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STOCKHOLM CONVENTION

Guidance on preparing inventories of PCN

MAY 2021

UN environment programme

STOCKHOLM CONVENTION

Guidance on preparing inventories of polychlorinated naphthalenes (PCNs)

2021

Secretariat of the Basel, Rotterdam and Stockholm Conventions

Acknowledgement:

The European Union, the Governments of Germany and Sweden are gratefully acknowledged for providing the necessary funding that made the production of this publication possible.

The feedback from Parties and observers to the Stockholm Convention on Persistent Organic Pollutants are highly appreciated.

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Recommended citation: UNEP (2021). Guidance on preparing inventories of polychlorinated naphthalenes (PCNs). Secretariat of the Basel, Rotterdam and Stockholm Conventions, United Nations Environment Programme.

Contact information:

Secretariat of the Basel, Rotterdam and Stockholm Conventions
Office address: 11-13, Chemin des Anémones - 1219 Châtelaine, Switzerland
Postal address: Avenue de la Paix 8-14, 1211 Genève 10, Switzerland
Tel.: +41 22 917 8271
Email: brs@brsmeas.org

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Abbreviations and acronyms

AMAP	Arctic Monitoring and Assessment Programme
ASR	Automotive shredder residues
CSO	Civil society organisation
DDT	Dichlordiphenyltrichlorethan
Di-CNs	Dichlorinated naphthalenes
DSI	Detailed site investigation
ECD	Electron capture detector
ESM	Environmentally sound management
GC	Gas chromatography
HBCD	Hexabromocyclododecane
HCBD	Hexachlorobutadiene
HCH	Hexachlorocyclohexane
Hepta-CNs	Heptachlorinated naphthalenes
Hexa-CNs	Hexachlorinated naphthalenes
IPCS	International Programme on Chemical Safety
Mono-CNs	Monochlorinated naphthalenes
MS	Mass spectrometer
Octa-CN	Octachlorinated naphthalene
Octa-FN	Octafluorinated naphthalene
PAHs	Polyaromatic hydrocarbons
PBBs	Polybrominated biphenyls
PBDEs	Polybrominated diphenyl ethers
PCBs	Polychlorinated biphenyls
PCDDs	Polychlorinated dibenzo-*p*-dioxins
PCDFs	Polychlorinated dibenzofurans
PCNs	Polychlorinated naphthalenes
PCP	Pentachlorophenol
PCP-Na	Sodium salt of pentachlorophenol
PCTs	Polychlorinated terphenyls
PCBz	Polychlorinated benzenes
Penta-CNs	Pentachlorinated naphthalenes
PFNs	Polyfluorinated naphthalenes
PFOS	Perfluorooctane sulfonic acid
POPs	Persistent Organic Pollutants
PSI	Preliminary site investigation
RDF	Refuse derived fuel
SCCPs	Short chain chlorinated paraffins
Tri-CNs	Trichlorinated naphthalenes
Tetra-CNs	Tetrachlorinated naphthalenes
UNECE	United Nations Economic Commission for Europe
UNEP	United Nation Environment Program
UNIDO	United Nation Industrial Development Organisation

1. Introduction

1.1 Polychlorinated naphthalenes (PCNs) under the Stockholm Convention

In May 2015, by decision SC-7/14, the Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants (POPs) amended Annex A to the Convention to list therein polychlorinated naphthalenes[1] (dichlorinated naphthalenes, trichlorinated naphthalenes, tetrachlorinated naphthalenes, pentachlorinated naphthalenes, hexachlorinated naphthalenes, heptachlorinated naphthalenes, octachlorinated naphthalene, hereinafter collectively referred to as PCNs) with specific exemptions for production of those chemicals as intermediates in production of polyfluorinated naphthalenes, including octafluoronaphthalene, and the use of those chemicals for the production of polyfluorinated naphthalenes, including octafluoronaphthalene. By the same decision, the Conference of the Parties amended Annex C to the Convention to list PCNs therein.

On 15 December 2016, one year after the date of communication by the depository, the amendments listing PCNs in Annexes A and C to the Convention entered into force for most Parties[2].

The listed PCNs[1] have toxic properties, resist degradation, and bio-accumulate in fatty tissues. They are transported through air, water and migratory species, across international boundaries and deposited far from their place of release, where they accumulate in terrestrial and aquatic ecosystems.

Parties to the Convention for which the amendment has entered into force are to take measures to eliminate releases of PCNs from intentional production and use, unintentional production, and from stockpiles and waste. The use of unintentionally produced by-product PCNs is prohibited.

1.2 Purpose of the guidance

Under Article 7, Parties are required to develop and endeavour to implement a plan for the implementation of their obligations under the Convention. National implementation plans (NIP) have to be updated with information on how Parties, for which the amendments have entered in force, will address obligations arising from amendments to Annexes A, B and/or C to the Convention to list new chemicals, in accordance with decision SC-1/12.

Under Article 15, Parties are required to report to the Conference of the Parties on the measures it has taken to implement the provisions of the Convention and on the effectiveness of such measures in meeting the objectives of the Convention.

To develop effective strategies for the elimination of PCNs and the environmentally sound management of products, stockpiles and wastes containing PCNs, Parties need to acquire a sound understanding of their national situation concerning these chemicals. Such information can be obtained through an inventory of PCNs. The establishment of inventories is thus one of the important phases in the development of NIPs (decision SC-2/7).

In addition, the information obtained through the establishment of the inventory of PCNs could be reported pursuant to Article 15 reporting for the 2018 cycle and thereafter.

The objective of this document is to provide Parties with guidance on the establishment of inventories of the PCNs. The document should be used by national focal points of the Convention and those involved in the process for NIP review and update, in particular the task teams responsible for establishing the inventory. The document and inventory will also be of interest to other stakeholders concerned with the elimination of PCNs.

Article 6, paragraph 1 (a), of the Stockholm Convention requires each Party to develop appropriate strategies for the identification of products and articles in use and wastes consisting of, containing or contaminated with POPs. The identification of PCNs wastes is the starting point for their effective environmentally sound management.

[1] Monochlorinated naphthalenes (Mono-CNs) are not listed in the Convention.

[2] Amendments shall not enter into force for those Parties that have submitted a notification pursuant to the provisions of paragraph 3(b) of Article 22 of the Stockholm Convention. In accordance with paragraph 4 of Article 22, the amendment will not enter into force with respect to any Party that has made a declaration regarding the amendment to the Annexes in accordance with paragraph 4 of Article 25. Such Parties shall deposit their instruments of ratification regarding the amendment, in which case the amendment shall enter into force for the Party on the ninetieth (90) day after the date of deposit with the Depositary.

1.3 Other guidance documents to be consulted

The users of this guidance should also consult *General guidance on POPs inventory development* (UNEP/POPS/COP.9/INF/19/Add.1) (UNEP, 2019) and other guidance documents to support review and updating of national implementation plans available on the website of the Stockholm Convention.[3]

This document can be used in conjunction with documents developed under the Basel convention which provide guidance on the development of identifications strategies and inventories in relation to POPs wastes and in particular PCNs wastes:

(a) General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP 2017a)

(b) Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with polychlorinated biphenyls, polychlorinated terphenyls, polychlorinated naphthalenes or polybrominated biphenyls including hexabromobiphenyl (UNEP 2017b)

(c) Methodological guide for the development of inventories of hazardous wastes and other wastes under the Basel Convention (UNEP 2015c).

1.4 Objectives of the inventory

The main objective of the inventory is to obtain information needed for the implementation of their obligations under the Stockholm Convention. More specifically, the objectives are to:

(a) Establish the country baseline with respect to PCNs production, use, stockpile and disposal;

(b) Provide the basis for development of a strategy in the NIP (i.e. identify the economic sectors that should be prioritized and the type of actions required for those sectors);

(c) Report to the Conference of the Parties to the Stockholm Convention on progress made to eliminate PCNs through national reporting;

(d) Identify the need to apply for the specific exemptions provided by the Convention by notifying the Secretariat;

(e) Identify areas where financial or technical support are needed (when resources are limited, to fill the gaps in the inventory/fulfil the obligations of the Convention).

The information obtained about PCNs through the inventory could consider the following:

(a) Past and current production at national level;

(b) Import and export of PCNs and PCN containing products and articles at the national level;

(c) Past use of PCNs in manufacturing in closed and open applications;

(d) Past use of PCN containing products;

(e) PCNs in products, stocks and wastes;

(f) Recycling practices of PCN containing products;

(g) Disposal practices for production residues and products and articles containing PCNs when they become wastes;

(h) Import/export of wastes containing or contaminated by PCNs;

(i) Sites potentially contaminated by PCNs;

(j) Alternatives to PCNs currently used in production of closed/open applications.

Information collected on the above will provide broader understanding of the sources of PCNs, the scope of their impacts and the risks that they pose to human health and the environment in a country. The information is important for Parties to evaluate whether they comply with obligations under the Convention regarding PCNs and identify areas where they need to develop effective strategies and action plans for managing those POPs in order to meet the obligations. Information collected as part of the inventory will also provide a valuable basis for Parties to

[3] http://chm.pops.int/tabid/7730/Default.aspx.

report to the Conference of the Parties on measures taken to implement the provisions of the Convention and the effectiveness of such measures (reporting under Article 15).

The inventory process is usually iterative. In establishing the inventory of PCNs for the first time, Parties will also identify resources and technical capacity needed to further improve the accuracy of the inventory.

2. How to develop an PCNs inventory

2.1. General guidance on POPs inventory development

Please refer to General guidance on POPs inventory development (UNEP/POPS/COP.9/INF/19/Add.1) (UNEP, 2019) for general approach to developing national inventories. The guidance describes general process to be taken in making an inventory. In summary, the following steps should be taken:

Step 1: Initiating the inventory development process

- Establishing a national inventory team
- Identifying relevant stakeholders
- Defining the scope of the inventory
- Developing a workplan
- Contacting the stakeholders

Step 2: Choosing data collection methodologies

- Indicative method
- Qualitative method
- Quantitative method

Step 3: Collecting and compiling data

- Tier 1: Initial assessment
- Tier II: Main inventory
- Tier III: In-depth inventory

Step 4: Managing and evaluating the data

Step 5: Preparing the inventory report

2.2. Step 1: Initiating the inventory development process

For general description of Step 1, please refer to Chapter 2.2 of General guidance on POPs inventory development (UNEP/POPS/COP.9/INF/19/Add.1) (UNEP, 2019).

In initiating the inventory development process, Parties are advised to establish a multi-stakeholder **national inventory team**. It is important to clearly define the responsibilities for national inventory team in developing the inventory as to streamline the work.

To define the scope of the inventory, the national inventory team should identify relevant stakeholders who will be contacted for the information in the process. Potential sectors and stakeholders involved in the life-cycle of PCNs are listed in Table 1 below.

Other POPs in particular PCBs have been used in several of the applications where PCNs have been used. For PCBs this includes closed applications such as condensers and transformers or oils in heat exchangers or hydraulic oils. PCBs and PCNs have been used in the same open applications such as cables, paints, sealants or treatment of paper or textiles (IPCS 2001; UNEP 2012; Wagner et al. 2014; PCB Elimination Network 2014).

PCNs have also been used in wood treatment where a range of other POPs such as pentachlorophenol (PCP), endosulfan, lindane, technical-grade hexachlorocyclohexane (including alpha-, beta-HCH and lindane) or mirex have been used.

Furthermore short-chain chlorinated paraffins (SCCPs) are also used in similar open applications as PCNs.

The activities for the development of inventories for PCNs should therefore be integrated with those for other POPs with same applications, closed or open, such as PCBs, SCCPs and POPs used in wood treatment.

PCNs as unintentional POPs (UPOPs) are formed together with polychlorinated dibenzo-*p*-dioxins (PCDDs), dibenzofurans (PCDFs), PCBs and other UPOPs (hexachlorobenzene, pentachlorobenzene) in sources listed in the UNEP toolkit (UNEP 2013). PCNs as UPOPs could be addressed together with other UPOPs in most sources. For some specific sources, unintentional PCNs might require an additional inventory effort.

When identifying wastes, containing or contaminated with PCNs, Parties may also consider an approach developed for PCBs inventorying and make use of the existing guidance for PCB inventory development (UNEP 1999; PCB Elimination Network 2010). The related Basel Convention technical guidelines also address PCN and PCB waste in the same guidelines supporting such an integrated approach (UNEP 2016).

Table 1: Sectors and stakeholders involved in the life-cycle of PCNs (and PCBs)

Sectors	Stakeholders
For all sectors	• Ministry of Environment • Ministry responsible for waste management • Ministry of Industry • Ministry of Labour • NIP coordinator and steering committee • Basel Convention focal point (and stakeholders) • CSO/NGOs
PCN production	• Industry/organochlorine association having produced or producing PCNs
Manufacturing of products/articles where PCNs have been used	• Industry (formerly) producing transformers and capacitors • Industry producing hydraulic fluids • Industry producing cables for electrical equipment and cables sheaths • Industry producing paints and other coatings (in particular chloroprene paints and lacquers and PVC copolymer paints) • Industry producing sealants/caulks and putty • Industry producing chloroprene rubber • Industry producing wood preservatives • Industries producing oils, impregnated paper, impregnated textile
Use of PCN containing materials	• Authorities in charge with construction permitting • Users/owners of transformers and capacitors (e.g. electricity supply companies etc.) • Users of hydraulic oil, especially in the mining sector • Electrical equipment companies and construction companies using electrical cables and cables sheaths • Users/industries and importers of paints (including chloroprene paints and lacquers and PVC copolymer paints and thinners) • Building and road construction companies using paints and coatings • Ship repair companies using paints and coatings • Users (e.g. prefabricated concrete building companies)/industries and importers of sealants and materials for sealants • Users/industries and importers of chloroprene rubber used especially for rubber belts, rubber belts for printers, conveyor belts and shock absorbing materials • Ministry of Agriculture or Forestry and institutes and industries working with wood and treatment of wood • Ministry of defence
Unintentional PCNs (specific productions)	• Industry producing chlorinated solvents • Industries producing chlorinated paraffins • Industry producing chlorine with chloralkali processes (in particular those having

Sectors	Stakeholders
	used graphite electrodes)
End-of-life treatment	• Recycling companies (for cables, chloroprene rubber and impregnated/treated wood waste) • Ship scrapping/dismantling companies • Companies treating painted scrap (e.g. electric arc furnaces) • Landfill owners

2.3. Step 2: Choosing data collection methodologies

There are a number of different approaches that have been used for gathering information for POPs inventories, i.e. indicative method, qualitative method and quantitative method. For more information on those methodologies, please refer to Chapter 2.3 of General guidance on POPs inventory development (UNEP/POPS/COP.9/INF/19/Add.1) (UNEP, 2019).

Questionnaires are valuable instruments for primary data collection in inventory programs. Based on contact and consultation meetings with stakeholders, questionnaires with explanatory notes can be developed and sent to the relevant stakeholders to gather the information needed to compile data for a Tier II or Tier III assessment. Questionnaires for PCNs producers, users and companies importing or selling PCNs are available in Appendix 1 to 2 to the present guidance and can be modified and adjusted as needed.

Samples of products and articles can be gathered during on-site inspections at factories, markets, in buildings and construction possibly containing PCNs. Samples, recycling locations, and waste disposal/storage facilities.

2.4. Step 3: Collecting and compiling data

For general description of Step 3, please refer to Chapter 2.4 of General guidance on POPs inventory development (UNEP/POPS/COP.9/INF/19/Add.1) (UNEP, 2019).

An initial assessment (Tier I) is carried out to obtain an overview of the relevant uses and stakeholders to be contacted in the key sector under investigation. Tier I methods usually rely on available literature and statistics in combination with calculations based on already existing information, such as the risk profile (UNEP/POPS/POPRC.8/16/Add.1) (UNEP 2012) and risk management evaluation (UNEP/POPS/POPRC.9/4) (UNEP 2013) adopted by the POPs Review Committee.[4]

Main inventory (Tier II) will follow to generate data on the main sectors through interviews and questionnaires to the national stakeholders, and further identify missing information. This could also include actions such as desk study on pesticides storage facility contents.

If needed and resources are available, a more in-depth inventory (Tier III) can be initiated after evaluation of the data gathered in the main inventory.

2.4.1 Tier I: Initial assessment

Tier I methods usually rely on readily available information and statistics. Methods used for higher tiers involve more resource-intensive data collection activities and possibly country-specific measurements but should also yield more accurate results.

Parties should endeavour to use methods that provide a robust level of certainty. This is especially true when, for example, the preliminary inventory concludes that PCNs could pose high human health and environmental risks in the country and more accurate data is needed to prioritize risk reduction measures and estimate their costs, while making efficient use of available resources and taking into account available technical capacity.

The initial assessment (Tier I) provides the inventory team with a general idea of where the problems may lie and, more importantly, which sectors require further investigation and information gaps. Tier I outputs are rather qualitative and require (subsequent) verification. The (preliminary) inventory (Tier II) focuses on the major sectors and generates (semi)quantitative data. The in-depth inventory (Tier III) uses in depth assessment and possibly, includes analytical measurement methods to obtain precise data on the relevant sectors.

[4] http://chm.pops.int/tabid/243/Default.aspx.

2.4.2 Tier II: Main inventory

The preliminary inventory generally focuses on specific sectors. It involves surveys and site visits to better estimate national data that were identified as missing in the initial assessment/Tier I.

Possible applications and uses (see Table 5) and target locations can be identified, followed by site visits including:

(a) Current and former production sites of PCNs;

(b) Former production sites of PCN (and PCB) containing products;

(c) Companies which have possibly used PCNs;

(d) Waste collection centres and recyclers;

(e) Waste management facilities;

(f) Storage and disposal locations of materials containing PCNs.

2.4.3 Tier III: In-depth inventory

The in-depth inventory may be undertaken if the preliminary inventory concludes that PCNs could pose high human health and environmental risks in the country or near contaminated sites and if more accurate data are needed to prioritize risk reduction measures and estimate their costs. Data collection in this tier relies on the use of analytical methods that may include monitoring measurements with instrumental analysis. Instrumental analysis is similar to the analysis of PCBs using gas chromatography electron capture detector (GC-ECD) or gas chromatography mass spectrometry (GC-MS) (see Draft Guidance on Sampling, Screening and Analysis of Persistent Organic Pollutants in Products and Articles) (UNEP 2017c). It may also involve detailed inspections of sites mentioned in Tier II.

2.5 Step 4: Managing and evaluating the data

For general description of Step 4, please refer to Chapter 2.5 of General guidance on POPs inventory development (UNEP/POPS/COP.9/INF/19/Add.1) (UNEP, 2019).

The compiled data (draft inventory) should be assessed by stakeholders and possibly by an external expert. Depending on the feedback, further information may need to be gathered.

2.6 Step 5: Preparing the inventory report

The final stage of the inventory is preparation of the inventory report. This report includes results of inventories of all key sectors investigated by the country compiled in a single document.

The essential elements of the report are:

(a) Objectives and scope;

(b) Description of data methodologies used and how data were gathered, including all the assumptions and conversion factors adopted as a result of expert judgment;

(c) Final results of the inventory for each sector considered a priority for the country (using a format to be provided in this guidance, as such or adapted from that format);

(d) Results of the gap analysis and limitations identified for completion of the inventory;

(e) Further actions (e.g. stakeholder involvement, data collection strategies) to be taken to complete the inventory and recommendations.

Other information (e.g. stakeholder list) could be included in the report depending on the national preferences.

3. Information on PCNs

3.1. Production of PCNs

Polychlorinated naphthalenes (PCNs) comprise of 75 possible congeners in eight homologue groups, as listed in Table 2, with one to eight chlorine atoms substituted around the planar aromatic naphthalene molecule. The basic structure of the PCNs is shown in Figure1 and has the molecular formula $C_{10}H_{8-n}Cl_n$, where n=1-8.

The homologue groups listed in the Stockholm Convention and considered in this inventory are dichlorinated naphthalenes (di-CNs), trichlorinated naphthalenes (tri-CNs), tetrachlorinated naphthalenes (tetra-CNs), pentachlorinated naphthalenes (penta-CNs), hexachlorinated naphthalenes (hexa-CNs), heptachlorinated naphthalenes (hepta-CNs), and octachlorinated naphthalene (octa-CN). Mono-CNs are not listed in the Stockholm Convention. Almost all congeners have actually been found in commercial formulations (Noma et al. 2004). All 75 PCN congeners and 8 homologues have different CAS numbers and molecular formula (see Table 2). They are structurally similar to polychlorinated biphenyls (PCBs), which are listed in Annex A and C to the Convention.

Physical-chemical properties vary considerably due to the degree of chlorine substitution. The physical state ranges from thin liquids to hard waxes. Tri- through octa-CNs are very lipophilic with high log K_{ow} (>5) and their water solubility and vapour pressure decrease with the degree of chlorination (see Table 3).

Although two publications on the WHO Toxic Equivalency Factor (TEF) schemes recommend including certain PCNs, no TEFs have been proposed through the WHO experts so far (van den Berg et al. 2006; 2013).

Table 2: Names and CAS numbers for PCNs homologue groups (NICNAS 2002)

PCNs name	CAS number	Molecular formula
(*Monochloronaphthalene*)[5]	25586-43-0	$C_{10}H_7Cl$
Dichloronaphthalene	28699-88-9	$C_{10}H_6Cl_2$
Trichloronaphthalene	1321-65-9	$C_{10}H_5Cl_3$
Tetrachloronaphthalene	1335-88-2	$C_{10}H_4Cl_4$
Pentachloronaphthalene	1321-64-8	$C_{10}H_3Cl_5$
Hexachloronaphthalene	1335-87-1	$C_{10}H_2Cl_6$
Heptachloronaphthalene	32241-08-0	$C_{10}HCl_7$
Octachloronaphthalene	2234-13-1	$C_{10}Cl_8$

Table 3: Selected physical and chemical properties (UNEP 2013 based on IPCS 2001)

Congeners	Molecular weight (g/mol)	Solubility (µg/L) [a]	Vapour pressure (Pa)[b] (sub-cooled liquid, 25°C)	Henry's law constant (Pa·m³/mol, 25°C)[c]	Log K_{ow} [d]	Log K_{oa}[e]	Log K_{aw}[e]	Melting point (°C)	Boiling point (°C)
Di-CNs	197.00	137–862 (2713)	0.198–0.352	3.7–29.2	4.2–4.9	6.55 to 7.02	-2.83 to -1.98	37–138	287–298
Tri-CNs	231.50	16.7–65 (709)	0.0678–0.114	1.11–51.2	5.1–5.6	7.19 to 7.94	-3.35 to -2.01	68–133	274*
Tetra-CNs	266.00	3.7–8.3 (177)	0.0108–0.0415	0.9–40.7	5.8–6.4	7.88 to 8.79	-3.54 to -2.02	111–198	Unknown
Penta-CNs	300.40	7.30 (44)	0.00275–0.00789	0.5–12.5	6.8 - 7.0	8.79 to 9.40	-3.73 to -2.3	147–171	313*
Hexa-CNs	335.00	0.11* (11)	0.00157–0.000734	0.3–2.3	7.5 - 7.7	9.62 to 10.17	-4.13 to -3.04	194	331*

[5] Not listed in Annex A to the Stockholm Convention.

Congeners	Molecular weight (g/mol)	Solubility (µg/L) [a]	Vapour pressure (Pa)[b] (sub-cooled liquid, 25°C)	Henry's law constant (Pa·m³/mol, 25°C)[c]	Log K_{ow} [d]	Log K_{oa}[e]	Log K_{aw}[e]	Melting point (°C)	Boiling point (°C)
Hepta-CNs	369.50	0.04* (2.60)	2.78 x 10-4, 2.46 x 10-4	0.1–0.2	8.2	10.68 to 10.81	-4.34 to -4.11	194	348*
Octa-CN	404.00	0.08 (0.63)	1.5 x 10-6	0.02	6.42–8.50	11.64	-5.21	198	365*

*Estimated value, using methodologies laid out in Lyman et al. (1982).
a) Values outside of brackets were experimentally determined by aqueous saturation method (Opperhuizen et al. 1985) for the solid congeners; values in brackets are predicted using WSKOWWIN 2000.
b) Source: Lei et al. (1999). c) Values obtained from Puzyn and Falandysz (2007).
d) Measured Kow sources: Opperhuizen (1987), Opperhuizen et al. (1985), Bruggeman et al. (1982)), Lei et al. (2000)
e) estimates from Puzyn et al. (2009)

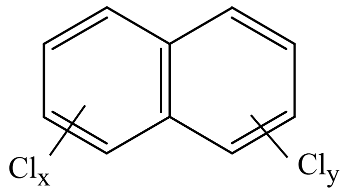

Figure 1: General structure of polychlorinated naphthalenes (PCNs)

Investigations of seven Halowax formulations have shown that Halowax contains others POPs, including PCBs (from 220 to 640,000 ng/g), chlorobenzenes (from 1100 to 9800 ng/g), chlorophenols (from 1050 to 34,200 ng/g), PCDD/F (92-5900 ng/g) (Noma et al, 2004 a, 2004b, 2004c; Noma et al., 2005a and 2005b). According to (Nova et al., 2004 a) detection of by-side chlorobiphenyls (CBs) in technical Halowaxes demonstrate clearly that those formulations were in the past an early source of environmental pollution with CBs, which proceeded for around 20-30 years use of original CB formulations.

PCNs were produced for technical use during the first decade of the 20th century, e.g. as dielectrics, for flame proofing or for the protection of paper and fabrics (Hayward 1998).

In the US, the largest volume of PCN containing products were called Halowax produced by Coppers Company. In Europe the largest volume products were called Nibren waxes, made in Germany by Bayer. Other European PCN trade names included Seekay (UK, from ICI Runcorn), Clonacire (France), Cerifal (Italy) and Woskol (Poland).

Commercial mixtures and trade names and respective major homologues are listed in Table 4. Trade names of products from the producers in different countries have been compiled from different publications (Falandysz, 1998; Jakobsson and Asplund, 2000; UNEP 2013; UNEP 2017b):

(a) Basileum (Germany);

(b) Cerifal (Italy);

(c) Chlonacire wax (France);

(d) Halowax (United States of America);

(e) Hodogaya Amber wax (Japan);

(f) Nankai wax (Japan);

(g) Nibren wax (Germany);

(h) N-Oil, N-Wax (United States of America);

(i) Perna wax (Germany);

(j) Seekay wax (United Kingdom);

(k) Tokyo ohka wax (Japan);

(l) Woskol: Zakady Azotowe (Poland).

Table 4: Trade names, composition and manufacturers of technical PCN mixtures* (IPCS 2001).

Trade name		Approximate composition	Manufacturer
Halowax	1031	mono-diCN (22% Cl)	Koppers Co Pittsburg, PA, USA
	1000	mono-diCN (26% Cl)	
	1001	di-penta (50% Cl)	
	1099	di-pentaCN (52% Cl)	
	1013	tri-pentaCN (56% Cl)	
	1014	tetra-hexaCN (62% Cl)	
	1051	hepta-octaCN (70% Cl)	
Basileum	SP-70	mono-diCN (80% PCN)	Desowag-Bayer, Germany
Nibren wax	D88	(50% Cl, estimated from melting point)	Bayer Leverkusen, Germany, formerly I.G. Farbenindustrie
	D116 N	(50% Cl, estimated from melting point)	
	D130	(60% Cl, estimated from melting point)	
Seekay wax	R68	(46.5% Cl)	ICI Runcorn, Great Britain
	R93	(50% Cl)	
	R123	(56.6% Cl)	
	R700	(43% Cl)	
	RC93	(50% Cl)	
	RC123	(56.5% Cl)	
Clonacire wax	95	(50% Cl, estimated from melting point)	Prodelec, Paris, France
	115		
	130		

*Mono-CNs are not listed as POPs in the Stockholm Convention. Mono-CN products might however contain higher chlorinated PCNs listed in the Convention.

There may be other trade names for PCN commercial mixtures (UNEP 2013). In former USSR, PCNs or Halowax was produced by Khimprom enterprises, while volumes were not assessed or reported (UNEP 2016).

The PCN production declined after the World War II, when they were gradually substituted by PCBs and for insulation purpose by plastics. Still, PCNs remained high volume chemicals until the 1970s (AMAP, 2004; Jakobsson and Asplund 2000) and have been produced and used until around 2000 (Falandysz et al. 2008; Yamashita et al. 2003; Yamamoto et al. 2016).

Little accurate information on production volumes of PCNs exists. It is estimated that the volume of PCN production never exceeded one tenth of that of PCB production (Beland and Geer 1973). According to Hayward (1998), a total of between 50,000 and 150,000 tonnes of PCNs have been produced in the US from 1910 to 1960 (Hayward 1998). The production of PCNs in the US stopped in the 1980s (UNEP 2013).

In the UK, the production stopped in the mid-1960s, although it was reported that in the 1970s, small amounts of PCNs were still being produced (UNEP 2013).

PCNs were imported to Japan in around 2000 from DuPont Dow Elastomers Ltd. based in the UK (Yamamoto 2016). In Japan, about 5000 t of PCNs were produced between 1940 and 1976 and the production and use of PCNs were banned in 1979 (Japan Ministry of Economy, Trade and Industry 1979). In Germany Bayer produced PCNs until 1983. Still around 300 tonnes of PCNs were used in Germany in 1984, mainly for use as dye intermediates (UNEP 2013).

Estimates for the total global PCN production so far vary between 150,000 tonnes and 400,000 tonnes (AMAP 2004; Brinkman & De Kok 1980). The atmospheric PCN concentrations at numerous locations around the globe are one order of magnitude lower than those of PCBs at identical sites (Lee at al. 2007), which have been produced at a volume of around 1.3 million tonnes (Brevik et al. 2007). The lower estimated volume of PCN production (around 150,000 tonnes) seems the most realistic estimate for global PCN production.

PCNs are known to have been produced for manufacturing of products until early 2000s where PCN-containing products were still found on the Japanese market (Falandysz et al. 2008; Yamamoto et al 2016; Yamashita et al. 2003).

The PCN production is assumed to have ended (UNEP 2012, 2013) with the exception of production of PCNs as intermediate for the production of polyfluorinated naphthalenes (PFNs) listed as specific exemptions under the Convention (UN Secretary General 2015), for which Russia emphasized the relevance in particular for octafluoronaphthalene (Octa-FN) production (IISD 2015; UNEP 2015a). The amount of PCN production for this purpose is unknown. It is also not known which countries are producing and using PCNs for such productions.

PCNs are used for laboratory and analytical purposes. Reports from Japan have suggested that PCN formulations for laboratory use and research may have been imported from suppliers in Canada and UK in the late 1990s (Yamashita et al. 2003, Falandysz 2003 in Santillo and Johnston 2004). A recent study by Chinese authors states that there is no information about the production of technical PCN formulations in China (Pan et al. 2011); however a small quantity of production (not specified) of octa-CN for scientific purposes was reported for Jiangsu province recently (China 2011).

3.2. Uses of PCNs

PCNs have been used mainly for their chemical inertness, including low flammability, their electrical insulating properties and recalcitrance including resistance to biodegradation and biocidal function. PCNs share these properties and their scope of application with the PCBs, with which they were gradually replaced after World War II (Hayward 1998). An overview of former uses of PCNs is given in Table 5 and concentrations in some open applications in Table 6.

The uses include industrial and consumer applications in closed and open applications. PCNs were often used for the same applications as PCBs because of their structural similarity.

PCNs were mainly used between 1920 and 1960 but remained high volume chemicals until the 1970s (AMAP 2004; Jakobsson and Asplund, 2000; UNEP 2013). PCNs have been used in products until early 2000 (Yamashita et al. 2003; Yamamoto et al. 2016).

According to (UNECE 2007), the most important uses, in terms of volume, have been in: cable insulation, wood preservation, engine oil additives, electroplating masking compounds, feedstock for dye productions, dye carriers, capacitors and refracting index oils.

The use of PCNs as wood preservatives was popular in the 1940s and 1950s with higher chlorinated congeners (IPCS 2001) and was continued with mainly lower chlorinated PCNs until 1987 (Jacobsson & Asplund 2000).

Other uses include as dipping encapsulating compounds in electronic and automotive applications, temporary binders in paper coating and impregnation, binders for ceramic components, casting materials for alloys, grinding and cutting lubricants, separators in batteries and moisture proofing sealant (NICNAS 2002; Jacobsson & Asplund 2000).

Until the 1980s, PCNs have been used in paints in Europe (Potrykus et al. 2015). In the US, only very small amounts of PCNs (about 15 tonnes/year) were used in 1981, mainly as capacitor dielectrics and refractive index testing oils (IPCS 2001).

After 1980, their use declined considerably. In Europe, the most recent available data on use has been reported for Germany and the Former Yugoslav Republic of Macedonia, where small amounts were used as casting material until 1989 (ESWI 2011; Popp et al. 1993).

The most recent reported application was chloroprene rubber additive until early 2000. Approximately 12.6 t of PCNs were used to produce approximately 259 t of synthetic chloroprene rubber (Neoprene FB) (Japan Ministry of Economy, Trade and Industry, Chemical Council 2002; Yamamoto et al. 2016). Approximately 207 t of Neoprene FB was exported and the rest was used for the production of Neoprene FB products such as rubber belts and sealants (Yamamoto et al. 2016). In 2002, it was also found that Sumitomo 3M Co. Ltd. had imported approximately 54 t of rubber compound made from Neoprene FB from Canada starting in 1995 and used it to manufacture aerosol adhesives (Yamamoto et al. 2016). The total amount of product was reported to be more than 210,000 cans of aerosol adhesives. The Japanese Government directed manufacturers to stop shipping and to recall the products containing PCNs (Yamamoto et al. 2016).

Some use of PCNs has been reported for military purposes such as fog ammunition (Generalstab Schweizer Armee 1945) and inert artillery and mortar projectiles (Hewitt et al. 2011; Clausen et al. 2004; Falandysz 1998).

Table 5: Former PCN uses in closed and open applications

Sector	Application
Batteries	• Separator in storage batteries (Jacobsson & Asplund 2000)
Plastics and cables	• Cable covering compositions (Jacobsson & Asplund 2000) • Additive in plastic (Jakobsson & Asplund 2000) • Intermediate for polymers and as flame-retardants in plastics (Crookes and Howe 1993; Jacobsson and Asplund 2000]
Rubber	• Additive in Neoprene and possibly other chloroprene with use in printer belts (Yamashita et al. 2003; Yamamoto et al. 2016)
Sealants	• Water proof sealants (NICNAS 2002)
Paints, lacquers, dyes/dye carrying agents	• In anti-corrosion/underwater paints and lacquers (Jacobsson and Asplund 2000) • Raw material/feedstock dye carriers (IPCS 2001; UNEP 2016)
Wood preservative / fungicide	• Impregnation of wood (IPCS 2001; Jakobsson & Asplund 2000)
Textile and paper industry	• Coating/impregnation of paper and textiles for water proofing (Van de Plassche and Schwegler 2002, Jakobsson & Asplund 2000) • Binders in paper coating and impregnation (NICNAS 2002)
Oil additives and lubricants	• Additives in oils for lubrication in gear and machinery (Jakobsson & Asplund 2000; US Department of Agriculture 1954) • Oils in mining sector (Popp et al. 1997) • Cutting oils (Jakobsson and Asplund 2000) • Engine oil additive (Van de Plassche and Schwegler 2002) • Refracting index testing oils (Van de Plassche, Schwegler 2002)
Military use	• Fogg ammunition; smoke grenades (Generalstab Schweizer Armee 1945; EMPA 2006). • Inert artillery and mortar projectiles (Hewitt et al. 2011; Clausen et al. 2004; Falandysz 1998) • Paper filter for gas masks in WW1 (Howard 1998) • Paints for ships (Redfield et al. 1952) and possibly other metal surfaces of military vehicles/equipment.

Table 6: Concentration of PCNs (or PCBs)* in selected application and some waste fractions

Product/sample (POPs measured)	Level of PCN or PCB content (mg/kg)	References
Neoprene rubber (PCN)	36,000 – 45,000	Yamamoto et al. 2005 Yamashita et al. 2003
Rubber coated plastic (PCN)	1000	Yamashita et al. 2003
Rubber belt for printers (PCN)	41 to 2000 (3/21)	Yamamoto et al. 2005
Rubber belt for printers (PCN)	0.001 – 0.1 (17/21)	Yamamoto et al. 2005
Aerosol adhesives (PCN)	1150 – 1200	Yamashita et al. 2003
Sealants (PCB)*	28,000 – 224,000	Kohler et al. 2003; Behnisch 1997
Paints (PCB)*	30,000 – 160,000	Zennegg et al 2014; Weber et al 2015
Cables coatings in recycling (PCB)*	10 – 325	Lehnik-Habrink et al. (2005)
Automotive shredder residue (PCN)	0.026 – 0.040	Yamamoto et al. 2005
Refused derive fuel (PCN)	0.011 – 0.086	Yamamoto et al. 2005
PCN (technical mixture)	930,000 – 1,000,000	Yamashita et al. 2003

Product/sample (POPs measured)	Level of PCN or PCB content (mg/kg)	References
Transformer oils (Askarel PCB)*	ca. 600,000**	Mueller 2017
Contaminated transformer oil (PCB)*	50 – 100,000	Mueller 2017
Capacitor/condensers (PCB)*	ca. 600,000**	Mueller 2017
Automotive shredder residue (PCNs)	0.026 – 0.040	Yamamoto et al. 2005
Refused derive fuel (PCNs)	0.011 – 0.086	Yamamoto et al. 2005

*For these applications only PCB data were available. Due to the use in the same application and similar chemical properties, the levels of PCB use might reflect levels if PCN was/are used.
**The PCBs can be mixed with ca. 300,000 mg/kg PCBz.

For the above-mentioned uses (Table 5 and 6) mainly the tri- to octa-CNs were used in different mixtures. Mono-CNs[6] and mixtures of mono- and di-CNs have been used for chemical-resistant gauge fluids and instrument seals, as heat exchange fluids, as high boiling specialty solvents, for colour dispersions, as engine crankcase additives, and as ingredients in motor tune-up compounds. Mono-CNs have also been used as raw materials for dyes.

The European Chemicals Agency (ECHA) classification and labelling (C&L) inventory indicates that there are notifiers for a limited number of specific PCN congeners[7] (PCN congeners 1, 2, 5, 9, 27 and 75). Specific congeners are listed in the ECHA inventory of pre-registered substances (PCN congeners 1 to 5, 7 to 12, and 75 with envisaged registration deadlines in 2010 or 2013). So far, no registration has been submitted to ECHA. This suggests that there are no EU companies which produce or import PCNs in high volumes. The entries in the C&L inventory and the fact that pre-registrations have been submitted to ECHA at least indicates that PCNs are of certain interest for EU companies, although pre-registrations could also have been submitted due to strategic reasons instead of real registration obligations (UNEP 2013).

Similarly to other POPs (Secretariat of the Stockholm Convention 2012a,b), Halowax can still be purchased via internet. For example, octa-CN (Halowax 1051) are offered from at least 27 suppliers. However, it has not been assessed which of these suppliers provide analytical standards and whether there is still trade with PCNs for industrial use. Trade amounts available for sale are not known.

PCBs have also been used in most of these former PCN applications. In some cases, PCBs have substituted PCNs where high toxicity had been discovered in the 1940s or 1950s (e.g. US Ministry of agriculture 1954). PCNs have been used in paints until 1980s (e.g. by Bayer; Potrykus et al. 2015) where they have partly replaced PCBs which have been largely phased out from such open applications in the early 1970s. For chloroprene rubber, PCNs have been used until 2000 and have therefore been used for a longer period than PCBs.

A third organochlorine chemical group which has been used and has substituted PCNs and PCBs in most open applications are the chlorinated paraffins (CPs). In May 2017, in its decision SC-8/11 the COP to the Stockholm Convention listed short-chain chlorinated paraffins (SCCPs) in Annex A to the Convention for elimination.

3.2.1 PCN in products, stockpiles and wastes

In most applications PCNs have not been produced or used for over 30 years. For the applications with short lifetime like textiles, papers, lubricants, cutting oils or grease, it can be assumed that the bulk of PCN-containing products has already been disposed of (Santillo and Johnston 2004, Potrykus et al. 2015).

For some applications with long-term use like painted ships or bridges (see Brinkmann and Reymer 1976) it is possible that a certain proportion of PCNs is still in products. Capacitors and transformers or sealants in buildings have a long lifespan and might still be in use or in stock. Information on the estimated quantities of such long-term uses is not sufficient (ESWI 2011).

Traces of PCNs are contained in commercial PCBs (0.01–0.09%; Falandysz, 1998, Kannan et al., 2000, Yamashita et al., 2000) and are therefore contained in PCB transformers and capacitors. Based on these calculations, overall quantities of PCNs contained in PCB-containing fluids is estimated between 100–169 tonnes (UNEP 2012).

Applications which have been more recently used, such as chloroprene rubber, sealants or adhesives (Yamamoto et al. 2016) might still be in use in products or in stock and may enter current/future waste flows.

A preliminary monitoring of PCNs in wastes has been conducted in Japan in 2005 (Yamamoto et al. 2005). The Neoprene FB samples contained a high level of PCN of 36,000 mg/kg while the rubber printer belts contained a

[6] Mono-CNs are not listed as POPs in the Stockholm Convention.
[7] http://echa.europa.eu/web/guest.

lower level with maximum of 97-2000 mg/kg (Yamamoto et al. 2005) (Table 6). Concentration in refuse derived fuel (RDF) and automotive shredder residues (ASR) ranged from 0.01 – 0.086 mg/kg (Yamamoto et al. 2005; Table 6).

For the management of PCN-containing articles, products and wastes, it is important to consider that other POPs, in particular PCBs, have been used in the similar applications such as capacitors, transformers, anti-corrosion paints, sealants and cables among others.

The Open-ended Working Group of the Basel Convention has integrated PCNs into the draft updated technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with PCBs, polychlorinated terphenyls (PCTs), or polybrominated biphenyls (PBB) including hexabromobiphenyl (HBB) (UNEP 2017b).

PCNs have also been used in wood treatment together with other POPs (e.g. PCP). The PCNs in products, stocks and wastes related to this application should be addressed together with those other POPs.

According to category A3180 of Annex VIII to the Basel Convention, wastes containing PCNs are classified as hazardous (TNO 2006b, UNECE 2007; UNEP 2017a).

3.2.2 PCNs stocks in closed applications

Former use of PCNs in closed applications are largely identical to the use of PCBs. In most closed applications such as transformers or capacitors the volume of PCBs used were higher than that of PCNs and have been addressed globally for more than a decade. Therefore, where appropriate, PCNs could be addressed within or together with the inventory of PCBs in closed applications.

(a) PCNs in capacitors

A major use of PCNs was in capacitors, particularly in the impregnated paper, since the 1930s (Jacobsson and Asplund 2000). PCNs have been used in capacitors from 1930s until 1980s. PCNs have been used for a slightly longer period than PCBs which were mainly used between 1940s to 1980s. However, the product and use volume of PCBs were ca. 10 times larger than that of PCNs. PCNs in capacitors could be addressed within the inventory of PCBs in capacitors or, where possible, a common inventory could be developed. The UNEP questionnaire developed for inventory of PCB equipment.

As capacitors are a sealed entity contamination after manufacture can be excluded. Considering the fact that after 1990 or newer no PCN was used anymore it can be assumed that capacitors manufactured after this date are PCN free. Capacitors that bear no information about the dielectric fluid and were manufactured before 1990 or before should be sampled and analysed or regarded as possibly containing PCN or PCB. Since capacitors are built into hermetically closed containers and there is no direct access to the cooling liquid, it is not possible to take samples for analysis without destroying the casing of the equipment.

In the case of light ballasts and WEEE equipped with small capacitors, it is difficult to determine whether they contain PCBs as dielectric fluids. The PCB or PCN content of such equipment should be carefully determined by referring to equipment type designations and production dates (UNEP 2016).

The decision steps for categorising capacitors are the following:

(a) Check year of manufacture: If manufactured in or after 1990 → "PCN/PCB free"

(b) Check nameplate: If there is an indication about presence/absence of PCN/PCB → categorise accordingly.

(c) If unclear then either drill, sample and analyse capacitor - or categorise as PCB/PCN containing

(b) PCNs in hydraulic fluids

PCNs, together with PCBs, have been used in the hydraulic fluids in the mining sector at least until 1989 (Popp et al 1997). During the development of inventory of PCBs in hydraulic oils in the mining sector and other sectors, PCNs could also be detected by the screening methods of PCBs based on the chlorine content.

The volume of hydraulic oils contaminated by PCNs (and PCBs) should be noted and distinguished in the inventory. The respective concentration of PCN should also be recorded.

3.2.3 PCNs in open applications

A major use volume of PCNs were in open application such as cables, paints, sealants/caulks and putty, chloroprene rubber, wood preservatives, paper, textiles (see Table 5). Depending on the time span when PCNs were used in the individual applications and the half-life of these products, most of the products/articles might have entered end of life. Some PCN applications which are more recent (e.g. paints and chloroprene rubber) and have longer half-lives (cables, sealants or putty in buildings) may be (partly) still in use and in products.

As described in chapter 3.2, PCBs were also used in a range of open applications where PCNs were used. Since PCBs in open applications have not been systematically addressed within Stockholm Convention inventory activities yet, they are included here in chapters where PCB use might be relevant. For several of this uses PCBs have been used in larger volumes compared to PCNs. Some other POPs have been used in these open applications and are mentioned in this chapter.

The concentration range of PCNs/PCBs in some open applications are compiled in Table 6.

(a) PCNs and other POPs in cables

The use of PCNs as flame retardants in cables and cable sheaths was a major use of PCNs (Jacobsson & Asplund 2000). Other POPs like PCBs and PBDEs have also been used as flame retardants in cables and cable sheaths.

The major use of PCNs was during 1920s to 1960s and most of these cables from electrical equipment have already entered end of life and have either been disposed to landfills, treated in cable recycling or other end of life treatment and could therefore not require a specific inventory or management activity.

Cables used in construction of houses or other long-term use might still exist.

Cables containing PCBs (used in the 1960s/1970s) and PBDEs (produced since the 1970s) are partly still in use. Within the inventory, the information on cables containing PCBs and PBDEs could also be addressed.

The estimated total amount of the remaining PCN-containing cables should be noted in the inventory report and the NIP. If data on PCN levels in the recycled cables are available, such information should also be noted in the inventory.

The information on the management of such cables should be assessed in the inventory report as a basis for the establishment of environmentally sound management of cables in the country.

Such an inventory links to the releases of unintentionally formed POPs from the smouldering of cables. The related releases of unintentional POPs should also be calculated and integrated (see UNEP U-POP toolkit category 2l (UNEP 2013)).

The technical guidelines of the Basel Convention (UNEP 2016) and BAT/BEP guidelines for Annex C chemicals (UNEP 2008) should be consulted for the environmentally sound management of waste cables.

(b) PCNs and PCBs in paints

PCNs have been used in lacquers and underwater paints and as raw materials for dyes (IPCS 2001; Jacobbson & Asplund 2000). Bayer produced paints containing PCNs until the beginning of the 1980s (Potrykus et al. 2015). PCBs have been used in such paints which were the major open applications of PCBs until the 1970s and possibly early 1980s (Jartun et al. 2009; Wagner et al. 2014).

Since both PCBs and PCNs have similar open applications in paints and painted constructions and equipment with PCBs in a larger volume than PCNs, both PCBs and PCNs should be addressed in the inventory of such applications.

PCNs[8] and PCBs have been used in paints and coatings as corrosion protection for metal constructions such as bridges, towers, ships, pressure pipes, water sluices, electricity poles, transformers, tanks (outdoor and indoor) and machinery (Eklund & Eklund 2014; ELSA 2014; LfU 2012; Johnsen & Engoy 1999; PCB Elimination Network 2014; USEPA 2000; USEPA 2013; Wagner et al. 2014). For PCBs it has been described that such additives were mainly used in chloroprene paints and chloroprene lacquers as well as in PVC copolymers (BUWAL 2000). Concentrations ranged from 5 to 35% (BUWAL 2000). For Aroclor-containing paints, a concentration of up to 10% Aroclor 1254 has been reported, which, after drying, resulted in a PCB concentration of up to 25% (Griggs & Bellrichard 2011).

Chloroprene paints containing PCNs or PCBs were also used in underwater paints and lacquers for concrete and brick. They were used as undercoat and as top coat/covering colour (BUWAL 2000).

[8] Most information has been published for PCBs but applications are most likely identical.

Monitoring data are mainly available for PCBs (Weber et al. 2015). For Switzerland it is estimated that at least 20% of swimming pools contain PCBs while the share of PCNs has not been estimated (Knechthofer 2009) and currently an inventory is developed for all public pools (AGIR 2013).

For the inventory, the former use of PCNs and PCBs in paints for corrosion protection of metal constructions and for paints used in swimming pools and other underwater paints and lacquers uses should be assessed.

As a first step the producers, users/industries and importers of paints (including chloroprene paints and lacquers and PVC copolymer paints and thinners) should be interviewed to obtain information on the former use of paints containing PCNs (and PCBs) in the country (see the questionnaire in Appendix 2). This could include:

(a) The time when PCNs and PCBs have been used in paints;

(b) Type of paints in which PCNs and PCBs have been used;

(c) Application areas of paints containing PCNs and PCBs in the country;

(d) Known individual constructions in which paints containing PCNs or PCBs (might) have been used.

An inventory of major metal/steel constructions (steel bridges, steel towers, pressure pipes, pipelines, water sluices, electricity poles etc.) which have been built before 1980s should be compiled. Information on which anti-corrosion paints/lacquers have been used should be included.

For constructions which potentially contain PCNs or PCBs, painting/repainting history of the construction should be documented, including whether the construction has been (partly) sand blasted to remove paints. The information of abrasive blasting of paints is in particular relevant since such activities can result in releases of 100 kg to tonnes of PCNs or PCBs into the environment. It has been reported for the abrasive blasting of paints from a bridge in Czech Republic releasing approximately 100 kg of PCBs into the Elbe river (ELSA 2016) and the abrasive blasting of a painted concrete bridge in Norway where ca. 1600 kg of PCBs have been released with associated contamination of the environment (Jartun et al 2009). The blasting of paints from a dam in Switzerland has recently contaminated the river Spöl (Russi 2016).

The inventory should also assess the former use of paints containing PCNs and PCBs in ships including military ships. Within this assessment, information on the areas where those ships have been painted and repainted should be collected. Such areas may be contaminated with PCNs and PCBs and possibly also with other chemicals such as DDT, tributyltin and heavy metals (Eklund & Eklund 2014; ELSA 2016; Johnsen & Engoy 1999).

In a Tier III assessment (selected) metal constructions should be monitored for the presence of PCNs and PCBs[9]. The assessment could also assess contamination in the surrounding in particular if paints have been removed by abrasive blasting (e.g. sand/air-blasting).

For the inventory the estimated total amount of the remaining PCN and PCB paints and painted objects should be noted in the inventory report and the NIP. This should also include major contaminated objects like bridges, towers, ships, silos or other objects.

The use of paints containing PCBs in silos for animal feed has been reported which resulted in the contamination of feed and milk (de Alencastro et al. 1984; Justitia 2016). While contamination of cows with PCNs has also been documented (US Ministry of agriculture 1954) major sources were lubricating oil and grease. It is unknown if PCN containing paints have been used for purposes sensitive for human exposure.

PCB paints have also been used as flame retardants for wood panels for room ceilings (“Wilhelmi” Panels), for road marking), paints on concrete, brick and in screed (Jartun et al. 2009; Weber et al. 2015). It is unknown if PCN paints has been used for these purposes.

(c) PCNs and PCBs in sealants/caulks and putty

The use of PCNs in sealants and putty has been reported until around 2000 (Yamashita et al. 2003; UNEP 2013). For PCBs, sealants/caulks and putty in buildings and other constructions have been major open applications (USEPA 2015; Wagner et al. 2014) while for PCNs those applications were minor. For PCBs, the uses were mainly from 1950s to 1970s or 1980s depending on the regulations in countries or regions.

PCNs seem to have been used until ca. 2000 in East Asia (Yamashita et al. 2003). The buildings with a large amount of sealants were those with (prefabricated) concrete where sealants were used as joints. Typical sealants containing PCBs were polysulfide sealants (e.g. Thiokol). Due to the similar properties, these sealants may also contain PCNs.

[9] In addition, heavy metals (lead, cadmium and chromium) used in anticorrosion paints could be included in such monitoring (Minnesota Pollution Control Agency 2011).

Other sealants that contain PCBs and potentially contain PCNs are polyurethane, acrylic and butyl sealants. PCBs and PCNs have not been used in modern silicone rubber sealants.

Sealants containing PCBs or PCNs have also been used in putty for windows. Sealants in buildings contain 5 to 30% of PCBs (Priha et al. 2005).

Due to the long lifetime of sealants in buildings of more than 30 to 60 years, a considerable share of these sealants/caulks may still be in use.

For the inventory, the former use of PCNs and PCBs in sealants for buildings and other constructions should be assessed. As a first step, the producers, users/industries and importers of sealants and materials for sealants should be interviewed to obtain information on the former use of PCNs and PCBs in sealants/caulks in the country (see questionnaire in Appendix 2). This could include:

(a) The time when PCNs and PCBs have been used in sealants/caulks;

(b) Application areas of sealants/caulks containing PCNs and PCBs in the country;

(c) Known individual buildings and other constructions in which sealants/caulks containing PCNs or PCBs have been used.

If the use of PCNs or PCBs in sealants/caulks in the country or region has been confirmed, an inventory of impacted buildings and constructions built between 1940 and 1980 where sealants/caulks have been used should be compiled. The information on individual buildings should include the amount of remaining sealants and volumes of PCNs and PCB.

For buildings/constructions which are known to contain sealants with PCNs or PCBs, the history of the construction should be documented, in particular whether sealants have partly been removed due to aging or there have been and PCNs/PCBs remediation activities. As a result of remediation activities, such sealants may have been removed or covered by coatings to minimize releases of PCNs/PCBs. Indoor sealants containing PCBs may have been removed to reduce exposure; however, the sealants outside of the buildings are often not removed. Such remediation activities should be assessed and documented for the respective buildings. The materials surrounding the sealants, e.g. concrete on both sides of the caulks or backfill insulation materials have been contaminated.

In a Tier III assessment, buildings and other constructions which possibly contain PCNs or PCBs should be monitored for the presence of PCNs and PCBs in sealants. X-ray fluorescence screening could be used for a pre-screening. Since such sealants may contain chlorinated paraffins, a positive detection of chlorine is not a final proof for the presence of PCNs or PCBs.

The assessment could also note contamination in the surroundings of buildings and construction in particular if sealants have partly been removed by abrasive blasting (e.g. sand/air-blasting).

(d) PCNs in chloroprene rubber

PCNs have been used in chloroprene rubber until around 2000 (Yamashita et al. 2003; Yamamoto et al. 2016). Such chloroprene rubber has been used in rubber belts, rubber belts for printers and shock absorbing materials.

For an inventory the former use of PCNs and PCBs in chloroprene rubber for different uses should be assessed. As a first step the producers, users/industries and importers of chloroprene rubber should be interviewed to obtain information on the former use of PCNs and PCBs in the country. This could include:

(a) The time span when PCNs and PCBs have been used in chloroprene and other rubbers;

(b) Application areas of chloroprene and other rubbers containing PCNs and PCBs in the country;

(c) The life span of the individual products;

(d) Known volumes of PCNs or PCBs in the different uses.

If the use of PCNs or PCBs in chloroprene and/or other rubbers in the country or region has been confirmed, further inventory activities should be initiated. Here the use with the highest share of PCNs and/or PCBs should be assessed for contemporary presence.

For the inventory, the volume of chloroprene rubber containing PCNs and the related materials currently in use and in stock should be recorded.

Exposure relevance should be considered for priority setting for further assessment and management.

In a Tier III assessment, conveyer belts or other suspected rubber materials should be measured for PCNs or PCBs. X-ray fluorescence screening could be used for a pre-screening for chlorine; however as untreated chloroprene rubber also contain chlorine (approx. 40%), a chlorine test is not helpful for determining the presence of PCNs or PCBs.

(e) PCNs in wood preservatives

PCNs have been used in wood preservatives in the past. Higher chlorinated PCN mixtures were used in the 1920s to 1970s while lower chlorinated naphthalenes were used until 1987 (Jacobsson and Asplund 2000). Treated wood used in construction of buildings might still exist to a considerable extent while other wood might already have entered end of life.

In addition to PCNs, other POPs have been used in wood treatment such as pentachlorophenol (PCP and PCP-Na), DDT, dieldrin, endosufan, hexachlorocyclohexane/Lindane, mirex and PCBs. In an inventory of treated wood, all other POPs used for wood impregnation could be addressed and managed.

Stakeholders in the inventory should include institutes specialized for wood and treatment of wood, the wood and construction industry and the ministry of agriculture/forestry and construction.

In the initial assessment of an inventory of PCNs and other POPs in treated wood, the chemicals used in wood treatment in the history in the country should be retrieved from the respective institutions such as the ministry of agriculture or forestry and the ministry of construction as well as institutes and industries working with wood and treatment of wood. The following information should be gathered:

(a) The time span when PCNs (as well as PCP/PCP-Na, endosulfan, lindane/HCH, DDT, dieldrin, mirex and PCBs) have been used in wood treatment in the country;

(b) Application areas of treated wood for the individual POPs (e.g. construction, furniture, railway sleepers, electricity post and cross arms, fences);

(c) The life span of the individual products and the likely current presence;

(d) Known volumes of PCNs (as well as PCP/PCP-Na, endosulfan, lindane/HCH, DDT, PCBs and other listed POPs) in the different wood treatment uses.

In a second step, compile, assess, and verify the information as to what types of wood PCNs and other POPs have been used in wood treatment in the past; how much wood has been treated; and how much of the wood still remains. In addition to the use of PCNs/POPs as preservative, PCNs has also been used in paints on wood.

For the inventory, the total amount of treated wood should be estimated based on the use volume of PCNs and other POPs wood preservatives, the time when PCNs were used and the lifetime of the major applications.

The recycling and end of life treatment of wood should be assessed. It is of particular relevance that wood treated with PCNs, PCBs, PCP/PCP-Na and other POPs are not recycled into furniture (including particle boards) or as wood chips for bedding for food animals and other animals. Such recycling has resulted in the contamination of eggs (Brambilla et al. 2009). When assessing the quantities of wood treated with PCNs, PCBs, PCP and other POPs, information on recycling of such wood into wood bedding for food animals, production of toys and furniture (e.g. particle board, oriented strand board) should also be collected to determine approaches to prevent such recycling.

An assessment of thermal treatment of treated wood may be conducted to determine whether the treated wood is destroyed in specific waste wood incinerator with environmentally sound management of residues or it is destroyed together with virgin wood in biomass incinerator where often the ashes are recycled as fertilizer for agriculture or other land uses. Ashes from burning waste wood can be extremely contaminated with unintentional POPs including polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/PCDF) with levels as high as 100 µg TEQ/kg for fly ashes in the dust filter (Bai et al. 2016).

(f) PCNs in open applications not considered of contemporary relevance

Former uses of PCNs in this chapter are not considered relevant for inventory purposes since the related products have entered end of life decades ago and are in landfills or have been released to the environment. Since PCNs are partly releases from landfills (Environment Canada 2010, 2011) it might be useful to have a rough estimate how much PCNs and other POPs are disposed to landfills and their current and future relevance (Weber et al. 2011) also when considering that landfill mining is becoming more popular and might result in recovery of POPs (Torres et al. 2013).

Oils in open applications

PCNs have formerly been used in a range of oils in open or semi-open applications such as additives in lubrication oils in gear and machinery, cutting oils, engine oil additive and refracting index testing oils (IPCS 2001; Jakobsson and Asplund 2000, Haskoning 2002). Since those uses has ceased several decades ago, all or almost all of these oils have become wastes. Sites where such oils have been used and recycled in the 1930s to 1980s might be contaminated with PCNs and PCBs.

Minor amounts of PCNs might still be present in waste oils and through recycling, in particular in transformers. When conducting monitoring for PCNs in waste oils, it is recommended that PCBs and SCCPs are also measured together.

The sites where such oils have been produced or used in history might be contaminated with PCNs, PCBs, SCCPs and mineral oils. This should be addressed in the inventory of contaminated sites.

Papers

PCNs have formerly been used in papers to attain waterproofing and flame resistance and in binders for papers (Jacobsson & Asplund 2000). Due to the relatively short half-life of impregnated papers, such materials have already entered end of life. The production sites of impregnated papers might have been contaminated with PCNs as well as other POPs such as PCBs and PFOS. Those POPs potentially used in impregnated papers should be considered when undertaking an assessment of contaminated sites.

Textiles

PCNs have formerly been used in textiles to attain waterproofing, flame resistance and protection against insects, moulds and fungi (Jacobsson & Asplund 2000). Due to the relatively short lifetime of textiles of 1 to 10 years (International Fabricare Institute 1988) such materials have already largely entered end of life. In many countries textiles end up in landfills.

The production sites of impregnated textiles for water proofing and flame retardation might have been contaminated with PCNs as well as other POPs such as PCBs, PFOS, HBCD, PBDEs and SCCPs. Those POPs potentially used in impregnated textiles should be considered when undertaking an assessment of contaminated sites.

Battery separators

PCNs have formerly been used in separators in batteries before 1970s (Jacobsson & Asplund 2000). Due to the relatively short lifetime of batteries of less than 10 years, PCNs in this use have already entered end of life and have mainly be disposed to landfills or entered recycling.

The production sites of batteries in the 1930s to 1970s might have been contaminated with PCNs as well as other pollutants in particular heavy metals (e.g. cadmium, lead, mercury, zinc).

Specific military use

In addition to paints in ships (Redfield et al. 1952) PCNs have been used in some specific areas in military e.g. fog ammunition/smoke grenades (Generalstab Schweizer Armee 1945; EMPA 2006) and inert artillery and mortar projectiles (Hewitt et al. 2011; Clausen et al. 2004).

In 1940s it has been discovered that the use of PCNs in fog ammunition can result in large contamination of the environment and food animals (Generalstab Schweizer Armee 1945; EMPA 2006). This use most likely ended in the 1970s. Due to the relatively short lifetime of batteries of less than 10 years, PCNs in this use have already entered end of life and have mainly be disposed to landfills or entered recycling.

The soil at sites where such ammunition has been used might be contaminated with PCNs. At these sites PCNs and other pollutants related to military activities should be considered when undertaking an assessment.

3.2.4 Unintentionally produced PCNs

(a) Background and link to UNEP Toolkit

PCNs are unintentionally formed and released by thermal and other processes (Liu et al. 2014; UNEP 2012) and are subject to the requirements of Article 5 and Annex C to the Convention.

To assist Parties in the development of the inventories of the unintentionally produced POPs listed in Annex C to the Convention, the "Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs under Article 5 of the Stockholm Convention on Persistent Organic Pollutants (Toolkit)" has been developed (see http://toolkit.pops.int/).

PCNs are unintentionally formed together with other unintentional POPs such as PCDD/PCDF. PCDD/PCDF releases and are accompanied by releases of other unintentional POPs listed in Annex C, which can be minimized or eliminated by the same measures that are used to address PCDD/PCDF releases. When a comprehensive inventory of PCDD/PCDF is elaborated, it allows the identification of priority sources, setting of measures and development of action plans to minimize releases of all unintentional POPs. The Toolkit recommends, for practical reasons, that inventory activities be focused on PCDD/PCDF, as these substances are indicative of the presence of other unintentional POPs. They are considered to constitute a sufficient basis for identifying and prioritizing sources of all such substances as well as for devising applicable control measures for all Annex C POPs and for evaluating their efficacy.

For a number of sources such as waste incineration, other combustion processes or metal industries PCN emissions are reduced by the same measures applied to reduce PCDD/PCDF.[10]

This chapter provides some information on some major sources of unintentionally produced PCNs. More information on inventories of unintentional POPs pursuant to Article 5 and Annex C can be found in the Toolkit (http://toolkit.pops.int/)

(b) Unintentional PCNs in industrial PCB mixtures

Unintentional PCNs are present in technical PCB mixtures at levels between ca. 40 to 1300 mg/kg (Table 7). The levels of PCNs in PCB mixtures are below 1%.

Table 7: Estimated unintentional production of PCNs from technical PCB mixtures

Country	PCB mixture	PCB production (tonnes)	Mean PCN concentration (mg/kg)	Amount of PCNs in PCBs (kg)	Reference
US	Aroclors	435,100	39	16,969	Yamashita et al. 2000
UK	Aroclors	66,748	39	2,603	Yamashita et al. 2000
Japan	Kanechlors	59,119	84	4,966	Yamashita et al. 2000
Germany	Clophens	123,552	95	11,737	Yamashita et al. 2000
France	Phenochlors	201,679	298	60,100	Yamashita et al. 2000
Former USSR	Sovol	100,000	730	73,000	Yamashita et al. 2000
CZ	Delors	21,500	171	3,677	Taniyasu et al. 2003
China	PCB-3	6,000	1,300	7,300	Huang et al. 2015
Total		**1,013,698**		**180,352**	

PCNs may exist as unintentional contaminants in PCB transformer oils since commercial PCBs contained traces of PCNs (0.01–0.09% of PCB content; Falanysz 1998, Huang et al. 2015; Kannan et al. 2000, Yamashita et al. 2000).

Most of the assessments of transformer oils containing PCBs have been conducted using test kits which measure the total amount of chlorine of PCBs such as Clor-N-Oil or Dexsil test. Within those assessments, PCNs are also tested positive through the same mechanism as PCBs and could be managed accordingly.

(c) Unintentional PCNs in the production of chlorinated solvents

Unintentional POPs are formed in the production of chlorinated solvents where the smaller organochlorine compounds undergo condensation reactions and build-up of aromatic compounds including unintentional POPs (UNEP 2015b). High levels of unintentional POPs like hexachlorobenzene and PCNs are formed in the production of chlorinated solvents such as tetrachloroethylene, trichloroethylene and ethylene dichloride (Mumma and Lawless 1975; Weber et al. 2011; Zhang et al. 2015). A first total screening of unintentional POPs in the production of chlorinated methanes in China revealed the formation of high levels of PCNs and PCBs, leading to estimated unintentional PCN production of 427 kg/year (563 g TEQ/year) for 2010 (Zhang et al. 2015). High levels of hexachlorobutadiene (HCBD) can be formed in these processes (UNEP 2015b; UNEP 2017d).

[10] The reduction of PCNs by air pollution control measures can be expected slightly lower compared to reduction of PCDD/PCDFs due to the higher volatility of PCNs compared to PCDD/PCDFs as has been found for the PCBs (Sakuarai et al. 2003).

In the production, solvents are distilled and the unintentional POPs are separated from the solvents. The distillation results in residues with high boiling points “heavy ends” including the unintentional POPs like PCNs, PCBs and HCBD (UNEP 2015b; Zhang et al. 2015).

For the inventory, factories producing chlorinated solvents or having produced chlorinated solvents in the past should be approached and inventories of distillation residues should be developed. This could include:

(a) The current and historic produced amount of distillation residues from these processes;

(b) The amount of PCNs and other POPs in the respective distillation residues (see Zhang et al. 2015);

(c) The current management of these residues including destruction or disposal practice;

(d) The historic management practice of these residues including destruction and disposal practice.

For a Tier II inventory the qualitative and quantitative information on the respective organochlorine solvent production should be gathered without doing actual measurement of POPs in the residues.

For Tier III inventory measurements of residues from chlorinated solvents should be analysed for PCNs and other unintentionally produced POPs.

(d) Unintentional PCNs in the production of chlorinated paraffins

Chlorinated paraffins are produced by chlorination of C10–C30 n-alkanes from petroleum using molecular chlorine, either of the liquid paraffin or in a solvent, typically carbon tetrachloride. Depending upon the n-alkane feedstock, the reaction takes place at temperatures between 50 and 150 °C, at elevated pressures and/or in the presence of UV light (Kirk-Ottmer 1991).

A first assessment of unintentional POPs in chlorinated paraffins revealed that chlorinated paraffins can contain high levels of PCBs and PCNs as well as PCDFs (Takasuga et al. 2012a,b; UNEP 2013). The chlorination pattern of the PCBs and PCNs indicated that they had been formed by chlorination of biphenyl and naphthalene (Takasuga et al. 2012 b) and that they were likely present in the feedstock.

Total amount of unintentionally PCNs in the CP were 40 mg/kg, slightly lower compared to the PCB concentration (Takasuga et al. 2012 b).

For a Tier II inventory, factories producing chlorinated paraffins should be approached for information including:

(a) The amount of PCNs and other unintentional POPs in the chlorinated paraffin products;

(b) The amount of PCNs and other unintentional POPs in residues from chlorinated paraffin production;

(c) The current and historic amount of residues;

(d) The current management of these residues including destruction or disposal practices;

(e) The historic management practice of these residues including destruction and disposal practices;

For Tier III inventory products and residues from the respective producers should be analysed for PCNs and other unintentionally POPs.

(e) Unintentional PCNs in the production of chlorine

High levels of PCNs have been formed during production of chlorine via chloralkali electrolysis formed together with PCDD/PCDFs and other unintentional POPs (Brack et al. 2003; Kannan et al. 1998; Weber et al. 2008). The highest levels of unintentional POPs were formed from chloralkali processes using graphite electrodes in particular when they use pitch-binders produced from coal tar containing high levels of polyaromatic hydrocarbons which were chlorinated during this process and served as precursors (Otto et al. 2006). Since naphthalene is present in coal tar in an order of magnitude higher than dibenzofuran, the levels of PCNs in such residues from chloralkali electrolysis can be considerably higher than that of dibenzofuran

Most chloralkali electrolysis has stopped the use of graphite electrodes more than 20 years ago. Therefore the unintentional POPs production in these industries has been reduced with significantly lower emission factors for PCDD/PCDF (UNEP 2013). It is not known to which extent such processes produce PCNs.

For a Tier II inventory qualitative and quantitative information on the respective chloralkali sector should be gathered without doing measurement of POPs in the residues. The information could include:

(a) Amount of residues generated by chloralkali production per year;

(b) Available data on pollutants in the residues;

(c) Historic residues from chloralkali production with emphasize on sludges from graphite electrodes;

(d) Treatment of the residues including thermal treatment and disposal.

For Tier III inventory measurements of residues could be analysed for PCNs and other unintentional POPs.

(f) Unintentional PCNs in thermal processes

PCNs are formed together with PCDD/PCDFs in thermal processes such as incineration or metal industries by the same mechanism (Imagawa et al. 2001; Weber et al. 2001). The total concentration of PCNs in waste incineration are in the same order of magnitude as PCDD/PCDFs with somewhat higher levels of PCNs in the gas phase (Takasuga et al. 2004) and similar levels in fly ash (Imagawa et al. 2001). Preliminary emission factors are compiled for major thermal sources in Table 8.

Table 8: Preliminary emission factors of unintentionally PCNs from some measured sources

Sources (release vector)	Emission factor (µg/t)	References
PCBs (technical mixture)	39,000,000 – 1,300,000,000	Yamashita et al (2000); Huang et al. (2015)
Chlorinated paraffins (product)	40,000,000	Takasuga et al. (2012b)
Tetrachloromethane production (waste)	4,750,000	Zhang et al. (2015)
Iron ore sintering (air)	14–1749	Liu et al. (2012d)
Electric arc furnace (air)	1970–4475	Liu et al. (2012c)
Cement kiln (air)	242	Liu et al. (2011)
Secondary copper smelting (air)	141–9154	Ba et al. (2010), Nie et al. (2012a)
Secondary aluminum smelting (air)	575–13610	Ba et al. (2010)
Secondary zinc smelting (air)	3431	Ba et al. (2010)
Secondary lead smelting (air)	1336	Ba et al. (2010)
Primary copper smelting (air)	11.2–69.0	Nie et al. (2012a)
Primary magnesium smelting (air)	3329	Nie et al. (2011)
Cooking process (air)	5.1–50.3	Liu et al. (2010)
Thermal wire reclamation (air)	2715–8650	Nie et al. (2012b)
Municipal solid waste incineration (air)	71–53253	Guo et al. (2008): Takasuga et al. 2004
Municipal solid waste incineration (ash/waste)	1-2000	Noma et al (2004); Imagawa et al (2001)
Municipal solid waste incineration (slag)	0.1 - 1	Noma et al (2004);
Medical waste incineration (air)	981	Guo et al. (2008)
Medical waste incineration (ash/waste)	5400	Helm et al. (2003)
Hazardous waste incineration (air)	269–5763	Guo et al. (2008)

3.3. Import and export of PCNs

3.3.1. Import and export of PCNs for exempted use

Until such time that the production and use specific exemptions[11] are in effect for PCNs, the chemicals may be exported or imported by Parties that are registered for those specific exemptions (see Guidance for the control of the import and export of POPs, UNEP 2012b). Such imports and exports should be recorded in the inventory including the volumes.

Information on exports could be gathered from the chemical industry or associations that are producing or using PCNs, and possibly from customs. The information obtained should be included in the inventory.

Currently PCNs do not have specific Harmonized System (HS) codes; therefore HS codes cannot be used for assessing imports of PCNs at the moment. For the PCN mixtures, CAS numbers and trade names may be used for the search at the custom level (see Table 2 and Table 5).

[11] Production of PCNs as intermediates in chemicals for the production of PFNs, including octafluoronaphthalene and use of PCNs for the production of PFNs, including octafluoronaphthalene.

Care should be taken to avoid double counting any import, export and use of PCNs when documenting the life cycle. For example by not double counting the volumes of the imported PCNs and further use of PCNs in production of PFNs and to clearly document this in the report. Since the imported PCNs should only be used for the production of PFNs, no additional PCNs should remain in the country. It is still useful to quantify the amount of PCNs used for the production of PFNs as a proof that the produced or imported PCNs have only been used for the exempted purpose.

3.3.2. Import and export of PCNs in products and articles

PCNs in products and articles should not be imported or exported after the entry into force of the amendment. The use of PCNs in articles and products has stopped in the 1980s and 1990s with the exemption of PCN use in chloroprene rubber which continued until 2000. There is no indication that PCNs are intentionally used in products or articles today. Import and export of new products are not considered to contain intentional PCNs (for unintentional PCN contamination in chemicals and products).

Imported secondhand equipment might still contain PCNs. From the former uses (see Table 5) in particular transformers and capacitors have long service lives and therefore imported used transformers and capacitors might still contain PCNs. Since such imported used equipment should anyway be screened for PCB contamination, the PCNs could also be detected.

3.3.3. Import and export of PCNs in wastes

Import and export of PCN-containing wastes may take place for the purpose of environmentally sound disposal in accordance with the Basel Convention procedures for transboundary movement of hazardous wastes. A "*Draft updated technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with polychlorinated biphenyls, polychlorinated terphenyls, polychlorinated naphthalenes or polybrominated biphenyls*" has been developed (UNEP 2016). In this Basel guideline waste categories possibly containing or contaminated with PCNs (or PCB)[12] have been compiled (UNEP 2016; Table 9). Annex I lists some of the wastes which may consist of, contain or be contaminated with PCNs (and PCB/PCT). List A of Annex VIII includes a number of wastes or waste categories that have the potential to contain or be contaminated with PCNs (or PCBs) (see Table 9; UNEP 2016). List B of Annex IX of the Basel Convention includes some wastes or waste categories that have the potential to contain or be contaminated with PCNs (Table 9).

The import and export of such wastes should be recorded in the inventory including detailed description of the wastes and information on the respective environmentally sound disposal.

Notifications of import and export of wastes listed in the Basel Convention includes in the respective Basel categories in the import/export procedure documents. This information can be used for the inventory purpose of potentially PCN contaminated waste imports or exports. The notifications might include specific information on PCN, PCB or other POPs content.

For a Tier III inventory, selected imported/exported waste fractions with high risk of PCN contamination such as category Y5, Y 10, Y12, Y45, A1090, A1100; A1190; A3040; A3180; A3180 could be analysed for PCN content.

Table 9: Basel Convention waste categories that might contain or be contaminated with PCNs (UNEP 2017b)

Basel Conv. Annex category	Category	Type of waste
Annex 1	Y5	Wastes from the manufacture, formulation and use of wood preserving chemicals;
	Y6	Wastes from the production, formulation and use of organic solvents;
	Y8	Waste mineral oils unfit for their originally intended use
	Y9	Waste oils/water, hydrocarbons/water mixtures, emulsions;
	Y10	Waste substances and articles containing or contaminated with PCBs and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs);
	Y11	Waste tarry residues arising from refining, distillation and any pyrolytic treatment
	Y12	Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish

[12] Since the amount of industrial PCBs is ca. 10 times largest than PCNs, the major contaminants are normally PCBs.

Basel Conv. Annex category	Category	Type of waste
	Y13	Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives)
	Y18	Residues arising from industrial waste disposal operations;
	Y41	Halogenated organic solvents.
	Y45	Organohalogen compounds other than substances referred to in this Annex (e.g. Y39, Y41, Y42, Y43, Y44)
List A of Annex VIII	A1190	Waste metal cables coated or insulated with plastics containing or contaminated with coal tar, PCBs, lead, cadmium, other organohalogen or Annex I compounds to exhibit Annex III characteristics;
	A1090:	Ashes from the incineration of insulated copper wire;
	A1100:	Dusts and residues from gas cleaning systems of copper smelters;
	A3040	Waste thermal (heat transfer) fluids;
	A3160	Waste halogenated or unhalogenated non-aqueous distillation residues arising from organic solvent recovery operations;
	A3170	Wastes arising from the production of aliphatic halogenated hydrocarbons
	A3180	Wastes, substances and articles containing, consisting of or contaminated with PCBs, PCT, PCNs, PBB, or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg* or more;
	A4140	Waste consisting of or containing of specification or outdated chemicals corresp. to Annex I categories and exhibiting Annex III haz. characteristics;
List B of Annex IX	B1040	Scrap assemblies from electrical power generation not contaminated with lubricating oil, PCB or PCT to an extent to render them hazardous;
	B3040	Rubber wastes ((i) Waste and scrap of hard rubber (e.g., ebonite); (ii) Other rubber wastes (excluding such wastes specified elsewhere).

3.4 Site potentially contaminated by PCNs

All sites where PCNs have been produced or used, for any of the activities described in this guidance, could be potentially contaminated with PCNs. High releases and contamination at (former) PCN production sites to air (25–2900 ng/m3) water (up to 5500 ng/l) and soil (up to 1300 mg/kg) has been reported (USEPA 1977; IPCS 2001) much higher compared to other areas (Table 10). This indicates past pollution and possible current contamination at and around PCN production sites. PCN contamination at chloralkali production sites in mg/kg in soils and sediments have been documented (Bavel et al. 1999; Brack et al. 2009; Kannan et al. 1998) (Table 10).

For PCBs, more detailed contemporary assessment of former production and use sites have been compiled revealing considerable level of contamination (Donato et al. 2006; Kocan et al. 2001; USEPA 2016) with related exposure to the food chain and of humans in the surrounding environment (Turrio-Baldassarri et al. 2008, 2009; Wimmerova et al. 2015).

Landfills in which wastes containing PCNs have been disposed of can be considered a contaminated site with releases of PCNs in leachates and landfill gas (Environmental Canada 2010).

Table 10: PCN levels in environmental matrices impacted and not impacted by industrial sources

Sample matrix	Level of PCN contamination	References
Soil at (former) PCN production site	1300,000 µg/kg	USEPA 1977
Soil at chloralkali plant	7,400 – 18,000 µg/kg	Bavel et al 1999; IPCS 2001
Soil at electric arc furnace	10 µg/kg	Odabasi et al. 2017
Soil (background)	0.003 µg/kg	Odabasi et al. 2017
Sediment at chloralkali plant	260 – 23,000 µg/kg	Järnberg et al. 1997 Kannan et al. 1998
Sediment (background)	0.2 µg/kg	IPCS 2001
Sewage sludge (China)	1 – 11 µg/kg	Zhang et al. 2014
Surface water (production site)	up to 5500 ng/l	USEPA 1977
Air at workplace (e.g. using PCN containing beranit for casting mould)	14,500,000 ng/m^3	IPCS 2001
Ambient air at PCN production site	25–2900 ng/m^3	USEPA 1977
Ambient air at electric arc furnace	1.6 ng/m^3	Odabasi et al. 2017

Sample matrix	Level of PCN contamination	References
Ambient air across Ghana	0.027 – 0.095 ng/m^3	Hogarh et al. 2012
Air at e-waste recycling (Ghana)	0.38 ng/m^3	Hogarh 2016
Air background	0.001 – 0.040 ng/m^3	IPCS 2001

3.4.1 Contamination at (former) production sites of PCNs

Major POPs contaminated sites are at and around respective POPs production sites (Kocan et al. 2001; USEPA 2016; Weber et al. 2008; Vijgen et al 2011). Most companies having produced PCNs historically have stopped production decades ago. Some companies might still continue to produce PCNs for the exempted uses as intermediate for the production of fluorinated naphthalenes. High releases and contamination at (former) PCNs production sites to air (25–2900 ng/m^3) water (up to 5500 ng/l) and soil (up to 1300 mg/kg) has been reported (USEPA 1977; IPCS 2001). This indicates past pollution and possible current contamination at and around PCNs production sites.

From recent monitoring it is known that for former production companies of PCBs - having similar volatility as PCNs - the production sites and surroundings can be highly contaminated (Donato et al. 2006; Kocan et al. 2001; USEPA 2016; Wimmerova et al. 2015). It has been found that the wider environment around such production sites has been contaminated including the food chain in the local surroundings (Turrio-Baldassarri 2007, 2009) with elevated levels reported in humans (Turrio-Baldassarri et al. 2008; Wimmerova et al. 2015).

The largest volume of POPs at former production sites are normally stored at landfills from the disposal of production waste (Götz et al. 2012; Weber et al. 2011; Vijgen et al. 2011).

The food chain in the area with a radius of ca. 10 km[13] could be assessed for PCN contamination and exposure risk (Table 11).

3.4.2 Sites where PCNs have been used

Contamination by POPs is found at and around factories where the respective POPs have been used for the manufacturing of goods or used within production processes. Factories which have used PCNs in the manufacturing of equipment such as production of transformers and capacitors/condensers or used in production processes such as cutting oils can have resulted in contamination at and possibly around the site (USEPA 1977; Table 11).

From the removal of PCBs containing paints from bridges and other metal construction it is known that related PCBs contamination of the wider environment has occurred (Jartun et al. 2009; ELSA 2016). PCNs have also been used for paints on metal construction and therefore at sites where such paints are removed, e.g. by sand blasting or air blasting, PCNs contaminated sites can be generated. Contaminated sites might be at ship yards where paints of ships are, or have been, removed which is normally done by abrasive blasting with related release of pollutants.

Military areas can be contaminated with PCNs where fog ammunition and inert artillery or mortar projectiles with PCNs have been used (Clausen et al. 2004; Hewitt et al. 2011; Generalstab Schweizer Armee 1945). While the majority of use of such PCN-containing ammunition might have taken place on specific military areas, the fog ammunition has partly been used outside military areas in the past (Generalstab Schweizer Armee 1945).

Please note: For most of uses of PCNs also other POPs has been used in particular PCBs (e.g. transformers, capacitors, paints, cutting oils) or PCP (wood treatment) or DDT (ship paint). At the respective potentially contaminated sites all POPs which have potentially contributed to contamination could be monitored.

3.4.3 Sites where waste containing PCNs have been disposed of

Dump sites and landfills where PCNs containing waste has been disposed are potentially contaminated. Environmental Canada detected PCNs in all assessed landfill leachates (Environment Canada 2010). Higher contamination is expected at landfills from (former) production and use sites and related landfills and could be assessed as priority sites.

In addition, some production waste of certain organochlorine production processes can contain high levels of unintentional PCNs. Particular high levels of PCNs were and are generated in certain organochlorine solvent productions such as chloromethanes, trichloroethene or tetrachloroethene (Lysychenko et al. 2016; UNEP 2015b; Zhang et al 2015) or in chloralkali production (Brack et al 2003; Kannan et al. 1998). Landfills and dump sites where

[13] Higher PCB levels were detected in humans up to 50 km in the prevailing wind direction of a former PCB factory (Wimmerova et al. 2013). Therefore at least 10 km around production plants and related landfills should be assessed for impact on the environment and the food chain.

waste from organochlorine solvent productions or chloralkali electrolysis has been disposed can be considered PCN contaminated. The level of contamination depends on the volumes of disposed waste and the respective disposal practice in the past. The sites are also contaminated with other unintentional POPs such as HCB, PeCBz, PCDD/F and HCBD (Lysychenko et al. 2015; UNEP 2015b).

Table 11: Potential PCN-contaminated sites along the life cycle of PCNs

Live cycle stage; Sector	Activities	Locations (potential other POPs/PBT)
PCN production	(Former) Production	Production site (other POPs produced at the site and UPOPs)
	Disposal of waste from PCNs production	Landfills related to waste from production (other POPs produced at the site and UPOPs)
	Former water discharge from production sites	River sediment and flood plains related to releases from production site (other POPs produced at the site)
Sites where PCNs have been used in production (ca. 1930s to 1990s)	Production of transformer and condenser	Site of production; Landfill site of related wastes; Impacted surface waters (sediment and flood plains) (PCBs)
	Production of chloroprene/Neoprene industry (formerly) using PCNs (used until early 2000)	Site of production; Landfill site of related wastes; Impacted surface waters (sediments and flood plains)
	Production of paints and coatings	Sites of production (PCBs; SCCP; heavy metals)
	Production of impregnated textiles and paper	Site of production; Landfill site of related wastes; (PCBs; PFOS; SCCP)
	Other uses of PCNs in production processes (cutting oils, heat exchange oils; lubricants; solvents in chemical production)	Sites where PCNs were used in these productions Landfill site of related wastes; (PCBs; SCCP)
	Wood treatment	Wood treatment sites (PCP; endosulfan; HCH; DDT; mirex)
Use of PCN-containing materials	Paints for buildings, bridges, towers and other metal construction and related removal	Sites where PCN paints have been used and have been removed. Soil impacted from buildings, bridges (PCBs, lead, Cd)
	Ship painting and paint removal	Docks where ships were painted and repainted (PCBs; DDT; Sn-organics)
	Use of PCNs in smoke grenades, fog ammunition and artillery and mortar projectiles.	Soil/environment at military sites where smoke grenades, inert artillery and mortar projectiles were used.
Unintentional PCNs (specific productions)	Chlorinated solvent production and related residues (“HCB waste” containing PCNs)	Disposal sites of residues from chlorinated solvent production and EDC production (HCB; HCBD; PCDD/F)
	(former) chloralkali production	Chloralkali sites and sites were residues where disposed (e.g. graphite electrode sludge) (PCDD/F)
End-of-life treatment	Electric Arc furnaces treating PCNs (and PCBs) painted scrap	Recycling areas and landfills with deposited wastes (PCBs)
	Ship scrapping/dismantling	Ship scrapping areas (PCBs; DDT; Sn-organics)
	Open burning or non-BAT incineration of PCNs-containing waste	Related sites and sites were residues/ashes are disposed
	Former application of PCN impacted sludge	Application/agricultural land

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Appendix 1: Questionnaire for compiling information on the current and former production of polychlorinated naphthalenes (PCNs)

1) Background information

In May 2015, the Conference of the Parties (COP) amended the Stockholm Convention on persistent organic pollutants (POPs) to add polychlorinated naphthalenes (PCNs) to Annex C and Annex A of the Convention, with specific exemption[1] for production and use of PCN as intermediate for the production of polyfluorinated naphthalenes (PFNs), as provided in Annex A of the Convention (decision SC-7/14; United Nations 2015).

The listing includes dichlorinated naphthalenes, trichlorinated naphthalenes, tetrachlorinated naphthalenes, pentachlorinated naphthalenes, hexachlorinated naphthalenes, heptachlorinated naphthalenes, octachlorinated naphthalenes. Therefore monochloronaphthalene (Mono-CNs) can be produced and used[2].

Pursuant to paragraph 4 of Article 21 of the Convention, the amendment was communicated by the depositary to all Parties and on 15 December 2015, one year after notification, the amendment listing PCNs in Annexes A and C to the Stockholm Convention enter into force for most Parties[3].

Like all POPs, these chemicals possess toxic properties, resist degradation, and accumulate in the environment and bioaccumulates including contamination of humans.

Parties to the Convention have to meet the obligations under the Convention leading to the elimination of PCNs for the production and use and countries have to manage former articles and products.

2) Aim of the questionnaire

In principle, this questionnaire is aimed at gathering information on the former and current production of PCNs. This information will be very valuable in order to assess the current situation and will constitute the basis for the country to propose further actions for PCN elimination to be included within the update of the National Implementation Plan of the country.

1. Name and address of industry:

Name of industry/company or institution	Address

[1] Each Party to the Convention needs to submit a notification on its intention to use for the time-limited specific exemption (5 year starting with December 2016, after which Parties need to switch to alternatives to PCNs) for production and use of PCN as intermediate for the production of polyfluorinated naphthalenes, as provided in Annex A of the Convention.

[2] Mono-CN containing listed PCNs might be restricted from use depending on the total POPs concentration.

[3] Amendments shall not enter into force for those Parties that have submitted a **notification** pursuant to the provisions of paragraph 3(b) of Article 22 of the Stockholm Convention. In accordance with paragraph 4 of article 22, the amendment will not enter into force with respect to any Party that has made a **declaration** regarding the amendment to the Annexes in accordance with paragraph 4 of Article 25. Such Parties shall deposit their instruments of ratification regarding the amendment, in which case the amendment shall enter into force for the Party on the ninetieth (90) day after the date of deposit with the Depositary.

2. Type of company or industry

□Current production

□Historic production

3. If you are currently still producing PCNs, please specify below the reasons for continuing PCN production.

□As intermediate for the production of polyfluorinated naphthalenes (PFNs)

□For other purposes. Please specify for what use…………………………………………………………………………………….

In case you produce PCNs for PFN production: Are there alternatives available to produce PFNs?

………
………
………
……

In case there are alternative synthesis methods for PFNs. What are the reasons that you do not use the alternative synthesis methods?

………
………
………
……

4. Former and current production of polychlorinated naphthalenes (PCNs)

PCNs mixtures **(please specify the PCN homologue composition and/or chlorine content)**	**Trade names**	**Years of production (from and until)**	**Total volume (tonnes) produced**	**Total volume (tonnes) traded at national level**	**Total volume (tonnes) exported**

If possible provide detailed information on the former yearly production (can be provided in a separate sheet).

If information on the respective further uses are known

5. (Former) Waste management of production residues

□Recycling in the following processes: ……………………………………………………………………………………………......

□Incineration (name/address of facility):……………………………………………………………………………………………

□Open burning (location)………

□Landfilling (name/address of site):……………………………………………………………………………………………….

6. Possible contamination from the (former) production of PCNs

Location	Type of contamination	Type of activity at the location	Have the site been investigated?	Levels of PCNs, and other POPs (if available)
At production site				
Around production site				
At associated landfills				

7. Further Remarks

8. Information on respondent

Name	
Department	
Position	
Telephone	
Mobile Phone	
Email Address	
Signature	
Date	

Appendix 2: Questionnaire for compiling information on the former use of polychlorinated naphthalenes (PCNs) and polychlorinated biphenyls (PCBs) in open applications

1) Background information

In May 2015, the Conference of the Parties (COP) amended the Stockholm Convention on persistent organic pollutants (POPs) to add polychlorinated naphthalenes[1] (PCNs) to Annex A, with specific exemption and Annex C of the Convention (decision SC-7/14; United Nations 2015). Pursuant to paragraph 4 of Article 21 of the Convention, the amendment was communicated by the depositary to all Parties and on 15 December 2015, the amendment listing PCNs in Annexes A and C to the Stockholm Convention entered into force for most Parties.

Polychlorinated biphenyls (PCBs) are also listed in the Stockholm Convention and have been used in similar ways as PCNs in open applications. Bboth POPs groups are addressed in this questionnaire. Where appropriate information on other POPs can also be gathered with this questionnaire.

Like all POPs, these chemicals possess toxic properties, resist degradation, accumulate in the environment and bioaccumulates including contamination of humans.

Parties to the Convention have to meet the obligations under the Convention leading to the elimination of PCNs and PCBs for the production and use and countries have to manage former articles and products.

2) Aim of the questionnaire

In principle, this questionnaire is aimed at gathering information on the former use of PCNs and PCBs in the following products (open applications), namely:

- Cables/cable [2];
- Paints[3];
- Sealants/caulks and putty[4];
- Chloroprene rubber;
- Wood preservatives[5].

As for the above mentioned applications sometimes other POPs were used, when gathering the relevant information on PCNs and PCBs, information on the other POPs can also be compiled.

This information will be very valuable in order to assess the current situation and will constitute the basis for the country to propose further actions for PCNs elimination to be included within the update of the National Implementation Plan of the country.

A. Former use of PCNs and PCBs in cables (as flame retardant, plasticiser and impreganation)

1. Name and address of industry:

Name of industry/company or institution	Address

2. Type of company or industry:
□ Production of:

[1] Including dichlorinated naphthalenes, trichlorinated naphthalenes, tetrachlorinated naphthalenes, pentachlorinated naphthalenes, hexachlorinated naphthalenes, heptachlorinated naphthalenes, octachlorinated naphthalene.

[2] Other POPs like PCBs and PBDEs have been used as flame retardants in cables.

[3] Paints were a major open application for PCBs until the 1970s/1980s (Jartun et al. 2009; Wagner et al. 2014).

[4] Sealants/caulks in buildings/construction has been a major open application (USEPA 2015; Wagner et al. 2014) for PCBs.

[5] In addition to PCNs, other POPs have been used in wood treatment such as pentachlorophenol (PCP and PCPNa), endosulfan, hexachlorocyclohexane/lindane and mirex.

□ Electrical cables □ PVC □ Lead jacket □ Cable sheaths

□ Recycling of:
□ Electrical cables □PVC □Lead jacket □ Cable sheaths

3. Former use of PCNs, PBDEs and PCBs in production of cables

Production of cables		PCN Content (%)	PBDE Content (%)	PCB content (%)	Years of production (from and until)	Total volume of PCNs/PCBs/PBDEs (tonnes) used in cable production
Electrical cables	PVC					**………t/………t/………t**
	Lead jacket					**………t/………t/………t**
	Other cables					**………t/………t/………t**
Cable sheaths						**………t/………t/………t**

4. If no PCNs (PBDEs and PCBs) where used as flame retardants in cable production, please describe below what alternative flame retardants have you used in cables:

Flame retardants used:………

5. Recycling and end-of-life management of cable possibly containing PCNs, PBDEs or PCBs
□ Recycling of cables □ Thermal recovery □ Cable stripping □ Extruding and pelleting

Are contaminants such as PCNs, PBDEs and PCBs considered in the recycling of cables?
□Yes □No

If yes, how are PCNs/PBDEs/PCBs eliminated in recycling (please describe below)?
………
………
……

Cables recycled (tonnes)	**PCNs, PBDEs and PCBs present or absent and content (ppm)**	**Products made from recycling (tonnes)** **Related PCNs, PBDEs and PCBs content (ppm)**	**Waste generated during recycling (tonnes)** **Related PCNs, PBDEs and PCBs content (ppm)**

6. Destruction and disposal of cables
□ Incineration (name/address of facility):………………………………………………………………
□ Open burning (location):……………………………………………………………………………
□ Landfilling (name/address of site):…………………………………………………………………

B. Former use of PCNs and PCBs in paints and coatings (as plasticizer, flame retardant and anti-corrosion)

1. Name and address of industry:

Name of industry/company or institution	Address
0	

2. Type of company or industry:

Production of:

□ Chloroprene paints and lacquers

□ PVC copolymer paints

□ Other types of paints and coatings: (Please describe here)………………………………

3. Former use of PCNs and PCBs in production of paints and coatings

Production of paints	**Application areas of paints and coatings produced**	**PCN Content (%)**	**PCBs content (%)**	**Years of production (from and until)**	**Total volume of a) PCNs and of b) PCBs (tonnes) used in paints and coatings production**
Chloroprene paints and lacquers					**a)…………..t** **b)…………..t**
PVC copolymer paints					**a)…………..t** **b)…………..t**
Other types of paints and coatings: (Please describe here)					**a)…………..t** **b)…………..t**

4. In case you had no production of chloroprene paints and lacquers and PVC copolymer paints, what alternative paints and lacquers have you produced? (Please describe below)

……
……
………

5. Former waste management of production residues

□ Recycling in the following processes: ……………………………………………………

□ Incineration (name/address of facility):……………………………………………………

□ Open burning (location):………………………………………… ………………………

□ Landfilling (name/address of site):…………………………………………………………

C. Former use of PCNs and PCBs in sealants/caulks and putty

1. Name and address of industry:

Name of industry/company or institution	Address

2. Type of company or industry:

Production of:

□ Sealants/caulks
□ Putty

3. Former use of PCNs (and PCBs) in production of sealants/caulks and putty

Production of sealants/caulks and putty	**Application areas of sealants/caulks and putty produced**	**PCN Content (%)**	**PCBs content (%)**	**Years of production (from and until)**	**Total volume of a) PCNs and of b) PCBs (tonnes) used in sealants/caulks and putty production**
Sealants/caulks					**a)……………t** **b)……………t**
Putty					**a)……………t** **b)……………t**

4. If no PCNs (and PCBs) where used in sealants/caulks and putty production to impart flexibility and longer life, please describe below what alternative substances have you used in sealants/caulks and putty to impart the same properties:

Alternative substances used:………

5. Former waste management of production residues

□ Incineration (name/address of facility):………………………………………………………………
□ Open burning (location):……………………………………………………………………… …………
□ Landfilling (name/address of site):……………………………………………………………………

D. Former use of PCNs (and PCBs) in chloroprene rubber

1. Name and address of industry:

Name of industry/company or institution	Address

2. Type of company or industry:

□ Production of chloroprene rubber for:

□ Rubber belts □ Rubber belts for printers □ Conveyer belts □ Shock absorbing materials

□Recycling of chloroprene rubber from:

□ Rubber belts □ Rubber belts for printers □ Conveyer belts□ Shock absorbing materials

3. Former use of PCNs (and PCBs) in production of chloroprene rubber

Production of chloroprene rubber	**PCN Content (%)**	**PCBs content (%)**	**Years of production (from and until)**	**Total volume of a) PCNs and of b) PCBs (tonnes) used in chloroprene rubber production**
Rubber belts				**a)…………..t** **b)…………..t**
Rubber belts for printers				**a)…………..t** **b)…………..t**
Conveyer belts				**a)…………..t** **b)…………..t**
Shock absorbing materials				**a)…………..t** **b)…………..t**

4. If no PCNs (and PCBs) where used as flame retardants in chloroprene rubber production, please describe below what alternative flame retardants and what other additives do you use in rubber products:

Flame retardants used:………………………………………………………………………

Other additives used:……………………………………………………………………………

5. Former waste management of production residues

□ Recycling in the following processes: …………………………………………………………………

□ Incineration (name/address of facility):…………………………………………………………………

□ Open burning (location):………………………………………………………………………………

□ Landfilling (name/address of site):……………………………………………………………………

6. Recycling and end-of-life treatment of chloroprene rubber

Please describe below the products manufactured from recycling of chloroprene rubber.

……

Are contaminants such as PCNs and PCBs considered in the recycling of chloroprene rubber?

□ Yes □ No

How are PCNs/PCBs eliminated in recycling (please describe below)?

………

………

Chloroprene rubber recycled (tonnes)	PCNs and PCBs present or absent and content (ppm)	Products made from recycling (tonnes) Related PCNs and PCBs content (ppm)	Waste generated during recycling (tonnes) Related PCNs and PCBs content (ppm)

7. Destruction and disposal of chloroprene rubber

□ Incineration (name/address of facility):…………………………………………………………………….

□ Open burning (location):……………………………………………………………………………………….

□ Landfilling (name/address of site):…………………………………………………………………………

E. Former production and use of wood preservatives containing PCNs, pentachlorophenol (PCP and PCP-Na), endosulfan, hexachlorocyclohexane (lindane), DDT, dieldrin and mirex

1. Name and address of industry:

Name of industry/company or institution	Address

2. Type of company or industry:

□ Production of wood preservatives
□ Use of wood preservatives
□ Recycling of wood materials

3. Production of wood preservative and (former) use of PCNs, pentachlorophenol (PCP and PCP-Na), endosulfan, hexachlorocyclohexane/lindane, DDT, dieldrin and mirex

Active ingredient	% active ingredient	Trade names	Effective against	Years produced (from & until)	Amount produced (t)
PCNs					
PCP or PCP-Na					
Endosulfan					
HCH					
Lindane					
DDT					
Dieldrin					
Mirex					
Others 1:					
Others 2:					

4. Former waste management of production residues

□ Recycling in the following processes: ………………………………………………………………
□ Incineration (name/address of facility):………………………………………………………………
□ Open burning (location):………………………………………………………… ………………..
□ Landfilling (name/address of site):……………………………………………………………………………

5. Former use of wood preservative containing PCNs, pentachlorophenol (PCP and PCP-Na), endosulfan, hexachlorocyclohexane/lindane, DDT, dieldrin and mirex

Active ingredient	Amount used	Purpose of using individual active POP ingredients in wood preservatives	Type of treated wood (construction, windows, electricity poles, etc.)	Years used (from & until)
PCNs				
PCP or PCP-Na				
DDT				
Lindane				
HCH				
Dieldrin				
Mirex				
Endosulfan				
Others 1:				
Others 2:				

6. Recycling and end-of-life treatment of waste wood containing organochlorine POPs (PCNs, PCP/PCP-Na, endosulfan, HCH/Lindane, DDT, dieldrin, mirex)
Please describe below the products manufactured from recycling of waste wood containing organochlorine POPs (PCNs, PCP/PCP-Na, endosulfan, HCH/Lindane, DDT, dieldrin, mirex).
………

Are contaminants such as organochlorine POPs (PCNs, PCP/PCP-Na, endosulfan, HCH/Lindane, DDT, dieldrin, mirex) considered in the recycling of waste wood? □ Yes □ No

How are organochlorine POPs (PCNs, PCP/PCP-Na, endosulfan, HCH/Lindane, DDT, dieldrin, mirex) eliminated in recycling (please describe below)?
………

Waste wood recycled (tonnes)	**Organochlorine POPs (PCNs, PCP/PCP-Na, endosulfan, HCH/Lindane, DDT, dieldrin, mirex) present or absent and content (ppm)**	**Products made from recycling (tonnes)** **Related organochlorine POPs (PCNs, PCP/PCP-Na, endosulfan, HCH/Lindane, DDT, dieldrin, mirex) content (ppm)**	**Waste generated during recycling (tonnes)** **Related organochlorine POPs (PCNs, PCP/PCP-Na, endosulfan, HCH/Lindane, DDT, dieldrin, mirex) content (ppm)**

7. Disposal of waste wood containing organochlorine POPs (PCNs, PCP/PCP-Na, endosulfan, HCH/Lindane, DDT, dieldrin, mirex)
□ Incineration (name/address of facility):…………………………………………………………………………………………………..
□ Open burning (location):………..
□ Landfilling (name/address of site):……………………………………………………………………………………………….........

F. Locations possibly contaminated from use and disposal of articles containing with PCNs and PCBs and PCP

Location/address	**Type of contamination**	**Type of activity at the location**	**Have the site been investigated?**	**Levels of PCNs, PCBs and other (if available)**

1. Further Remarks

2. Information on respondent

Name	
Department	
Position	
Telephone	
Mobile Phone	
Email Address	
Signature	
Date	

www.pops.int

Secretariat of the Stockholm Convention

Office address:

United Nations Environment Programme (UNEP)
International Environment House 1
11-13 Chemin des Anémones
CH-1219 Châtelaine GE
Switzerland

Postal address :

Palais des Nations
Avenue de la Paix 8-14
CH-1211 Genève 10
Switzerland

Tel: +41 22 917 82 71
Fax: +41 22 917 80 98

Email: brs@brsmeas.org