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Persistent Organic Pollutants Review Committee
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Rome, 27–30 October 2014
Item 4 (a) of the provisional agenda**

Technical work: consideration of a draft risk management evaluation on pentachlorophenol and its salts and esters

Draft risk management evaluation: pentachlorophenol and its salts and esters

Note by the Secretariat

I. Introduction

1. At its ninth meeting, the Persistent Organic Pollutants Review Committee adopted decision POPRC-9/3 on pentachlorophenol and its salts and esters (UNEP/POPS/POPRC.9/13, annex I). By paragraph 3 of that decision, the Committee decided to establish an intersessional working group to prepare a risk management evaluation that included an analysis of possible control measures for pentachlorophenol and its salts and esters in accordance with Annex F to the Stockholm Convention on Persistent Organic Pollutants.

2. In accordance with decision POPRC-9/3 and the workplan for the preparation of a draft risk management evaluation adopted by the Committee (UNEP/POPS/POPRC.9/13, para. 124 and annex III), the intersessional working group has prepared a draft risk management evaluation which is set out in the annex to the present note. It has not been formally edited. A compilation of comments and responses relating to the draft risk management evaluation is set out in document UNEP/POPS/POPRC.10/INF/4.

II. Proposed action

3. The Committee may wish:

(a) To adopt, with any amendments, the draft risk management evaluation set out in the annex to the present note;

(b) To decide, in accordance with paragraph 9 of Article 8 of the Convention, on the basis of the risk profile adopted at its ninth meeting (UNEP/POPS/POPRC.9/13/Add.3) and the risk management evaluation, whether pentachlorophenol and its salts and esters should be recommended for consideration by the Conference of the Parties for listing in Annexes A, B and/or C to the Convention.

* Reissued for technical reasons on 1 October 2014.

** UNEP/POPS/POPRC.10/1.

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Annex

PENTACHLOROPHENOL AND ITS SALTS AND ESTERS

DRAFT RISK MANAGEMENT EVALUATION

Draft prepared by the ad hoc working group on pentachlorophenol and its salts and esters
Persistent Organic Pollutants Review Committee

July 2014

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Executive Summary

1. Pentachlorophenol (PCP) and its salts and esters (sodium pentachlorophenate (Na-PCP), a PCP salt and; pentachlorophenyl laurate (PCP-L), a PCP ester) were proposed as a POPs candidate by the European Commission in 2011. At its eighth meeting, the POPs Review Committee concluded that while the PCP molecule does not meet all the screening criteria specified in Annex D, taking into account its transformation product pentachloroanisole (PCA), PCP and its salts and esters do meet the screening criteria. This led to the POPs Review Committee at its ninth meeting to decide that PCP, its salts and esters, are likely, including consideration of the transformation product, PCA, as a result of their long-range environmental transport, to lead to significant adverse human health and environmental effects such that global action is warranted (Decision POPRC-9/3).

2. PCP has had multiple uses in the past (biocide, insecticide, fungicide, disinfectant, defoliant, anti-sapstain agent, anti-microbial agent and wood preservative) which have now been phased out with the remaining key use being wood preservation, particularly for use in utility poles and cross-arms, with minor uses for railway ties (cross ties or 'sleepers') and outdoor construction materials (UNECE 2010). PCP has also been used to produce the ester PCP-L, which was used in textiles, but there is no evidence of continued use. Its salt, Na-PCP, is used for similar purposes to PCP and readily dissociates to PCP. PCA is not used as a commercial chemical or pesticide and is not intentionally released directly into the environment.

3. PCP is produced by one manufacturer at a production facility in Mexico (6,600 t/per annum), which is then formulated into a manufacturing concentrate at a formulation facility in the USA (7,000 t/per annum). In addition 1,500 t/per annum of Na-PCP is produced and used in India (for use in wood treatment only). The main share of the PCP market and use is in North America.

4. The use of PCP for wood treatment has already been banned or heavily restricted by a number of nations including EU Member States, Morocco, Sri Lanka, New Zealand, Indonesia, Ecuador and Australia, indicating the availability of technically feasible alternatives in those countries. PCP is used as a heavy duty industrial wood preservative in the USA and Canada (restricted to industrial use only) and continued use has been permitted in recent decisions contingent upon implementation of control and risk management measures. Additionally, use of Na-PCP appears to be mainly in India. In the USA and Canada alternative chemical treatments based around copper arsenates and creosote are used in some situations; while non-chemical alternative materials such as concrete and steel are also manufactured and used to a certain degree within infrastructure networks.

5. A number of chemical alternatives (such as chromated copper arsenate (CCA), creosote, copper naphthenate, and ammoniacal copper zinc arsenate) exist and are broadly comparable in price and application process to PCP. However alternative products are not directly interchangeable and will have specific strengths and weaknesses for any given application. The commonly used commercial chemical alternatives to PCP (and Na-PCP), namely CCA and creosote have also had concerns raised for their own environmental and health profiles.

6. Non-chemical alternatives (such as steel, concrete, fibreglass composite or heat treatment of wood) to PCP-treated wood offer possible options, with potentially longer life spans, in certain circumstances, reduced maintenance costs, pest/fire resistance, standardized specifications (noting that wood is a natural product). However, initial costs for manufacture and installation are significantly higher than treated wood and different life cycle analyses exist demonstrating that life-time costs and environmental profile can be either better or worse than treated wood with no clear resolution. In some parts of the USA, certain utility companies have indicated that they have begun to use and integrate steel utility poles which are lighter than wood (meaning reduced freight costs) and provide durability and strength. However opposing opinion highlights the increased conductivity of steel structures and requirement for protection against surface corrosion (typically through galvanization) as well as the increased risk of damage to steel structures during transport and installation.

7. The risk profile concluded that PCP and its related compounds are likely to lead to significant adverse human health and environmental effects. In addition, the manufacturing and use of PCP-treated wood is a source of dioxins and furans. Therefore, the implementation of further control measures would reduce potential risks from exposure to humans and the environment from PCP and PCA. In addition it will reduce the potential exposure to dioxins and furans present as impurities from in-service PCP-treated wood, which is not covered by the listing of dioxins in Annex C (UNEP/POPS/POPRC.9/13/Add.3).

8. In terms of benefits of reduced PCP exposure, a prohibition would be most effective and would reduce and eventually eliminate releases of PCP to the environment, contributing to reductions in PCA. A prohibition would lead to replacement of PCP by available alternatives in uses such as utility poles and cross-arms (considered critical by Canada). However, at present some alternatives present technical feasibility issues (e.g. linked to climate conditions) and there seems to be no consensus on whether there would be a net health/environmental benefit from using different alternatives to PCP in some applications. In addition, alternatives also result in the release of other harmful substances (e.g., PAHs, heavy metals) which may require management strategies. A specific exemption for use in industrial wood preservation could overcome such concerns. Such an exemption could be time-limited and could also be linked to requirements for control of releases and emissions throughout the lifecycle as well as for management of stockpiles and waste containing PCP.

9. Overall, the suggested control measure is that PCP should be listed under Annex [A or B] to the Convention which would be consistent with the POPs properties of this intentionally produced substance and its related compounds and would send a clear signal that phasing out production and use of PCP is desirable where it provides an overall net benefit. Either annexes may be adjusted to specify the appropriate exemptions or control measures. Additionally inclusion on Annex [C] (unintentional releases of PCP) is also a potential option.

1. Introduction

10. On May 17, 2011 the European Community and its Member States submitted a proposal to list Pentachlorophenol (PCP) and its salts and esters in Annex [A, B and/or C] of the Convention (UNEP/POPS/POPRC.7/4), which was considered by the Persistent Organic Pollutants Review Committee (POPRC) at its seventh meeting held in October 2011. The Committee deferred its consideration on PCP and its related compounds (sodium pentachlorophenate (Na-PCP), pentachlorophenyl laurate (PCP-L) and pentachloroanisole (PCA), a transformation product of PCP) to its eighth meeting, held in 2012 (UNEP/POPS/POPRC.7/19); on the basis of the receipt of additional information on the transformation of PCP to PCA (UNEP/POPS/POPRC.8/INF/7). The Committee at its eighth meeting decided that, while the PCP molecule itself does not meet all the screening criteria specified in Annex D, PCP and its salts and esters meet the Annex D screening criteria, taking into account its transformation product PCA (Decision POPRC-8/4).

1.1 Chemical identity of Pentachlorophenol and its salts and esters

11. Pentachlorophenol is an organochlorine compound and was first introduced for use as a wood preservative in the 1930s. Since its introduction, PCP has had a variety of other applications (e.g. biocide, insecticide, fungicide, disinfectant, defoliant, anti-sapstain agent and anti-microbial agent). It has been also used in the production of the ester pentachlorophenyl laurate (PCP-L) which was used in textiles. The salt sodium pentachlorophenate (Na-PCP) was used for similar purposes as PCP and readily dissociates to PCP. The environmental toxicity, fate and behaviour profile of PCP, Na-PCP and PCP-L are quite similar. PCP is produced by reacting chlorine with phenol at high temperatures in the presence of a catalyst. Chlorinated contaminants including hexachlorobenzene, pentachlorobenzene, and dioxins and furans are produced during the manufacturing process. In addition, dioxins and furans formed during the manufacturing process can be released during the use and disposal of PCP-treated wood. Dioxins and furans are also a natural by-product of wood incineration (treated or untreated). These compounds are inherently toxic, as well as environmentally persistent and their presence increases the ecological and human health hazards associated with the use of PCP. As dioxins from chemical production of chlorophenols are already listed under Annex C of the Stockholm Convention, Parties should have measures in place to control these substances. Reduction measures by countries are reported in the risk profile in Section 3 (Other Considerations, paragraph 163). These measures have to be consistent with the Convention text in both Annex C and Article 5. However the presence of dioxins as impurities in PCP as a commercial product (covered by Annexes A and B) is not covered by the listing of dioxins in Annex C (UNEP/POPS/POPRC.9/13/Add.3).

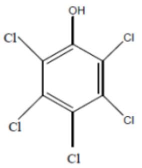
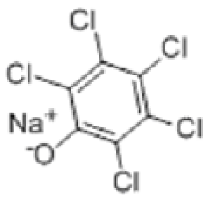
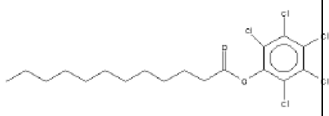
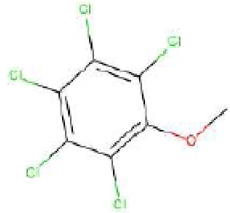
12. PCA is not used as a commercial chemical or pesticide and is not intentionally released directly into the environment. PCA is a metabolite that may be formed in soil and sediment from the biodegradation of PCP under aerobic conditions by certain microorganisms.

13. There are several sources of PCP in the environment, including the release of PCP during its production and use as well as from sites contaminated by previous use. PCP and consequently PCA can also be a transformation product and metabolite of other organochlorine compounds such as hexachlorobenzene, lindane and quintozene (PCNB). The extent of these potential sources of PCP/PCA in the environment has not been quantified. PCP production and subsequent use is the only

input of new PCP/PCA contamination to the global environment, other than quintozene (PCNB), as well as a source of dioxins and furans.

14. Further information pertaining to the chemical identity of PCP and its related compounds is listed in Table 1 and may be found in the Risk Profile on PCP (UNEP/POPS/POPRC.9/13/Add.3) and its supplementary information (UNEP/POPS/POPRC.9/INF/7). Information on releases can be also identified therein.

Table 1 Information pertaining to the chemical identity of PCP and its related compounds

	Pentachlorophenol	Sodium Pentachlorophenate	Pentachlorophenyl laurate	Pentachloroanisole
Chemical name and abreviation	2,3,4,5,6-pentachlorophenol (PCP)	Na-PCP	PCP-L	PCA
CAS number	87-86-5	131-52-2 and 27735-64-4 (as monohydrate)	3772-94-9	1825-21-4
Molecular formula	C_6HCl_5O and C_6Cl_5OH	C_6Cl_5ONa and C_6Cl_5ONa x H_2O (as monohydrate)	$C_{18}H_{23}Cl_5O_2$	$C_7H_3Cl_5O$
Molecular Mass	266.34 g/mol	288.32 g/mol	448.64 g/mol	280.362 g/mol
Structural formulas of the isomers and the main transformation product				

1.2 Conclusions of the Review Committee regarding Annex E information

15. The POPs Review Committee has conducted and evaluated a risk profile for PCP and its salts and esters in accordance with Annex E of the Convention including consideration of the transformation product pentachloroanisole, (UNEP/POPS/POPRC.9/13/Add.3) and has concluded that PCP its salts and esters are likely, as a result of their long-range environmental transport, to lead to significant adverse human health and environmental effects such that global action is warranted (Decision POPRC-9/3).

1.3 Data sources

1.3.1 Overview of data submitted by Parties and Observers

16. This risk management evaluation is primarily based on information that has been provided by Parties to the Convention and Observers. Data relating to Annex F were submitted by the following Parties: Argentina; Bulgaria; Canada; Croatia; China; Germany; Morocco; Nepal; Netherlands; Romania; Serbia; Sri Lanka and Sweden; and the following observers: the Alaska Community Action on Toxics with the International POPs Elimination Network and contributions from Beyond Pesticides (ACAT/IPEN), United States of America; Indian Chemical Council (ICC); Pentachlorophenol Task Force with KMG-Bemuth (PCPTF-KMG 2014) (the USA and Canadian registrant of PCP) and Wood Preservation Canada (WPC).

17. The exploration of management options for PCP prepared for the 8th meeting of the UNECE CLRTAP Task Force on Persistent Organic Pollutants (Montreal, 18 -20 May 2010) (UNECE 2010) is also used in this report. Other information sources are listed under “Other References” section of this document.

1.3.2 Information on national and international management reports

18. In 2011 Canada released a re-evaluation decision on Heavy Duty Wood Preservatives (HDWPs) and in 2013 released a Heavy Duty Wood Preservatives (HDWPs) risk management plan (RMP), which included PCP (PMRA 2013). In the United States as part of the re-registration eligibility decision for PCP, risk management measures were taken into account as part of the re-evaluation for continued use of PCP (USEPA 2008a).

1.4 Status of the chemical under International Conventions

19. PCP and its salts and esters are subject to a number of agreements, regulations and action plans:

(a) Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade;

(b) OSPAR List of Chemicals for Priority Action (1998) of the Convention for the Protection of the Marine Environment of the North-East Atlantic;

(c) Annex 1A (List of Priority Hazardous Substances) in the Third North Sea Conference;

(d) In addition, PCP has been nominated as a candidate for inclusion in Annex I of Long-range Transboundary Air Pollution (LRTAP) Protocol on POPs of the United Nations Economic Commission for Europe.

1.5 Any national or regional control actions taken

20. Specific national or regional control actions have been described under Annex F by several parties and have also been reported in the Risk Profile and its supporting information (UNEP/POPS/POPRC.9/INF/7); Section 2.5 and Appendix V).

21. For all EU Member States the use of PCP was restricted in 1991 by Council Directive 91/173/EEC and all uses including wood preservation officially terminated at the end of 2008 (according to Commission Directive 1999/51/EC). According to Annex XVII to the European Regulation (EC) No. 1907/2006 of the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), PCP and its salts and esters shall not be placed on the market, or used as a substance; as a constituent in other substances, or in mixtures, in a concentration equal to or greater than 0.1 % by weight. Additionally, PCP was excluded from Annex I to Council Directive 91/414/EEC concerning the placing of plant protection products on the market and authorisations for such products containing PCP thus had to be withdrawn in the EU by 25 July 2003 (Commission Regulation (EC) No 2076/200). Moreover, PCP was not included in Annex I or IA to Directive 98/8/EC concerning the placing of biocidal products on the market.

22. EU Directive 2010/75/EU on industrial emissions covers emissions and discharge of installations dealing with treatment of PCP containing material including waste incineration.

23. Harmonised EU legislation restricts the use of PCP as a substance or in mixtures, but some European countries – Norway, Denmark, Germany, Netherlands and Austria – have implemented additional restrictions to the import and marketing of consumer products containing PCP. As such, consumer goods treated with PCP may not be placed on the market in these countries if they contain more than 5 mg/kg of PCP and its salts and esters (Netherlands 2012, Norway 2010 and OSPAR 2004).

24. In Serbia, PCP cannot be placed on the market according to the Rulebook on Bans and Restrictions of Production, Placing on the Market and Use of Chemicals, which is harmonized with EC Regulation No. 1907/2006. (Serbia 2014)

25. PCP is not registered as a pesticide in Morocco and its import is not allowed according to Act No. 42-95 concerning the supervising and management of trade of agricultural pesticides (21st January 1997) (Morocco 2014).

26. In Sri Lanka all uses of PCP have been prohibited since 1994 and an official declaration in the form of a Government Gazette 1190/24 to ban certain pesticides including PCP was published on 29 July 2001 (Sri Lanka 2014).

27. PCP has either no uses or is banned in a number of other countries, such as Indonesia, New Zealand and Switzerland. For a comprehensive list of countries with severe restrictions, or bans on PCP please see Appendix V of UNEP/POPS/POPRC.9/INF/7.

28. In Canada, PCP is only used as a heavy duty wood preservative primarily to treat utility poles and cross-arms, with other uses in outdoor construction timbers. To be used in Canada, PCP products must be registered under the Pest Control Product Act (PCPA) by Health Canada’s Pest Management Regulatory Agency (PMRA). Sources of manufacture/supply must also be registered for PCP products. The PMRA published a re-evaluation decision on Heavy Duty Wood Preservatives (HDWPs) on 22 June 2011 (PMRA 2011) which granted continued registration to PCP subject to conditions that included the addition of new risk-reduction measures to product labels. In addition, as a condition of registration, treatment facilities using PCP are required to be consistent with the

"*Recommendations for the design and operation of wood preservation facilities – technical recommendations document (TRD)*" published by Environment Canada in 2004 and recently updated in December 2013. To further reduce potential environmental exposure, a Risk Management Plan for PCP and other wood preservatives was developed in 2013 by the PMRA (PMRA 2013). Guidance is also provided by Environment Canada for out-of-use treated wood and treated wood waste disposal as per the "Industrial Treated Wood Users Guidance Document" (Environment Canada, 2004a).

29. In the USA, PCP is currently classified as a Restricted Use Product (RUP) when used as a heavy duty wood preservative and is predominately used to treat utility poles and cross-arms. Wood preservative uses of PCP are only eligible for re-registration provided that the registrants implement the conditions and requirements determined in the Re-registration Eligibility Decision (RED) for PCP adopted by the Environmental Protection Agency in September 2008 (USEPA 2008a). Risk management measures were required to be implemented by 31 December 2013 [USEPA 2008a]. In the USA, disposal of PCP and PCP-contaminated substances is regulated under the Resource Conservation and Recovery Act (RCRA) as F-listed (F021) or D-listed (D037) hazardous wastes (USA, 2014).

30. According to the Risk Profile, PCP is not produced or used in China. PCP-Na was used for wood preservation for the purpose of railway construction, but there is no further use for this application now due to upgrading of construction material. PCP-Na was used as molluscide, but this application has been banned and the registration of this application has been cancelled.

31. Other stakeholders, including industry organizations and major users of treated wood, have developed guidelines and best management practices (BMPs) to minimize health and environmental issues during manufacture and use of treated wood (Cooper and Radivojevic, 2012).

2. Summary information relevant to the risk management evaluation

32. Historically, according to the data profile of IRPTC (1983), 90,000 tonnes of PCP per year were produced globally. The Economist Intelligence Unit (1981) estimated world production to be of the order of 50,000-60,000 tonnes per year, based on the North American and European Community output (UNEP/POPRC.7/INF/5). By the 1990s, the widespread use was discontinued in most countries and at present it is banned in a number of countries (UNEP/POPS/POPRC.9/INF/7).

33. PCP and its salt and esters are currently produced in Mexico and in India and formulated in the USA. KMG Chemicals (2014) states that the company is the only producer of wood treating PCP in the world (under the commercial name 'Penta'), with a production facility in Matamoros, Mexico and a formulation facility in Tuscaloosa, Alabama, USA, where it formulates the solid PCP blocks produced in Mexico into a liquid concentrate. The company never produced PCP laurate esters and ceased production of Na-PCP in 2006 (UNECE, 2010). It is reported that KMG Bernuth in the USA formulated 7,257 tonnes of PCP (liquid concentrate) in 2009, marketed for wood preservation purposes in the USA, Canada, and Mexico (UNECE, 2010). No data are provided by the company on the quantities of solid PCP produced in Mexico and shipped to the USA for formulation. However the Mexican Government reported a similar level of production for 2009 (6,610 tonnes) and also supplied import/export information. Mexico reported that 3,670-7,343 tonnes of PCP were exported yearly between 2007 and 2011 to the USA (where the formulation facility is located), Colombia and Peru Mexico also reported imports of PCP from the USA, China and Germany between 1997 and 2011 (UNEP/POPS/POPRC.9/INF/7). The industry association Indian Chemical Council (ICC) reports that Na-PCP is also used in India mainly as a wood preservative but also for the preservation of water-based 'distemper paints' while in storage, with 1,800 tonnes per year of Na-PCP being produced in the state of Maharashtra and West Bengal, India (ICC 2014).

34. Based on responses from Parties and Observers, it appears that PCP is currently allowed worldwide only for wood preservation uses. Regarding its salts and esters, in addition to Na-PCP use in India for preservation of wood and paint products during storage (ICC 2014), Mexico also reported in their response to Annex E questionnaire registered uses in wood preservation, adhesives, tannery, paper and textile for Na-PCP. However Mexico has now clarified that wood preservation is the only use authorised in Mexico and that is no longer aware of any other active uses (Mexico 2014). No country has reported use of PCP-L (within the Annex F survey).

35. PCP consumption for wood preservation appears to concentrate in Canada and the USA, whereas Na-PCP appears to be mainly used in India, mainly for wood preservation purposes. In the USA and Canada PCP is only allowed as a heavy duty wood preservative for industrial use, primarily for the treatment of utility poles and cross-arms, which account for more than 90% of PCP-

consumption in those countries with the remainder being wood treated for other uses (laminated beams for bridge construction, sound barriers, fence posts and railway sleepers) (UNECE 2010).

36. The Canadian response to the Annex F questionnaire reported that PCP is registered for the treatment of wood for utility poles, cross-arms, outdoor construction materials, pilings and railway ties, although it is indicated that PCP-treated railway ties have not been installed since 1993 (Canada 2014). Late in 1990, PCP product manufacturers within Canada voluntarily withdrew PCP-based goods from a range of applications (both domestic and industrial) (Canada 1990; CCME 1997). With approximately 15 million wood poles in a distribution network that covers three quarters of a million kilometres, the predominant use of PCP is for the treatment of wood utility poles and cross-arms. Canada has reported an increase of the amount of PCP used, from 372 tonnes in 2008 to 537 tonnes in 2012 (Canada 2014).

37. The USEPA reported that in 2002, approximately 4,990-5,444 tonnes were used for utility poles, lumber and timbers. In 2002 4,083 tonnes were imported and 1,361-1,815 tonnes were produced domestically. According to a USA EPA report (USEPA 2008b), there is an estimated 130–135 million preservative-treated wood utility poles in service in the USA, representing over 90% of the pole market and presenting a replacement rate of 2 to 3% (approximately 3-5 million poles) per year (USWAG 2005). Available data show variability in the proportion of treated poles that use PCP. In 1995, about 45% of poles were treated with PCP, whereas in 2002 this figure was around 56% (based on EPA proprietary data and Vlosky (2006)).USA EPA (2008b) indicates that, in 2004, PCP-treated poles accounted for about 40% of all treated poles that year (3.9 million poles).

2.1 Identification of possible control measures

38. Following review of the available literature and inputs from the Parties and Observers, a number of possible control measures have been shortlisted. These take into account the differing capabilities and conditions among the Parties. In particular, it is noteworthy that some Parties have partially or wholly phased-out the use of PCP, while in only a very few countries (Parties and Observers) report a narrow but significant use, which is as a wood preservative, mainly for utility poles, and cross-arms. Within those countries (Canada and USA in particular) continued use based on regulatory controls has been supported in recent regulatory decisions.

39. With the aim of protecting human health and the environment from exposure to PCP a number of options for possible control measures are considered. These measures could provide varying degrees of assurance that future exposure will be controlled in relation to releases from manufacture and from the life-cycle of its use as a wood preservative, specifically those:

(a) From production of PCP;

(b) From wood treatment facilities, including during the treatment process; transfer of treated wood from dipping tanks for drying; during the drying process; from leachates and outdoor storage of treated wood; evaporation from treated wood products; from wood waste including the sawing and processing of treated wood; and as solid waste from the bottom of the dipping tank or treatment cylinder;

(c) During the installation of treated wood (including the sawing, piercing and managing of wood waste residue).

(d) During the service life of products, such as utility poles and railway cross-ties/sleepers;

(e) During use in secondary uses e.g. domestic use in gardens (though the extent of this use is unknown and is prohibited in Canada);

(f) During the waste phase, either when landfilled or incinerated; and

(g) From contaminated sites, where PCP can persist for many years.

40. Note that manufacture of PCP leads to production of contaminants including HCB, PeCB, dioxins and furans, which are already listed in the Convention. Dioxins and furans formed during the manufacturing process may be released from treated articles. Control measures introduced in the USA and Europe have reportedly led to reductions in concentrations of dioxins and furans as impurities in PCP, as set out in the Risk Profile (paragraph 163).

41. As indicated above (paragraph 34), it is understood that the identified non-wood treatment uses in the risk profile are no longer active. Therefore there would be no negative (or positive) impacts for these uses of inclusion of PCP under the Convention, and hence no need for derogation for these uses. The focus of the remaining discussion is therefore only upon wood preservative use.

42. A *prohibition* on production, use, import, and export of PCP (inclusion on Annex A) would eliminate new inputs of the substance into the life-cycle of products and would reduce and eventually eliminate releases to the environment from these sources. It would require the use of alternative chemical wood preservatives, or alternative materials to be used in applications such as utility poles and cross-arms, as well as railway sleepers and outdoor construction timbers. It would also address exposure through the other uses of PCP (though no information is available on the extent of other current uses, so they are not considered in any detail). It might also be appropriate to consider prohibiting the marketing of existing PCP-treated goods (for example the Netherlands has restricted those that contain more than 5 mg/kg) (Netherlands 2014).

43. A *restriction* on use could be implemented in a number of ways. One option would be to limit use to industrial wood preservation (as the main/only use identified), which would remove the potential for releases from other uses such as treatment of wood for non-industrial (e.g. domestic) use, or use in leather or textiles, either contemporary uses, or through reinstatement of historical uses. Parties would therefore need to be included on the register of specific exemptions or acceptable purposes. There could be a requirement to review the specific exemptions or acceptable purposes and time-limited requirements to report on progress with elimination of PCP as with other substances on the Convention (e.g. perfluorooctane sulfonate, PFOS). Another option could be to limit the uses covered, for example as wood preservatives only for utility poles and cross-arms but not for some of the other uses, such as outdoor construction materials, pilings or railway sleepers (e.g. UNECE (2010) suggest that more alternatives are available for timber and lumber uses than for utility poles, and that these could be more readily replaced). It could be appropriate to include the production of PCP as a specific exemption or acceptable purpose (depending on the Annex in which PCP might be included). It is assumed that such a restriction could be introduced through inclusion on Annex [A or B].

44. Restrictions or prohibition could also be complemented with requirements for measures to control emissions. Requirements for *control of discharges and emissions* could take various forms, and ideally would be targeted at all of the life-cycle stages where emissions can occur. By way of example, Canada's recent decision (PMRA 2011) which found currently registered uses to be acceptable was contingent upon implementation of additional control measures, most notably adherence to the technical recommendations document (TRD) on recommendations for the design and operation of wood preservation facilities (Environment Canada 2004b), which is supported by technical guidance. These include, among other things numerous guidelines related to each of the following: Chemical receiving and unloading area; chemical storage; chemical mixing; treatment process systems; wood drip areas; treated wood storage areas; general practices; maintenance; waste handling/disposal; and monitoring. Environment Canada (Environment Canada 2004a) has also published guidelines that address the later life-cycle stages, covering issues such as: locating new storage facilities and managing existing ones; installation and handling; considering alternatives at sensitive sites; and managing waste wood (encouraging re-use, tracking post-use wood, using the waste management hierarchy).

45. Furthermore, as part of the USA's Re-registration Eligibility Decision (RED) (USA 2014) and Cost Estimates for Risk Mitigation Technologies at a Typical Wood Treatment Plant (USEPA 2008c), a number of control measures are highlighted, including: installing automatic doors on treatment cylinders to replace manual doors; installing hydraulic bridge rails to replace manual bridge rails; and pulling a final vacuum after completing the wood treatment (reducing bleeding during post-treatment handling, shipping, storage and product use). Such measures will reduce but not completely eliminate releases of PCP.

46. In addition, the labelling of (new) PCP-treated wood should help to facilitate proper environmentally sound management of stockpiles and wastes in full compliance with Article 6 of the Convention. The practicalities of applying labelling would require further investigation.

47. The unintentional formation of impurities such as dioxins and furans during PCP manufacture should already be addressed by the inclusion of these substances in Annex C (unintentional releases). However, PCP is also considered as a by-product similar to polychlorinated biphenyls (PCBs) or pentachlorobenzene, therefore the inclusion of PCP itself in this Annex, as unintentional production could be seen as relevant even if it is not the main source identified in the risk profile.

48. Listing under the Convention would also make it subject to the provisions on stockpiles and waste in Article 6. Article 6 in the Convention requires that wastes and stockpiles are handled in a safe, efficient and environmentally sound manner. The article also requires disposal in such a way that the POP content is destroyed or irreversibly transformed, or otherwise disposed of in an environmentally sound manner. The article bans disposal operations that lead to recovery, recycling, reclamation, direct use or alternative use of POPs material if they are above the low persistent organic

pollutant content referred to in paragraph 1(d)(ii) to be established by joint work with the Basel Convention Conference of the Parties. Pressure-treated wood at the end of its service-life will still contain some PCP, although there are some indications that the amount remaining will be relatively low (USA 2014). This wood will need to be disposed of in accordance with Article 6. As incineration can lead to the unintentional production of dioxins, the BAT/BEP guidelines and provisions of Annex C of the Convention are likely to be of relevance in the operation of the appropriate elimination or disposal technology. Re-use in e.g. gardens may not be allowed under Article 6(d)(iii) if the wood contains PCP above the low POP content established by the Stockholm Convention.

49. International trade in treated wood waste and other PCP-containing waste could potentially be significant. For example, in 2012, Canada exported around 92,000t of waste consisting of, containing or contaminated with PCP (e.g. wood wastes, contaminated soils) (Canada 2014). Article 6 of the Convention is therefore also of relevance in the case of PCP.

50. Parties could also consider implementing *maximum residue levels in water, soil, sediment or food*. The USA has established various drinking water standards (USA 2014) and occupational exposure limits (USEPA, 2000); Canada has introduced guidelines for PCP in drinking water and soil (Health Canada 2012 and CCME 1997) as well as occupational exposure (Canada 2014b); and PCP is covered by WHO drinking water guidelines (WHO, 2003). In addition, the Netherlands has remediated large areas of land contaminated by PCP over a set “intervention value” (Netherlands 2014). In accordance with Article 6(e) of the Convention, Parties should develop strategies for identifying sites and remediating contaminated sites in an environmentally sound manner.

2.2 Efficacy and efficiency of possible control measures in meeting risk reduction goals

2.2.1 Technical feasibility

Prohibition on use

51. No information has been identified to suggest that there would be any concerns over technical feasibility in prohibiting PCP use in uses other than wood treatment. The sole remaining non-wood use identified from India, is the use of Na-PCP as a biocide in distemper paints to protect the product while in storage. The quantity of Na-PCP used for this purpose is unknown, with wood treatment likely to be the main use of Na-PCP. India manufactures and uses approximately 1800 tonnes of Na-PCP per annum (ICC 2014b) Uses other than wood preservation are not considered further because no information is available on any actual present-day use in non-wood-preservative applications.

52. As set out in section 2.3 on alternatives, there are a wide range of chemical and material alternatives in current use in many countries where they are both technically and economically viable. The wide commercial availability of alternatives for PCP indicates technical feasibility under certain conditions. It might therefore be possible to continue the main activities involved (e.g. utility transmission), although some of the alternatives would provide a technically inferior solution, for example in terms of longevity of the poles. The fact that different wood preservatives are more suited to particular environments than others should not be overlooked in the context of technical feasibility. For example, PCP for wood poles is reportedly more suitable than alternatives such as creosote and CCA for southern pine and Douglas fir (the latter being the most widely used for utility poles in the Western USA) (GEI 2005). It is reported that use of some chemical alternatives could lead to distortions in wood cross-arms, leading to strain on electrical wires and associated power outages in these circumstances (GEI 2005). In this respect the use of non-chemical alternatives might also provide a valuable option as replacement for PCP. Furthermore, it is also reported that wooden poles can allow greater flexibility of use (e.g. compared to non-wood poles which require retrofitting if new lines are adding to an existing transmission line) (USA 2014b). Moreover, the use of wood poles and cross arms allows utilities to quickly obtain replacements on short notice, following a fire, storm, or other incidents that result in the need to replace a large number of poles quickly. For example, following Hurricane Sandy in the USA, wood treating companies supplied utilities with approximately 65,100 wood poles and 103,500 wood crossarms within just a few weeks [Bush 2013].

53. ACAT/IPEN (2014b) notes that these concerns appear to have been adequately addressed in the many countries that have already eliminated PCP use in wood preservation. However it is less clear whether countries with climatic conditions similar to Canada have transitioned away from PCP to other chemical alternatives / non-chemical materials. The PCPTF (2014c) highlights that the use of PCP as a heavy duty wood preservative for utility networks has not been significant outside the USA and Canada, with some of the countries that have banned PCP for wood preservation not actually using it to a significant extent for this purpose (Canada and PCPTF 2014c).

54. A key concern for technical feasibility of a prohibition on use is that it would require significant industry changes for countries where PCP use occurs (e.g. Canada and USA). In these countries it is argued that the use of PCP is critical because there are limitations with respect to the alternatives (Environment Canada 2013) and the fact that wooden poles cannot be individually replaced as they reach the end of their service life (using alternatives to wooden poles would require the replacement of whole sections of utility lines which function as an integrated system).

55. A prohibition on re-use of treated materials could be technically challenging to implement although it could be facilitated through labelling. Materials such as utility poles or railroad ties may be sold for reuse, often into a secondary market where they may be installed in residential settings for garden borders (USA 2014) and it is likely to be difficult to identify and control use of PCP-treated wood for such uses. Labelling of articles containing PCP would facilitate prevention of such uses, and consequently potential health or environmental impacts.

Restriction on use

56. A restriction on use could establish specific exemptions or acceptable purposes, such as use in wood preservation, with other uses not being possible. Again, no technical feasibility concerns have been identified for non-wood-treatment activities.

57. A restriction could overcome the identified technical feasibility concerns with a full prohibition by providing specific exemptions for uses (e.g. for utility poles for which there seems to be greater level of socio-economic impact or issues with the availability of alternatives than with the other uses such as for outdoor construction materials, pilings or railway sleepers) which could be time-limited to allow for (or require) further investigation, development and registration of alternatives, and could also be linked to requirements for control of emissions.

Control of discharges and emissions

58. Controlling discharges and emissions to the environment appears to be technically feasible, at least in terms of controls to reduce emissions during the manufacturing and wood-treatment process, although it would not eliminate all releases. For example, Canada reports (Canada 2014) that 54 of the 55 wood treatment facilities operating in Canada are certified under a certification programme ensuring that facilities fulfill the requirements outlined by Canada's TRD (see above). All nine of the companies reported as using PCP were certified (Environment Canada 2014). The joint US EPA and PMRA re-evaluation concluded that under these control measures, risks to human health and the environment were sufficiently controlled to permit continued use In Mexico, the production of PCP is regulated under a variety of environmental laws, with the production facility being required to have an authorisation from the Ministry of Environment and Natural Resources ("SEMARNAT") regarding environmental impact.

59. Measures to address handling and use of treated wood (i.e. after the impregnation process) are likely to be more technically challenging to implement, given the much more disperse use and large numbers of organisations and individuals involved. Labelling requirements of PCP-treated wood could alleviate this problem.

60. Given that dioxins and furans can be released from PCP-treated wood (as set out in the risk profile), measures to control releases of PCP from treated wood in service could also reduce, but not eliminate, dioxin emissions to the environment.

Waste management and stockpiles

61. Labelling requirements could facilitate the identification and management of wastes and stockpiles of wood containing PCP. If the wastes exceed the low POP content value they will be subject to destruction or irreversible transformation Treatment of such wastes must be conducted according to Article 6 obligations and taking the BAT/BEP guidelines into account.

2.2.2 Identification of critical uses

62. None of the information received from the Parties/Observers or reviewed in the literature suggests that any of the non-wood-treatment uses are considered to be critical.

63. The use of PCP in wood treatment for registered uses, which include utility poles but also other uses such as outdoor construction materials, is considered as a critical use by Canada (Canada 2014) due to current limitations of chemical and non-wood alternatives. In addition the US and Canadian assessments concluded that PCP is acceptable for continued registration as a heavy- duty wood preservative taking into account the control measures required. The United States, as an observer government, offers a similar situation.

64. Depending on the circumstances of use, the negative impact on society that could result if no exemption or acceptable purpose is permitted for this use could include e.g. reduced longevity of wood utility poles with some chemical alternatives (with a consequential need for more frequent replacement and associated economic and environmental impacts), as well as safety concerns highlighted above when using certain types of wood for cross-arms (GEI 2005).

2.2.3 Costs and benefits of implementing control measures

Prohibition on use

65. In terms of environmental and health benefits of reduced PCP/PCA exposure, a prohibition would be most effective in continuing to reduce releases of PCP to the environment. However, a prohibition would lead to increased use of alternative chemicals, at least some of which have toxic properties of concern, or alternative materials, with different life-cycle analyses coming to different conclusions on whether wood, concrete or steel are best from a life-cycle perspective (Bolin 2011, Aqua-e-Ter 2012 and SCS Group 2013). Different arguments can be made as to whether there would be a net health/environmental benefit from using alternatives to PCP**.**

66. If a prohibition on manufacture were to be introduced, this would impose costs for countries producing the substance (e.g. Mexico), assuming that facilities would need to cease production. The company's sales of PCP were estimated at around $30m in 2009 (UNECE 2010) (a breakdown for PCP and/or for Mexican production was not available in the latest financial report). It is likely that these losses would be offset by increases in sales for producers of alternatives, though the geographical spread of impacts would probably differ.

67. In terms of a prohibition on use, since power generation and telephone companies use PCP widely in North America –about 38% of all utility poles are treated with PCP in USA for example (Aqua-e-Ter 2012) – the majority of the socio-economic impacts would fall on Canada, the USA and on those other countries still using PCP in wood preservation (such as India). The Steel Market Development Institute (2011) indicates that one major utility in the USA (Tucson Electric Power) has begun converting to the use of steel poles and claims that "more than 600 electric utility companies are using steel distribution poles, with some converting the majority of their distribution system poles to steel" (Steel Market Development Institute, 2011). The Wood treating industry is of the contrary view that steel poles are still used for only a small portion of the market, and mostly for more specialised applications (PCPTF-KMG 2014b). There would be limited or no costs for countries that have already prohibited use.

68. The main cost elements associated with a prohibition on use would include:

(a) Differences in costs for purchasing and processing the alternatives in manufacture of utility poles and other products (see the section on 'information on alternatives'). Alternatives with a higher initial purchase price may actually be more cost effective over the life of the product when durability and other factors are taken into account;

(b) Changes in material and labour costs due to a different frequency of replacement of e.g. utility poles (wooden poles treated with less efficacious preservatives would need more frequent replacement; steel and concrete poles may need less frequent replacement, dependent on application);

(c) Changes in the associated equipment needed to install, inspect, and maintain utility poles made of alternative materials (e.g., steel). The resulting effects on worker safety have not been quantified for either PCP-treated poles or for alternatives;

(d) Costs for wood treaters associated with loss of revenues and potentially costs associated with loss of residual value of their capital equipment. There are nine treaters using PCP in Canada (Environment Canada 2014);

(e) If a prohibition is extended to in-service and already treated wood (i.e. phased replacement of existing stock), costs associated with identifying/monitoring the presence of PCP-treated wood, diversion to other uses and replacement of in-service wood and disposal.

Restriction on use

69. A restriction on use would not have the same degree of benefit as a prohibition in terms of reduced PCP exposure, given that certain specific uses would remain as specific exemptions or acceptable purposes. The above comments regarding the net change in health/environmental costs and benefits of using PCP should also be taken into account. However, a restriction allowing continued use only in (industrial) wood preservation, would have the benefit of eliminating exposure through any other current or future uses in other applications, such as textiles.

70. A restriction allowing continued use for specified (exempt) uses could minimise some of the more significant negative costs identified for a prohibition, such as loss of sales revenues and employment from manufacture, as well as lost revenues or redundant capital equipment for wood treaters. However, it will also minimize the more significant benefits identified for a prohibition, such as increase of sales revenues and employment from manufacturers and industries involved in the sales/application of alternatives.

71. The costs associated with replacing PCP under a restriction or a prohibition could be significantly reduced if replacement is allowed to be undertaken at a slower pace in countries where use is still considered critical.

Control of discharges and emissions

72. There would be benefits of reduced discharges from wood preservation facilities releases; in-service and at the end-of-life stage. No quantitative information has been identified on the relative scale of emissions from these stages and the extent that they could be reduced by complying with best available techniques / best environmental practices. Measures to improve wood treatment practices (especially those that reduce the amount of free PCP in the wood) could contribute to reducing releases during service life.

73. A US EPA (USEPA 2008c) analysis for worker mitigation strategies estimated the average total costs of mitigation strategies per plant as around:

(a) Automatic door: $700,000 for a small plant and $1,100,000 for a large plant (rounded);

(b) Automatic bridge rails: $200,000 and $300,000 respectively;

(c) Pulling final vacuum: $55,000 and $85,000 respectively.

It should be noted that these mitigation measures were evaluated as part of an evaluation of occupational exposure via the dermal and inhalation routes. They are provided within the text as a guide, but it should be recognised that measures to reduce or eliminate releases of PCP to the environment would need a re-evaluation of the scope required.

74. The extent, to which these additional costs might actually be borne, however, is unknown since it is not known how many facilities already have such measures in place. All Canadian PCP treatment plants facilities already conform to the requirements of the TRD (Canada 2014).

75. There would also be costs associated with control of emissions from use of the treated wood, such as related to storage facilities, use of alternatives at sensitive sites and management/tracking of waste wood.

Waste management and stockpiles

76. Depending on the waste management route adopted, there could be changes in costs. For example, diverting old treated wood to incineration from landfill could destroy the PCP (making sure that dioxin formation is minimised), but this would likely come at a cost, e.g. of increased incineration capacity. However, there could also be reduced costs associated with the need for reduced treatment of landfill leachates contaminated with PCP.

77. If restrictions are introduced on sales of PCP-treated wood to secondary markets (e.g. garden boundaries), there could be potential changes in costs through availability and use of alternative (e.g. virgin) materials, costs associated with disposal and also costs of identifying this wood (e.g. through labelling).

Environmental quality guidelines in water, soil, or sediment and remediation of land

78. Provided that environmental quality guidelines are adhered to, these could limit human and environmental exposure to PCP, and hence provide additional benefits.

79. In addition to the benefits in terms of reduced exposure for humans and the environment, it is possible that a restriction prescribing industrial pollution prevention or prohibition on use could lead to decreased costs through e.g. reducing the extent of land contamination and hence the need for land remediation costs.

80. It is clear that remediation of historically PCP-contaminated land represents a long-term and expensive challenge, with level of cost depending on the intervention levels used and extent of remediation. For example, the US EPA spent $US3.2 million in 2009-10 cleaning up a single PCP contaminated site (Havertown) (USEPA 2012). A project is underway in New Zealand (where past use of PCP is one of the major sources of contaminated sites) to clean up a canal contaminated with

dioxins from PCP use at timber treatment plants prior to 1990, with an estimated cost of NZ$4.4 million (US$3.7 million) (BOPRC 2014). Large areas have also been remediated in other regions, such as the Horst area of the Netherlands (Netherlands 2014), which was necessary in order to allow for residential development in the area. Reduced land contamination could also lead to an increase in land values, as another benefit of the various control measures under consideration. However, past practices leading to contaminated sites as described above may not be indicative of current industrial PCP practices, nor the potential for contamination based on current practices.

2.3 Information on alternatives (products and processes)

2.3.1 Introduction

81. The responses to the Annex F request for information along with supporting information from USA and Canada identify that the sole use for PCP is for industrial wood treatment, with particular key use for utility poles and cross-arms (see section 2.0). The ICC (ICC Annex F response) also quotes the use of Na-PCP for treatment of wood and the ICC (2014b) further identify active use for Na-PCP: as a biocide in water-based distemper paints to resist microbial degration while in storage ahead of use. Communication from Mexico (2014) indicated that the only current active use remaining with Mexico is for wood treatment, noting other identified uses had now ceased.

82. Utility poles and cross-arms form a key part of the power network infrastructure with load bearing structures which are required to meet standard levels of performance to ensure continued transmission of electricity. Both chemical and non-chemical alternatives exist for PCP within these applications, and more broadly within wood treatment a number of accepted wood preservation chemicals exist with potential to replace PCP dependent on the specific application. Table 2 originally produced within the USA EPA assessment of alternatives (US EPA 2008b) and repeated within the UNECE exploration of management options (UNECE 2010) provides details of viable chemical alternatives and approved applications by the American Wood Preservatives Association (AWPA). These applications are also expected to be representative of pesticide use in Canada and Mexico. The following sections provide a detailed breakdown of chemical alternatives (2.3.2), non-chemical alternatives (2.3.3) and then finally a summary of cost comparisons for both chemical and non-chemical replacements for PCP (2.3.4).

2.3.2 Chemical alternatives for wood preservation

83. The USA EPA assessment of alternatives (US EPA 2008b) identifies the key major mass production preservatives for wood as PCP, chromated copper arsenate (CCA) and creosote-based products. The Canadian guidance document for industrial treated wood (Environment Canada 2004a) concurs with these identified preservatives with the addition of Ammonical Copper Zinc Arsenate (ACZA). A number of additional preservatives (Ammonium Copper Quaternary (ACQ), and Copper Naphthenate have also been identified as being used within North America and may provide viable options for the treatment of wood for certain scenarios where PCP is currently used. In New Zealand ACQ and Copper Naphthenate are approved preservatives along with CCA (which is the major product), copper azoles, and azoles/permethrin. Borate salts are also used but these are non-fixed preservatives and can only be used for indoor timber uses due to their leaching potential, and are therefore not an alternative for current PCP uses. Creosote is not approved in New Zealand as is the case with PCP (New Zealand 2014).

84. Under the European Union biocidal products regulation (Regulation EU 528/2012) to date includes 32 biocide active substances which are approved at EU-level for use in wood preservative biocidal products. These active substances cover a broad array of applications including some of the substances already named above but the vast majority of these 32 biocide active substances are not used for industrial wood preservation. The most widely-used wood preservative for key applications such as utility poles in the EU is understood to be creosote, following the prohibition of PCP and CCA use. Further details are provided at the end of section 2.3.2.

85. The remainder of the present chapter will provide a breakdown of each key alternative with an analysis of its technical feasibility, highlighting its potential strengths, weaknesses and risks to health and the environment.

Chromated Copper Arsenate (CCA)

86. CCA is a product made up of active ingredients in a ratio of 5:3:2 for chromic acid, arsenic acid and cupric oxide, respectively (Canada 2014b). The product is already widely used in North America and is recognised as the main preservative wood treatment product in the USA for industrial

use, with 44% market share (US EPA 2008b). It is also widely used in Canada (Canada 2014). India has also identified CCA as the likely replacement product for Na-PCP in wood treatment (ICC 2014a). It is also widely used in New Zealand (New Zealand 2014). While CCA is widely used for wood treatment, it was voluntarily removed from use on wood intended for the domestic/residential (e.g. homeowner) use market in 2003 in both the USA and Canada due to public health concerns. It is now limited to use on wood intended for industrial applications and handled by professional users (Environment Canada 2013, US-EPA 2008b).

87. CCA is typically used in a pressure treating process for wood following a similar process to PCP and creosote, although CCA is used at lower application temperatures: 65oC compared to 100oC for PCP and Creosote (USEPA 2008c). On completion of pressure treating (for all preservative types) it is necessary to include a drying cycle. It is however not appropriate to use kiln drying for CCA (air drying is preferred) as there is the potential to release chromium to air (USEPA 2008c). The pressure treatment process, when correctly applied, provides high fixation rates for CCA with the metal components tightly bound to wood (Environment Canada 2004a).

88. CCA has both strengths and weaknesses in treatment of wood compared to PCP. CCA is recognized as producing a clean, dry, odour free finish which is easy to paint. Conversely, as PCP is an oil-based wood treatment, PCP-treated wood can ‘bleed’ and typically has a phenolic odour (GEI 2005). This makes CCA-treated wood more applicable to public locations such as pavements or pedestrian areas. The high fixation rates for CCA also mean it is suitable for use in areas with high moisture soil content or high water table. However CCA treatments can have an effect on moisture content of wood leaving them particularly dry. This has previously caused additional problems for climbing utility poles, now overcome with the use of softeners (Canada 2014). For hot dry climates the use of CCA can also be an issue for shrinking, cracking or warping of wood. This is particularly an issue for load-bearing structures such as cross-arms for utility poles (GEI 2005). The use of oil-based preservatives such as PCP and creosote provide an additional ‘suppleness’ to wood which can protect against warping and cracking in hot dry climates. CCA is also recognized as being corrosive to some metal types meaning that galvanized metal fastenings should be used in combination with CCA applications (UNECE 2010). This approach is taken as the industry standard in the USA (USEPA 2008b).

89. The ICC and ACAT/IPEN (ICC 2014a and ACAT/IPEN 2014) have both raised concerns regarding CCA’s environmental and human health impacts, noting that CCA contains highly toxic and carcinogenic substances with concerns for these substances reaching the natural environment CCA contains two carcinogens, hexavalent chromium (CrVI) and arsenic, along with copper which is highly toxic to aquatic organisms (CDC 2013, USEPA 2013, USEPA 2008d). However, post fixation, in service CCA treated wood does not contain hexavalent chromium, but rather trivalent chromium (USEPA 1998). Trivalent chromium is classified as a group 3 (“Not classifiable as to its carcinogenicity to humans”) carcinogen while hexavalent chromium is groups 1 (“Carcinogenic to humans”) (IARC 2014*)*. KMG (PCPTF-KMG 2014) notes that:

“CCA is no longer authorized for use in the European Union under the Biocidal Products Regulation and we would not expect the EU members of the POPRC to endorse CCA as an alternative to PCP.“

90. Health Canada’s Pest Management Regulatory Agency (PMRA), who carried out a joint risk assessment with the US EPA for heavy duty wood preservatives, notes that the original assessment for CCA is expected to have overestimated risk, and that wood treatment facilities following the Technical Recommendations Document (TRD) (labelling, storage, risk management plans) would greatly reduce the risk of exposure and environmental loss. The same document also states that CCA used in freshwater conditions has a low potential for leaching and that any material lost from utility poles in submerged conditions is retained in the sediment at the foot of the pole with minimal risk for exposure to aquatic species (PMRA 2011 and USEPA 2008a). Laboratory studies by Kamchanawong (2010) and Mercer (2012) assessed the leaching potential of CCA within hypothetical environments that simulate unlined landfill conditions; For the Kamchanawong this was under tropical conditions. The results of these studies highlighted potential for leaching which in real world environments may cause a concern for groundwater. However environmental relevance of these studies is unknown. In Canada and the USA, registrants voluntarily withdrew consumer (i.e. non-industrial) uses of wood treated with CCA as of 2004. These uses are therefore prohibited in Canada and the USA, as is export of wood for these purposes (USEPA 2014, US EPA 2003, PMRA 2002, and PMRA 2006). It is difficult to treat certain wood species used for utility poles with CCA due to the inability of the treatment to penetrate blocked wood pores. In addition, CCA-treated utility poles are more difficult to climb. (UNECE 2010)

Creosote based products

91. Creosote is produced from the distillation of coal tars and contains between 200-250 chemical species, although 85% of these are polycyclic aromatic hydrocarbons (PAHs) (Environment Canada 2013). A large number of toxic substances are contained in creosote including PAHs, phenol, and cresols. Creosote is a widely-used preservative for wood with proven efficacy, although it has negative environmental and health consequences. Efficacy studies show that creosote is effective against a broad spectrum of harmful organisms, including wood rotting fungi, against wood rot in soil and water contact, against insects, and against marine borers (Sweden 2014). Creosote is widely used in the USA with 16% of the utility pole market (USEPA 2008b) and 31% of all wood in the USA (Vlosky 2009) as well as Canada (2014) and Sri Lanka, although information from Sri Lanka suggests service life is 30 to 50 years under harsh tropical climates (Sri Lanka 2014). Also in the EU, creosote is extensively used across the EU Member States, and according to the European Electricity Industry Association, Eurelectric (2010), about 1 million m^3 of wood were treated with creosote each year. Creosote is of particular use in railway ties and cross-arms for utility poles (UNECE 2010) and in the EU the majority of creosoted wood is accounted for by these uses (WEI-IEO 2008).

92. Creosote, like PCP, is an-oil based product used within industrial pressure treating of wood. In Canada, it is also used as a brush-on treatment for newly cut surfaces of pressure-treated creosote timbers and lumber for industrial applications and handled by professional users (PMRA, 2011). The use of oil-based preservatives provides a waterproof layer to wood surfaces and to an extent also the metal fittings during service life. The use of oil-based preparations such as creosote and PCP provides ‘suppleness’ to treated wood which can help prevent shrinking, warping and twisting, particularly in harsh climatic conditions (UNECE, 2010). This is of particular importance for load bearing structures such as railway cross-ties and cross-arms of utility poles (USEPA, 2008b). The Canadian Annex F response (Canada, 2014) states that the Canadian railway system is around 50,000 km long with approximately 90 million ties in service. The Canadian response to the Annex F survey also states that creosote is the only significant wood preservative currently used to treat railway ties. Production and availability of creosote is tied to steel production and any market fluctuations in the steel market. PCP has been identified as an important alternative for this use, should creosote become unavailable. This highlights the importance of PCP within the resilience of the rail infrastructure for Canada.

93. Concerns have been raised regarding health and environmental effects of creosote. KMG (PCPTF-KMG, 2014) highlight that the main constituents of creosote are PAHs which are already recognized as a Persistent Organic Pollutant (POP) under the UNECE Convention on Long Range Transboundary Air Pollution (CLR-TAP). FNV (FNV, 2010) highlights that the use of creosote has been in discussion for several decades because of the harmful impact on the environment and health of workers carrying out preservation. Carpenters and construction workers are also likely to be exposed during use of treated wood. Both IARC and US EPA have determined that coal tar creosote is a probable human carcinogen (ATSDR 2002) In the USA and Canada creosote is limited to industrial applications only (USEPA, 2008b). In Europe it was added to Annex I of the biocidal products directive 98/8/EC, meaning it can no longer be placed on the market without authorisation (Sweden, 2014). It is also mentioned in annex XVII of the European REACH regulation (EC 1907/2006) covering specific restrictions on use. Health Canada’s Pest Management Regulatory Agency (PMRA), who carried out the risk assessment for heavy duty wood preservatives, notes that the assessment for creosote is expected to have overestimated risk, and that wood treatment facilities following the Technical Recommendations Document (TRD) (labelling, storage, risk management plans) would greatly reduce the risk of exposure and environmental loss (PMRA, 2011).

Copper Naphthenate

94. Copper naphthenate is an oil-borne wood preservative (UNECE, 2010), which is produced as a mixture of copper salts and naphthenic acid, a by-product of petroleum refinery processes (Feldman, 1997). While the composition of copper salts are well understood, the naphthenic acid component can be of variable composition depending on the nature of the source petroleum processed (Feldman, 1997). Copper naphthenate has been approved for both industrial and domestic use in the USA (USEPA, 2008b).

95. Copper naphthenate holds a smaller proportion of the wood treatment market than CCA, PCP and creosote but demand is expected to grow (USEPA 2008b). The US-EPA data for 2004 quotes 900 tonnes used in the USA with further potential for growth. Copper naphthenate is approved for above ground, ground and freshwater use but not suitable for coastal/marine applications. Equally it can be used in the USA within pressure treating processes as can PCP, CCA and creosote.

96. Smith et al (undated) quotes quality issues experienced during the mid-1990s with specific batches of product. In these cases the product formed an emulsion during pressure treating which led to patchy treatment of utility poles and poor protection in areas where oil coverage was also poor. This notes that copper naphthenate would be concentrated in the oil fractions. Poles treated with these batches of copper naphthenate began to experience problems within four years of installation. Wood damage from fungi and pests particularly at the mid-to-top end height of the poles was experienced in a number of cases. One case study in Wisconsin, USA in 1997 quotes 217 poles where 43% were in poor repair. No recent batching issues are known to exist.

97. Information from the Toxnet database (Toxnet 2011) illustrates that despite its wide use the environmental profile and toxicity of copper naphthenate is poorly characterised; due in part to the variable nature of the petroleum product. This takes into account that the petroleum product component can have the presence of multiple compounds including notably benzene (Feldman, 1997). Toxnet also highlights that, like CCA, copper naphthenate leaches from wood and that studies on mice suggest that this substance may have potential to be genotoxic. However, the naphthenate acid molecule is not expected to bioconcentrate significantly; modelled bioconcentration factors (BCFs) are 1464-1659 (U.S. EPA, 2011), which are well below the Stockholm Convention criterion of 5000. US EPA (1996) also indicate potential health effects for occupational exposure when manually applying copper naphthenate to wood in domestic and residential settings.

Ammonical Copper Zinc Arsenate (ACZA)

98. ACZA is an aqueous product based on active ingredients in the ratio of 5:3:2: for cupric oxide, zinc oxide and arsenic acid, respectively. The ACZA product comes pre-mixed with active concentrations accounting for 10% of the formulation and ammonia as a transfer agent. ACZA can be used in pressure treatment where evaporation of the ammonia fixes the metals compounds to the surface of the wood and additionally ammonia also provides corrosion protection of working metal parts in the tank itself during transfer of ACZA. In Canada ACZA superseded ammoniacal copper arsenate (ACA) with full registration in 1999.

99. In the USA, ACZA is more typically used in the Western States due in part to its particular ability to treat Douglas Fir, the prevalent wood type in that area (USEPA, 2008b). ACZA is less widely used in the Eastern and Southern states. Production facilities are centred in the Western States.

100. ACZA, like CCA, has a high fixation rate. It can also provide better performance than CCA in protection against some species of pest (USEPA 2008b). ACZA is also approved for use in coastal/marine applications with only a limited number of other approved preservatives (notably creosote). However while CCA provides a clean, dry, odour-free finish to treated wood, ACZA treated wood tends to retain an ammonia odour which may be less suited to public locations such as pavements or pedestrian areas.

101. The environmental profile and concerns are broadly similar to those for CCA with the presence of both arsenic and copper oxide. ACZA has the potential to leach from wood, including treated utility poles (Lebow 1996 and US EPA 2008a), it also has the potential to be toxic and an irritant on direct exposure for workers (Environment Canada, 2013). Within the USA it is listed as a 'restricted use pesticide' reserved for industrial purposes (USEPA, 2008b). Health Canada's Pest Management Regulatory Agency (PMRA), who carried out the risk assessment for heavy duty wood preservatives, notes that the assessment for ACZA is expected to have overestimated risk, and that wood treatment facilities following the Technical Recommendations Document (TRD) (labelling, storage, risk management plans) would greatly reduce the risk of exposure and environmental loss and that the use of ACZA is used only within closed systems

Other Alternative preservatives for wood treatment

102. Alongside the chemical alternatives described above, additional chemical alternatives exist; within North America (ACQ), copper azoles and sodium borates (SBX) also form part of the mixture of wood treatment products available. These alternatives are also used within New Zealand. Additionally (Subsport 2012) also identify silicone polymers as a viable alternative. In the European Union under the EU biocidal products regulation (EU 528/2012) there are 32 named active substances approved at EU for use in wood preservative biocidal products, including a number of those already detailed (EU biocides 2012), however the vast majority of these 32 biocide active substances are not used for industrial wood preservation. The Table shown in the annex to the present risk management evaluation on pentachlorophenol and its salts and esters provides details of these substances together with applicable legislation on use restrictions for Europe. Further detailed explanation of ACQ, copper azoles and SBX as potential alternatives to PCP is given below.

Table 2 AWPA Approved uses for preservatives in wood treatment (UNECE, 2010)

	Creosote and oil borne preservatives					Waterborne Preservatives					
Product/application	**Creosote**	**Creosote-petroleum**	**Creosote Solution**	**PentaChloroPhenol**	**Copper Naphthenate[d]**	**Chromated Copper Arsenate[e]**	**Ammonium Copper Quaternary (ACQ) – type C and type D**	**Ammonium Copper Quaternary ACQ – type B**	**Copper Azole type B**	**Copper Azole type A**	**Ammonical Copper Zinc Arsenate (ACZA)**
Lumber, timbers and plywood											
C2-lumber, timber, bridge ties and mines ties	+	+[a]	+	+[a]	+[a]	+	+[a]	NA	+[a]	+[a]	+
C9-Plywood	+	+	+	+	NA	+	+	NA	+	+	+
C22-Permanent Wood Foundations	NR	NR	NR	NR	NA	+	+	+	+	+	+
C28-Glued laminate members	+	NA	NA	+	+	+	+	NA	NA	NA	+
Piles											
C3-Piles	+	+	+	+	+[b]	+	+	NR	NR	NR	+
C18-Marine construction	+	NR	+	NR	NA	+	NR	NR	NR	NR	+
C21-Marine lumbers and timbers	+	NA	NA	+	+	+	+	NA	+	+	+
C24-Sawn timber used to support residential & commercial structures	+	NA	NA	+	NA	+	+	NA	NA	NA	+
Poles											
C4-Poles	+	NR	+	+	NA	+	NR	+	NR	NR	+
C23-Round poles and posts used in building construction	+	NR	+	+	NA	+	NR	NR	NR	NR	+
Posts											
C5-Fence posts	+	+	+	+	+	+	+	+	+	+	+
C14 – Wood for highway	+	+	+	+	+	+	+	+[f]	+[c]	+[c]	+
C15 – Wood for commercial residential construction	+	+	+	+	+	+	+	NA	+	+	+
C16 – Wood used on farms	+	+	+	+	NA	+	+	NA	+	+	+
Cross-ties and Switch ties											
C6-Cross-ties and Switch ties	+	+	+	+	NR	NR	NR	NR	NR	NR	NR

It should be noted that although these uses may be "approved" by AWPA, the actual regulatory approvals must come from PMRA in Canada and USEPA in the USA.

NA: Not available, NR: Not recommended

a) Not for saltwater use

b) Land and freshwater use; not for foundations

c) Posts sawn four sides only

d) Copper Naphthenate is also approved by AWPA as a waterborne preservative for some uses.

e) Chromated Copper Arsenate is available for industrial applications only

f) Round, half-round, and quarter-round only

103. ACQ is a waterborne wood preservative used in a similar fashion to CCA (Environment Canada, 2013). Since the removal of CCA from the domestic wood market in Canada and the USA in 2003, the use of ACQ has grown significantly. In 2007 ACQ (and micronized ACQ) held 45% of all preservative wood treatments in the USA with CCA second placed (Vlosky 2009). However, ACQ is not currently used in the USA for utility poles and cross-arms. In Canada, while ACQ is widely used (mainly in the domestic wood market), it is not used within infrastructure applications including utility poles (Environment Canada, 2013). ACQ’s widespread use has been focused within the domestic wood market and soft woods, due in part to the low occupational risk for workers and minimal risk of environmental loss (Environment Canada, 2013). ACQ is recognized as being useful for treating Douglas Fir which is typically hard to treat, but is also more corrosive to metals than CCA and ACZA. The use of ACQ would require the use of stainless steel fittings in treatment facilities which can be expensive (USEPA, 2008b). More recently, the advent of micronized ACQ provides a product with lower corrosivity and greater penetration, using finely ground copper oxide within the product to improve application (Vlosky, 2009).

104. ACQ comes as four different products labeled types A-D that contain both copper and a quaternary ammonium compounds (“quat”) as actives. Of these, ACQ-A and ACQ-B contain the “quat” ‘DDAC’, ACQ-C contains ‘ADBAC’ and ACQ-D contains both ‘DDAC’ and ‘DDACB’. All four products types are based around the ratios of copper oxide to “quat” and may contain either ammonia or ethanol amine as the carrier solution (Environment Canada, 2013). DDAC is persistent in both water and soil, while ADBAC has lower persistence issues, with a half-life of ADBAC in soil of 13 days. DDACB the active in ACQ-D is persistent and harmful to soil organisms and has guideline maximum concentrations for water at 0.0015 mg/L (Environment Canada, 2013). ACQ-A, ACQ-C and ACQ-D are all used within Canada (Environment Canada, 2013). The ammonical component evaporates quickly within air leaving copper oxide which is highly toxic to fish should it reach the natural environment (Dubey 2010). Copper is released from ACQ-treated wood in landfill leachates raising concerns over further contamination (Dubey 2010).

105. Copper azole is a waterborne product made up of copper-amine complex and co-biocides (USEPA, 2008b). Two formulations exist based on the ratio of copper to other compounds. The product is supplied as a concentrate and then diluted at point of use (Environment Canada, 2013). In the USA it is approved for above ground, ground and freshwater use but is not appropriate for use in tropical conditions or coastal/marine applications (UNECE, 2010) and is not currently used in the USA for utility poles and cross-arms. In Canada it is approved for the domestic wood market only and is not used on infrastructure applications including utility poles (Environment Canada, 2013). Like ACQ, copper azole is corrosive to metal fastenings and so stainless steel would be required, which can be expensive for treatment facility upgrades (USEPA, 2008b). However a micronized copper azole product does exist with lower levels of corrosivity and potential for deeper penetration of wood (Vlosky 2009). This particularly product is still relatively new to market with an unknown long term track record for use in infrastructure applications (USEPA, 2008b). Copper azole is not known to be carcinogenic (Environment Canada, 2013).

106. Tebuconazole (the non-metal biocide ingredient in copper azole) has a half-life of 100 days in soil and is also moderately toxic to aquatic life (Environment Canada, 2013). However tebuconazole degrades more quickly in aquatic conditions than in soil and is largely eliminated by fish reducing the potential for bioaccumulation. The product produces irritation on direct contact with skin and long term occupational exposure can lead to lung, liver and kidney damage Azoles such as Tebuconazole are effective against decay fungi, but not against termites or mold. Thus, they must be used with other chemicals, notably copper. [Townsend, 2013].

107. The use of copper-based preservative systems as a replacement for pentachlorophenol for treatment of critical structural components like utility poles and cross arms may not be suitable because of the presence of copper-tolerant fungi widely distributed in the environment. A variety of fungi are capable of detoxifying copper-containing compounds either by immobilization or uptake (Morrell, 1991).

108. Sodium borates are a waterborne preservative with varying amounts of borate (USEPA, 2008b). The product comes as a powder which is then mixed to the desired strength prior to use (Environment Canada, 2013). In Sri Lanka (Sri Lanka, 2014) sodium borates are used to treat rubber wood as a diffusion treatment, but their use as a replacement for PCP is limited. Sodium borates and leave wood with a clean, dry, odour-free finish. Borates compounds are toxic for reproduction in accordance with the UN GHS criteria. However they also readily leach from wet wood affecting performance (USEPA, 2008b). Sodium borates are reserved specifically for use within indoor applications or above ground where wood is continuously protected from water (UNECE, 2010) and therefore sodium borates are not an alternative for current PCP uses.

109. Copper boron azole has been proposed as an alternative to CCA but not specifically for use on utility poles and cross-arms (ICC-ES 2013). Monoethanolamine is usually used to complex with the copper, which increases costs (Townsend 2006). Copper is released from CBA-treated wood in landfill leachates raising concerns over further contamination (Dubey 2010). Copper is highly toxic to aquatic organisms (USEPA 2008d).

110. Silicone polymers also provide a possible option to treating timber products. Instead of killing fungi, this approach creates a physical barrier to fungal attack. Inorganic silicone polymers and organic acid are used in a water-based wood treatment and dried under elevated temperature (Subsport 2012). The mixture encapsulates the wood fibres, creating a physical barrier on the wood surface and making it inaccessible for rot fungus. The product is sold under the trade name OrganoWood along with a surface coating for industrial uses called OW-surface coating, by Organoclick based in Sweden (Organoclick 2014). However, PCPTF-KMG 2014 and Canada 2014b note that silicone polymers appear to be untested for widescale industrial use, particularly for utility poles and that further more silicone polymers are not registered within Canada for industrial wood use. The recommendations made by Organoclick, 2014 suggest use for above soil application. PCPTF-KMG 2014 raise a concern about the use of silicone with ground contact application as a potential issue and that given the importance of ground contact for utility poles this should be considered. While silicone polymers pose an interesting option for wood treatment their largely untested nature on the wider industrial scale means that in the short term they are not a viable replacement option for PCP without further testing.

2.3.3 Non-chemical alternatives for wood

111. Alongside the chemical alternatives to the use of PCP as a preservative for wood treatment there are also non-chemical options that are currently in use. Wood has applications within domestic and industrial construction for a broad range of uses. PCP-treated wood has particular application to infrastructure usage such as utility poles for electricity supply networks and cross-ties for rail networks. It is possible for these specific applications to adopt alternative materials such as concrete, steel, fibreglass reinforced composite (FRC) or even hardwood alternatives which are more resistant to attack from fungi and pests in some situations. This section will explore the technical feasibility, efficacy and costs of the non-chemical alternatives.

112. The application of concrete, steel and FRC provide both generic and specific technical improvements and weaknesses compared to treated wood. Table 3 provides a brief overview of the generic strengths and weaknesses summarized within the USA EPA review (USEPA, 2008b) with individual commentary following after Table 3.

Table 3 Generic improvements and weaknesses of non-wood alternative materials.

	Concrete	Steel	FRC
Generic technical improvements compared to treated wood			
Standardised size and specification	X	X	X
Less maintenance required	X	X	-
Impervious to attack from fungi and pests	X	X	X
Generic technical weaknesses compared to treated wood			
More expensive than wood poles (based on up-front costs).	X	X	X
Non-wood poles cannot be climbed using existing equipment such as'Gaffs', but are designed to provide their own systems such as 'fixed steps'	X	X	X
Increased risk of animal electrocution requiring additional insulation	X	X	-
Heavier than wood poles	X	-	-

Concrete

113. Concrete utility poles and cross-ties provide a standardized product with high tensile strength (estimated to be around 8000 psi) and durability (USEPA, 2008b). This includes greater resistance to damage from lightning strikes, fires, vibration, fungal and insect pests and wind (Bolin, 2011). Concrete poles are less likely than treated wood products to warp or twist compared to treated wood (USEPA, 2008b). New Zealand (New Zealand 2014) state that for railway cross-ties the National Rail Company in New Zealand successfully switched to concrete in 1991 which is now the preferred choice of material. The enhanced durability in ideal locations, less frequent maintenance and potential longer service life than chemically-treated wood demonstrated a high level of efficacy in meeting the structural needs of utility poles (USEPA, 2008b). A manufacturer's claim states that the service life of concrete poles can potentially reach 75 years (Stresscrete 2014), while Canada (Canada 2014b) states

the average treated wood life span has been estimated at 70 years or higher (Mankowski 2002), Other estimates provided for the potential longevity of concrete poles are between 50 and 80 years, while estimates of wood pole longevity are 20 – 70 years. Detailed information has not been provided on how geographic climatic considerations affect the relative longevity of concrete and wood poles. The strong durability of concrete poles and standardised formulation can be a key factor in maintaining a long service life and preventing failure of poles at a premature point. The most significant issue for concrete compared to treated wood is weight, where concrete poles are quoted to be three times the weight of wood (Bolin 2011). The overall weight of concrete utility poles adds to freight and installation costs (USEPA, 2008b), with widescale adoption of concrete poles likely to have implications for industry who would need to 're-tool'. Concrete poles have the advantage of not requiring chemical treatment with persistent and toxic chemicals that are released into the environment, thus conferring benefits to worker and environmental health. Forest ecosystem protection and conservation of trees are additional benefits of the use of concrete rather than wood poles if trees are not from commercially managed forests, but on the other hand cement and concrete come from finite resources that must be excavated and there can be other environmental impacts in production of cement, such as the use of fly ash or other harmful substances, as well as emissions of air and water pollutants) [ACAT/IPEN, 2014b]; while wood poles from commercially managed forests represent a renewable resource. Although initial purchase costs for the concrete poles are higher as indicated in some studies (USEPA 2008b), these cost differentials may be offset to some extent by added disposal costs, and there could be longer-term cost savings over the life of the poles. Life cycle analysis studies by the wood preservative industry (Bolin, 2011 and Aqua-e-Ter, 2012) conclude that in comparison to wood based products, manufacture of concrete posts have a greater demand for natural resources such as water, and importantly are linked to much higher carbon dioxide and air quality pollutant emissions (the study assumed that treated wood and concrete poles have similar service lifespan). Concrete poles are also hygroscopic meaning that they are more susceptible to freeze/thaw damage in harsh climates. The USA EPA report also quotes data from EPRI (EPRI, 1997) which suggests that concrete posts cannot be used in coastal/marine applications as sea-salt attacks the concrete. However, a major manufacturer of concrete poles, StressCrete indicates effective use of concrete in both fresh water and saltwater environments when specially formulated for this particular environment. Because of their corrosion resistance, durability, and lack of chemical treatment, they are used in proximity to sensitive water bodies and can be used in freshwater and saltwater environments. One additional drawback for concrete structures relates to end of life: while treated wood poles can be re-installed at different locations during a working life, concrete posts can only be installed once, although the material can be recycled because it does not have to be consigned to a hazardous waste landfill.

Steel

114. Steel utility poles are manufactured as hollow structures, which allow them to be lighter than treated wood poles (by 30-50%) with similar or greater load bearing strength (USEPA, 2008b, ACAT/IPEN, 2014, and UNECE,2010). This reduced weight improves freight and installation costs. The USA EPA and UNECE reviews (USEPA, 2008b and UNECE, 2010) note that steel poles can be open to surface corrosion which can be difficult to assess by maintenance crews. They are also susceptible to below ground corrosion. However both of these issues can be overcome by using galvanized steel structures (ACAT/IPEN, 2014). Zamanzadeh (2006) states that the use of galvanized steels for below-ground structures alone may not be sufficient. Care is required when assessing the placement of poles as galvanized steel below ground can be subject to attack (particularly in acid soils) leading to corrosion which can significantly reduce service life. Assessment should be made during installation and where necessary additional measures, such as corrosion resistant backfill used. The main drawback for steel structures is that they need to be handled with care during transport and installation as they can be easily damaged (USEPA, 2008b and PCPTF-KMG, 2014). The USA EPA also notes that in overloaded weight burdens steel poles will buckle rather than split or break, which means that the transmission of electricity will be halted while repairs are carried out (USEPA, 2008b). As with any metal structure there is also an increased risk of electrocution not only to animals such as raptors but also work crews (WPC 2014), although the poles can be insulated to prevent this problem. Unlike concrete structures, steel poles can be recycled or used again as needed similar to current treated wood alternatives (Bolin, 2011). The use of steel as an alternative material for utility poles has been investigated by some of the utilities in the USA (such as Nevada, Arizona, and Austin Texas) (ACAT/IPEN, 2014) with integration in the power generation network done on a strategic targeted basis driven in part by geographic and climatic conditions. Life cycle analysis by the wood preservative industry (Bolin, 2011) concluded that in comparison to wood-based products, the manufacture of steel poles requires greater consumption of natural resources such as water, and most importantly is linked to higher emissions of carbon dioxide and air pollutants. Studies by SCS Global

(2013) and Bolin (2011) suggest the service life of steel poles is between 60 – 80 years, while estimates of wood pole longevity are 20 – 70 years. Detailed information has not been provided on how geographic climatic considerations affect the relative longevity of steel and wood poles. The SCS Global study devised a matrix of 21 environmental parameters which demonstrated the longer service life of steel poles combined with reduced maintenance needs meant that steel poles had an overall better environmental profile than treated wood poles.

Fibreglass Reinforced Composite (FRC)

115. FRC-based alternatives are relatively new to market and so have a limited history of use (WPC, 2014). However, like steel and concrete, FRC provides a standardized material with known specifications (USEPA, 2008b). FRC poles, like steel, are lighter than treated wood meaning a reduction in freight and installation costs. However FRC-based products can distort when screwing down hardware (WPC, 2014) and therefore the mounting hardware may loosen over time making FRC generally not appropriate for load-bearing components such as poles and cross-arms. FRC poles are engineered for a specific configuration of cross-trees and other attachments. Post installation modification of this is not possible in most situations. FRC poles may also be more susceptible to UV radiation, which in hot dry climates can lead to delamination of FRC layers and weakening of the overall structure (USEPA, 2008b). FRC-based poles are also only available in lengths under 55 feet which may prohibit some applications depending on terrain (WPC, 2014). Wood Preservative Industry reports (Aqua-e-Ter, 2012) also provide lifecycle analysis which suggest the energy demand requirements to produce FRC poles are greater than treated wood alternatives and that FRC poles will have a greater carbon footprint than treated wood, however this is likely to be offset by lower toxicity, and lower disposal costs [ACAT/IPEN 2014].

Untreated wood alternatives

116. Alongside the non-wood alternatives to PCP-treated wood it is also possible to make use of alternative wood types with greater resistance to attack by fungi and pests. Hardwood varieties can have a viable service life of up to 25 years without the need for chemical treatment (USEPA, 2008b). The main issue for greater use of hardwood varieties will be the availability of viable stock which will vary globally. Decay-resistant woods such as cedar, and hardwoods may be used without chemical treatment (UNECE 2010). These woods have greater mechanical strength than chemically-treated softwoods, although initial purchase cost is more expensive than chemically treated woods. Switching to hardwood varieties that have greater resistance to attack by pests would likely have adverse effects, both economically with additional cost of wood but also on forestry and local ecosystems with the need to meet demand for wood (USEPA, 2008b). The use of hardwood varieties will have varying efficacy based on climatic conditions, application and availability of suitable stock. This is offset by the enhanced benefits of reduced chemical use and emission to environment compared to PCP.

Heat treatment of wood

117. This approach uses thermal treatment of wood near or above 200^{o}C in low oxygen conditions to make it resistant to decay while maintaining dimensional stability. Principal uses are restricted to above ground non-structural uses such as siding, decking, flooring, garden furniture, playground furniture, window and door frames, and indoor furniture. Therefore, heat treated wood is not a viable alternative to current uses of PCP (i.e. in ground, ground contact, water contact and structural). The treatment process varies according to the wood species and no chemicals are required. Six major processes are available including Thermo Wood (Finland), Plato Wood (Netherlands), Retification (France), Bois perdure (France) Westwood (USA, Canada, and Russia), and Oil heat treatment (Germany) (ECRD, 2001). A comparison of production costs among the various methods indicates a range from 65 – 160 €/m3 (Wang Undated).

118. Burying utility lines is considered an option where aesthetic or weather conditions preclude above-ground power distribution systems. However, a negative aspect of this option is that chemical treatments of the lines are often required to prevent decay and pest problems.

2.3.4 Summary of alternatives

119. The preceding chapters have provided a summary description of the key chemical and non-chemical alternatives. Within North America, chemical alternatives such as CCA and creosote are already in mass production, while new alternatives such as copper naphthenate and ACZA are growing in popularity. The preceding chapter also highlights that the chemical alternatives on the market have their own strengths and weaknesses and may not be directly interchangeable with PCP for specific applications. This is also true for non-chemical alternatives. Furthermore due to their different structural properties, non-chemical alternatives will often not be feasible as replacing individual

component poles within established wood pole transmission lines. Table 4 provides a cost comparison provided within the USA EPA assessment of alternatives for PCP (US-EPA, 2008b).

120. As a separate matter the ICC (ICC, 2014a) states the use of Na-PCP and that alternatives to Na-PCP will take a minimum of 8-10 years to develop, produce and manufacture at competitive price rates to the existing Na-PCP product. Within New Zealand Na-PCP was used primarily as an anti-sap stain rather than preservative and was phased out in the 1980s, with a number of viable alternatives market ready (New Zealand 2014). The data in Table 4 suggest that, based on costs, the use of PCP, CCA, Creosote and Copper Naphthenate are broadly similarly with ACZA approximately $20 per pole more expensive. The costs for ACQ are significantly higher than the other products due to the issue of corrosivity and need for stainless steel fittings. This issue may be countered with the use of micronized ACQ. No costs are provided for copper azoles although they are expected to be more expensive than PCP.

121. Table 5 displays the costs quoted for non-chemical alternatives per pole and take into account full production and installation costs as well as maintenance. While non-chemical alternatives require lower maintenance than treated wood, the initial installation costs are such that these savings do not off-set additional up-front costs (USEPA, 2008b). When the anticipated longer service life is included, the costs are competitive. This position is based on a case study of a large power distribution utility that found that the 480 installed steel poles out of over 200,000 non-steel utility poles it maintains save the utility 10-20% in lifecycle costs compared with a comparable 480 chemically-treated wood poles.

Table 4 Summary of costs quoted in the US-EPA (2008) for chemical alternatives

Chemical Alternatives – cost based on 'per utility pole' treated basis							
PCP	CCA*	Creosote	Copper Naphthenate	ACZA	ACQ**	Copper Azoles	Sodium Borates***
$199	$197	$198	$200	$220	$240 - $287	-	-

* Cost includes $20 for softening agents

** Cost includes the requirement for stainless steel fittings at $37 - $75 per pole.

*** Note that Sodium Borates would not be suitable as a PCP alternative because they are a non-fixed preservative.

Table 5 Summary of costs quoted in the US-EPA (2008) for non-chemical alternatives

Non-Chemical Alternatives – cost based on 'per utility pole' basis for production, installation and maintenance costs			
Treated Wood	Spun Concrete	Steel*	Fiberglass Reinforced Composite
$800	$1750	$1370	$1650

* The Alaska Community Action on Toxics note a separate study by SCS Global (2013) which suggests steel poles are of comparative price to treated wood when assessed for full life span and reduced maintenance costs.

2.4 Summary of information on impacts on society of implementing possible control measures

2.4.1 Health, including public, environmental and occupational health

122. The risk profile documents human health and environmental concerns associated with PCP and PCA which are reported to be that PCP and PCA are highly toxic to aquatic species and moderately toxic to terrestrial species. Also a number of sub-lethal effects have been witnessed with the potential to cause harm to aquatic and terrestrial species. Effects within birds show the greatest degree of variability from non-toxic to highly toxic. In mallard and pheasant, sub-lethal effects include reduced numbers of hatchlings, while within the aquatic compartment sub-lethal effects include damage to reproduction, survival and growth. For humans PCP has been detected in the blood, urine, seminal fluid, breast milk and adipose tissue of humans which demonstrates exposure, and therefore potential hazard to foetuses, infants and adults. Additionally, compared to other chlorinated compounds, PCP is one of the most dominant contaminants measured in blood plasma and a number of epidemiological and industrial health studies, primarily based on inhalation and dermal exposure, have made associations with a variety of cancers. (Further information can be identified in UNEP/POPS/POPRC.9/13/Add.3,ACAT/IPEN, 2014, and USEPA 2008a). The persistent nature of PCP and PCA means that the effects of releases could be long lasting, though as indicated in the risk profile where long -term monitoring data exists, concentrations of PCP and PCA are decreasing in air and biota

123. A study by the Centre of Public Health Research in Wellington, New Zealand, (CPHR, 2007) concluded that several decades after use and exposure of PCP ceased, some adverse health effects (both physical and neuropsychological) are still present in some former timber workers exposed to PCP and also elevated blood serum levels of dioxins still persist.

124. Based on the evidence reviewed, the ACAT/IPEN (2014) response claims that listing PCP under the Stockholm Convention would have positive human health and environmental impacts. However, Canada counters that no effects at global environmental levels have been established, and therefore there is no basis for claims of expected reduced effects. Sweden's (2014) response also highlights that controlling the use of PCP contributes to reducing emissions of dioxins and furans (see for more information Sweden EPA, 2009).

125. The Canadian Re-evaluation Decision on PCP (PMRA, 2011) identified potential health risks in some occupational tasks within wood-treatment facilities. However, it noted that it was likely that risks had been overestimated due to the fact that the assessment was based on exposure estimates which pre-dated industry's widespread adoption of risk reduction measures. As such it concluded that currently registered uses of PCP are acceptable provided new risk-reduction measures and adequate controls are implemented in such facilities. . The USEPA Re-evaluation Decision on PCP similarly concludes that PCP containing products are eligible for re-registration, provided that risk mitigation measures are adopted. In addition, USA and Canada's response to Annex F notes that alternatives are not without health and environmental risks (see section 2.3). Therefore, substitution of one or more of these alternatives for PCP may or may not result in significant reduction of overall risks of concern (USA 2014c).

126. Canada also notes that while further limiting the currently registered uses of PCP and moving to alternatives may decrease PCP and PCA releases to the environment, it is unclear if this will result in a net environmental and health risk reduction. Canada reports that current contributions of PCA/PCP from registered uses have not been well characterised relative to other historical global uses or sources of release of PCA (e.g. metabolism of HCB), and therefore it is not possible to predict whether existing or additional control measures on Canadian uses will result in meaningful health or environmental impacts. In particular, Canada points out that air monitoring data of PCA at the Canadian High Arctic station of Alert (Nunavut) from 1993-2011 show a steep decline in PCA concentrations since 2003 in spite of continued, and slightly increasing, levels of PCP use in Canada (see section 2 and Canada, 2014). However, the observed decline of PCA in the Arctic is likely to be reflective of a global decline in use of PCP and not necessarily correlated with use in Canada.

2.4.2 Agriculture, aquaculture and forestry

127. Although uses in agriculture (e.g. herbicide, defoliant or bactericide) have largely been eliminated due to the availability and viability of alternatives, banning PCP under the Convention would ensure greater transparency and compliance to ensure elimination of any remaining uses. This would entail health and environmental benefits for agricultural lands, aquaculture waters and food products by preventing further contamination with PCP and associated dioxins and furans (ACAT/IPEN 2014). However, the USA counters that the significance of any benefits to human health and the environment would need to be carefully assessed and compared to the increased use of alternatives (USA 2014b).

128. Furthermore, the ACAT/IPEN (2014) response states that replacing the use of wood-treated poles with non-chemical alternative materials will contribute to conserving forests and forest ecosystems. However, other Parties and observers (Canada, 2014 and ICC, 2014) claim that PCPextends the service life of treated wood, which also contributes to forest conservation. In addition, PCPTF-KMG (2014) notes that forests are planted specifically for the production of wood of high value suitable for utility poles and that these forests also contribute to carbon sequestration.

2.4.3 Biota

129. The Risk Profile (UNEP/POPS/POPRC.9/13/Add.3) documents that PCP and PCA are very highly toxic to aquatic organisms, even though reported environmental monitoring concentrations are generally lower than those levels expected to cause an environmental effect particularly in remote areas, Howeverthe risk profile concludes that given the widespread distribution of PCP/PCA, that measurable levels of PCP/PCA are frequently found in biota and that PCP and PCA have an endocrine mode of action, environmental effects cannot be excluded. The risk profile also indicates that PCP has been shown to adversely affect the immune system in several animal species. Neurotoxic effects have also been reported in in vitro systems, as in vivo changes in brain tissue, and from neurofunctional

tests in animals. The ACAT/IPEN (2014) response expects positive impacts on biota and biodiversity if the use of PCP is banned.

130. However it is also noted by the above observers that the various chemical alternatives containing copper also present hazards to aquatic species. Some of the other chemical alternatives discussed above may release harmful substances that have adverse effects on invertebrates, fish and wildlife (e.g. creosote releases bioaccumulative PAHs and CCA releases carcinogenic substances such as arsenic, as well as copper, which is toxic to aquatic organisms).

131. Regarding non-chemical alternatives, increased risks of animal electrocution requires adequate insulation for metallic and other conducting materials (USEPA, 2008b). The USA (2014c) considers that these risks can be effectively mitigated.

2.4.4 Economic aspects

132. Several countries where PCP and its salts and esters are currently used expect negative economic impacts if PCP is listed under the Convention. In particular, Canada indicates that prohibition will negatively affect the heavy-duty wood treatment industry that uses PCP (currently 9 plants in different locations use the substance) and emphasises the widespread use of PCP in wood utility poles in Canada. At a replacement cost of around $2,000 per pole, they suggest that there is a large economic benefit to extending the service life of utility poles. Canada reports that the annual turnover of PCP (“penta”) treated poles sold in Canada is 38-45 million CAD whereas the value of “penta” poles treated in Canada and exported to the USA annually is 72-80 million CAD. Also Canada highlights the importance of PCP as an alternative to creosote for railway ties due to uncertainty with the future availability of creosote, which is tied with steel production. Finally, it notes that while the amount of PCP used to treat wood for the other registered uses is not as large, certain uses such as wood for bridges and other construction uses can be valuable in terms of extending the service life of important wooden infrastructures (Canada, 2014).

133. For the ICC, Na-PCP is necessary for preserving wood and hence to forest conservation in India. They note that it will take a minimum of 8-10 years to develop, produce and popularise cost effective substitutes to Na-PCP in India. In this regard, ICC highlights the socio-economic importance of the wood industry in a country where the demand for timber is estimated to increase from 58 million m3 in 2005 to 153 million m3 in 2020 (ICC, 2014).

134. The views expressed by ACAT/IPEN (2014) indicate potential economic benefits for some producers and users of alternatives. Although alternative materials can have higher costs upfront (e.g. steel or concrete), their potentially longer life expectancy and their reduced ratio of poles needed per km can make them cost-competitive in some situations (see section 2.3.3 for more details). ACAT/IPEN (2014) also consider that the economic effects of banning production are not expected to be significant due to the fact that PCP is only produced by a single company headquartered in the USA, with a manufacturing facility in Mexico and a formulating facility in the USA [KMG 2014]. (ACAT/IPEN, 2014). However, the USA (2014c) counters that with an estimated 130–135 million preservative-treated wood utility poles in service in the USA (USEPA 2008b) it is likely that significant impacts would be identified for chemical users because of the large number of utility companies using wood poles, and the cost associated with their replacement and disposal.

2.4.5 Movement towards sustainable development

135. According to ACAT/IPEN, elimination of PCP is consistent with the Strategic Approach to International Chemicals Management (SAICM), adopted in 2006, that emerged from the Johannesburg World Summit on Sustainable Development (2002). SAICM makes the essential link between chemical safety, sustainable development, and poverty reduction. The Global Plan of Action of SAICM contains specific measures to support risk reduction that include prioritising safe and effective alternatives for persistent, bioaccumulative, and toxic substances (ACAT/IPEN, 2014).

136. Canada values the contribution of PCP to the sustainable use of renewable forestry resources, due to its wood preservation properties, which can extend the average service-life of a wood pole up to 70 years (Canada, 2014 based on Mankowski et al, 2002) and recently concluded that PCP is acceptable for continued registration.

2.4.6 Social costs (employment etc.)

137. Social impacts may occur as a consequence of positive or negative economic impacts in countries where PCP and its salts and esters are currently used. In view of the replacement of PCP

with alternatives in a large number of countries, ACAT/IPEN (2014) expects that there should be few social costs associated with the elimination of PCP.

138. Negative social impacts are expected for those countries producing and using the substance (e.g. Mexico, USA, Canada), assuming that facilities would need to cease production. In particular, the production plant in Mexico employs over 50 people and is reported to have been an important member of the local community for over a quarter of a century (KMG, 2014). However there could be distributional effects, as increased employment might occur with use of the alternatives, but potentially in different locations/countries.

2.5 Other considerations

2.5.1 Access to information and public education

139. In Bulgaria, information on PCP is available on the website of the Ministry of health for biocides (http://www.mh.government.bg) and on website of the Bulgarian Food Safety Agency for plant protection products (http://www.babh.government.bg).

140. In the Netherlands, companies that import products that may contain PCP are informed through the website: http://www.antwoordvoorbedrijven.nl/regel/pentachloorfenol. The Netherlands Food and Consumer Product Safety Authority informs the general public on the regulation concerning PCP in clothes and textiles: https://www.vwa.nl/onderwerpen/consumentenartikelen/dossier/kleding-en-textiel/eisen-produceren-en-verhandelen-kleding-en-textiel/chemische-eisen-textiel-en-leer.

141. US EPA’s Office of Pesticide Programs regulates PCP as a wood preservative in the USA. All publicly available documents on PCP’s registration are available at: http://www.epa.gov/oppsrrd1/reregistration/pentachlorophenol/.

142. In Canada, several documents on PCP providing information on required control measures and on best management practices when working with wood preservatives are publicly available online at the websites of Canada’s Pest Management Regulatory Agency ((http://www.hc-sc.gc.ca/ahc-asc/branch-dirgen/pmra-arla/index-eng.php) and Environment Canada (through the publications catalogue https://www.ec.gc.ca/default.asp?lang=En&n=FD9B0E51-1).

2.5.2 Status of control and monitoring capacity

143. In Canada, the PMRA is responsible, in partnership with other regulators, for promoting compliance with the conditions of use for PCP through the development of strategies/programmes, education activities and enforcement action in situations of non-compliance. PCP wood preservation facilities are required to be in compliance with Environment Canada’s TRD (Environment Canada, 2004b) which recommend routine workplace, biological and environmental monitoring. In addition, the Canadian Wood Preservation Certification Authority (CWPCA) operates a third party certification programme to ensure that certified plants fulfill the requirements outlined by the TRD (Canada, 2014).

144. Air monitoring of PCA is undertaken at the Canadian High Arctic station of Alert since 1993 and is ongoing (Hung, 2014, unpublished). In addition, Canada currently collects air samples in the Great Lakes Basin, which has recently begun to be screened for PCA (Canada 2014).

145. Data on PCP releases are available in the US EPA’s Toxics Release Inventory (TRI) http://www.epa.gov/tri/tridata/. According to reported data in 2012, a total of 234,240 pounds (106,259 kg) of PCP were released to the environment, but 99% of these were released to hazardous waste landfills regulated by the Resource Conservation Recovery Act (RCRA) (USA, 2014). The UK notes the importance of volatilisation from treated wood in-use (as this may not have been included in the above data): such releases were estimated to be 300, 000 kg in 2012 in the UK alone.

146. Monitoring PCP in water is conducted in the EU according to the European Water Framework Directive (2000/60/EC), which identifies PCP as a Priority Substance. In addition, PCP concentrations in sludge and effluent water are monitored annually since 2004 by the Swedish EPA (Sweden, 2014). PCP is also included within the European Pollutant Release and Transfer Register (E-PRTR) Regulation (EC No. 166/2006), which requires all EU-based installations with environmental permits under the Integrated Pollution Prevention and Control (IPPC) regime to make a assessment of their emissions to air, land and water and to report these annually to Member State competent authorities (PRTR 2006). Typically these assessments are made up of a mixture of monitoring, modelling and calculated estimates.

147. Control and monitoring institutions in Bulgaria include: the Bulgarian Food Safety Agency for authorization and registration or re-registration of Plant Protection Products; the Ministry of Health for

authorization of Biocides; the Ministry of Environment and Water for the control of placing on the market and use of Chemicals and Mixtures and the State Customs Agency on the control imports and exports (Bulgaria, 2014).

148. In Serbia, data collection and monitoring regarding air and water pollutants is managed by the Serbian Environmental Protection Agency. Surface water and groundwater monitoring results from 2012 revealed that in all monthly samples collected from the Danube the PCP concentration was below 0.01µg/l (Serbia, 2014).

149. Sri Lanka has a system to control the importation of all pesticides including POP pesticides under the Control of Pesticides Act No. 33 of 1980, which is managed by the Office of the Registrar of Pesticides. Specific custom codes have been identified under the Import and Export Control Act No. 01 of 1969 to control PCP and its salts and esters at the entry point (Sri Lanka 2014).

3. Synthesis of information

3.1 Summary of risk profile information

150. Pentachlorophenol (PCP) is an organochlorine compound primarily used as oil based wood preservative. Since its introduction in the 1930s it has also been used as a biocide, pesticide, insecticide, disinfectant, defoliant, anti-sapstain agent, anti-microbial agent and is used in the production of the ester pentachlorophenyl laurate (PCP-L). The salt sodium pentachlorophenate (Na-PCP) has been used for similar purposes as PCP and readily dissociates to PCP. PCA is not used as a commercial chemical or pesticide and is not intentionally released directly into the environment. It can be produced through the transformation of PCP and other chemicals, such as hexachlorobenzene (HCB) Quintozine (PCNB) and lindane, in the environment. The relationship between PCP and PCA including degradation pathways are complex, and PCP is not the only source of PCA. For the purposes of the proposal to add these substances to the Stockholm Convention, PCP and PCA should be considered together as PCP and its salts and esters.

151. PCP and PCA are hepatotoxic, carcinogenic, immunotoxic, neurotoxic and toxic to the reproduction. It should be noted that some of these hazards can be induced by an endocrine mode of action and there is a lack of scientific consensus related to the existence of a threshold for this mode of action. Due to the concentration of PCP/PCA observed in humans, adverse effects for human health related to the toxicities listed above cannot be excluded.

152. PCP and PCA are very highly toxic to aquatic organisms. Reported environmental monitoring concentrations are generally lower than those levels expected to cause an environmental effect particularly in remote areas. However, given the widespread distribution of PCP/PCA, that measurable levels of PCP/PCA are frequently found in biota, and that PCP and PCA have an endocrine mode of action, environmental effects cannot be excluded.

153. PCA is partially soluble in water and is likely to be immobile to slightly mobile in soils and partition to sediment in aquatic systems. It is expected to volatilise from moist soil and aquatic systems based on its Henry’s law constant but, under laboratory conditions, volatility was observed from water, but not from soil. PCA meets the Annex D criteria for bioaccumulation. PCA is likely to undergo long-range transport to remote locations as evidenced by the predicted and observed volatility in laboratory studies, as well as detection in air and snow in remote locations.

154. PCP and PCA are detected in air, water, soil and biota throughout the world, including in remote regions, which suggests mobility and potential for long-range transport. PCA is more dominant than PCP in air whereas PCP is found in higher concentrations than PCA in soil, sediment and sludge. In biota, PCA and PCP concentrations are comparable. Where long-term monitoring data exists, concentrations of PCP and PCA are decreasing in air and biota.

155. PCP manufacturing, use, and disposal are sources of dioxins and furans.

156. PCP and PCA are likely, as a result of their long-range environmental transport, to lead to significant adverse human health and/or environmental effects, such that global action is warranted.

3.2 Summary of risk management evaluation information

157. PCP is produced by one manufacturer at a production facility in Mexico (6,600 t/per annum), which is then formulated into a manufacturing concentrate at a formulation facility in the USA (7,000 t/per annum). In addition, 1,500 t/per annum of Na-PCP is produced and consumed in India (for use in wood treatments only). The main share of the PCP market is in North America.

158. PCP has had multiple uses in the past which have now been phased out. The primary remaining use is in preservation of wood from damage by fungi and pests, particularly for use in utility poles and cross-arms, with minor uses for railway ties (cross ties or ‘sleepers’) and outdoor construction materials.

159. The use of PCP for wood treatment has already been banned or heavily restricted by a large number of nations including Indonesia, Ecuador, Morocco, Australia, Sri Lanka and New Zealand, as well as EU Member States. However use of PCP as a heavy duty wood preservative remains significant in the US and Canada. In these countries alternative chemical treatments based around copper arsenates and creosote are widely used in some situations; while non-chemical alternative materials such as concrete and steel are also manufactured and used within some infrastructure networks both there and elsewhere.

160. A number of chemical alternatives (such as chromated copper arsenate, creosote, copper naphthenate, ammonium copper zinc arsenate and silicone polymers) exist and are broadly comparable in price and application process to PCP. However, alternative products are not directly interchangeable, some of them may have toxicity concerns (e.g., CCA and creosote) and will have specific strengths and weaknesses for any given application.

161. Non-chemical alternatives to PCP treated wood are available, and may have longer life spans in certain circumstances, reduced maintenance costs, pest/fire resistance and standardised specifications (which is less achievable with wood as it is a natural product). Initial costs for manufacture and installation are significantly higher than treated wood, although other costs may be lower (e.g. freight costs). It should also be noted that concrete and steel products can be recycled whereas PCP treated timber must be treated as hazardous waste at disposal.

162. Different life-cycle analyses have drawn different conclusions, with some showing that lifetime costs and environmental profile are better and others showing them as worse than treated wood, with no clear resolution. Evidence has been provided to demonstrate that in parts of the USA some utility companies have begun to use/integrate steel utility poles which are lighter than wood (meaning reduced freight costs) and provide durability and strength. However opposing opinion highlights the increased conductivity of steel structures and requirement for protection against surface corrosion (typically through galvanization) as well as the increased risk of damage to steel structures during transport and installation.

3.3 Possible risk management measures

163. Consistent with Decision POPRC-9/3, PCP and its related compounds warrant global action. The suggested options for possible control measures are assessed in section 2.1 in detail and can be summarised as follows:

(a) *PCP may be listed in Annex A without specific exemptions*. The fact that the vast majority of countries worldwide have already replaced PCP also for its use as wood treatment gives a good indication that the total prohibition of its use is technically feasible. Prohibition of sales and use of PCP would reduce and eventually eliminate releases of PCP to the environment (over a long period of time, given ongoing releases from articles in use). A prohibition without specific exemptions could be facilitated if a transitional period is given to countries where some uses are still considered critical. It would require replacement of PCP by available chemical alternatives or alternative materials in critical uses such as utility poles. However, it is important to note that, at present, some alternatives present technical feasibility issues (e.g. linked to climate conditions) and there seems to be no consensus on whether there would be a net health/environmental benefit from using different alternatives to PCP in some applications. It could be appropriate to include an exemption under the Convention for production of PCP limited to the specific use exemption. It may also be relevant to provide guidance on criteria for the selection of alternatives to PCP, in order to discourage the replacement of PCP with other environmentally harmful substances;

(b) *A restriction on use could be introduced through inclusion of PCP in [Annex A or B] with time-limited specific exemptions or review requirements*. Although this option will not result in immediate elimination of PCP, it could provide a phase-out period and overcome the identified technical feasibility concerns with immediate prohibition by specifying *specific exemptions*, such as use in industrial wood preservation for utility poles and cross-arms, with other uses not being possible. As it is time-limited, further investigation and registration of alternatives, and such restriction could also be linked to requirements for control of releases and emissions. This approach obliges Parties to register their intention to produce/use PCP for such a purpose. A restriction could significantly reduce the costs associated with replacement, allowing it to be undertaken at a slower pace in countries where use is still considered to be critical. However, there would be less immediate reduction in environmental and human exposure to PCP than with inclusion in Annex A without exemption;

(c) Linked with the above point, restrictions could also be linked *to measures to control emissions*. Requirements for control of discharges and emissions could take various forms, and ideally would be targeted at all of the life-cycle stages where these emissions can occur. The Canadian TRDs provides an example of technically feasible means to control emissions from industrial facilities, whereas the Industrial Treated Wood Users Guidance Document (Environment Canada, 2004a) includes measures to control releases from use and disposal of wood;

(d) Stockpiles and wastes containing PCP would be subject to the provisions in Article 6. Pressure-treated wood at the end of its service-life will still contain some PCP and needs to be disposed of according to obligations under Article 6. As incineration can lead to the unintentional production of dioxins, the provisions of Annex C of the Convention are likely to be of relevance;

(e) In addition, the labelling of PCP-treated wood should help to facilitate proper environmentally sound management of stockpiles and wastes in full compliance with Article 6 of the Convention;

(f) The unintentional formation of impurities such as dioxins and furans during PCP manufacture should already be addressed by the inclusion of these substances in Annex C (unintentional releases). However, PCP is also considered as a by-product similar to polychlorinated biphenyls (PCBs) or pentachlorobenzene, therefore the inclusion of PCP itself in this Annex, as unintentional production could be seen as relevant even if it is not the main source identified in the risk profile. On top of the above, parties could also consider implementing *maximum residue levels* in water, soil, sediment or food. Adherence to such levels could help to limit human and environmental exposure to PCP, and hence provide additional benefits. There may be a need for remediation of land contaminated with historical uses of PCP in this context, as undertaken in several countries (at often substantial cost). Technical assistance for analysis & remediation costs to developing countries or countries with economies in transition could be explored.

164. Overall, the suggested control measure is that PCP and its related compounds should be listed under the Convention. This would be consistent with the POP properties of this intentionally produced substance and would send a clear signal that phasing out production and use of PCP is desirable. Ultimately the decision on how Annex [A or B] may be adjusted to specify he appropriate exemptions or control measures to be agreed amongst the Parties. Parties need also to agree on the inclusion in Annex [C].

4. Concluding statement

165. Having decided that PCP, its salts and esters including its transformation product PCA are likely, as a result of long-range environmental transport, to lead to significant adverse effects on human health and/or the environment such that global action is warranted;

166. Having prepared a risk management evaluation and considered the management options;

167. The Persistent Organic Pollutants Review Committee recommends, in accordance with paragraph 9 of Article 8 of the Convention, that PCP and its salts and esters be considered by the Conference of the Parties to the Stockholm Convention for listing and specifying the related control measures under the Stockholm Convention in Annex [A or B and C] as described above.

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Annex to the risk management evaluation on pentachlorophenol and its salts and esters: Named active substances for wood treatment within the EU under EC528/2012

Named active substance	CAS number	EU use restrictions
4,5-Dichloro- 2-octyl-2H-isothiazol-3- one (DCOIT)	64359-81-5	Directive 2011/66/EU of 1 July 2011
Alkyl (C12-16) dimethylbenzyl ammonium chloride - C12-16 ADBAC	68424-85-1	Directive 2013/7/EU of 21 February 2013
Basic copper carbonate	12069-69-1	Directive 2012/2/EU of 9 February 2012
Boric acid	10043-35-3	Directive 2009/94/EC of 31 July 2009
Boric oxide	1303-86-2	Directive 2009/98/EC of 4 August 2009
Bifenthrin	82657-04-3	Directive 2011/10/EU of 8 February 2011
Chlorfenapyr	122453-73-0	Directive 2013/27/EU of 17 May 2013
Clothianidin	210880-92-5	Directive 2008/15/EC of 15 February 2008
Copper (II) oxide/ Copper hydroxide	1317-38-0/ 20427-59-2	Directive 2012/2/EU of 9 February 2012
Creosote	8001-58-9	Directive 2011/71/EU of 26 July 2011 Authorisation will only be granted if deemed that no viable appropriate alternative is available. Those Authorities allowing such products in their territory shall report no later than 31 July 2016 to the Commission justifying their conclusion that there are no appropriate alternatives and indicating how the development of alternatives is promoted.
Cypermethrin	52315-07-8	Regulation (EU) No 945/2013 of 2 October 2013
Dazomet	533-74-4	Directive 2010/50/EU of 10 August 2010 The EU level risk assessment addresses only professional use outdoors for the remedial treatment of wooden poles, such as transmission poles, by insertion of granules. If applicants at Member State level wish to seek authorisation for uses not covered at the EU level the authority must assess these uses with concern to protect risks to human populations and the environment.
Dichlofluanid	1085-98-9	Directive 2007/20/EC of 3 April 2007
DDACarbonate	894406-76-9	Directive 2012/22/EU of 22 August 2012
Didecyldimethylammonium Chloride (DDAC)	7173-51-5	Directive 2013/4/EU of 14 February 2013
Disodium octaborate tetrahydrate	12280-03-4	Directive 2009/96/EC of 31 July 2009
Disodium tetraborate (all species)	12267-73-1/ 1303-96-4/ 1330-43-4/	Directive 2009/91/EC of 31 July 2009
Etofenprox	80844-07-1	Directive 2008/16/EC of 15 February 2008
Fenoxycarb	72490-01-8	Directive 2011/12/EU of 8 February 2011
Fenpropimorph	67564-91-4	Directive 2009/86/EC of 29 July 2009
Flufenoxuron	101463-69-8	Directive 2012/20/EU of 6 July 2012
Hydrogen cyanide	74-90-8	Directive 2012/42/EU of 26 November 2012
IPBC	55406-53-6	Directive 2008/79/EC of 28 July 2008
K-HDO	66603-10-9	Directive 2008/80/EC of 28 July 2008
Propiconazole	60207-90-1	Directive 2008/78/EC of 25 July 2008
Sulfuryl fluoride	2699-79-8	Directive 2006/140/EC of 20 December 2006
Tebuconazole	107534-96-3	Directive 2008/86/EC of 5 September 2008 Under the EU regulation for placing biocidal products on the market (EC 528/2012); Tebuconazole has been identified as a candidate who meets Persistent, Bioaccumulative and Toxic (PBT) criteria. Considered a candidate for substitution with phase out of active use.
Thiabendazole	148-79-8	Directive 2008/85/EC of 5 September 2008
Thiacloprid	111988-49-9	Directive 2009/88/EC of 30 July 2009
Thiamethoxam	153719-23-4	Directive 2008/77/EC of 25 July 2008
Tolylfluanid	731-27-1	Directive 2009/151/EC of 27 November 2009

Source: http://ec.europa.eu/environment/chemicals/biocides/active-substances/approved-substances_en.htm