

Pentachlorophenol



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The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l'Espagne.

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Annex 1: Monitoring Strategy for pentachlorophenol

Executive Summary

Pentachlorophenol (PCP) is an organo-chlorine compound (C_6HCl_5O) used mainly as a fungicide. Its salt, sodium pentachlorophenate ($C_6Cl_5NaO - NaPCP$), is used for similar purposes and readily degrades to PCP. The ester, pentachlorophenyl laurate (PCPL), is also used. All three substances are toxic, persistent and liable to bioaccumulate, although PCPL is less toxic by an order of magnitude. They need to be considered together. Priority was given to PCP in the 1992 OSPAR Action Plan, and it was therefore included in 1998 in the OSPAR List of Chemicals for Priority Action.

Production of PCP in the EU ceased in 1992. In 1996, 378 tonnes of NaPCP and 30 tonnes of PCP were imported from the USA; there may possibly be other imports from Asia. NaPCP is mainly used in France, Portugal and Spain, as a sapstain control agent to protect newly cut wood surfaces against fungal attack. 1-2 tonnes a year of PCP is used to a small extent as a wood-preserved, mainly in Ireland. Imported PCP is manufactured into PCPL in the UK; a little under 50 % of the product is used in France and the UK, in roughly equal shares, mainly for rot-proofing textiles for military purposes; the rest is exported outside the EU. The other major sources of inputs of PCP, NaPCP and PCPL to the sea are waste textiles and timber that have been treated with PCP (incineration of such waste may give rise to problems with furans and dioxins) and contaminated sites such as former PCP-production plants or wood-preservation plants. Some evidence points to the production of PCP during natural combustion processes: it is unclear whether this could be significant.

Monitoring results are only available for PCP. During the period 1983 to 1997 there has generally been a decreasing trend in concentrations. Monitoring results suggest that concentrations in UK waters are higher than elsewhere. Even there, however, a 1993-1995 survey showed results the highest of which were no more than 10 % of the environmental quality standard for PCP (2 $\mu g/l$), and the riverine and direct input survey shows a continuing decrease from 1991 to 1999. No information is reported on concentrations in biota.

The marketing and use of PCP and its compounds was prohibited in the EC in 1991, except for the treatment of wood, impregnation of fibres and heavy-duty textiles not intended for clothing, as an ingredient in chemical synthesis and, under individual authorisations, *in situ* treatment of buildings of cultural or historic interest. Under an amendment of 1999, no substance or preparation placed on the market after September 2000 may contain more than 0,1 % by mass of PCP and its compounds. France, Ireland, Portugal, Spain and the United Kingdom have the benefit until the end of 2008 of the possibility of derogations similar to, but more restrictive than, those under the 1991 prohibition.

The action recommended is: to urge the setting of stringent discharge limits for the remaining installations producing or using PCP or its compounds; to support EC action to ban after 2008 the import of products containing PCP or its compounds; to promote an information campaign by producers of products that contain, or used to contain, PCP or its compounds on the correct disposal of products containing PCP; to consider an OSPAR recommendation on the clean-up of PCP-contaminated sites; to develop a monitoring strategy for PCP; to initiate reporting to OSPAR on the remaining use of PCP and its compounds, and on their levels in imported products, concentrations of them in the environment, and the clean-up of contaminated sites; and to ask other relevant international forums to take account of the background document.

A monitoring strategy for pentachlorophenol is annexed to this background document.

Récapitulatif

Le pentachlorophénol (PCP) est un composé organochloré (C_6HCl_5O) utilisé pour l'essentiel comme fongicide. Son sel, le pentachlorophénate de sodium ($C_6Cl_5NaO - NaPCP$), est utilisé à des fins analogues, et se dégrade directement en PCP. L'ester, ou laurate de pentachlorophényl (PCPL) est également employé. Ces trois substances sont toxiques, persistantes et susceptibles de bioaccumulation, quoique la toxicité du PCPL soit moindre, et ce d'un ordre de grandeur. Il faut donc les considérer ensemble. La priorité a été accordée au PCP dans le Plan d'action OSPAR 1992, et en 1998, il a de ce fait été inscrit sur la Liste OSPAR des produits chimiques devant faire l'objet de mesures prioritaires.

La fabrication du PCP a cessé dans l'Union européenne en 1992. En 1996, 378 tonnes de NaPCP et 30 tonnes de PCP ont été importées des Etats-Unis ; il se peut par ailleurs qu'il y ait d'autres importations en provenance d'Asie. Le NaPCP est surtout utilisé en France, au Portugal et en Espagne, pour lutter contre la tache colorée de l'aubier et protéger les surfaces du bois nouvellement coupé contre l'attaque des champignons. 1 à 2 tonnes de PCP sont utilisées par an dans une faible mesure comme produit de préservation du bois, ceci surtout en Irlande. Au Royaume Uni, le PCP importé est transformé en PCPL, un peu moins de 50% de ce produit étant consommé en France et au Royaume Uni, dans des proportions à peu près égales, surtout pour empêcher la moisissure des tissus destinés à des usages militaires ; le reste est exporté à l'extérieur de l'Union européenne. Les autres grandes sources d'apport de PCP, de NaPCP et de PCPL à la mer sont constituées par les déchets de textiles et de bois ayant été traités au PCP (l'incinération de ces déchets peut donner lieu à des problèmes du fait de la formation de furanes et de dioxines) ainsi que les sites contaminés, tels que les anciennes installations de fabrication de PCP ou les installations de préservation du bois. Certains indices donnent à penser que du PCP se forme pendant les processus naturels de combustion, quoique que l'on ne sache pas si cette source pourrait être significative.

Seuls les résultats de la surveillance du PCP sont disponibles. De 1983 à 1997, les teneurs présentent une tendance générale à la baisse. Les résultats de la surveillance donnent à penser que dans les eaux du Royaume Uni, les teneurs sont plus élevées qu'ailleurs. Toutefois, même dans ce cas, les résultats d'une étude faite de 1993 à 1995 prouvent que les teneurs les plus élevées ne dépassent pas 10% de la norme de qualité environnementale applicable au PCP ($2 \mu g/l$), tandis que l'étude des apports fluviaux et directs a mis en évidence une baisse ininterrompue de 1991 à 1999. Aucun renseignement n'a été communiqué quant aux teneurs dans le biote.

La commercialisation et l'utilisation du PCP et de ses composés ont été interdites dans la Communauté européenne en 1991, excepté pour le traitement du bois, l'imprégnation des fibres et des textiles lourds non destinés à l'habillement, comme ingrédient pour les synthèses chimiques, et, sous réserve d'autorisations individuelles, pour le traitement *in situ* des bâtiments présentant un intérêt culturel ou historique. En vertu d'un amendement adopté en 1999, aucune substance ni préparation mise sur le marché après septembre 2000 ne peut contenir plus de 0,1% de PCP et de ses composés, par masse. Jusqu'à la fin de 2008, la France, l'Irlande, le Portugal, l'Espagne et le Royaume Uni bénéficient de possibilités de dérogations analogues à celles prévues par l'interdiction prononcée en 1991, quoique plus restrictives que celle-ci.

Les actions recommandées sont les suivantes : encourager la fixation de plafonds de rejet rigoureux applicables au reste des installations fabriquant ou utilisant du PCP ou ses composés ; soutenir l'initiative communautaire européenne visant à interdire, après l'an 2008, l'importation de produits contenant du PCP ou ses composés ; favoriser une campagne d'information, par les fabricants de produits qui contiennent ou qui contenaient du PCP ou ses composés, campagne faisant état des bonnes méthodes d'élimination des produits contenant du PCP ; considérer une recommandation OSPAR sur l'assainissement des sites contaminés par le PCP ; élaborer une stratégie de surveillance du PCP ; commencer à rendre compte, dans le cadre d'OSPAR, du reste des applications du PCP et de ses composés, ainsi que de leurs teneurs dans les produits importés, de leurs teneurs dans l'environnement, de même que de l'assainissement des sites contaminés ; et enfin demander aux autres instances internationales compétentes de prendre en considération le document de fond.

Une stratégie de surveillance sur le pentachlorophénol est annexée à ce document de fond.

1. Identification of all sources of pentachlorophenol and its salt and ester and their pathways to the marine environment

1.1 Substances

1. Pentachlorophenol (PCP) is on the OSPAR list of chemicals for priority action. Because of the degradation of PCP's salt sodium pentachlorophenate (NaPCP) to PCP under favourable environmental conditions (depending on the acid-base status of the environment), it has been decided to widen the scope of the background document to include also PCP's salt NaPCP. Another reason for expanding the scope is the similarity in environmental toxicity, fate and behaviour profiles of PCP and NaPCP. The background document also includes the assessment of PCP's ester pentachlorophenyl laurate (PCPL) since at present the most extensive use of PCP is the production of PCPL.

1.2 Identification of sources

2. The identified main sources of PCP, NaPCP and PCPL into the environment are:

- production of PCPL from PCP;
- treatment of wood (sapstain control agent);
- impregnation of heavy-duty textiles and fibres (fungicide);
- use and disposal of PCP, NaPCP and PCPL treated wood and textiles (including imported goods);
- contaminated sites (former PCP production and wood preservation plants) and treatment of contaminated soil and groundwater;
- natural sources or burning processes.

3. During the production of PCP and its derivatives dioxins and furans are formed as by-product. According to Commission Directive 1999/51/EC the concentration of hexachlorodibenzoparadioxin (HCDD) in the PCP or in its derivatives may not exceed 2 ppm from the 1 September 2000. The former limit value for dioxin was 4 ppm.

4. Dioxins and furans are also formed during burning and incineration of PCP-containing material. Dioxins and furans are on the OSPAR List of Chemicals for Priority Action.

2. Monitoring data, quantification of sources and assessment of the extent of problems

2.1 Production and import of PCP, NaPCP and PCPL

5. Production of PCP and NaPCP ceased in the EU in 1992. After that, these chemicals have been imported to the European market from the USA. There is unconfirmed information that additional NaPCP may be imported from South-East Asia. Currently no import of PCPL takes place, but PCPL is produced from PCP by one plant in the UK (European Commission DG III/Environment Resources Management, 1998).

6. In 1996 a total of 378 tonnes of NaPCP and 30 tonnes of PCP were imported into the EU. From 378 tonnes of NaPCP imported, 126 tonnes were imported to France, 108 tonnes to Portugal and 144 tonnes to Spain (Figure 1). From the 30 tonnes of PCP imported in 1996 into the EU, 28 tonnes were synthesised to 46 tonnes PCPL in the UK (Figure 2). Of the 46 tonnes of PCPL produced, 5-10 tonnes were exported to France and a similar quantity was used in the UK. The rest was exported to countries outside the EU. The

2 tonnes of PCP not used to convert to PCPL was sold to two distributors, who each received about 1 tonne. (EC DG III/ERM, 1998).

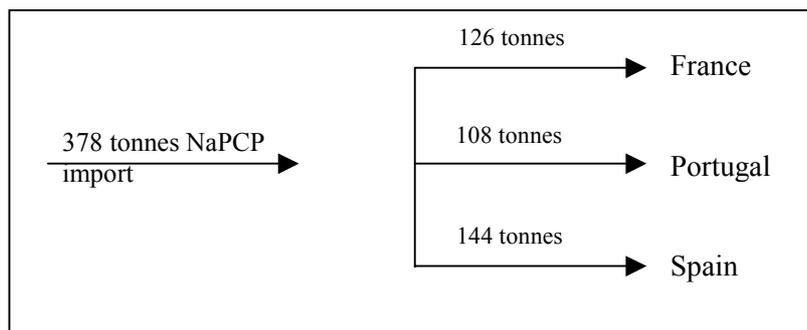


Figure 1: Import volumes of NaPCP in 1996 (DGIII/ERM 1998)

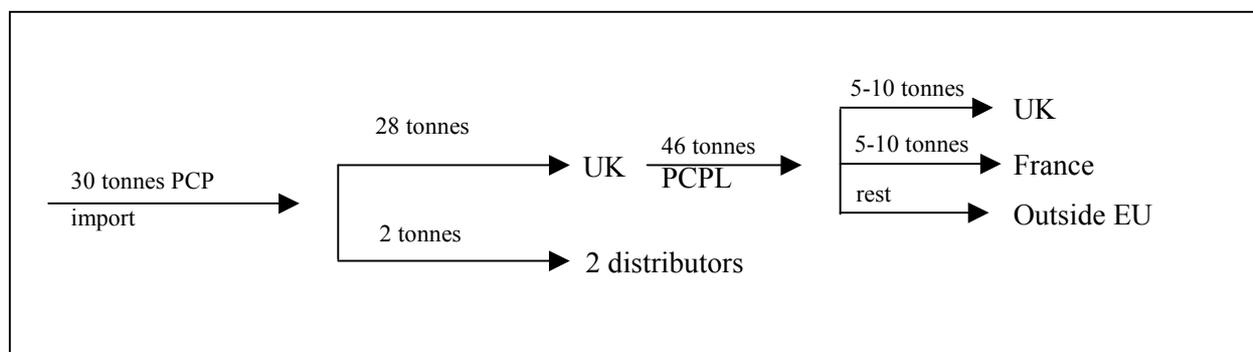


Figure 2: Use of PCP and distribution of PCPL in 1996 (DGIII/ERM 1998)

7. More recent data from the two US producers, which export these substances to the EU, indicate that the volumes have slightly declined (Table 1). According to a PCP importer all PCP is sold to customers in the UK. In addition, all of the material is converted to PCPL which is used solely for the preservation of industrial textiles. However, industry has indicated that substances might be imported also from Asia.

Table 1: Import of PCP, NaPCP and PCPL into the EU by two US producers (metric tonnes per year)

	1996	1997	1998	1999
PCP	75	15	30	15
NaPCP	397	385	341	324
PCPL	0	0	0	0

2.2 Use of PCP, NaPCP and PCPL

8. Today the predominant use of pentachlorophenol containing chemicals is in the treatment of wood as a sapstain control agent for freshly cut timber. The surface layer of freshly-felled or sawn wood is vulnerable to attack by fungi, the growth of which causes the wood to be stained, often to a bluish-green colour, and this reduces its commercial value. To protect the wood from such attack, timber is either treated with chemicals like NaPCP or kiln dried. Drying of wood has been the predominant way of treatment for example in the Nordic countries in the 1990s. Use of NaPCP has continued in south-west France, Portugal and north-east Spain mainly in the treatment of low-quality pine for the fabrication of non-returnable pallets/pallet boards (EC DG III/ERM, 1998). Some NaPCP is used to protect construction timber. In 1996 almost 90 % of the total EU consumption of PCP, NaPCP and PCPL was through the use of NaPCP for sapstain control in France, Portugal and Spain. In Portugal three product types are treated with NaPCP: pallet boards, construction timber and fencing panels (EC DG III/ERM 1998).

9. Use of pentachlorophenol as a wood preservative started in the late 1930s (WHO 1987). In the past PCP has been a widely used preservative in Europe to protect wood from organisms that weaken the wood by undermining its structure. In formulations used, PCP was dissolved in organic solvent alone or in combination with other fungicides. According to the US Pentachlorophenol Task Force (2000) virtually all pentachlorophenol sold in the US today is used for pressure treatment of wood. In 1996 only 1-2 tonnes of PCP was used for wood preservation according to a survey carried out by the European Commission DG III and Environmental Resources Management (1998). According to the same study 1 tonne of PCP was used in Ireland by three companies for preservation of wood in 1996. Two of the companies work in the field of cottage industries supplying treated wood panels to their local area. The third (and the largest) company is switching to CCA (chromium, copper and arsenic compounds). More recent data from the US Pentachlorophenol Task Force (2000) indicates that PCP is no longer used as a wood preservative in Europe.

10. The main use of PCP today in the OSPAR region is the production of PCPL. This has been carried out by one plant in the UK.

11. PCP, NaPCP and PCPL may be used in the remedial treatment of timber and as a surface biocide for masonry. Treatment is used for example when timber in industrial or domestic premises repeatedly becomes wet or stays wet and therefore is susceptible to decay by wood-rotting fungi. One species of wood-rotting fungus, dry rot (*Serpula lacrymans*) is able to grow also on the surface and within brick and plaster and can spread considerable distances this way. The Building Research Establishment (BRE) has estimated in 1982 that there were probably around 10 000 dry rot treatments carried out each year in the British Isles; a proportion of these could have used PCP-containing formulations (Hobbs *et al.*, 1993). By 1990, the use of PCP in formulations for remedial treatment of any kind was rare (Fosroc 1990). According to the ninth amendment of Council Directive 76/769/EEC, from 1 July 1992 it is only possible to carry out dry rot and cubic rot treatment for buildings of cultural, artistic and historic interest, or in emergencies. In addition, treatment must be carried out by specialised professionals authorised by Member States and each individual treatment requires authorisation. No data are available on the number or the extent of treatments carried out in EC Member States after 1992.

12. PCPL is used in the preservation of textiles, which are subject to attack by fungi and bacteria during storage and use. These include wool, cotton, flax and jute fabrics and yarns used in covers, tarpaulins, awnings, tents, webbing and netting and also sisal and manila ropes. More than 10 years ago PCPL was used in jute fabrics which were used as a secondary backing for fibres during transportation from eastern countries. From the jute, PCPL could migrate to the fibres of woollen carpets. Currently PCPL has not been found in woollen carpets (Bettens, 2000). PCPL (PCP or NaPCP) has not been used for leather preservation for at least the last ten years according to the US Pentachlorophenol Task Force (2000). The main part of all treatment carried out today in Europe is for textiles used by the military. There are alternative rot-proofing agents available for this purpose but, for example, the UK Ministry of Defence justifies the continued use not only with the statement that PCPL is an effective preservative against a wide range of decay-causing organisms, but also because it has proved to be compatible with many of the other treatments and materials required for military use (Hobbs *et al.*, 1993). According to the UK Department of the Environment and Transport (2000) the NATO specification for treatment of fabric requires certain standards to be met, but the UK Ministry of Defence are conducting research to find alternative chemicals to meet those standards. There are indications that PCPL is used for the treatment of heavy-duty textiles in France and for textiles for transport and tents in Belgium (Bettens, 2000).

13. PCP, NaPCP and PCPL have been used in the past also for instance as preservative in oil-based paint-like products, as preservative in glues (leather, toilet paper etc) and in adhesives, as an intermediate product for the synthesis of pharmaceuticals, as an intermediate product in obtaining colouring substances (anthraquinon colorants and intermediates), in mushroom farms for wooden trays where mushrooms are grown, in slime control in pulp and paper production and as an agricultural chemical in weed control (for instance as a fungicide or on crops as a defoliant).

14. There are several alternative substances and techniques available for the treatment of wood and textiles (UBA, 1994). Substitutes for NaPCP in wood treatment are for example quaternary ammonium compounds (trimethyl coco ammonium chloride and benzalkonium chloride), dichlofluanide, propiconazole, 3-iodine-2-propynyl-butylcarbamate etc. Drying of wood has been the predominant treatment against sapstain in the Nordic countries in the 1990s. The most common substitutes for PCP in industrial preservation are water-borne mixtures, usually copper, chromium and arsenic compounds, referred to as CCA. For the impregnation of textiles substances such as zinc-2-pyridinethiol-N-oxide, 2,2'-dihydroxy-5,5'-dichloro-diphenylmethane-ester, tributyltinoxide ester etc. can be used instead of PCPL.

2.3 Emissions, discharges and losses

15. In this chapter all known sources of emissions, discharges and losses in the OSPAR area are evaluated. These consist of point sources like a site producing PCPL, plants formulating substances, plants treating wood and plants impregnating textiles and fibres. Releases from diffuse sources include use of treated wood and textiles, disposal of treated products, formation during burning process and emissions from contaminated sites/soils.

2.3.1 Production of PCPL

16. Pentachlorophenyl laurate (PCPL) is being manufactured by one company in Europe. In the synthesis of laurate, imported PCP is used as starting material. According to the manufacturer, discharges of PCP to water from production do not exceed 10 µg/l in their trade effluent. The manufacturer also states that this level of discharge applies also to the companies processing the textile fabrics. The trade effluent from the production plant is discharged to sewer from where it goes to a sewage treatment plant, which treats both industrial and domestic sewage from a wide area (data from producer of PCPL, 1999). As a rough estimation, PCPL releases to water could have been about 900 kg and PCP releases about 600 kg in 1996 from the production of PCPL calculated according to the EC Technical Guidance Document (TGD) on Risk Assessment of New and Existing Substances (1996)¹.

17. According to Commission Directive 1999/51/EC, placing on the market and use of PCP is not permitted as a synthesising and/or processing agent in industrial processes from 1 September 2000. As a consequence the production of PCPL will eventually cease.

2.3.2 Formulation of substances

18. Formulations which are used in wood treatment or in textile impregnation may be ready-for-use products or may need some dilution, dissolution or addition of other (active) substances. Formulation of the treatment fluid may take place by the importer or the producer or the end user of the substance. In addition there may be companies which buy the substance from producer or importer, formulate it and sell it forward and companies which do not formulate treatment fluids themselves but buy in fluids which they repack under their own label.

19. In France in 1994, imported PCP was formulated before use but imported NaPCP was used as delivered (Ozanne, 1995). The majority of PCPL produced (by the only producer of PCPL in Europe) is formulated for use on textiles by the producer, while some is formulated by other companies for other use (Hobbs *et al.*, 1993). As a rough estimate NaPCP releases from the formulation to water could have been about 7 600 kg and to air 950 kg in 1996 calculated according to the EC Technical Guidance Document

¹ Emission factors used in the calculations are derived from Industrial category 3: chemical industry, chemicals used in synthesis, where release fraction to water is 2 % for both PCPL and PCP. Volumes used are 46 tonnes PCPL produced and 28 tonnes PCP processed in 1996. Emissions to air are negligible and emissions to soil a few kg for both substances.

(TGD) on Risk Assessment of New and Existing Substances (1996)². PCPL releases could have been about 900 kg to water and 100 kg to air in 1996.

2.3.3 Wood treatment plants

20. For anti-sapstain treatment with chemicals like NaPCP, the active compounds are supplied as powders or water-based concentrates for mixing or dilution, for use at solution concentrations 2-5 %. These are made up in large tanks in which the timber is immersed for short periods (10-20 seconds). After treatment, the timber is stacked to drain and to allow excess solution to dry. Treated timber may then be kiln- or air-dried and packaged for despatch. (Hobbs *et al.*, 1993).

21. At the wood treatment facility emissions to the environment (air, water and soil) may occur:

- during the dipping process (volatilisation to air);
- during transport from dipping to drying (runoff from wood surface to soil);
- during the drying process (volatilisation to air and leachates to soil);
- from leachates from treated wood stored outdoors (runoff from wood surface to soil);
- via evaporation from treated wood products (volatilisation to air);
- as wood waste from sawing and processing of treated wood;
- as solid waste, sludge from the bottom of dipping/treatment tank.

However, measured emission data or sufficient initial data to estimate emissions are not available.

22. In the production of pallet boards in South Europe, the dipping at the majority of sites takes place outdoors (EC DGIII/ERM, 1998). Major releases may occur when the wood has just been removed from the dipping tank due to possible spillage or runoff of treatment fluid from the surface of wood to soil. In the past timber would have been allowed to drain directly onto the soil, but now at least in some plants timber is drained on impermeable, concrete pavements or on tables or worktops. In the UK treated timber is now generally drained in roofed areas. If treated (and dried) wood is stored outdoors, it is difficult to prevent rainwater washing over it and then running into the soil or into surface water. Therefore potential for local soil contamination is high due to both runoff from wood surface after dipping and also during storage due to rainwater. As a water soluble substance (greater solubility than PCP), NaPCP is quite mobile and tends to migrate through soils with the potential to enter groundwater.

23. In addition, releases as a solid waste may occur during sawing (sawdust) and processing (wood chips) of wood. Also sludge, consisting of sawdust and active substance, accumulated in the dipping tank may cause emissions if it is not treated in a proper way. According to a Finnish study at the beginning of the 1980s PCP-containing solid waste of about 0,3 litres per m³ treated wood was collected (Viitasaari 1988).

24. Use of PCP as a preservative is minor nowadays. In 1988 it was estimated that 150 tonnes of PCP were still used each year in the UK for these preservative formulations, either alone or in combination with other fungicides (Hobbs *et al.*, 1993). In 1990 there were about 500 plants in the UK where organic solvent-based preservatives were applied. PCP emissions from plants preserving wood are likely to be lower compared to dipping with NaPCP since organic solvent-based preservatives are normally applied by double vacuum process in large sealed containers in order to achieve the necessary deep penetration. Treated timber should be almost dry when it is removed from the treatment vessel. Consultants in Environmental Sciences have investigated the pollution impact of timber preservatives in general. They concluded that the most significant point source of water pollution by preservatives is as a result of accidental spillage at treatment plants. A summary of leaks and spillages from timber treatment plants confirmed that these have been a

² Emission factors used in the calculation are those generally used for formulation (from TGD, Part II, Appendix I, Table A2.1), where release fraction to water is 2 % and to air 0,25 % for both NaPCP and PCPL. Volumes formulated are 378 tonnes NaPCP and 46 PCPL. Releases to soil are small.

major source of river pollution in the UK (Hobbs *et al.*, 1993). According to the US Pentachlorophenol Task Force (2000) PCP is no longer used as a wood preservative in Europe.

25. According to Commission Directive 1999/51/EC, the anti-sapstain and the wood preservation use of NaPCP and PCP will cease by 31 December 2008 in France, Ireland, Portugal, Spain and the UK. In the other EU countries, where no national bans on PCP and its derivatives exist, these uses ceased by 31 August 2000.

2.3.4 Use of treated wood

26. Emissions, discharges and losses of PCP and NaPCP are likely from wood in use. The volume of wood which was treated with PCP and NaPCP in the mid-1980s was much higher than in the mid-1990s or today. A part of this wood is probably still in use in buildings. However, it is unclear how much PCP/NaPCP this wood contains nowadays.

27. Rain may wash NaPCP from the surface of the treated pallets, leading to high local levels in soils where pallets and pallet boards are stored and used in the open (Hobbs *et al.*, 1993). In a laboratory test concentration of PCP was analysed from a leachate from wood samples, which had been impregnated either with an aqueous solution of NaPCP or with an organic solution of PCP by a three minute dipping. Eleven weeks after impregnation wood samples were placed in an Erlenmeyer vessel with ultrapure water and they were allowed to stay in the vessel for 1, 2 or 4 hours followed by a 16 hour period without water and then placed again in water for 8, 16 or 48 hours. After each period of leaching the water was renewed. PCP releases to water were higher from wood which had been treated with NaPCP than with PCP. PCP concentration of formulation used in impregnation was 50 ± 3 g/l, and the PCP concentration in the leachates from NaPCP treated wood was at the highest 69 mg/l (Marchal *et al.*, 1995). However, based on this information it is impossible to calculate emissions via rain water to soil.

28. NaPCP may also reach the environment by volatilisation in spite of its low volatility. In a doctoral thesis by Marchal (1996) PCP emission rates from NaPCP treated wood were measured. In this study, small pine wood blocks were treated by immersion in NaPCP for 18 hours and then dried for 3 weeks. PCP emissions were measured in a flux chamber. An average steady-state flux rate of $10,8 \mu\text{g}/\text{m}^2/\text{hour}$ was observed after 96 hours, based on a loading rate of $5,4 \text{ m}^2/\text{m}^3$ (wood surface/chamber volume). Marchal observed that PCP emissions were strongly affected by both temperature and the loading rate. In an earlier study by Marchal *et al.*, (1995) two loading rates were used $2,7$ and $5,4 \text{ m}^2/\text{m}^3$ and wood samples were 3 and 11 weeks after impregnation with PCP or NaPCP. PCP concentration was highest ($192 \mu\text{g}/\text{m}^3$) from wood treated with PCP with loading $5,4 \text{ m}^2/\text{m}^3$ and 3 weeks after drying. With the lower loading rate concentration was somewhat lower i.e. $163 \mu\text{g}/\text{m}^3$. Wood treated with NaPCP showed lowest emissions to air ranging from 33 to $46 \mu\text{g}/\text{m}^3$ (but higher concentration with higher loading rate).

29. An estimate of PCP emissions to air from NaPCP treated wood can be derived from a doctoral thesis carried out by Marchal³. Based on the flux rate from the Marchal thesis, emissions to air in Portugal are

³ Firstly the steady-state flux rate of $10,8 \mu\text{g}/\text{m}^2/\text{hour}$ should be divided by a factor of 8,8 to reflect more representative loading rate i.e. $0,33 \text{ m}^2/\text{m}^3$ (Ozanne G. has commented in the Association française pour la Préservation du Bois on 17 and 25 April 1997, that the loading rate of $5,4 \text{ m}^2/\text{m}^3$ was well above a value representative of typical ambient conditions, suggesting an alternative value of $0,33 \text{ m}^2/\text{m}^3$). Ozanne has suggested to further divide the flux-rate by a factor of 3 to reflect the fact that only 1/3 of the NaPCP in treated wood is available for emission to air due to competing loss processes affecting the wood. However we feel that the measured flux rate already takes that into account and therefore an additional factor of 3 will not be used. Secondly, the surface area of NaPCP treated wood produced annually in Portugal, Spain, France and UK can be calculated. It has been assumed that 15 l of 2,5 % (by weight). NaPCP solution is used to treat one cubic meter (m^3) of wood by immersion and that 40 m^2 of wood surface area are associated with each cubic meter of treated wood. Volumes of NaPCP used in wood treatment annually are 450 tonnes in Portugal, 300 tonnes in France, 200 tonnes in the UK and 100 tonnes in Spain (Ozanne 1997; as cited in Foster 1999). Thirdly, when multiplying

516 kg/a, in France 344 kg/a, in the UK 229 kg/a and in Spain 115 kg/a. This corresponds to an emission factor of 0,1 % per year, which is much less than the estimate made by WHO. Depending on the solvent, temperature, pH, and type of wood 30 – 80 % of PCP may evaporate within 12 months from dip- or brush-treated wood (WHO 1987).

30. Morgan and Purslow (1973) reported work on permanence of PCP in double vacuum treated timber. They showed that, whereas small cubes of pine sapwood dip-treated with PCP lost 20 % of the applied substance after 6 months, double vacuum treated blocks lost only 4 % of PCP after 9 months. Similar results were found for the cubes kept outside under shelter and for those kept inside. Dobbs and Grant (1981) found that during the exposure of samples of Scots pine double vacuum treated with PCP in an organic solvent the PCP concentration in the wood was greatly depleted. After two years of outdoor exposure, samples contained 2 000 µg PCP/g compared with 8 000 µg PCP/g when freshly treated. Double vacuum treated wood is likely to be used in joinery and therefore surface-finished with stain, varnish or paint. This may reduce losses by volatilisation and protects the timber surface from the effects of light.

31. PCP/NaPCP treated timber may exist in houses/buildings treated for remedial purposes. Dobbs *et al.*, (1979) estimated that an average whole house treatment involves about 1 kg of active ingredients. Where treatments are carried out against dry rot, the area treated is likely to be more localised and so smaller amounts of active ingredient may be used. No data on volumes of wood treated for this purpose are available. Emissions from the buildings are likely to be due to volatilisation, but it is not possible to predict the quantities of PCP/NaPCP released from this source.

32. In addition to emissions from ongoing production of treated wood or wood already in buildings or in products, some emissions may take place from treated wood which has been imported into Europe. Since the German ban on PCP came into force in 1989, several studies on the PCP content of leather goods, wood and textiles have been carried out in the Federal Republic of Germany (UBA 1994). In 1992 and 1993 45 samples of wooden goods/articles (kitchen equipment, children's play equipment and fruit crates) were analysed. In all samples the PCP concentrations were below 2,5 mg/kg. A Swiss campaign was carried out in 1996 to study the market situation (i.e. import) of wood, textile and leather treated with PCP; 129 samples of wood were analysed and the highest PCP levels detected were in the range of 500 - 1 000 ppm. A limit value of 5 ppm was exceeded in 9,3 % of the samples (OFEFP 1998). In addition, wood chips imported from South-America and wood imported into Finland from Africa have occasionally contained PCP.

2.3.5 Impregnation of heavy-duty textiles and fibres

33. Pentachlorophenyl laurate (PCPL) is used in the treatment of fabrics and webbings, but also for yarns and ropes. PCPL is insoluble in water and is therefore applied either in solvent solution or, more normally, as a concentrated aqueous solution/emulsion. Fabrics and webbings are usually passed through a batch containing the emulsion, using a roller system in a continuous process. The fabric is then squeezed by rollers (the mangle), the pressure of which is adjusted so that the required quantity of PCPL remains in the fabric. Any excess emulsion is passed back into the treatment vessel. The fabric is then dried and other additives such as water repellents and fire retardants are applied at the same time. (Hobbs *et al.*, 1993).

34. Loose stock fibre, yarns in hank or package form and sometimes webbings are treated in the machines used for batch dyeing. These are closed vessels containing the fibre into which the treatment emulsion is poured and then pumped back and forth to ensure that all parts of the fibre are treated. After treatment, the fibre or yarn is dried before use (Hobbs *et al.*, 1993).

35. Releases to waste water may occur as not all textiles in the treatment plant are treated with PCPL and therefore the equipment has to be washed out. During treatment in a dyeing machine, it is unlikely that all the chemical is taken up by the fibre. The producer of PCPL assumes an 80 % 'exhaustion' i.e. 80 % of the

the flux rate by surface areas treated annually, emissions to air are in Portugal 516 kg/a, in France 344 kg/a, in the UK 229 kg/a and in Spain 115 kg/a.

PCPL in the emulsion is adsorbed to the fibre or yarn. Hobbs *et al.*, (1993) have carried out a calculation of PCPL releases during hypothetical batch treatment of yarn. According to the calculation the concentration of PCPL in a river water is 1,6 µg/l⁴.

36. The calculated concentration corresponds well with monitored concentrations. The UK National Rivers Authority for the North-West Region has monitored nine river sites for PCP on a regular basis for the year September 1989 to September 1990. Monitoring took place at six different rivers and all nine monitoring sites were downstream from discharges from sewage works which take trade effluent from companies using PCPL as a rot-proofing agent or washing NaPCP-treated cloth. Concentrations have been quite high: at one site the annual mean value has been higher than the EQS of 2 µg/l and some of the values have been close to this (Hobbs *et al.*, 1993). However, according to the UK Department of the Environment, Transport and the Regions (2000), concentrations measured by the National Rivers Authority and the Environment Agency during 1994 – 1996 have been considerably lower: 0,15 µg/l in 1994, 0,20 µg/l in 1995 and 0,02 µg/l in 1996. No information was given on how many rivers were measured in 1994 – 1996 or whether the monitoring sites were downstream from companies using PCPL or NaPCP.

37. Many textile finishing operations include a highly alkaline wash. In these factories, the pH of the waste water is high and when waste water containing PCPL is mixed with this water, PCPL is likely to undergo chemical hydrolysis, producing PCP in its ionic form. PCPL also contains PCP as an impurity (maximum 1 % PCP) (data from producer of PCPL 1999).

38. According to Commission Directive 1999/51/EC, the impregnation of textiles and fibres with PCPL will cease by 31 December 2008 in France, Ireland, Portugal, Spain and the UK. In the other EU countries, where no national bans on PCP and its derivatives exist, this use ceased from 31 August 2000.

2.3.6 Use of treated textiles

39. Discharges to water and emissions to air are possible from the use of PCPL (and PCP) treated textiles. Textiles treated today in Europe are heavy-duty textiles for outdoor use where they may be in contact with rain, surface water or sea water. Textiles are used for transport lorries, public market trade stalls, army tents, awnings, ropes, sails and marine fabrics (Bettens, 2000). The main use of textiles treated in Europe is for the UK armed forces. No estimates are available of the volume of treated textiles, but the volume of PCPL used for treatment has ranged from 30 to 46 tonnes per year in the late 1990s. Releases during the user phase depend on the type of textile, the environmental conditions and the application. PCPL is very insoluble in water and has a low vapour pressure. When treated tents and tarpaulins are exposed to the weather, PCPL may undergo photodegradation; no studies on this release have been reported. Also, when wet, PCPL will slowly de-esterify to produce PCP on its ionic form which washes out of the textile or is lost by vaporisation (Hobbs *et al.*, 1993). This is a very slow process: it is generally expected that it takes 10 years for the PCPL concentration to drop from 2 % to less than 1 %; at this level the preservative effect is considerably reduced (British Textile Technology Group 1989). However it is not possible to estimate the extent of emissions or discharges.

40. In addition to textiles treated in Europe imported textile and leather are a source of releases. In practice the control of the import of treated wood products and textiles is difficult. Since the German ban on PCP came into force in 1989, several studies on the PCP content of leather goods, wood and textiles have been carried out in the Federal Republic of Germany (UBA 1994). From 1990 to 1993 altogether

⁴ It is assumed, that 500 kg of yarn is treated in one batch. PCPL of 12,5 kg is applied and 10 kg (80 %) is taken up by the fibre. Of the remaining 2,5 kg PCPL, 80 % is assumed to be removed in effluent treatment in the plant before discharge to waste water. PCPL of 0,5 kg will be discharged to waste water which will be treated by a sewage treatment plant with capacity of 10 000 m³/day. The concentration of PCPL in the sewage treatment plant is 50 µg/l. Breakdown of PCPL is unlikely, but 50 % adsorption of PCPL to solids is assumed, so the concentration in the final effluent will be 25 µg/l. Effluent from sewage treatment plant will be discharged to river with the flow of 140 000 m³/day.

660 samples of leather products (shoes, gloves, insoles, etc.) were analysed in 11 German Federal States. The PCP content in 24 % of leather goods exceeded the limit value of 5 mg/kg. In another investigation in Baden-Württemberg in 1992, 86 samples of leather products were analysed and in 25 samples (29 %) the limit value of 5 mg/kg was exceeded. In Berlin the Regional Authority for Occupational and Technical Safety studied 21 samples of leather products in 1993. In only one of the 21 samples was the PCP concentration above 5 ppm. The German Tanning School analysed 170 samples in 1994 and only 3 % exceeded the 5 mg/kg. For textiles, 32 cotton T-shirts were analysed in 1994, and in all samples the PCP concentrations were below 0,03 mg/kg (UBA 1994).

41. A Swiss campaign was carried out in 1996 to study the market situation (i.e. import) of wood, textile and leather treated with PCP. 225 samples of textiles and 47 samples of leather were analysed and the highest PCP levels detected were in the range of 1000-3000 ppm. A limit value of 5 ppm was exceeded in 6,8 % of the samples of textile and in 4,3 % of the cases of leather (OFEFP 1998).

42. Textiles and yarns imported into the UK for dyeing and finishing sometimes contain PCPL or NaPCP. NaPCP is used as a fungicide in the maize or rice starch used to stiffen, or size, the yarn and this remains in the cloth after weaving. Since the use of NaPCP on imported cloth is not totally within the control of the textile finishers, PCP concentrations in their waste water can be high (Hobbs *et al.*, 1993). The UK National Rivers Authority for the North-West Region has monitored PCP at nine river sites on a regular basis for the year September 1989 to September 1990. Monitoring was carried out at six different rivers and all nine monitoring sites were downstream from discharges from sewage works which take trade effluent from companies using PCPL as a rot-proofing agent or washing NaPCP-treated cloth. Concentrations have been quite high: at one site the annual mean value has been higher than the EQS of 2 µg/l and some of the values have been close to this (Hobbs *et al.*, 1993). However, according to the UK Department of the Environment, Transport and the Regions (2000), concentrations measured by the National Rivers Authority and the Environment Agency during 1994 – 1996 have been considerably lower: 0,15 µg/l in 1994, 0,20 µg/l in 1995 and 0,02 µg/l in 1996. No information was given on how many rivers were measured in 1994 – 1996 or whether the monitoring sites were downstream from companies using PCPL or NaPCP.

43. If imported hides and skins have also been treated with NaPCP in their countries of origin then it is possible that this is released during their further processing and tanning. A spokesman for the British Leather Confederation stated that, only small quantities of NaPCP would be released from treated hides during processing and enter waste water (Hobbs *et al.*, 1993).

44. It can be concluded that releases from imported material (fabric, cloth or yarn) are possible, but since it is not possible to estimate the volume/number of treated products produced in or imported into the OSPAR region no further release estimate has been made.

2.3.7 Waste management of treated material

45. In principle there are three methods of management of wastes:

- recovery and recycling;
- landfills;
- incineration / burning.

46. As it is usually impossible without a special laboratory test to notice whether wood or textile has been treated with PCP, NaPCP or PCPL, a separate recovery and recycling of treated material seems to be impossible at the present. Therefore the two most common ways of disposal of PCP, NaPCP or PCPL wastes are landfills and incineration / burning.

47. Releases from landfills are mainly in leachates. There are measurements available on PCP concentrations from landfill. For example in a 5-year field study conducted in Finland for 43 landfills in the

late 1980s concentrations of PCP were measured (Assmuth *et al.*, 1990). The median concentration was 0,08 µg/l and the maximum 3,0 µg/l. Higher concentrations have been measured in other studies.

48. During burning of PCP-, NaPCP- or PCPL-containing wastes the most severe emissions may arise from the formation of polychlorinated dibenzodioxins (PCDDs i.e. dioxins) and polychlorinated dibenzofurans (PCDFs i.e. furans). When waste is burned at a low temperature and low oxygen content like in open fire or on a small scale in households, PCP-treated wood may result in higher dioxin and furan emissions than from incineration under controlled conditions with a view to preventing the formation of dioxins and furans. It is unknown how common or extensive this kind of burning is in the OSPAR area. Some PCDD/Fs are formed also in more controlled (e.g. higher temperature) burning and generally in thermal processes involving PCP (as in any thermal processes including CI in both industry and waste treatment). When PCP-treated wood is incinerated under controlled conditions in industrial units (i.e. in incinerators, boilers and other combustion units) some studies show that there is no resulting significant contribution of dioxins to the atmosphere (Viking Energy, 1995). However there are also several studies which show higher emission factors from wood which has been contaminated with PCP (Bremmer *et al.*, 1994):

- uncontaminated wood 1-2,2 µg I-TEQ /tonne;
- contaminated, without PCP 5-10 µg I-TEQ /tonne;
- contaminated, with PCP 25-50 µg I-TEQ /tonne.

2.3.8 Emissions of dioxins as an impurity in PCP

49. Dioxins (i.e. PCDDs) and furans (i.e. PCDFs) are formed as by-products during the manufacture of chlorinated phenols. Therefore PCP and its derivatives usually contain dioxins and furans at parts per million level. From 1 September 2000 the concentration of hexachlorodibenzoparadioxin (HCDD) in the PCP or in its derivatives may not exceed 2 ppm according to Commission Directive 1999/51/EC. The former limit value for dioxin was 4 ppm. The contribution of PCP and its derivatives to the PCDD/F loading to the aquatic environment is higher than to the atmospheric and terrestrial environment. PCDD/F releases to atmosphere from treated surfaces are not considered to be significant compared to other sources of PCDD/F emissions, principally combustion. PCDD/F congener patterns representative of PCP source (i.e. from treated wood and textiles) have been identified in sewage sludge, water and sediments throughout Europe. However, since PCP and its derivatives contain and emit the higher chlorinated PCDD/F congeners to the environment and do not contribute significantly to the burden of more toxic TCDD/F and PeCDD/F isomers, the contribution of PCP to the total I-TEQ (International Toxic Equivalents) of aquatic environmental samples is estimated to be in the order of 10 % (EC DG III/ERM, 1997).

2.3.9 Biotransformation of dioxins and furans from PCP

50. Experiments have shown that peroxidases are capable of synthesising dioxins and furans from precursors such as chlorophenols. The formation of HpDD and OCDD during the composting process has been proven in many experiments. However, ppm-concentrations of chlorophenols will generate only ppt-levels of HpCDD and OCDD or ppq-concentrations in units of I-TEQ (EC DG III/ERM, 1997).

2.3.10 Formation of PCP during the burning process

51. There are a few indications that PCP emissions may also come from naturally occurring combustion processes like forest fires or from burning of wood. Ahling and Lindskog (1980) have analysed the flue gases of domestic fires. They considered the levels of PCP found (19-180 µg/m³) to be too high to have been produced by contamination of the air stream prior to the fire. PCP has also been detected from sediment samples deposited many years ago. Salkinoja-Salonen *et al.*, (1984) measured significant concentrations of PCP in sediments deposited more than 50 years ago in a small lake in Finland. They calculated PCP was

rained out from the air at an annual rate of 2-4 $\mu\text{g}/\text{m}^2$, compared with a current rate of 10-17 $\mu\text{g}/\text{m}^2$. In another Finnish lake, Paasivirta *et al.*, (1990) have analysed sediments as much as 300 years old. Annual deposition rates for these ranged from 0,1-0,8 $\mu\text{g}/\text{m}^2$ while, in sediments deposited since 1961, deposition was calculated to be 2,1 $\mu\text{g}/\text{m}^2$. It is unclear whether natural sources or burning processes form a significant part of PCP releases.

2.3.11 Contaminated sites

52. Soil contamination is generally confined to areas in which wood treatment with PCP is carried out now or has been in the past. In these areas concentrations may stay high for a long time because of slow degradation in the soil. Degradation in the soil depends on the concentration of the substance, presence of acclimatised bacteria, aerobic/anaerobic conditions, organic matter, pH, nutrients, humidity and temperature. Depending on the soil type, PCP can be very mobile, leading to groundwater contamination.

53. Data on 154 soil contamination cases were gathered in a Finnish register by environmental authorities in 1992 (Ministry of the Environment 1994). Two third of the cases were sawmills. In almost all cases the soil had been polluted, but 32 of the cases were also in a groundwater area. High concentrations of contaminants were also observed from surface water and air. The volume of heavily contaminated soils (for example more than 4 mg/kg PCP) which needed immediate treatment was 720 m^3 . Volume of less contaminated soil, where no immediate actions were required (0,4 mg/kg to 4 mg/kg PCP) was 15 000 m^3 . Since this inventory these figures have increased. High PCP levels in sawmill areas and wastes have been measured.

54. McNeill (1990) reported the effects of 2 major spillages of wood preservative at a Scottish sawmill/timber treatment plant. Two incidents occurred in 1983, which resulted in the saturation of an area of 50 m^2 of soil. There were also runoff, contamination of groundwater and the receiving burn and river. In addition to the spillages, poor treatment practices i.e. runoff from stacked timber, contributed to the overall contamination of the soil (ACP 1994).

55. Similar cases are likely to exist in other European countries. In addition to contaminated soil and possible leaching to groundwater, discharges to rivers and sea are also possible. During cleaning of contaminated soil there are also emissions to air.

2.3.12 Summary of discharges, emissions and losses

56. It was not possible to determine exact volumes of releases to the environment from sources of PCP, NaPCP and PCPL due to lack of background data. However, it can be estimated that the main emissions are from treatment of wood and textiles. The main use of these substances today is as a sapstain control agent for wood. Therefore it is very likely that emissions from this source are highest taking also into consideration several soil contamination cases.

57. In addition, treated products and material and especially imported cloth may cause significant emissions. Other sources of releases are production and formulation of substances, disposal of PCP containing wastes and burning processes. Although production and application of PCP have stopped in many countries, there is still a potential of PCP releases from reservoirs such as sediment, soil, sludges, wood constructions and landfills.

2.4 Monitoring data

58. PCP has been detected in air, soil, water and sediments as well as in a large number of aquatic organisms, sampled mainly near known discharges. Monitoring data exist only on PCP, but not on NaPCP or PCPL. This may be due to high volume consumption of PCP in the past, but also due to an assumption that NaPCP will turn into PCP in the environment. However, the most probable reason for lack of measurements

on NaPCP or PCPL is that according to Hobbs *et al.*, (1993) the analytical procedure used for PCP and its compounds generally converts them all to the same derivative which is then measured by GC/MS. Because a large number of monitoring results on PCP in environmental compartments are available, only a summary of monitoring data will be presented here in the form of average/median values.

59. In the Euro Chlor Risk Assessment for the Marine Environment (1999) information from different sources has been gathered. From the North Sea, coastal waters and estuaries data are available for Germany, the Netherlands and the United Kingdom. All average/median PCP concentrations are below 1 µg/l, with a range of concentrations from non-detected to 0,79 µg/l. In estuary waters, average or median concentrations have generally shown a decreasing trend over time during the period from 1983 to 1997. Considering all of the available monitoring data (covering the period 1983 to 1997) the typical concentrations for coastal and marine waters are estimated to be 0,07 µg/l (excluding the UK, where several higher concentrations were measured in 1991-1992). When only data from 1993 onwards are considered, the water concentrations were considerably lower, in the range of <0,01 to 0,02 µg/l (except for a maximum median concentration of 0,11 µg/l in the UK). In a survey conducted in 1993-1995 in sea water around the UK by the Marine Pollution Monitoring Management Group (MPMMG, 1998) concentrations were higher than near the Netherlands or Germany. Median results at all sites were at most one tenth of the EQS i.e. 0,2 µg/l (EQS for PCP is 2 µg/l), but of the 41 sites with results, 29 have results in which all values were below the limit of detection. Concentrations measured by the UK National Rivers Authority and the Environment Agency during 1994 – 1996 from marine and estuaries have been considerably lower: 0,07 µg/l in 1994, 0,02 µg/l in 1995 and 0,01 µg/l in 1996 (UK Department of the Environment, Transport and the Regions, 2000). However, no reason has been given for the large difference in the concentrations from the same period measured by different UK institutes.

60. A similar decreasing trend can be found in river waters from the Rhine and Meuse. Based on the data collected from 1990 to 1997 for the rivers in the Netherlands, Germany and Belgium, average PCP concentrations ranged from 0,01 µg/l to 0,17 µg/l (Euro Chlor 1999). From France only data from the Seine (Caudebec) is available. This average concentration 0,03 µg/l from 1995 is at the same level as in rivers of the Netherlands, Germany and Belgium. An extensive river water monitoring (including red list monitoring) in the United Kingdom in 1990-1992 shows somewhat higher concentrations. Most of the median levels of PCP were below 1 µg/l, although there were some large recorded values in industrial areas e.g. 40 µg/l in the Mersey (ACP 1994). The National Rivers Authority (NRA) has identified textile industries as a major contributor to PCP levels in rivers. However, median values for rivers where these industries are situated (i.e. North-West Region) were all below 1 µg/l. The dataset contained however a maximum value of 73,35 µg/l from river Douglas in 1991. The occasional very high concentrations of PCP may be assumed to be the result of a spillage or other incident (ACP, 1994). Data from an earlier study (1989-1990) from the same UK North-West Region are available, where the NRA monitored nine river sites. Sites were all downstream from discharges of sewage works which take trade effluent from companies using PCPL as a rot-proofing agent or washing NaPCP-treated cloth (some of the rivers were the same as in the 1992 study). Concentrations were higher in the 1989-1990 study than in the 1992 study: at one site the annual mean value was higher than the EQS of 2 µg/l and at six sites values were above or close to 1 µg/l (Hobbs *et al.*, 1993). In more recent measurements from 1994 - 1996 carried out by the UK NRA and the Environment Agency, concentrations have been considerably lower: 0,15 µg/l in 1994, 0,20 µg/l in 1995 and 0,02 µg/l in 1996 (UK Department of the Environment, Transport and the Regions, 2000). No information was given on how many rivers were measured in 1994–1996.

61. The Fraunhofer-Institut (1999) has gathered monitoring data from 1994 to 1998 on substances (including PCP) in EU Member States in the context of the EC Water Framework Directive. As a result of aggregation of monitoring data in the aquatic phase (fresh water) a median PCP concentration of 0,0706 µg/l (90-percentile 0,1351 µg/l) was detected. This contained 2 296 measurements from 85 sampling stations, from which 1 527 measurements were higher than the detection limit. Aggregation of sediment monitoring data produced a median PCP concentration of 15,50 µg/l (90-percentile 62,30 µg/l). This was a result of 66 measurements from 20 sampling stations; 61 of the measurements were higher than the detection limit.

62. The data from England and Wales show decreasing trends in the total riverine plus direct inputs of PCP (Table 2) (UK Department of the Environment, Transport and the Regions, 2001). Inputs are determined according to OSPAR RID principles.

Table 2: Riverine plus Direct Inputs of PCP from England and Wales (kg/yr) (UK Department of the Environment, Transport and the Regions, 2001).

Year		1991	1992	1993	1994	1995	1996	1997	1998	1999
Total inputs (Kg/yr)	Lower	2 203	1 627	1 219	1 186	237	163	74	95	77
	Upper	12 075	6 550	5 795	6 550	4 826	2 477	2 749	4 306	5 567

63. To summarise it can be concluded that the mean concentrations of PCP have decreased both in sea and river waters in the regions for which monitoring data are available. However it can also be seen that the concentrations have been somewhat higher especially in the early 1990s in the UK where the use of these substances has continued compared to countries which have banned the use of PCP. No data are available on the situation in other countries where these substances are still used. In addition, high peak concentrations from wood treatment plants and the textile processing industry are possible.

3. Desired reduction

64. PCP and NaPCP are very toxic to the aquatic environment and may cause long term effects. From the only toxicity study available, PCPL does appear to be 10-fold less toxic to fish than NaPCP (ACP, 1993). PCP, NaPCP and PCPL can be metabolised by aquatic and soil micro-organisms but may require a long time for adaptation. In standard laboratory degradation tests PCP degrades slowly. This is supported by the fact that the substance has been found in all environmental compartments. PCP is accumulated by aquatic organisms. Fresh water fish show a bioconcentration factor of up to 1 000 compared to < 100 in marine fish (WHO 1987). In addition PCP and its derivatives contain dioxins and furans as a by-product and dioxins and furans are also formed during the burning of PCP-containing wastes.

65. Pentachlorophenol (PCP) is on the OSPAR List of Chemicals for Priority Action. The OSPAR objective with regard to hazardous substances on this list is to prevent pollution of the maritime area by continuing to reduce discharges, emissions and losses of hazardous substances, with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances. Every endeavour will be made to move towards the target of cessation of discharges, emissions and losses of hazardous substances by the year 2020.

4. Identification of possible measures

4.1 Review of the existing national and international measures

66. The European Community has regulated the use of PCP, its salts and esters as such and in products by one Directive. In addition emission controls of the substances are included under other EC legislation. Prior to the EC Directive many European countries had placed tighter restrictions than in the EC Directive, or had instituted national bans, on the use of PCP and PCP-containing products. These countries include Austria, Denmark, Finland, Germany, the Netherlands, Norway, Sweden and Switzerland.

67. The EC has launched a concerted action between Member States to develop a risk assessment procedure for contaminated sites (CARACAS project) and the cleanup of contaminated sites (CLARINET project).

4.1.1 European Community

68. The uses of pentachlorophenol and its principal derivatives sodium pentachlorophenate (NaPCP) and pentachlorophenyl laurate (PCPL) have been limited in the European Union since the Member States adopted Council Directive 91/173/EEC (21 March 1991). Council Directive 91/173/EEC amending for the ninth time Directive 76/769/EEC prohibits the marketing and use of pentachlorophenol and its salts and esters in a concentration equal to or greater than 0,1 % by mass (1 000 ppm) in substances and preparations. However, four exceptions are given. The use of PCP and its compounds in industrial installations (not permitting the emission and or discharge of PCP in quantities greater than those prescribed by existing legislation) is permitted:

- a. in the treatment of wood;
- b. for the impregnation of fibres and heavy-duty textiles not intended in any case for clothing or decorative furnishings;
- c. as a synthesising and/or processing agent in industrial processes;
- d. for the *in situ* treatment of buildings of cultural and historic interest (subject to individual authorisation by the Member State concerned).

69. PCP used alone or as a component of preparations employed within the framework of the above exceptions must not exceed a total hexachlorodibenzoparadiioxin (HCDD) content of 4 parts per million (ppm). As from July 1992 all amateur uses of PCP-based formulations were revoked and these chemicals may not be sold to the general public.

70. In May 1999 restrictions on the use of PCP and its salts and esters were tightened by Commission Directive 1999/51/EC of adapting to technical progress for the fifth time Annex I to Council Directive 76/769/EEC on the approximation of the laws, regulations, and administrative provisions of the Member States relating to restrictions on marketing and use of certain dangerous substances and preparations (tin, PCP and cadmium). Paragraph 23 concerning pentachlorophenol and its salts and esters as an Annex to Council Directive 76/769/EEC was replaced by the amended paragraph 23 in Annex I to Commission Directive 1999/51/EC.

71. According to Commission Directive 1999/51/EC pentachlorophenol and its salts and esters shall not be used in a concentration equal to or greater than 0,1 % by mass in substances or preparations placed on the market. By way of derogation until 31 December 2008 France, Ireland, Portugal, Spain and the United Kingdom may choose not to apply this provision to substances and preparations intended for use in industrial installations not permitting the emission and/or discharge of PCP in quantities greater than those prescribed by existing legislation:

- a. in the treatment of wood. However, treated wood may not be used:
 - (i) inside buildings;
 - (ii) for the manufacture and re-treatment of:
 - containers intended for growing purposes;
 - packaging that may come into contact with raw materials, intermediate or finished products destined for human and/or animal consumption;
 - other materials that may contaminate the products mentioned in the two previous sub-indentents;
- b. in the impregnation of fibres and heavy-duty textiles not intended in any case for clothing or for decorative furnishings;
- c. by way of special exception, Member States may on a case-by-case basis authorise on their territory specialised professionals to carry out *in situ* and for buildings of cultural, artistic and

historic interest, or in emergencies, a remedial treatment of timber and masonry infected by dry rot fungus and cubic rot fungi.

72. In any case, PCP used alone or as a component of preparations employed within the framework of the above exceptions must not exceed a total hexachlorodibenzoparadioxin (HCDD) content of 2 parts per million (ppm).

73. Member States shall adopt and publish the provisions necessary to comply with the Commission Directive by 29 February 2000 at the latest. They shall apply these provisions as from 1 September 2000. However, Austria, Finland and Sweden may apply these provisions from 1 January 1999 except where otherwise specified in the Annex.

74. The Biocides Directive 98/8/EC will in future cover also those biocidal product types where PCP and its salts and esters are used. Wood preservatives and textile treatment preservatives have to be authorised by Member States. Only those products which contain active substances listed on the Annex I of the directive can be authorised. All existing active substances are to be evaluated and decisions made about their acceptability before May 2010.

75. The Integrated Pollution Prevention and Control Directive (IPPC Directive) 96/61/EC controls emissions to air, water and land (including wastes) from medium-sized and large industrial installations, waste management installations and installations for the intensive rearing of poultry and pigs. For PCP and its derivatives there are several categories of industrial activities in the IPPC Directive which could cover the production and use of PCP, NaPCP and PCPL. Such categories are for example:

- 4: Chemical industry (production);
- 6.2: Plants for the pre-treatment or dyeing of fibres or textiles (where the treatment capacity exceeds 10 tonnes per day); and
- 6.7: Installations for the surface treatment of substances, objects or products using organic substances, in particular for impregnating (with a consumption capacity of more than 150 kg per hour or more than 200 tonnes per year).

76. The IPPC Directive covers categories 6.2 (pre-treatment of textiles) and 6.7 (surface treatment of substances) only in cases where a minimum treatment capacity is exceeded, and it is not known if these treatment capacities are exceeded in the plants using PCPL and NaPCP in the OSPAR region. So in practice the IPPC Directive may only cover the production of PCPL. However, there are national regulations in the EU Member States which may also cover discharges and emissions from formulation and use of these substances.

4.1.2 Austria

77. The manufacturing, placing on the market and use of pentachlorophenol and pentachlorophenol sodium-salt and/or any other pentachlorophenol salts and compounds is prohibited. Prohibition includes all substances or preparations which contain PCP or compounds of PCP over 0,01 % (100 ppm) and products which contain PCP or compounds of PCP over 0,0005 % (5 ppm). Also treated wood is considered to be a product according to Chemicals Act. Prohibition does not include the use of PCP or compounds for scientific research or synthesis of other substances.

4.1.3 Denmark

78. Since the beginning of the 1960s pesticides used in Denmark have to be approved by the authorities. The last approval for a pesticide containing PCP expired in 1981. PCP has been regulated in Denmark since 1977, when PCP was prohibited as a disinfectant and preservative for the preservation of brickwork, wood and textiles that get in contact with food, and as an ingredient in textile detergents. In 1978 a limit value of

1 ppm of dioxin in PCP was introduced. This regulation resulted in the phasing out of all pesticides containing PCP in 1982. A general ban on the sale of chemical substances and products containing PCP or its salts and esters in concentrations equal to or greater than 0,1 % by mass was issued in 1992.

4.1.4 Finland

79. In Finland, the use of PCP for antisapstain treatment stopped in the 1980's. The last storage of PCP for the antisapstain treatment of sawn wood was used in 1988. The use of PCP in textile impregnation had already ceased by the end of the 1970s. In Finland, since 1991 an advance approval of wood preservation chemicals has been mandatory under the Chemicals Act. Already before that, toxic wood preservatives had to be authorised according to the Poison Act (1969). For the time being no preparations containing PCP have been approved for such use.

4.1.5 Germany

80. Germany's regulation of 12 December 1989 prohibits the manufacture, marketing and use of PCP, its salts and compounds, preparations containing more than 0,01 % (100 ppm) of such substances and treated products containing more than 0,0005 % (5 ppm) of PCP-related substances. By way of derogation, the competent authorities may authorise such substances, preparations and products for use as synthesising agents or secondary products, for scientific research or experimentation or for disposal.

4.1.6 The Netherlands

81. The Order subject to Article 24 of the Law on environmentally hazardous substances from 1992 prohibits in general the marketing and use of PCP and its salts and esters for any purpose if their concentration exceeds 0,1 %. Exemptions are given for the use as intermediates in closed industrial processes on condition that there are no emissions and that the content of hexachlorodibenzoparadioxine is below 4 ppm, and for purposes of laboratory research. The Order further establishes a complete ban on the sale to private consumers, a minimum drum size of 20 litres, and a labelling requirement 'Reserved for industrial and professional use'. The Regulation under the commodities Act on PCP from 1994 stipulates that goods treated with PCP may not be placed on the market in the Netherlands if they contain more than 5 mg/kg PCP.

4.1.7 Norway

82. According to a national approval system for pesticides, the import, sale and use of PCP-containing pesticides are not allowed. There is no authorisation system for wood preservatives or textile treatment chemicals in Norway. Norway has implemented the European Commission Directive 1999/51/EC.

4.1.8 Sweden

83. An approval system for pesticides has been in force in Sweden since 1973. Pesticides may not be imported, offered for sale, transferred or used without being approved. Pesticides as defined in the legislation on pesticides include agricultural pesticides as well as biocides like preservatives for wood, leather and textile, slimicides used in pulp industry and antifouling products. The approval for the use of PCP and related chlorophenols for wood treatment and preservation of heavy-duty textiles and leather was withdrawn by a decision in 1977. The withdrawal came into force on 1 January 1978.

4.1.9 Switzerland

84. The production, marketing, import and use of PCP, its salts and preparations is prohibited (Ordinance on Substances 1986). The prohibition includes also the import of PCP-treated textiles, leather products and wood. Prohibition does not include the use of PCP for scientific research.

4.2 Possible additional measures

85. According to Commission Directive 1999/51/EC the use of PCP, NaPCP and PCPL will cease by the end of 2008 in all EU Member States, and has already ceased in Switzerland. Possible additional measures to speed up the cessation of the remaining uses, reduce releases from the remaining uses and eliminate or reduce releases from other sources are:

4.2.1 Cessation of use

Description

86. Phasing out the use of PCP, NaPCP and PCPL before 2008 could be achieved by a voluntary agreement or by national implementation of the Commission Directive. A voluntary agreement could be made with the companies treating wood or textiles with NaPCP or PCPL. When implementing the Directive countries may also choose not to use the derogation provided by the Directive, or only use it partly.

Body to take action

87. Voluntary agreement: between producers or between producers and national authorities.

88. Ban: Contracting Parties still using PCP, NaPCP and PCPL.

Possible timeframe

89. 2001 – 2008.

4.2.2 Control under the Biocides Directive 98/8/EC

Description

91. During 2000 a Council Regulation on establishment and implementation of the first phase of the review programme of the Biocides Directive will be given. According to the draft Regulation wood preservatives will be included in the first list of notified existing active substances to be reviewed. The industry shall supply the information needed for the review to the competent authority of the designated Member State not later than 3,5 years after the Regulation enters into force. After the review the EC could in principle give stricter restrictions than in Commission Directive 1999/51/EC.

Body to take action

92. European Community.

Possible timeframe

93. 2004 – 2008.

4.2.3 Emission limit values

Description

94. Plant by plant permits could be used to reduce releases of PCP, NaPCP and PCPL into the environment and to ensure environmentally sound management of contaminated wastes. Permits should include stringent limit values for emissions into water bodies or sewage systems and emissions to air. Appropriate emission monitoring requirements would enable supervision of permits. Conditions on the management of PCP wastes could include, for instance, provisions on handling and storage of wastes at the plant and on destruction of wastes. If permits already are in place, revision of permit conditions may be needed. In practice, the minimum time required for new or revised emission limits to take effect will be from one to two years. BAT description for wood and textile treatment could facilitate the permit authorities in setting emission limit values.

Body to take action

95. Permits: Contracting Parties still using PCP, NaPCP and PCPL.

96. BAT description: OSPAR.

Possible timeframe

97. 2001 - 2008.

4.2.4 Economic instruments

Description

98. A charge on products treated with PCP, NaPCP and PCPL to promote use of alternative methods and products.

Body to take action

99. Contracting Parties still using PCP, NaPCP and PCPL.

Possible timeframe

100. 2001 – 2008.

4.2.5 Ban on import of treated material and products

Description

101. Import of products and materials treated with PCP, NaPCP and PCPL could be banned in countries where the use of substances is already banned. Import of treated products and material may be prohibited only after the use of substances has ceased. At EU level a ban on the import of treated material and products could be introduced after 2008.

Body to take action

102. Ban before 2008: Contracting Party.

103. Ban after 2008: European Community.

Possible timeframe

104. 2001 – 2008.

4.2.6 Labelling

Description

105. Requirement for the producers to label products and materials treated with PCP, NaPCP and PCPL in order to facilitate separate collection and environmentally sound waste management of these products and materials. Labelling could be achieved by a voluntary agreement or by national legislation.

Body to take action

106. Producers of treated products and material or Contracting Parties still using PCP, NaPCP and PCPL.

Possible timeframe

107. 2001 – 2008.

4.2.7 Information campaign

Description

108. Producers and traders of products and materials treated with PCP, NaPCP and PCPL could be requested to inform (e.g. by a leaflet) customers on adverse environmental effects of the substance and adequate disposal of the products and materials. The measure could be achieved by a voluntary agreement. The authorities could provide information for the general public on adverse effects of PCP, NaPCP and PCPL treated products, available alternatives (including alternative methods) and environmentally sound waste management.

Body to take action

109. Producers of treated products and material or Contracting Parties still using PCP, NaPCP and PCPL.

Possible timeframe

110. 2001 – 2008.

4.2.8 Clean-up activity

Description

111. Promoting clean-up activities of contaminated sites.

Body to take action

112. Contracting Parties.

Possible timeframe

113. 2001 – 2008.

5. Choice for action/measures

5.1 Assessment of options

114. In choosing the most appropriate set of actions from among the possible additional measures listed in Chapter 4, four criteria have been used: effectiveness, practicability, economic impact and monitorability (Table 3).

115. The first four actions listed in Table 2 reduce releases mainly from production, formulation and industrial use of PCP, NaPCP and PCPL. Actions 4-7 reduce releases from use of treated products and from

waste management of treated products. Concerning effectiveness, it should be noted that some of the measures are more general while others cover only some parts of the problem, for example waste management. Economic impact of measures takes into account impact on industry, public authorities and the public.

Table 3: Possible additional actions compared with four criteria.

Action	Effectiveness	Practicality	Economic impact	Monitorability
1. Cessation of use - voluntary agreement - ban	Medium High	Medium High	Medium Medium	Medium High
2. Biocides Directive	Medium	Low	Medium	Medium
3. Emission limit values	Medium	Medium	Medium	High
4. Economic instruments	Medium	Low	Medium	Medium
5. Ban on import (of products and material)	High	Medium	Medium	Low
6. Labelling	Low	Low	Low	Low
7. Information campaign - producers for customers - authorities for general public	Low Low	Medium Low	Low Medium	Low Low
8. Cleanup activities	Medium	Low	High	Medium

116. While accelerated phasing out of the use of PCP, NaPCP and PCPL seems to be the most effective and practical way of action, it may be unrealistic, given the negotiations on Commission Directive 1999/51/EC. Therefore, permits and emission limit values for plants producing or using PCP, NaPCP or PCPL seem to be the most appropriate way forward. The responsibility for setting emission limit values lies with the national authorities. The development of an OSPAR BAT description on treatment/impregnation of wood and textiles seems not to be the most effective and proportionate measure as only 5 countries use these substances, there is only a small number of companies using these substances, and this use will end at the latest by the end of 2008. Therefore, States that are OSPAR Contracting Parties are recommended that, in accordance with the OSPAR Convention, permits should be required, and stringent emission limit values set, for industrial plants producing or using PCP, NaPCP or PCPL. Such emission limit values should be based on BAT and set by public authorities.

117. Control under the Biocides Directive 98/8/EC may not be as effective and practical a measure as emission limit values, because of the timeframe in the Directive. The assessment of substances carried out under the Directive could only be finished at the earliest in 2004. Economic instruments seem not to be a practical and proportionate measure because the total amount of treated products and materials is fairly small, the product group is diverse and these products will again be phased out at the latest by 2008.

118. To control discharges from the use and disposal of products and materials, a ban on the import of products would be the most effective additional action. Subject to the requirements of EC and EEA law, States which are Contracting Parties and which have already banned the use of such substances could also consider banning the import of products and material containing PCP, NaPCP and PCPL. Furthermore, OSPAR Contracting Parties that are also EU Member States are recommended to request the European Commission to bring forward a proposal to ban of the import after 2008 of products containing these substances by amending the Marketing and Use Directive 76/769/EEC.

119. To facilitate separate collection and environmentally sound waste management, States that are OSPAR Contracting Parties are furthermore recommended to initiate an information campaign to be carried out by producers of treated products and aimed at their customers. This is been considered more practical than labelling treated products. The information distributed could include data on environmental effects of

substances and instructions for the correct disposal of products and material. A targeted campaign for users of treated products and materials carried out by the producers is probably more effective and practical than a general campaign for the general public carried out by public authorities.

120. To reduce the run-off of these chemicals from PCP contaminated sites, OSPAR is recommended to consider a general recommendation for cleaning up such sites.

121. To ensure that the information in this background document and the conclusions reached by OSPAR are formally communicated to the European Commission, OSPAR should write to the European Commission in the terms of a letter to be drafted by Finland.

122. To ensure that the information in this background document can be considered in the context of other international agreements which deal with hazardous substances and to which Contracting Parties are party, OSPAR should send copies of this background document to the appropriate bodies dealing with those agreements and invite Contracting Parties who are common parties to OSPAR and those other agreements to promote action to take account of this background document by those other international bodies in a consistent manner.

5.2 Review of the implementation and effectiveness of the measures

123. In order to provide a sound basis both for future decisions and assessments of the quality status of the marine environment, OSPAR should invite Contracting Parties, on the basis of a survey of the available monitoring and research data, to identify gaps in knowledge and any monitoring and assessment tools that need to be developed, and to propose a monitoring strategy for PCPs.

124. To ensure effective follow-up, OSPAR is recommended to evaluate the implementation of these measures and their effectiveness in achieving the OSPAR 2020 target by 2009 at the latest.

125. In order to prepare for this evaluation of the implementation and effectiveness of national measures, OSPAR is recommended to initiate reporting:

- for Contracting Parties still using PCP, NaPCP and PCPL: production volume of PCPL, use volumes and use patterns of PCP, NaPCP and PCPL, amounts of treated material, releases to water, sewage and air, formation of PCP containing wastes and their handling.
- for all Contracting Parties: PCP, NaPCP and PCPL in imported products, environmental concentrations and clean-up activities of PCP contaminated soils.

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Annex 1: Monitoring strategy for pentachlorophenol

As part of the Joint Assessment and Monitoring Programme (*reference number 2003-22*), OSPAR 2004 adopted an Agreement on monitoring strategies for OSPAR Chemicals for Priority Chemicals (*reference number 2004-15*) to implement the following monitoring for tracking progress towards the objectives of the OSPAR Hazardous Substances Strategy (*reference number 2003-21*) with regard to pentachlorophenol. The Monitoring Strategy for pentachlorophenol will be updated as and when necessary, and redirected in the light of subsequent experience.

The sources of pentachlorophenol use are currently well characterised. However, the extent of emissions from products containing PCP and PCP contaminated soils are unknown. Use volumes are expected to decrease as further restrictions on PCP will take effect. Five Contracting Parties still have the possibility to use PCP until 2008. In addition, emissions from PCP-containing imported products, contaminated soils and products in use will remain.

PCP has been detected in air, soil, water and sediments as well as in a large number of aquatic organisms, sampled mainly near known discharges. Monitoring data exist only on PCP, but not on NaPCP or PCPL. This is obviously due to high volume consumption of PCP in the past, but also due to an assumption that NaPCP will turn into PCP in the environment. However, the most probable reason for lack of measurements on NaPCP or PCPL is that the analytical procedure used for PCP and its compounds generally converts them all to the same derivative (see OSPAR Background Document on PCP). A large number of monitoring results on PCP in environmental compartments are available, and concentration trend appears to be decreasing. However, monitoring activities are necessary to monitor progress towards the cessation target of 2020.

PCP is a priority substance under review under the EC Water Framework Directive. It is still unclear whether the monitoring obligations related to WFD will cover the open sea sufficiently to monitor the progress towards the OSPAR hazardous substances objectives.

Therefore, the best approach for OSPAR to take to monitor progress towards the 2020 cessation target in the medium term is to combine the use of the monitoring data that become available through the WFD with monitoring activities related to the sources of pentachlorophenol, including:

- a. examining progress in the implementation of programmes and measures on pentachlorophenol endorsed by the Background Document;
- b. collecting, with the assistance of the relevant industry trade associations, data on production and/or sales in the five Contracting Parties where pentachlorophenol is currently used; and
- c. investigating the possibilities for estimating quantities of pentachlorophenol exported from, the OSPAR region.

ASMO working groups will consider whether an EAC or BRCs for this substance is necessary and the degradation products, tri- and tetra-chlorophenol, should be considered in national screening projects.

PENTACHLOROPHENOL MONITORING STRATEGY	
Implementation of actions and measures	<ul style="list-style-type: none"> • Examination of progress in the implementation of regulations on marketing and/or use or emission and/or discharge which have been agreed, or are endorsed, by the Background Document
Production/use/sales figures	<ul style="list-style-type: none"> • Collect, with assistance from industry, data on quantities produced and/or sold in the countries of the OSPAR Convention Area • Estimate quantities imported to, and exported from, the OSPAR Convention Area
Riverine inputs	<ul style="list-style-type: none"> • Where available, data will be periodically compiled from EC WFD monitoring
Maritime area:	
Concentrations in sediments, water and biota	<ul style="list-style-type: none"> • Where available, data will be periodically compiled from EC WFD monitoring • The need for an EAC and a BRC will be considered

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