schuster, J., Gioia R., Moeckel C., Agarwal, T., Bucheli, T., Breivik, K., Steinnes, E. and Jones, K. (2011). Has the Burden and Distribution of PCBs and PBDEs Changed in European Background Soils between 1998 and 2008? Implications for Sources and Processes. Environ. Sci. Technol. 2011, 45, 7291–7297.

or distribution of PCBs over time. The data set included the quantification of 31 different congeners. Detection limits were as low as 2 ng/kg dry weight for individual congeners which is 1000 times lower than the detection limit in the study with soil samples presented by the GSI for example[41].

4.3 Other Related Findings

As the research for Tasks 2 and 3 resulted in significant knowledge gaps (owing primarily to the historic nature of the use of PCBs), other related findings are noted below which may contribute to an improved understanding of PCB usage in open applications in Ireland.

4.3.1 UK Production of Arochlors

The Monsanto company had production facilities in the UK producing an estimated 66,542 tonnes of PCBs from 1954 to 1977[42]. A report on the speciation of the UK PCB emission inventory of 2001[43] identified an absence of reliable sales data for Arochlors produced in the UK. This report did identify that PCBs were also marketed in the UK under the trade name of Pyrochlors.

No additional source of published information for Monsanto UK activities or Monsanto exports from the UK to Ireland was identified during the course of this study. On the basis of proximity alone, it is likely that Ireland represented a part of the market (either directly or indirectly) for Monsanto's UK operations during this time. This would greatly increase the likelihood of Arochlors (or Pyrochlors) being the predominant technical blend or constituents in PCB-containing materials used in Ireland.

The relative share of PCBs imported to Ireland from the UK (or other countries) in finished products compared to raw materials for manufacturing purposes is unknown, with limited data and surviving knowledge on Irish manufacturing history specific to PCBs in open applications (as described in Section 4.1.4). Given that Ireland was less industrialised and economically developed by comparison with the UK and mainland European countries during the period of production of PCBs, it is possible that PCBs were present in greater quantities in imported finished products for several applications. However, for a number of applications such as paints, there were a number of prominent production sites active in Ireland (e.g. Dulux in Cork) where raw materials containing PCBs may have been imported.

4.3.2 PCBs in Flooring Materials

In the review of Swedish inventories, the brand name 'Acrydur' and the company name 'Ulfcar' is often mentioned in connection with flooring compounds containing PCBs. This type of flooring compound was used extensively in Sweden and represented a significant amount of total PCB usage in buildings. In an interview with a former employee of Golvanalys i Sverige AB, it was identified that the PCB containing plastic-based flooring compound, with the brand name Acrydur, was manufactured in Germany by the company Degussa.

Another manufacturer in Germany, Rohn and Haas, produced a similar product associated with the brand name Silikal. Both brand names Acrydur and Silikal have been used for an extensive period and may represent both older products containing PCBs and newer products free of PCB. Where used, it is understood that PCBs were phased out in these products in Germany and Sweden during the same

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[41] Geological Survey of Ireland, 2012.
[42] IARC Monographs (2013), p.72
[43] Conolly, C. (2001). Speciation of the UK Polychlorinated Biphenyl Emission Inventory, p.3

time period of 1972-1973. The FloorTech company[44], based in Little Island, Cork, develops and installs resin based flooring and is an agent of the present day Silikal company. Telephone consultation was carried out with senior representatives of the FloorTech company for any information that may be available based on local knowledge or through contact with Silikal. It was confirmed that FloorTech operations in Ireland date to 1994, which follows the ban on the legal use of PCBs by several years. FloorTech consulted with colleagues in Silikal based in Germany regarding possible uses of PCBs within the wider Silikal company (prior to restrictions on use) and written responses were provided via e-mail. Based on surviving knowledge and available records, the Silikal representative identified that the company did not use (or manufacture) PCBs. It was stated that that all (Silikal) products have always been free of PCB. As identified above, flooring compounds such as those produced by Silikal and competing brands were manufactured and used over an extensive period of time and the Silikal products may be representative of newer products that were free of PCB.

The application of these products has been linked with seamless floors and non-slip floors. Such applications were a common feature in the food and beverage manufacturing sector and similar industrial facilities e.g. breweries, large-scale kitchens etc across Europe.

4.3.3 Carbonless Copy Paper

Carbonless copy paper refers to the type of coated paper used to transfer information written on a front sheet to sheets beneath. It is commonly used in business stationery (e.g. invoices, receipts, signed documents and dockets) where an original record and multiple copies are required. Prior to their ban, PCBs were used as a transfer agent in carbonless copy paper. It has been reported in Sweden that the use of PCBs in carbonless copy paper was extensive, well documented and led to severe pollution of waterways downstream of paper mills where recycled paper was processed. It is considered likely that any carbonless copy paper produced using PCBs and subsequently retained (e.g. business records) has been disposed over time, with no large source or stockpile of such paper remaining to be addressed. However, it is likely that any carbonless copy paper was sent to landfill if disposed of in Ireland.

The extent of former paper mill operations in Ireland has not been reviewed as part of this study, however it is understood that paper mills in Ireland during the 20th century were relatively few, compared at least to other European countries. A number of paper mills operated previously in Dublin along the Camac River. The most recent examples include the Swift Brook Mill and Clondalkin Paper Mill. Internet searches identified that these mills closed in 1971 and 1987 respectively. There is some anecdotal evidence[45] of recycling ‘scrap paper’ at the Swift Brook Mill.

Subject to further clarification on the nature of paper milling activities undertaken at this location and changes in the Camac riverbed over time, the possible presence of PCBs in nearby river sediment may warrant further investigation. The Camac River is subject to monitoring of water quality by the EPA as part of the Agency’s national river monitoring programme, which is carried out in alignment with the EU Water Framework Directive (WFD)[46]. A review of published monitoring data (catchments.ie) for the Camac River[47] did not yield any results for PCBs in water (biota) and it is

[44] http://floortech.com/
[45] https://www.irishlifeandlore.com/product/kit-brady-and-richard-farrelly/
[46] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy
[47] EPA mapping waterbody names: CAMAC_010, CAMAC_020, CAMAC_030, CAMAC_040

understood that sediment has not been tested for PCB in this waterbody as part of the national monitoring programme. Data published for the 2019-2021 monitoring programme indicates that the Camac River is subject to monitoring for general conditions (oxygenation, nutrient conditions, pH, temperature, conductivity/chloride) and invertebrate status (Q-value) only.

The monitoring of PCBs in waterbodies in Ireland (including analysis of biota and sediment samples) is summarised in the 2018 update of Ireland's National Implementation Plan (NIP) for the Stockholm Convention on POPs prepared by the EPA[48]. Summary information on the chemical status of surface waters in Ireland is also presented in two recent reports, namely:

- *'Water Quality in Ireland 2013-2018'* – issued by the EPA in 2019[49], including information on the ecological and chemical status of Ireland's surface waters collected over a six year period between 2013-2018 (i.e. the results of the second 6-year assessment undertaken since the introduction of the WFD)
- *'Significant Water Management Issues in Ireland'* - prepared by the Department of Housing, Heritage and Local Government in 2019[50] as a public consultation document informing the preparation of the third River Basin Management Plan for Ireland.

12 dioxin-like PCBs (DL-PCBs)[51] are listed as priority substances under the WFD as dioxin-like compounds. 24 PCBs[52] are listed as river basin 'specific pollutants' for determination of the ecological status of surface water bodies. As part of nationwide monitoring in recent years, information on priority substances (including PCBs) has been collected from a representative network of 324 surface water bodies comprising of 181 river water bodies, 98 lakes, 33 transitional waters and 12 coastal waters. As such, not all rivers are subject to monitoring for priority chemical substances such as PCBs (e.g. the Camac River as described above).

While this study has not sought to interrogate the results of monitoring for 'specific pollutants' (with respect to ecological status) or priority substances in individual waterbodies, the aforementioned reports, including the 2018 update of the NIP, contain a number of helpful summary statistics and points of information relevant to the monitoring of PCBs in Irish waterbodies more generally, including:

- 75% of monitored surface waters are in good chemical status (based on the results of monitoring during the period 2013-2018). When ubiquitous priority substances[53] are omitted, the percentage in good chemical status increases to 99% of surface waters.
- Of 191 river monitoring sites having 'specific pollutant' status available for 2013-2018, 173 sites passed while 18 sites failed. All of the 18 failed sites were attributed to levels of metals around known mining locations. The ecological status for four river water bodies was determined by their failing on specific pollutant status.

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[48] http://www.epa.ie/pubs/reports/waste/haz/nationalimplementationplanonpops2018.html

[49] https://www.epa.ie/pubs/reports/water/waterqua/Water%20Quality%20in%20Ireland%202013-2018%20(web).pdf

[50] https://www.gov.ie/en/consultation/7bcef7-public-consultation-on-the-significant-water-management-issues-for-t/?referrer=http://www.housing.gov.ie/water/water-quality/water-framework-directive/public-consultation-significant-water-management

[51] DL-PCB: PCB-77, PCB-8, PCB-105, PCB-114, PCB-118, PCB-123, PCB-126, PCB-156, PCB-157, PCB-167, PCB-169 and PCB189

[52] PCB-28, PCB-52, PCB-72, PCB-77, PCB-81, PCB-101, PCB-103, PCB-105, PCB-106, PCB-114, PCB-118, PCB-123, PCB-126, PCB-138, PCB-153, PCB-156, PCB-157, PCB-167, PCB-169, PCB-170, PCB-180, PCB-189, PCB-194 and PCB-209

[53] Ubiquitous substances including mercury and its compounds, brominated diphenyl ethers (pBDE), tributyltin and certain polyaromatic hydrocarbons (PAHs)

- Parameters causing poor chemical status in biota (2013-2018) were identified as mercury, heptachlor and heptachlor epoxide, and polybrominated diphenyl ethers (PBDEs). The parameter causing poor chemical status in water samples was identified as benzo(a)pyrene, which is a polyaromatic hydrocarbon (PAH). PCBs were not identified as a contributor to poor chemical status.

- Sediment data is collected where possible, under both a small-scale temporal trend OSPAR programme (Dublin Bay) and as part of the WFD programme. Sediment samples are collected from approximately 13 sediment (coastal/transitional) locations per annum. PCBs are included in the suite of analyses, with data indicating relatively low levels of PCBs in Irish transitional and coastal waters.

While there are limitations on the number of water body sites subject to monitoring for PCBs, the available data indicates that PCBs are not a significant contributor on a national scale to poor chemical status of waterbodies.

With regard to the previous commentary on former paper mill sites as a potential source of PCB contamination, additional targeted monitoring would be required to assess any such cases which are more localised and unlikely to be captured by the results of the wider national monitoring programme.

4.3.4 Best Practice - PCBs in Open Applications

Sweden and Switzerland are two countries which have implemented significant measures as part of their national regulatory frameworks for the proactive management of PCBs in open applications. These measures are further described below.

Sweden – PCB Ordinance

In 2007, a new ordinance (the PCB Ordinance SFS 2007:19) was introduced in Sweden which imposed requirements on the preparation of an inventory of PCBs and requirements on the remediation of PCBs in open applications (specifically in buildings), if the PCB level was higher than 500 mg/kg. The Ordinance followed on from the Ecocycle initiative described earlier in Section 4.1.1 and applied to buildings constructed between 1956-1973 with certain exceptions and building owners were responsible for making an inventory and removing PCB-containing materials including sealants, flooding compounds, sealed window units and condensers.

For buildings within the scope of the Ordinance of 2007, the inventory was required to be completed and reported to the supervisory authority (Environmental Department of the local municipal authorities) by 30 June 2008. Works to remove the PCB-containing materials (> 500 mg/kg) were then required to be carried out within a period of eight years i.e. by 30 June 2016. The Ordinance also imposed requirements that sealants and flooring compounds with PCB levels between 50 mg/kg (which is the limit for hazardous waste) and 500 mg/kg were to be removed when the building is subject to renovation, redevelopment or demolition.

The preparation of the building inventory required samples of suspected materials to be taken for laboratory analysis in order to determine which materials exceeded the threshold for mandatory remediation prior to 2016 (500 mg/kg) or the threshold for removal during the next renovation, redevelopment or renovation (50 mg/kg – 500 mg/kg).

No later than three weeks prior to the commencement of remediation work, an application regarding the remediation measures was required to be submitted to the supervisory authority, whereupon the authority assessed whether the measures proposed were adequate for the protection of human health and the environment. Such an application was also required by the Ordinance 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 remediation work and how that waste is to be managed, labelled and transported, and where it may be discarded. It is noted that a single service provider (Fortum Waste Solutions based in Kumla, Sweden) was the only company that could legally undertake waste treatment of the PCB waste arising (by means of combustion at a high temperature in a controlled process).

Further to a report prepared for the Swedish EPA in 2019[54], it is estimated that at least 70-85% of affected buildings dating from the period 1956 – 1973 have been decontaminated.

Switzerland – Ordinances on Constructions Works and Waste

Measures for the management of PCBs in open applications in Switzerland are summarised in the case study by Wagner et al. In 2003 the Swiss Federal Office for the Environment published legislation requiring investigation of the PCB content in buildings constructed between 1955 and 1983, calling for special measures to protect workers and the environment. Thresholds were established for PCBs in both building materials (e.g. 50 mg/kg of PCBs in caulk) and indoor room air (e.g. 2 µg PCB per m^3 indoor air in residential settings and hospitals). Immediate renovation work for the removal of PCB-containing materials is required in excess of prescribed thresholds.

The Swiss Ordinance on Construction Works (BauAV) and the Technical Ordinance on Wastes (TVA) require the screening of buildings prior to renovation or demolition. Where screening identifies the potential for PCB materials within a building, sampling and analysis is carried out. The screening and analysis is not limited to PCBs and is intended to identify all significant contaminants e.g. asbestos, PAH, short chain chlorinated paraffin, harmful flame retardants etc.

Appropriate decontamination, cleaning and removal techniques with associated precautions for the environment and workers have been developed. It was noted in the Swiss case study of 2014 that different approaches and techniques are constantly being developed, tested, adapted and improved.

Where PCB-containing materials are removed, indoor air measurements are carried out before the rooms are used again.

PCBs waste arising with a concentration of greater than 50 mg/kg is required to be managed as hazardous wastes and destroyed or irreversibly transformed in for example, approved high-temperature incineration plants or non-combustion facilities.

Other Examples

Other examples of best practice identified in other countries include:

- **Denmark NMK 96**

In Denmark, NMK 96 (Nedbrydningsbranchens Miljøkontrolordning) is a voluntary agreement dating from 1996 and was agreed between the Danish Demolition Association and Danish Ministry of Energy

[54] Swedish EPA Report 6885, 2019, p.31

and the Environment[55]. The agreement continues to set standards for environmental management in construction and demolition including waste segregation.

Before a demolition or renovation work is started, developers are required by NMK 96 to undertake a screening in order to assess whether buildings (or other structures such as bridges) contain PCBs[56]. The screening requirement applies to all buildings and structures that were built or renovated in the period from 1950 to 1977, demolition or renovation work that concerns more than 10 m^2 or works generating more than one tonne of waste. If the initial screening indicates that there is a risk that the building or structure contains PCBs, the developer must undertake a mapping of the parts of the building that may contain PCBs. The result of PCB screening or mapping must be notified to the municipal authority no later than two weeks before the demolition or renovation begins. The notification must also include information on the amounts of waste and waste types (with and without PCBs) produced by the demolition or renovation work as well as information on how the waste will be handled.

- **Vienna, Austria – Building Regulations**

In 2011, the Norwegian EPA initiated a report[57] on the assessment of initiatives to prevent waste in the building and construction sectors. This report highlighted measures adopted for the identification and management of hazardous waste management materials in Vienna, Austria in 2006. In Vienna, local regulations were implemented requiring the identification of hazardous substances (including PCBs) in buildings prior to demolition. Guidelines were developed containing procedural and contractual procedures governing the demolition of buildings.

- **Bavaria – Online Information System**

The Bavarian State Office for the Environment (Bayerisches Landesamt für Umwelt) provides a free online information system in Bavaria to support proper waste segregation and disposal arising from construction and demolition. The online register "Schadstoffratgeber Gebäuderückbau" ("Pollutant Advisor Building Restructuring")[58] provides detailed resources on pollutant and non-pollutant materials. The register can be searched by building section (e.g. wall, ceiling, floor etc.), building materials and components (over 250 names) or specific substances such as PCB. This resource is understood to be operated as a dynamically designed information portal, which can be continually updated and improved by users. Detailed resources are available targeting potential waste streams containing POPs and in particular PCB.

4.4 Estimation of PCBs used in Open Applications

In the absence of specific data for Ireland on PCB use, data from selected European countries were examined. It is noted that a broad range of academic and other research reports are available, with differing estimates of PCB quantities in open applications. The following review has therefore focused primarily on sources acknowledged by UNEP in its guidance of 2019, unless otherwise stated.

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[55] Advances in Construction and Demolition Waste Recycling Management Processing and Environmental Assessment, F. Pacheco-Torgal, Y. Ding, F. Colangelo, 2020

[56] Construction and Demolition Waste Management in Denmark, Bio by Deloitte (and others), September 2015, p.7

[57] Assessment of initiatives to prevent waste from building and construction sectors, Norden, 2011

[58] https://www.lfu.bayern.de/abfall/schadstoffratgeber_gebaeuderueckbau/suchregister/index.htm

Table 2 – National estimates on PCBs (tonnes)

Country	Building Sector Materials	Open Applications
Belgium	-	4,000 (250 still in use 1999)
Finland	130 -270[59]	350
Denmark	75 (building caulks)	-
Germany	2,200 (sealants)	24,000[33] (2,350 still in use 1998)
Norway	200	340
Sweden	70-190 (in caulking materials)	-
UK	500 (sealants) [60]	25,500

The data presented in Table 2 are 'best estimates' and will have been calculated using varying assumptions. For example, in Germany it was assumed that an estimated 20,000 tonnes of sealants were used in the construction sector and with contaminant data from sampled material this would correspond to 11% or 2,200 tonnes of PCBs used in sealants[61].

In Sweden, approximately 70-190 tonnes of PCBs are estimated to have been used in caulking material[62] and the total use of PCBs in sealants and flooring material is estimated to account for 15-20% of the total use of PCBs in the country[63].

In Denmark, it was estimated in 2002 that 75 tonnes of PCB remained present in building caulks[64]. More recently, it was reported that 37% of the total Danish housing stock was constructed in the period when PCBs were used in building materials[65]. According to the same report, mapping of PCBs in buildings indicated that 10% of all Danish buildings have materials such as caulking, sealants and paints with PCB concentrations exceeding 5,000 ppm.

UNEP also reports the findings of an inventory of PCBs in buildings in Norway[66]. According to the inventory, approximately 345 tonnes of PCB were estimated to remain in open applications in the

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[59] Priha, E., S. Hellman, and J. Sorvari, PCB contamination from polysulphide sealants in residential areas exposure and risk assessment. Chemosphere, 2005. 59(4): pp. 537-543

[60] ENDS, Research highlights PCB exposure from building sealants. Environmental Data Services (ENDS) Report, 2002. 335: p. 6.

[61] OSPAR Commission. (2001, 2004 update). Polychlorinated Biphenyls (PCBs). ISBN 0946956782.

[62] Naturvårdsverket (Swedish EPA) (1997). PCB i fogmassor, stort eller litet problem?, p.14

[63] IARC Monographs (2013)

[64] Wilkins, K., et al., Detection of indoor PCB contamination by thermal desorption of dust. A rapid screening method? Environ Sci Pollut Res Int, 2002. 9(3): pp. 166-8.

[65] Bräuner, E., Andersen, Z., Frederiksen, M. *et al.* Health Effects of PCBs in Residences and Schools (HESPERUS): PCB – health Cohort Profile. *Sci Rep* **6,** 24571 (2016), p.1

[66] Andersson, M., R.T. Ottesen, and T. Volden, Building materials as a source of PCB pollution in Bergen, Norway. Science of The Total Environment, 2004. 325(1-3): p. 139-144

building sector. The applications identified included plaster (85 tonnes), glue in double-glazed windows (200 tonnes), joint sealants (50 tonnes) and paint (10 tonnes).

4.4.1 PCBs in Building Materials - Ireland

In the absence of Irish sectoral knowledge on the historic use of PCBs, the estimates derived for the European countries above have been considered broadly in population terms to approximate the likely usage of PCBs in the Irish building sector assuming some degree of equivalence between usage in Ireland and these countries.

It is acknowledged that the prevalence and usage of PCB-containing materials in buildings is likely to have differed significantly between countries owing to a wide range of factors, including but not limited to:

- Rate of population growth
- Economic conditions
- Settlement patterns e.g. urban versus rural development
- Degree of industrialisation
- Construction methods and selection of building materials
- Proximity to manufacturing centres of PCB-containing material
- Market penetration of producers of PCB-containing materials etc.

Therefore, any comparison with usage in other countries only allows for a very broad and generalised approximation of the likely range of quantities of PCBs which are likely to have been utilised in the Irish building sector.

The Swiss case study highlights the prevalence of PCBs in buildings constructed between 1955 and 1983. In Sweden, experience has shown that sealants containing PCBs were used in buildings constructed between 1956 and 1973, though mainly during the period from 1965 to 1972. The period of concern therefore for open application of PCB-containing materials in buildings would appear generally to be from the late 1950s to the early 1980s.

Given that the estimates available for country-specific usage relate directly to this period, the estimated quantities of PCB have been considered in population terms (tonnes PCB per million population) based on population data for 1983[67]

[67] Population statistics from UN Department of Economic and Social Affairs, World Urbanization Prospects 2018 Database (https://population.un.org/wup/DataQuery/)

Table 3 – National estimates on PCBs in building materials by material type (tonnes)

Country	Estimated Quantity of PCBs in Building Materials (tonnes)	Building Material Types	Population (million, 1983)	Tonnes PCB per million population, (approx.) - 1983
Norway	345	Plaster, glue in double glazed windows, sealants, paints	4.125	84
Finland	130-270	Sealants	4.862	27-56
Germany	2,200	Sealants	77.79	28
Switzerland	50-150	Sealants	3.377	8-24
Sweden	70-190	Sealant / caulk	8.332	8-23
Denmark	75	Building caulks	5.12	15
UK	500	Sealants	56.331	9

As shown in Table 3, there is a wide variation in the estimated ranges of PCB containing materials in buildings across the European countries reported.

For the countries listed, the lowest estimated usage of PCBs in building materials (for the reference year 1983) was approximately 8 tonnes per million population (Switzerland and Sweden). Assuming a similar degree of application per unit of population in Ireland[68], this would equate to approximately 28 tonnes of PCBs.

The Norwegian inventory identifies the highest estimated quantity of PCBs when expressed per million of population (84). It is noted this inventory captured a broader range of material types including paints, plaster, glue in double glazed windows and sealants whereas the other country estimates are generally based on sealants only. Assuming a similar level of application in Ireland, this would equate to approx. 297 tonnes of PCBs.

Excluding Norway, the remaining country estimates are more comparable in their focus on ‘sealant’ materials and the next highest estimate after Norway arises in the case of Finland. Based on the upper end of the estimated range, approx. 56 tonnes of PCB per million population were used in building sealants in Finland. This would equate to approx. 198 tonnes for Ireland, again assuming a similar level of application per unit of population.

In summary, using available country estimates for PCBs in building materials, and assuming similar levels of usage of PCB-containing materials per unit of population across the European building sector, the likely quantities of PCB in buildings in Ireland may be broadly approximated in the range of 28-297 tonnes. As described previously, this approximation relies on several assumptions in the absence of reliable data for the historic usage of PCBs in open applications.

[68] Population of Ireland in 1983 = 3.532 million. It is noted that a similar exercise completed using population data for the previous decade (1972) does not result in a significant difference in the estimated quantities of PCBs per million population.

As Ireland was generally less well developed in economic and industrial terms by comparison with many European countries during the period of interest (1955-1983), it is considered likely that overall construction activity was lower in Ireland. It follows that the use of construction materials generally was also most likely lower when compared with most developed European countries. Therefore, the lower end of the above range is considered more likely to apply when approximating usage of PCBs in Irish buildings.

4.4.2 Irish Building Stock

In considering the share and types of buildings which may be of interest for further investigation regarding PCB-containing materials, a preliminary and high-level review of publicly available information on the Irish building stock is included below.

Residential

Historical data on house building in Ireland is published by the Housing Agency[69]. For the late 20th century, the number of new dwellings completed annually has been compiled from 1960 onward. This includes both private and local authority / social housing. House building data is aggregated per decade prior to 1960.

Table 4 – New dwelling completions in Ireland (1955-1983)

Period	New Dwellings Completed
1955-1959	50,964 (estimate)
1960-1969	113,604
1970-1979	248,928
1980-1983	117,564
Total (1955-1983)	**531,060**

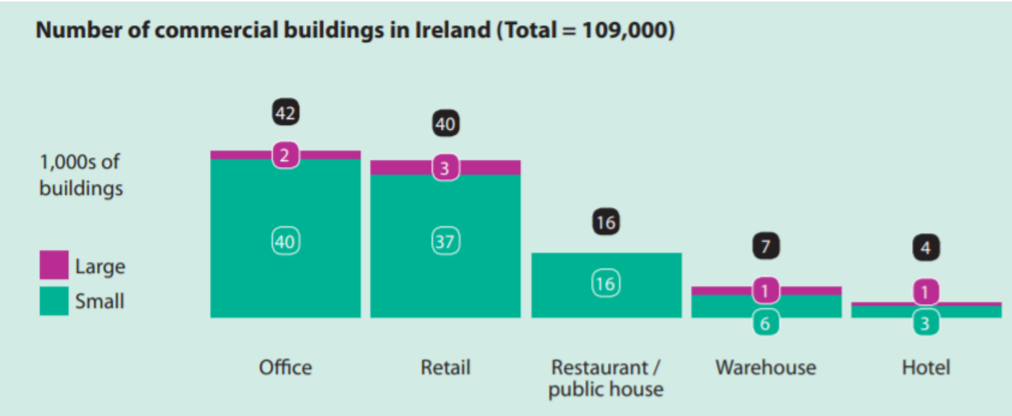
The Census of 2016 identified a total of 2,003,645 houses and apartments in the State[70]. Assuming all dwellings identified as completed during the period 1955-1983 remain in place (i.e. excluding demolition and/or significant renovation), this would account for approximately 26% of the total housing stock which may be of interest for further investigation regarding use of PCBs in building materials.

69 http://www.housingagency.ie/data-hub/house-building-historical-data
70 https://www.cso.ie/en/releasesandpublications/ep/p-cp1hii/cp1hii/hs/

Commercial & Public Sector

In 2015, a detailed review of the commercial building stock in Ireland was carried out by the Sustainable Energy Authority of Ireland (SEAI)[71]. This estimated the total number of commercial buildings in Ireland to be around 109,000.

Figure 1 – Number of commercial buildings in Ireland



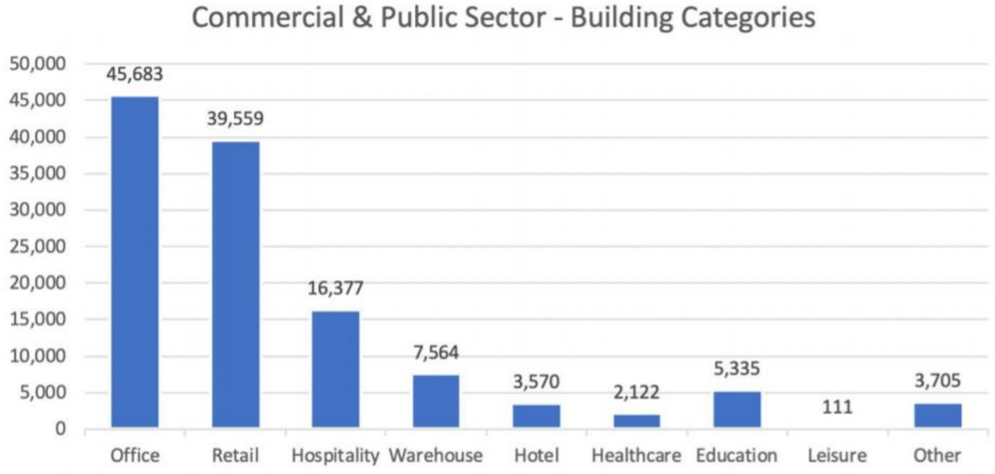
This SEAI study includes a breakdown of commercial properties into five main types as shown in Figure 1. Office and retail account for approximately 75% of the overall number of commercial buildings. The SEAI review placed commercial buildings in four age bands (i.e. pre-1919, 1919-1992, 1992-2006 and post 2006). Other studies or information sources may identify a more detailed breakdown of commercial properties by building age however it is understood that such data has not been aggregated.

The SEAI study of commercial premises also informed the recent *'Long-Term Renovation Strategy for Ireland'* published by the government in 2020. This Strategy categorised commercial and public sector buildings together. It was identified that there are an estimated 124,000 buildings in the commercial and public sector in total in Ireland, with 15,000 of these being in the public sector.

A breakdown of commercial and public sector buildings by building category is shown in Figure 2.

[71] Extensive survey of the commercial buildings stock in the Republic of Ireland, SEAI, November 2015

Figure 2 – Breakdown of commercial and public buildings in Ireland



In 2014, the then Department of Communications, Energy and Natural Resources published Ireland's first National Renovation Strategy *"Better Buildings – A National Renovation Strategy for Ireland"*. This was a forerunner to the current Long-Term Renovation Strategy for Ireland of 2020. The 2014 strategy document identified that there were 10,000 public sector buildings in Ireland comprising approximately. 5,000 education facilities, 3,000 offices and 2,000 health care facilities.

Industrial

No information on the total number of industrial premises in Ireland was identified during the course of this review. If not available by alternative means, further investigation of the number and age of industrial premises nationally may be possible by means of a review of EPA licensed facilities, COMAH facilities subject to regulation by the HSA and facilities holding Section 4 / Section 16 discharge licences.

4.4.3 Review of Environmental Samples - GSI Report

A review of the GSI report of 2012 was carried out for comparative purposes. In summary, it is noted that:

- PCBs were detected in 14 out of 194 soil samples analysed
- The analytical laboratory used for PCB analysis was the Swedish laboratory Synlab (formerly Alcontrol). The analytical method quantified seven individual congeners (ΣPCB7) in soils or sediments with a detection limit of 0.003 mg/kg dry weight (DW) for the individual congeners
- The (rather high) detection limit is reflective of the use of this methodology as an efficient and cost-effective tool used in countries such as Sweden for checking compliance with Swedish soil guideline values (0.008 mg/kg DW for sensitive land use)

It was reported that out of seven analysed congeners, the highly chlorinated congeners (138, 153 and 180) dominated in four of the 14 samples. These highly chlorinated congeners were in a range of 1-3 times over the detection limit for approximately 80% of the samples analysed. Where lower chlorinated congeners were not detected, this may be a result of too high a LOD. In the GSI report, where less chlorinated PCBs were not detected, this was interpreted as an of absence of “recently active sources”. A comparison of these GSI report results was carried out with a scientific publication investigating the variability of PCBs in urban soils in five European cities[72]. In that study 19 congeners where quantified with a detection limit ranging from 0.00003-0.00007 mg/kg DW.

As discussed earlier, the seven PCB congeners included in ΣPCB7 analytical methodology are not indicative of particular technical blends but represent a rather simple way of screening for PCB contamination. This method however is not considered suitable for analysing soil samples in order to draw conclusions on the possible sources of PCB contamination as:

- *The method detection limit is too high.* When analysing background levels, an inappropriately high limit of detection is likely to result in congeners which are present not being detected
- *The method accuracy might be problematic*. The uncertainty in quantification of individual congeners is up to 40% for levels close to the Limit of Detection (LOD)[73]. This is not problematic when evaluating total sum of PCBs for compliance with relevant limit values but the same uncertainty is problematic if trying to interpret relative abundance of PCB congeners in the sample
- *The method measures seven unspecific congeners*. These were all present in the original technical blends for Aroclor 1242, Aroclor 1254 and Aroclor 1260[74] and therefore cannot be attributed to any particular PCB source with confidence.

To generate a PCB profile from an environmental sample the analytical method must generate sufficient data (precise concentrations of many congeners) so interference or masking of the results does not occur by naturally occurring processes such as:

- *Accumulation of more chlorinated congeners*. This can occur if the less chlorinated and more water-soluble congeners are leaching to deeper layers below the sampling point
- *Transformation of higher chlorinated PCBs to less chlorinated.* PCBs do not fully degrade in the environment. During biodegradation and photochemical degradation, chlorine configurations change, creating new chemical compounds not necessarily present in the original technical blend.

[72] Cachada et al. (2009). The variability of polychlorinated biphenyls levels in urban soils from five European cities. Environmental Pollution 157 (2009) 511–518.
[73] Personal communication with Synlab Laboratories
[74] Schulz, D., et al (1989). Commercial Aroclor and Clophen mixtures by multimimensional gas chromatography

5 Knowledge Gaps

5.1 Irish Stakeholder Experience / Knowledge

As described in Section 4.1.4, there appears to be limited or no knowledge surviving within Irish supplier / manufacturing companies on the usage of PCB-containing materials. This is attributed to the historic nature of the use of PCB-containing materials and the loss of relevant knowledge of experienced personnel over time through retirement and changes in processes/materials. With the EU ban on the use of PCBs as a raw material or chemical intermediate in 1985 (and further to more general restriction on their use globally since the 1970s), it is now over 30 years since PCB-containing materials were legally traded.

Prior to the widespread use of computer systems and electronic records, company records for the period are generally limited or no longer maintained. As such, any surviving knowledge is most likely limited to anecdotal accounts of retired personnel.

In the course of consultation with a former window manufacturer, it was noted that long serving employees (some with 30+ years of company experience) were sought out however, no relevant knowledge remained.

5.2 Awareness

As identified by UNEP, awareness of PCBs in open applications (and the associated environmental risk) is generally very low. Unlike PCBs in closed systems (e.g. transformers, capacitors etc.), the continued presence of PCBs due to historic use in open applications is largely unregulated. Only a small number of countries (such as Sweden and Switzerland) have taken significant steps to control and remove PCB-containing materials in open applications.

As the presence of PCBs in legacy building materials is unlikely to be widely understood, PCB wastes from uses in open applications are unlikely to be recognised as hazardous waste at the time of disposal. Where waste containing PCBs is inappropriately treated, this provides a pathway for release of PCBs into the environment at the end-of-life stage. As buildings from the period of use (approx. 1950-80s) are renovated, demolished or replaced over time, there is potential for greater dispersion of PCBs into the wider environment.

5.3 Sampling & Analysis

In the countries of Scandinavia and Switzerland, which are viewed as having the most comprehensive strategies for management of PCBs in open applications, a number of studies and investigations have been completed to sample and analyse room air, dust and building materials for the presence of PCBs. While the objectives and approach in each country may have differed, the knowledge, understanding and subsequent remediation of PCBs in open applications has been significantly advanced by targeted sampling and laboratory analysis.

The absence of similar studies / monitoring programmes for PCBs in open application is common among most EU Member States. This was recognised in a report prepared for the European

Commission relating to the performance of selected Member States in the area of hazardous waste management[75]:

> *“Monitoring programmes need to be implemented and expanded to identify potential open sources of PCB, which would allow targeting them more efficiently.”*

5.4 Other Applications (Non-Building)

While it is noted within UNEP’s guidance that the *“large share”* of PCBs in open applications relates to use in buildings and other construction, there are other known open applications for which limited data exists. These include:

- Plasticisers (commonly used in plastic and rubber products)
- Lamination and impregnating agents
- Dedusting agents
- Immersion oils
- Conveyor belts and other rubber products

While paints containing PCBs are most likely to be found in buildings, other more specialised applications of paint may require further consideration including ships, military vehicles and items of plant/equipment used in heavy industry.

UNEP has also identified the following open applications of PCBs, which are considered minor or not well documented:

- Insulation (in wool felt, foam rubber and fiberglass)
- Cast waxes (filler/extender for investment casting waxes)
- Polymerization catalyst (chemical industry)
- Carrier for insecticides and bactericides
- Pesticide extenders (to dilute and/or extend the life of the active substances).

No further knowledge or information on these applications was observed during the course of this review.

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[75] BiPRO, Support to selected Member States in improving hazardous waste management based on assessment of Member States' performance – Final Report, December 2017, p.119

6 Recommendations

Based on the review of available information for the purposes of this study, very limited data exists for PCB-containing materials used in open applications in Ireland. The relevant knowledge and experience of these materials is likely to have been lost over time since the ban on PCBs was formally imposed across the EU in 1985. This is consistent with many other European countries.

Internationally, the predominant use of PCBs in open applications is known to be in building materials (or more broadly use in the building / engineering sector). Other open applications are generally understood to be far more limited and specialised in nature. A number of recommendations are set out below which may help to increase awareness and support future management and control of PCBs in open applications in Ireland.

6.1 Recommendation 1 – Pilot Programme of Sampling & Analysis

A pilot programme of sampling and analysis of PCBs in building materials is recommended to better understand the extent and period of usage of PCB-containing materials in open applications in Ireland.

The Swedish building inventory approach has successfully targeted PCB in open applications by focusing on application (e.g. building sealants) and period of use (mid-1950s to early 1970s), rather than known product names or knowledge of PCB profiles per product / product type.

This approach is generally endorsed by UNEP in its guidance of 2019, *"It should be noted that a detection of PCB in open applications is only possible if the (building) material is sampled and analysed in a laboratory. The recording of data of buildings, facilities, objects and materials with PCB in open applications after their identification would minimize the risks of inexpert treatment, non-environmentally sound management and disposal and therefore minimize the impact on the environment and the human health."*

Similar to the Swedish approach, sampling could be focused on sealant materials and flooring compounds. The presence of any double-glazed windows dating from the mid-1980s or earlier should also be surveyed. Where present, information should be sought on the manufacturer/supplier (if available).

Subject to availability of resources, a pilot programme could be developed with a focus on properties dating from the period of the mid-1950s to the mid-1980s. This period takes account of the timing of peak production and usage of PCBs globally, the timing of the ban on PCBs and the results of building sample analysis in other countries described in this report (e.g. Sweden, Switzerland). Similar to the Swedish approach, inventories for the buildings sampled could be prepared to inform the future Irish regulatory approach to PCBs in open applications.

Buildings owned by public bodies are likely to be the most accessible source of building material samples and would provide access to a range of different building types in different age bands e.g. local authority housing, public office buildings, educational facilities, hospitals / healthcare facilities.

Other areas of interest for sampling and analysis of materials would include industrial facilities, shipping and infrastructure (e.g. bridges, pipelines) where anti-corrosion paints and coatings containing PCBs may have been applied. However, these comprise unoccupied facilities and while relevant for environmental risk profiling, would be of a lower risk (in human exposure terms) compared to buildings.

The benefits of such a pilot programme would include:

- Verification of the use of PCB-containing materials in Irish buildings and construction and confirmation whether or not this is consistent with other European countries (or if any significant differences arise)
- Greater understanding of the period of usage of PCB-containing materials in open applications in Ireland
- Additional data on the extent and likely quantities of PCB-containing materials present in buildings
- Identification of any 'hotspots' by building type or age
- Scalability – the pilot programme could be initiated on a small number of samples (at relatively low cost) and progressively increased or refined in scope
- Increased focus on the largest use of PCBs in open applications identified internationally.

Useful guidance documents are published online and readily available for material identification, sampling and assessment.

The programme of building material sample analysis could also be supported by monitoring and analysis of indoor air concentrations of PCBs to evaluate potential human exposure.

As an example of the benefit of such investigation, it is noted that the analysis of caulk and sealant samples in a number of Swiss public buildings and schools during 1999-2000 was followed by the establishment of a national task force in Switzerland to address the problem of PCBs in building materials on a national scale[76].

The availability of suitably experienced and accredited laboratory facilities within Ireland for the testing of building material samples is likely to require further review.

6.2 Recommendation 2 – Review of Building Stock

In order to better estimate the quantities of PCBs in open applications, a further review of the age of the building stock and major infrastructure in Ireland could be considered. In tandem with or subsequent to the analysis of representative buildings samples, this review would assist in estimating the number of buildings likely impacted by the presence of PCB-containing materials.

Further to the initial findings related to Ireland's building stock set out in Section 4.4.2, it is likely that better estimates can be made of the number of buildings, facilities and engineering structures dating to the period of interest for PCB use in Ireland (likely 1950s-1980s).

[76] Wagner, U., et al. (2013) Management of PCB from Open and Closed Applications – Case Study Switzerland, p.3

- **Residential:** Consultation with the CSO, Department of Housing, Heritage & Local Government, Housing Agency and/or local authorities may provide additional data on the number of dwellings and their associated age bands
- **Commercial:** In addition to the above bodies, consultation with the SEAI regarding their study of commercial properties in Ireland may identify additional information on the age profile of these buildings.
- **Industrial:** In addition to the above bodies, further information on industrial properties in Ireland may be available through EPA and HSA records, IDA Ireland and/or the Department of Enterprise, Trade and Employment
- **Public Sector:** Consultation with the OPW and estate management personnel within State bodies and facilities (e.g. HSE, universities etc.) may assist in the identification and/or quantification of facilities dating from the period of interest for use of PCBs in open applications.
- **Large Infrastructure:** Bridges and pipelines are among the other likely engineering structures where PCBs were used in paints/coatings. Consultation with local authorities and Gas Networks Ireland (GNI) may assist in the further review of these structures.
- **Cables/Cable sheaths:** PCBs were added to cable sheaths as flame retardants, plasticisers and impregnating agents in lead cables. Consultation with ESB Networks may assist in the further review of electrical cables.

6.3 Recommendation 3 – Awareness & Guidance

A programme of awareness and/or training should be considered to further increase the understanding of PCBs in open applications generally among property owners (public and private). The findings from pilot sampling and analysis of materials in buildings (Recommendation 1) are likely to better inform any awareness raising programme and supporting materials.

Information or fact sheets may be prepared to highlight the environmental and human health risks associated with PCBs in open applications, buildings likely to be affected and measures that can be taken to reduce or minimise this risk. This information should be of a more general and non-technical nature for the general public and property owners. More technical information / guidance documents may be appropriate for the construction, engineering and waste management sectors. Similar guidance has been prepared in other countries (e.g. Sweden).

Given the increasing focus on climate change, energy consumption, the energy performance of buildings and improved building standards, many buildings dating from the period of interest for PCBs (1950s-1980s) are likely to be subject to renovation in future years, if not already. Specific guidance documents or similar materials may be required to inform the proper management of materials and waste arising from such building renovations.

Separate awareness raising measures are likely to be required for personnel within regulatory authorities e.g. local authorities (Environmental and Planning Departments), EPA and HSA. However, further consideration of the wider framework for management of PCBs in open applications is likely to be required prior to this (Recommendation 4).

6.4 Recommendation 4 – Framework for Management of PCBs in Open Applications

At present, there is no EU or national legislative instrument in Ireland explicitly for the management of PCB-containing materials in open applications, at least until such time as a PCB-containing material becomes waste (i.e. the holder of the material discards, intends or is required to discard such material).

For instance, the owner of an older building which may have sealants, window or flooring materials containing PCBs is not bound by any explicit regulation to remove these materials at a future point in time. If and when the building is demolished or refurbished, there is no legislative provision setting requirements specific to the management of any PCB-containing materials. Theoretically, PCBs in such open applications may remain in place indefinitely in the absence of targeted regulatory measures.

In practice, it may be reasonably expected that awareness of PCBs in open applications among the general public is low. This means that PCB-containing materials present within buildings are likely to remain in place indefinitely until a building is demolished or refurbished. At the time of any such demolition/refurbishment, it is also likely that PCB-containing waste materials would be inadvertently or unknowingly disposed of by means which may result in the release of PCBs to the wider environment (i.e. a manner that is not 'environmentally sound', as intended by the Stockholm Convention).

Significant further work in conjunction with the Department of Environment, Climate & Communications would be required to determine the appropriate legal framework for the comprehensive, consistent and proper management of PCBs in open applications. In advance of any such framework, it is considered that further investigation on the extent of PCBs in open applications in Ireland will be necessary.

Ahead of any legal framework, initial measures which may help to achieve a greater understanding of the occurrence of PCBs in open applications in Ireland are set out below. These measures are based on best practice applied in other countries and the consolidated guidance of UNEP published in 2019. Such measures may assist in developing a future legal framework.

1. Identification of PCBs in Open Applications

    - Pilot programme of sampling and analysis (Recommendation 1) to verify the extent and time period of PCB usage in open applications in Ireland

    - Based on the results of the pilot sampling programme, the time period of interest for PCBs in open applications specific to Ireland could be better defined

2. Development of guidance materials for construction and demolition (C&D) and waste sectors (Recommendation 3)

    - In addition to Recommendation 3 above, preliminary consultation with stakeholders in the waste and construction sectors (e.g. IWMA, CIF and their member companies) could be initiated to include discussion on current knowledge levels and knowledge gaps, possible options for future regulation / controls and the development of new or updated guidance documents e.g. *"Best Practice Guidelines on the Preparation of Waste Management Plans for Construction & Demolition Projects, June 2006".* It is understood this guidance document of 2006 is currently subject to revision and that revised Best Practice Guidelines for the Preparation of Resource and Waste Management Plans for Construction and Demolition Projects will be issued for public consultation. The consultation phase for the revised guidelines may provide a suitable opportunity to further review and strengthen guidance on PCB-containing materials in the building sector.

- Further to such preliminary consultation, a forum of relevant stakeholders could be organised to further consider and promote appropriate environmental measures for the management of PCBs in open applications in Ireland. Experience may be drawn from the previous work of the National Construction and Demolition Waste Council established in 2002. In Sweden, the Ecocycle Council of the Building Sector formed in the late 1990s consisted of representatives of 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.

- Given that the estimated quantities of PCBs in open applications are largely attributed to use in buildings, the regulatory framework in place for the management of Asbestos Containing Materials (ACMs) may help to inform the future regulation of PCBs in open applications. While there may be a different risk profile for human health and safety, asbestos is a legacy building material that was widely used in older buildings, requires specialised handling and has specific requirements for the treatment of associated waste materials. Section 5 of the HSA guidelines on ACMs in the workplace[77] provides a useful summary of the legal requirements for working with materials containing asbestos.

3. Review availability and capacity of appropriate service providers in Ireland and neighbouring countries to support the identification and investigation of PCB-containing materials. Such service providers would include:

    - Suitably accredited laboratory facilities for the analysis of PCBs in solid materials

    - Suitably authorised waste haulier and treatment facilities for the transport and recovery or disposal of waste materials containing PCBs

    - Trained / specialist personnel for the proper handling, removal and disposal of waste materials (e.g. from buildings) containing PCBs. In the absence of experience specifically related to PCBs, specialist companies experienced in the management of other hazardous materials (e.g. asbestos) may initially be best equipped for the safe and proper management of waste containing PCBs.

4. Consultation with the HSA regarding the health impact associated with the management of PCBs in open applications

    - The establishment or review of occupational exposure limits, to ensure the protection of those working in buildings who may be exposed to PCBs present in indoor air

    - Review of the requirements for monitoring of room air in buildings with PCB-containing materials

[77] https://www.hsa.ie/eng/Publications_and_Forms/Publications/Chemical_and_Hazardous_Substances/Asbestos_Guidelines.pdf

- Review of the legislative provisions and controls in place for other hazardous building materials, such as asbestos (e.g. Safety, Health and Welfare at Work (Exposure to Asbestos) Regulations 2006 and 2010).

Examples of existing frameworks for the management of PCBs in open applications identified in other European countries are further described in Section 4.3.4. These examples are likely to provide a useful starting point for any future framework in Ireland.

Finally, it is noted that any future framework should be aligned with the latest decisions of the Conference of the Parties (COP) to the Stockholm Convention. The most recent meeting of the COP to the Stockholm Convention (SC COP-9) was held in Geneva, Switzerland from 29 April to 10 May 2019. For reference, the outcomes from this meeting relevant to PCBs in open applications are summarised in Appendix E. The next meeting of the COP is scheduled for July 2021.

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Appendix A – List of PCB-Containing Products used in Open Applications

Appendix A
PCB CONTAINING PRODUCT TYPES AND PRODUCTS USED IN OPEN APPLICATIONS

As identified mainly through review of Swedish experiences from building sector stakeholder group (Ecocycle Council) and from international reports and peer review papers.

GENERAL INFORMATION ON PRODUCT TYPES

Application (overall)	Application (detailed)	Reported years of usage	Reported peak years of usage	Comments	Product type marketed within Ireland?	Supplementary Reference - see Appendix D
Sealants	Predominantly used in building exterior: between facade elements, in dilation joints (moving joints, connecting joints around windows, doors and the like). Also indoors as joint seals for example in entrances and stairwells.	1956-1973	1965-1972	Only in elastic polysulphide sealants, not in polyurethane and silicone sealants. Not all polysulphide sealants contain PCBs. Significant source of current emissions according to estimations in Germany and Switzerland.	Consultation with manufacturer and supplier representatives in Ireland identified no surviving knowledge, records or experience specific to sealants. Information sourced for other European countries indicates that PCBs are likely to have been present in certain sealant products used in Ireland.	1
Sealed window units	Seal between the two windowpanes in insulating windows primarily used in public buildings, ofice blocks etc.	1956-1973*		* until 1980 in windows imported to Sweden	Consultation with manufacturer and supplier representatives in Ireland, including a glass and window manufacturer, yielded no surviving knowledge, records or experience specific to sealed window units. Information sourced for other European countries indicates that PCBs may have been present in certain sealed window units, where installed in Ireland.	1
Flooring compounds	Plastic-based flooring compounds for seamless floors, non-slip floors	1956-1973	1965-1973	Historical use in Sweden centred on a single brand 'Acrydur' used for most floors of this type laid from the mid-1960s. The binder in the floor covering contained approx. 20% PCBs.	Based on consultation with an Irish agent company (FloorTech) for a competing flooring compound brand 'Silikal', Silikal products were stated as being free of PCB according to available company knowledge and experience. Beyond the Silikal brand, it was identified that such flooring products were manufactured over an extended period of time, with some products and brands previously containing PCBs likely to have been PCB-free subsequently.	

As identified mainly through review of Swedish experiences from building sector stakeholder group (Ecocycle Council) and from international reports and peer review papers.

GENERAL INFORMATION ON PRODUCT TYPES

Application (overall)	Application (detailed)	Reported years of usage	Reported peak years of usage	Comments	Product type marketed within Ireland?	Supplementary Reference - see Appendix D
Paints and coatings	Plasticiser in paints especially for corrosive environments and used widely to coat water tanks, bridges and other infrastructure pieces. Also in anti-corrosive coatings on transformers and machinery.	1947-1970s			Consultation with manufacturer and supplier representatives in Ireland yielded no surviving knowledge, records or experience specific to paints and coatings related to PCBs. Information sourced for other European countries indicates that PCBs may have been present in paints products used or manufactured in Ireland.	
Carbonless copy paper	Papermills using recycled paper which may have included carbonless copy paper	-1972		If conducting a sampling or survey, this would be targetted at environmental sampling (sediments) and not of the actual open application per se.	Refer to Section 4.3.3 of main report.	11

DETAILED INFORMATION ON PRODUCTS AND PRODUCT TYPES

Application	Application detail	Product name	Manufacturer	Reported years of usage	Reported peak years of usage (Sweden)	Supplementary Reference - see Appendix D	Comments
Building material	Roofing and siding material	Galbestos	H. H.Robertson Company, USA	1950-1970		21	Main PCB compound was Aroclor 1268.
Building material	Ceiling tiles	Travertone Sanserra, Santaglio, Embossed Design	Armstrong, USA	1967-1970		21	Ceiling tiles with 4–12% Aroclor 1254 in the coating in 1969–1970 (MMWR 1987)
Concrete	PCC (Polymer composite cement)		Belgium		1960-1969	7	
Flooring compounds	Plastic-based flooring compounds for seamless floors, non-slip floors	Acrydur	Degussa, Germany	1956-1973	1965-1973	1, 26	The Acrydur brand is still used today, so its identification does not necessarily confirm the use of a PCB-containing material. Acrydur was imported to Sweden via Ulfcar AB.
Flooring compounds	Plastic-based flooring compounds for seamless floors, non-slip floors	Silikal	Rohm and Haas, Germany	-1972		26	E-mail response from Silikal through consultation with Irish company FloorTech (an agent of Silikal) stated that Silikal products were PCB free.
Flooring compounds	Wood floor finishes	Fabulon	Halowax, USA			11	
Lubricant	Aircrafts	Castrol 3 C				23	Contained 1% Aroclor
Paint	Latex paint		Belgium		-1963	7	
Paint	Vinyl chloride paint		Belgium		-1973	7	
Paint	Chlorinated rubber paint		Belgium		-1973	7	
Paint*	Colouring agents/pigments produced for paints and printing inks			2006; 2011-2015		16, 14	Small quantities inadvertently generated during the production of certain pigments such as diarylides or azo pigments
Sealant		Thiokol	Germany			7	Polysulphide polymer produced in Germany
Sealant		Lasto-meric	Ljungdahls Färgfabrik, Sweden			3, 25	One of three larger producers in Sweden, earliest producer, company name leter changed to Göta kemi, manufacturer by license from Tremco in USA
Sealant		Bostik-vulkseal	Bostik, Sweden			3, 25	One of three larger producers in Sweden
Sealant		Tio-tät	Skandinavisk byggkemi/Nordsjöfärg, Sweden			3, 25	One of three larger producers in Sweden
Sealant		Trebofog	Trelleborgs gummifabrik/Trelleborg AB, Sweden			3	
Sealant		Weatherban	3M			3	
Sealant		PRC (with different product type numbers)	Product Research Company, PRC			3	
Sealant/coating	To ensure proper curing of concrete	Cumar, Kumar	USA	1941-1970		21, 11	Commonly used in grain farm silos in the US, "Kumar" introduced in Michigan in 1941 (ref 11)
Sealant/mastic		Thiokol	Belgium		-1973	7	
Sealed window units			Artic	1973-1974		2	
Sealed window units			Br. Bøckmann	1970-1974		2	
Sealed window units			Cudo	1959-		2	
Sealed window units			Drammen	1967-1974		2	
Sealed window units			Emmaboda Glasverk, Sweden	1965-1973		2	
Sealed window units			Frivaterm	1970-1974		2	
Sealed window units			Gurus/Duotherm	1953-1973		2	
Sealed window units			Hole Isoler	1972-1974		2	
Sealed window units			Li-therm	1972-1974		2	
Sealed window units			Masterpane	1968-1974		2	
Sealed window units			Multipane	1958-		2	
Sealed window units			Nordtermo/Astral	1969-1972		2	
Sealed window units			Nor-dan	1970-1974		2	
Sealed window units			Norsk Isoler, Norway	1973-1974		2	
Sealed window units			Norsk Isoler (HRI), Norway	1970-1974		2	
Sealed window units			Norsk Isolerglass, Norway	1970-1974		2	
Sealed window units			Paulssons Glas			2	
Sealed window units			Raufoss, Norway			2	
Sealed window units			Riis Isoler	1973-1974		2	
Sealed window units			Sanko Isoler	1974		2	
Sealed window units			Scanglas, Sweden	1961-1973		2	
Sealed window units			Scanglas, Denmark	1969-1971		2	
Sealed window units			Scandiglass, Norway	1972-1974		2	
Sealed window units			Swisstermo	1968-1972		2	
Sealed window units			Termonor	1973-1974		2	
Sealed window units			Østlandske	1970-1974		2	
Sealed window units			Polarpane	1968		2	
Sealed window units			Solarpane	1968		2	

* This is the only result from search in product registries of the Nordic countries (SPIN database) and the Swiss product register.

Appendix B – Trade Names of PCB

The list of trade names overleaf was identified by UNEP for the various applications of PCB (both closed and open) as part of its guidance document *"Consolidated Guidance on PCB in Open Applications"* of March 2019.

Where indicated in parentheses, the letter **t** denotes use in transformers. The letter **c** denotes use in capacitors.

Abestol (t, c)

Abuntol (USA)

Aceclor (t) (France, Belgium)

Acooclor (Belgium)

Adkarel

ALC

Apirolia (t, c)

Apirolio (t, c)

Areclor (t)

Arochlor (t, c)

Aroclor (t, c) (USA)

Aroclor 1016 (t, c)

Aroclor 1221 (t, c)

Aroclor 1232 (t, c)

Aroclor 1242 (t, c)

Aroclor 1254 (t, c)

Aroclor 1260 (t, c)

Aroclor 1262 (t, c)

Aroclor 1268 (t, c)

Arubren

Asbestol (t, c)

ASK

Askarel (t, c)

Auxol (USA)

Bakola

Bakola 131 (t, c)

Bakolo (6) (USA)

Blacol (Germany)

Biclor (c)

Biphenyl

Chloretol

Chlorfin

Chlorextol (t)

Chlorinated biphenyl

Chlorinated Diphenyl

Chlorinol (USA)

Chlorintol (USA)

Chlorobiphenyl

Chlorodiphenyl

Chloroecxtol (USA)

Chlorofen (Poland)

Chlorphen

Chorextol

Chorinol

Clophen / Clophenharz (t, c) (Germany)

Clophen Apirorlio

Clophen-A30

Clophen-A50

Clophen-A60

Cloresil

Clorinal

Clorinol

Clorphen (t)

Crophene (Germany)

Delor (Slovakia)

Delorene

Delor (Czech Republic

Delorit

Delotherm DK/DH (Slovakia)

DI 3,4,5,6,5

Diachlor (t,c)

Diaclor (t, c)

Diaconal

Dialor (c)

Diarol

Dicolor

Diconal

Disconon (c)

Dk (t, c) (decachlorodiphenyl)

Dl(a)conal

DP 3, 4, 5, 6.5

Ducanol

Duconal (Great Britain)

Duconol (c)

Dykanol (t, c) (USA)

Dyknol (USA)

E(d)ucaral (USA)

Educarel

EEC-18

EEC-IS (USA)

Elaol (Germany)

Electrophenyl (France)

Electrophenyl T-60

Elemex (t, c) (USA)

Elexem (USA)

Elinol

Eucarel (USA)

Euracel

Fenchlor (Italy)

Fenclor 42, 54, 70 (t, c) (Italy)

Fenocloro

Gilotherm

Hexol (Russian federation)

Hivar (c)

Hydelor

Hydol (t, c)

Hydrol

Hyrol

Hyvol

Hywol (Italy/USA)

Inclar (Italy)

Inclor (Italy)

Kanechlor (KC) (t, c) (Japan)

Kanechor

Kaneclor (t,c)

Kaneclor 400

Kaneclor 500

Keneclor

Kennechlor

Leromoli

Leromoll

Leronoll

Magvar

Man(e)c(h)lor (KC) 200,600

Manechlor (Nippon)

MCS 1489

Montar (USA)

Monter

Nepoli

Nepolin (USA)

Niren

No-Famol

NoFlamol

No-Flamol (t, c) (USA)

No-flanol (t,c) (USA)

Nonflammable liquid

Non-flammable liquid

Olex-sf-d

Orophen (Former East Germany)

PCB

Pheaoclor

Pheneclor

Phenochlor

Phenochlor DP6

Phenoclar DP6 (Germany)

Phenoclor (t, c) (France)

Phenoclor DP6 (France)

Phyralene (France)

Physalen

Plastivar (Great Britain)

Polychlorinated biphenyl

Polychlorinated diphenyl

Polychlorinated diphenyls

Polychlorobiphenyl

Polychlorodiphenyl

Prodelec

Pryoclar (Great Britain)

Pydraul (USA)

Pydraul 1 (USA)

Pydraul 11Y (USA)

Pyraclor

Pyralene (t, c) (France)

Pyralene 1460, 1500, 1501 (F)

Pyralene 3010, 3011 (France)

Pyralene T1, T2, T3 (France)

Pyramol (USA)

Pyranol (t, c) (USA)

Pyroclor

Pyronol

Pyroclar (Great Britain)

Pyroclor (t) (USA)

Pyromal (USA)

Pyronal (Great Britain)

Pysanol

Saf(e)-T-Kuhl (t, c) (USA)

Safe T America

Saft-Kuhl

Saf-T-Kohl

Saf-T-Kuhl

Sanlogol

Sant(h)osafe (Japan) Chlorobiphenyl

Sant(h)othera (Japan) Chlorodiphenyl

Sant(h)othern FR (Japan) Chloroecxtol (USA)

Santosol

Santoterm

Santotherm (Nippon)

Santothern

Santotherm FR

Santovac

Santovac 1

Santovac 2

Santovec (USA)

Santowax

Santvacki (USA)

Sat-T-America

Saut(h)otherm (Japan)

Siclonyl (c)

Solvol (t, c) (Russian Federation)

Sorol (Russian Federation)

Soval

Sovol (Russian Federation)

Sovtol (Russian Federation)

Tarnol (Poland)

Terpenylchlore (France)

Terphenychlore

Therainol FR (HT) (USA)

Therminal

Therminol (USA)

Therminol FR

Therpanylchlore (France)

Turbinol

Ugilec 141, 121, 21

Appendix C – PCB Congener Profiles

Appendix C

PCB PROFILES IN RAW TECNICAL BLENDS AND SOME SEALANT SAMPLES

PEER REVIEWED SCIENTIFIC PUBLICATIONS INVESTIGATING TECHNICAL BLENDS

Application (overall)	Manufacturer	Sample description	Country	Evaluation description	Technical blend	Supplementary Reference - see Appendix D	Comments
Capacitors, gas transmission turbines, rubber, adhesives	Monsanto	Technical blend, 1 lot analysed	USA	45 to 95 congeners quantified on 3 or 4 different chromatographic systems	Aroclor 1221	20	
Hydraulic fluids, rubber, adhesives	Monsanto	Technical blend, 2 different lots analysed	USA	45 to 95 congeners quantified on 3 or 4 different chromatographic systems	Aroclor 1232	20	
Capacitors, transformers	Monsanto	Technical blend, 2 different lots analysed	USA	45 to 95 congeners quantified on 3 or 4 different chromatographic systems	Aroclor 1016	20	
Capacitors, transformers, heat transfer, hydraulic fluids, gas transmission turbines, rubber, carbonless copy paper, adhesives, wax extenders	Monsanto	Technical blend, 3 different lots analysed	USA	45 to 95 congeners quantified on 3 or 4 different chromatographic systems	Aroclor 1242	20	
Heat transfer, hydraulic fluids, vacuum pumps, rubber, synthetic resins, adhesives	Monsanto	Technical blend, 2 different lots analysed	USA	45 to 95 congeners quantified on 3 or 4 different chromatographic systems	Aroclor 1248	20	Differences between the two lots
Capacitors, transformers, heat transfer, hydraulic fluids, vacuum pumps, rubber, synthetic resins, adhesives, wax extenders, caulk and joint sealants, insulation and other building materials, de-dusting agents, inks, cutting oils, wire and cable coatings, pesticide extenders	Monsanto	Technical blend, 2 different lots analysed	USA	45 to 95 congeners quantified on 3 or 4 different chromatographic systems	Aroclor 1254	20	Differences between the two lots
Transformers, hydraulic fluids, vacuum pumps, immersion oil for microscopes, synthetic resins, de-dusting agents, wire and cable coatings	Monsanto	Technical blend, 3 different lots analysed	USA	45 to 95 congeners quantified on 3 or 4 different chromatographic systems	Aroclor 1260	20	
Synthetic resins	Monsanto	Technical blend, 2 different lots analysed	USA	45 to 95 congeners quantified on 3 or 4 different chromatographic systems	Aroclor 1262	20	
Capacitors, transformers	Monsanto	Technical blend	USA	132 congeners identified in technical blends	Aroclor 1016	18	
Capacitors, turbines, rubber, adhesives	Monsanto	Technical blend	USA	132 congeners identified in technical blends	Aroclor 1221	18	Three monochlorobiphenyls constitute 50% of total. The common sum 7 PCBs
Capacitors, transformers, heat transfer, hydraulic fluids, gas transmission turbines, rubber, carbonless copy paper, adhesives, wax extenders	Monsanto	Technical blend	USA	132 congeners identified in technical blends	Aroclor 1242	18	Only 0.3 % heptachlorobiphenyls. The common sum 7 PCBs were all present.

PEER REVIEWED SCIENTIFIC PUBLICATIONS INVESTIGATING TECHNICAL BLENDS

Application (overall)	Manufacturer	Sample description	Country	Evaluation description	Technical blend	Supplementary Reference - see Appendix D	Comments
Capacitors, transformers, heat transfer, hydraulic fluids, vacuum pumps, rubber, synthetic resins, adhesives, wax extenders, caulk and joint sealants, insulation and other building materials, de-dusting agents, inks, cutting oils, wire and cable coatings, pesticide extenders	Monsanto	Technical blend	USA	132 congeners identified in technical blends	Aroclor 1254	18	No dichlorobiphenyls identified in this blend, only 1.2 % trichlorobiphenyls. The common sum 7 PCBs were all present.
Transformers, hydraulic fluids, vacuum pumps, immersion oil for microscopes, synthetic resins, de-dusting agents, wire and cable coatings	Monsanto	Technical blend	USA	132 congeners identified in technical blends	Aroclor 1260	18	The common sum 7 PCBs were all present.
No information found	Bayer	Technical blend	Germany	132 congeners identified in technical blends	Clophen A30	18	
No information found	Bayer	Technical blend	Germany	132 congeners identified in technical blends	Clophen A40	18	The common sum 7 PCBs were all present.
No information found	Bayer	Technical blend	Germany	132 congeners identified in technical blends	Clophen A50	18	The common sum 7 PCBs were all present.
No information found	Bayer	Technical blend	Germany	132 congeners identified in technical blends	Clophen A60	18	The common sum 7 PCBs were all present.
No information found	Kanegafuchi Chemical Co. Ltd	Technical blend and flue gas	Japan	~140 congeners quantified	Kanechlor KC300	27	Analysis of flue gas samples contained a greater number of congeners
No information found	Kanegafuchi Chemical Co. Ltd	Technical blend and flue gas	Japan	~140 congeners quantified	Kanechlor KC5400	27	Analysis of flue gas samples contained a greater number of congeners
No information found	Kanegafuchi Chemical Co. Ltd	Technical blend and flue gas	Japan	~140 congeners quantified	Kanechlor KC500	27	Analysis of flue gas samples contained a greater number of congeners
No information found	Kanegafuchi Chemical Co. Ltd	Technical blend and flue gas	Japan	~140 congeners quantified	Kanechlor KC600	27	Analysis of flue gas samples contained a greater number of congeners

Appendix C
PCB PROFILES IN RAW TECNICAL BLENDS AND SOME SEALANT SAMPLES

REPORTS OF PROFILING OF PRODUCT TYPES (SEALANTS)

Application (overall)	Manufacturer	Sample description	Country	Evaluation description	Technical blend	Supplementary Reference - see Appendix D	Comments
Sealant	Unknown	Indoor sealant	Sweden	Only analysis of the common sum 7 PCBs; comparison for similarity to 4 available technical blends (Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260)	Resembled Aroclor 1248	4	Resembled Aroclor 1248, pattern analysis was for more accurate quantification of sum 7 PCB, not for forensic purposes
Sealant	Unknown	Outdoor sealant between concrete	Sweden	Only analysis of the common sum 7 PCBs; comparison for similarity to 4 available technical blends (Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260)	Resembled Aroclor 1248	4	Resembled Aroclor 1248, pattern analysis was for more accurate quantification of sum 7 PCB, not for forensic purposes
Sealant	Unknown		Finland (assumed)			17	*"PCBs used in sealants have been mainly of Aroclor 1260 or Aroclor 1254 type"*, no access to original publication (Rantio et al., 2001)
Sealant	Unknown	Two rubbery samples of historical PCB-containing concrete joint material	USA	No trichlorobiphenyls		19	

Appendix D – Supplementary References

Refer to Appendices A and C

Ref No.	Supporting Reference
1	Naturvårdsverket (Swedish Environmental Protection Agency) (2019) Inventory and clearance of PCBs in buildings and facilities. Gunilla Bernevi Rex. Swedish Environmental Protection Agency. Report 6885.
2	Svensk Planglas-förening (Swedish Association of Glass Manufacturers) (2017) www.svenskplanglas.se
3	Miljöförvaltningen Stockholms Stad (1999) Inventering av fogmassor med PCB - handbok för fastighetsägare. Stockholm Municipality, handbook for real estate owners.
4	Naturvårdsverket (Swedish Environmental Protection Agency) (1997) PCB i fogmassor - stort eller litet problem? Jansson B, Sandberg J, Johansson N, Åstebro A. Rapport 4697.
5	IARC Monographs (2013) Polychlorinated Biphenyls and Polybrominated Biphenyls IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 107.
6	KEMI - Kemikalieinspektionen (Swedish Chemicals Agency) (1998) Förekomst av PCB och PCN i varor och kemiska produkter i Sverige - Kloruppdraget, underlagsrapport 5 PM Nr 18_94 Öberg T
7	OSPAR Commission (2001) Polychlorinated Biphenyls (PCBs), 2004 update. ISBN 0 946956 78 2.
8	Ifeu (1998) Investigation of emissions and abatement measures for persistent organic pollutants in the Federal Republic of Germany. UBA Texte 75/98.
9	ATSDR (2000) Federal Republic of Germany - U.S Department of health and human services - Agency for Toxic Substances and Disease Registry.
10	UNEP Chemicals (1999) Guidelines for the identification of PCBs and materials containing PCBs.
11	UNEP (2019) Consolidated Guidance on PCB in Open Applications. Secretariat of the Basel, Rotterdam and Stockholm conventions, United Nations Environment Programme, Geneva.
12	AMAP (2000) PCB in the Russian Federation: Inventory and proposals for priority remedial actions. Arctic Monitoring and Assessment Programme (AMAP) Report 2000:3
13	El-Saeid, M et al. (2017) Congener specific determination of polychlorinated biphenyls (PCBs) in human milk. Advances in Plants & Agriculture Research Volume 6 Issue 4, 2017.
14	Rodenburg, L. et al. (2015) Polychlorinated biphenyls in pigments: inadvertent production and environmental significanceColora. Technol., 131, 353–369, 2015.
15	Conolly, C.(2001) Speciation of the UK Polychlorinated Biphenyl emission Inventory. A report produced for Department for Environment, Food and Rural Affairs, the National Assembly for Wales, the Scottish Executive and the Department of the Environment in Northern Ireland.
16	SPIN (2020) SPIN Substances in preparations in Nordic countries
17	Kontsas, H. et al.(2004) Worker Exposure to Polychlorinated Biphenyls in Elastic Polysulphide Sealant Renovation Ann. occup. Hyg., Vol. 48, No. 1, pp. 51–55, 2004.
18	Schulz, D.E.(1989)Complete Characterization of Polychlorinated Biphenyl Congeners in Commercial Aroclor and Clophen Mixtures by Multldimenslonal Gas Chromatography-Electron Capture DetectionEnviron. Sci. Technol., Vol. 23, No. 7, 1989
19	Saba, T. and Boehm, P.D. (2011) Quantitative Polychlorinated Biphenyl (PCB) Congener and Homologue Profile Comparisons. Environmental Forensics, 12:134–142, 2011.

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Ref No.	Supporting Reference
20	Frame, G.M., Cochran, J.W., Bowadt, S.S. (1996) Complete PCB congener distributions for 17 Aroclor mixtures determined by 3 HRGC systems optimized for comprehensive quantitative, congener-specific analysis. J. High Reol. Chromatogr. Vol 19 1996. p 657.
21	Erickson MD, Kaley RG. (2011) Applications of polychlorinated biphenyls. Environ Sci Pollut Res. 2011; 18 (2):135–151.
22	BUWAL. (2000) Praxishilfe: PCB-Emissionen beim Korrosionsschutz. Bern, Switzerland: Bundesamt fur Umwelt, Wald und Landschaft.
23	BUWAL. (1994) Diffuse Quellen von PCB in der Schweiz. Schriftenreihe Umwelt Nr. 229. Bundesamt fur Umwelt, Wald und Landschaft.
24	Wagner, U.K et al. (2014) Management of PCBs from Open and Closed Applications – Case Study Switzerland
25	Håkan Forsberg (Plast och kemibranscherna). (2020) personal communication
26	Jarl Ringström (founder of Göta Kemi in 1975, prev. Ljungdahls Färgfabrik) (2020) personal communication
27	Kyoung Soo Kim, Yusuke Hirai, Mika Kato, Kouhei Urano, Shigeki Masunaga (2004) Detailed PCB congener patterns in incinerator flue gas and commercial PCB formulations (Kanechlor) Chemosphere 55[4] 539–553 (2004)

Appendix E – Review of SC COP-9 Meeting Outcomes (PCBs in Open Applications)

The Ninth Meeting of the Conference of the Parties (COP) to the Stockholm Convention (SC COP-9) was held from 29 April to 10 May 2019. This meeting resulted in the adoption of 27 decisions, including Decision SC-9/3[78] pertaining to PCBs. As stated in Decision SC-9/3, the Conference *"takes note of the consolidated guidance on polychlorinated biphenyls in open applications[79], and encourages Parties to endeavour to identify, as soon as possible, open applications such as cable sheaths, cured caulk and painted objects containing more than 0.005 per cent polychlorinated biphenyls and to manage them in accordance with paragraph 1 of Article 6 of the Stockholm Convention on Persistent Organic Pollutants"*.

Preceding SC COP-9, a report[80] on progress towards the elimination of PCBs was prepared by a Small Intersessional Working Group (SIWG) established by the COP. It is important to note that the recommendations of this report are not binding and were *"noted"* by the COP as part of Decision SC-9/3. While the recommended actions are non-binding, they may be of assistance in the development of any future management framework in Ireland for PCBs in open applications. The key recommendations of the SIWG's report include **(emphasis added in *bold*)**:

149(b) Actions in developing legal framework:

(i) ***All Parties should put in place legal and administrative measures*** *to implement the obligations of the Stockholm Convention in particular with respect to Annex A, Part II (a) on PCB in equipment and* ***(e) environmentally sound management of PCB****.*

(ii) ***Legal framework*** *should include the identification and remediation of PCB contaminated sites and* ***identification of PCB in open-applications****;*

(c) Actions in building analytical capacity:

(i) National capacities should be developed for PCB analyses, ***including for open applications****, by providing the necessary equipment and quality system training, in particular in Africa;*

(ii) Laboratories should be accredited for PCB analysis, taking into account the ISO/IEC 17025 standard, and provided with training to include specific types of PCB analyses within the scope of reporting;

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[78] UNEP/POPS/COP.9/INF/10. Available from: http://chm.pops.int/TheConvention/ConferenceoftheParties/Meetings/COP9/tabid/7521/Default.aspx
[79] UNEP, 2019
[80] UNEP (2019). Report on progress towards the elimination of polychlorinated biphenyls. Secretariat of the Basel, Rotterdam and Stockholm conventions, United Nations Environment Programme, Geneva.

(f) Actions in addressing PCB in open applications:

(i) All Parties should be reminded of their obligations under the Stockholm Convention, in particular Annex A, Part II (f): "In lieu of note (ii) in Part I of this Annex, endeavour to ***identify other articles containing more than 0.005 % PCB manage them in accordance with paragraph 1 of Article 6****";*

(ii) BAT/BEP guidance on PCB in open applications as well as guidance on the identification and management of PCB in open applications should be developed;

(iii) Awareness should be raised on PCB in open applications as well as other POPs that have similar open applications e.g. polychlorinated naphthalenes and short-chain chlorinated paraffins, through regional preparatory meetings, technical assistance and webinars;

(iv) ***Health impact should be considered in the managing of PCB in open applications****, in particular those in buildings and PCB should be analysed for indoor contamination and contamination of relevant materials before renovation, remediation, or demolition works.*

In summary, the non-binding actions recommended by the SIWG to the Parties to the Convention advised that a legal framework be established to address the 'environmentally sound management' of PCB and provide for the identification of PCBs in open applications. Building analytical capacity, considering appropriate laboratory accreditation, was also advised. Health impacts related to the use of PCB in open applications should also be considered.

Actions recommended for the Conference of the Parties collectively included the development of BAT (Best Available Techniques) or BEP (Best Environmental Practices) guidance on PCB in open applications and also the development of guidance on the identification and management of PCB in open applications. This latter guidance was published by UNEP in 2019. It is understood that BAT/BEP guidance on PCB in open applications remains under consideration only.

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