DATA ON MANUFACTURE, IMPORT, EXPORT, USES AND RELEASES OF ALKANES, C10-13, CHLORO (SCCPS) AS WELL AS INFORMATION ON POTENTIAL ALTERNATIVES TO ITS USE

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EXECUTIVE SUMMARY

The report has been produced according to a format and structure provided by ECHA. Draft reports have been reviewed and commented on by ECHA and this final report has been accepted by ECHA.

INFORMATION SOURCES

The information presented in Sections 1 and 2 is based on the risk assessment report and update (EC 2000 and 2008) with additional information supplied by industry. The additional information is largely qualitative and indicates limited current use.

The information on possible alternatives to SCCPs presented in Section 3 has been taken from a wide variety of sources, including reviews from both industry and regulators looking at potential alternatives. As far as possible, preference has been given to existing reviews of substances when collating information on properties and effects.

SECTION 1: INFORMATION ON MANUFACTURE, IMPORT AND EXPORT AND RELEASES FROM MANUFACTURE

SCCPs are produced at four sites in the EU27. The amounts supplied in the EU25 in 2004 were <600 tonnes (EC, 2008); more recent information indicates a similar level of supply in the EU27of <1,000 tonnes in 2007. Specific information on imports and exports is not available, but industry judgement is that these are limited, as are imports and exports of articles containing the substance. Releases to the environment from production are estimated to be low.

SECTION 2: INFORMATION ON USES AND RELEASES FROM USES

SCCPs are used as flame retardants and plasticisers. The current use areas of SCCPs have been identified as: rubber (in particular in conveyor belts for use in mines); sealants and adhesives; paints and coatings; and textiles (flame retardant back coatings). These are listed in the order of the amount used. The supplied tonnage in 2004 was <600 tonnes for use in rubber, <300 tonnes for use in sealants and adhesives, <100 tonnes of use in paints and coatings and <100 tonnes for use in textiles. For 2007 the major uses identified were in rubber followed by sealants and adhesives, with minor amounts being used in other areas.

Each of the use areas involves a number of lifecycle steps – formulation, industrial use, service life and disposal. Estimates of the emissions from each of these steps have been included where possible. These are taken from the published risk assessment reports (EC 2000, 2008); more recent information suggests that the amounts sold are roughly similar to those used in these assessments.

The major emissions come from the service life of articles and products containing the substance. These are estimated as 0.6 – 1.7 t/year to air, 7.4 – 19.6 t/year to waste water, 4.7-9.5 t/year to surface water and 8.7-13.9 t/year to industrial soil. Emissions from industrial processes (formulation and use) are at least an order of magnitude lower than these. There is also release of SCCPs through their presence in MCCPs; this release is estimated to be <33.4 t/year.

The trend in use of SCCPs is generally downwards, although it has been suggested that for most uses where substitution is possible this has already occurred.

SECTION 3: INFORMATION ON ALTERNATIVE SUBSTANCES AND TECHNIQUES

A number of possible alternative substances have been identified for each use area. Industry consider that MCCPs are the most suitable alternatives in all use areas, although there may be an issue over their effectiveness in some areas as they have a lower chlorine content. LCCPs are similarly possible alternatives for all uses. In rubber, aryl phosphates may be alternatives but these appear to be used in PVC rather than in chlorinated rubber, hence a change of material may be needed here too. For textiles, the main alternatives appear to be brominated substances.

Alternative substances appear to be in use in all areas, although it is not clear whether the human health and environmental impacts of these alternatives are any less than those associated with SCCPs.

1 Information on manufacture, import and export and releases from manufacture.

Information on manufacture, import and export and release from manufacture has been obtained from the following sources.

- Consultations with manufacturers – the following organisations have been contacted.
    - Chlorinated Paraffins Sector Group of Euro Chlor – this is the main trade association for the EU producers of SCCPs. The membership covers the following chlorinated paraffins producers: Caffaro, INEOS Chlor, Leuna Tenside, Química del Cinca. Two other companies are associate members: NCP (South Africa) and Novacke Chemické Závody.
    - Chlorinated Paraffins Industry Association – this is the main trade association for the producers of SCCPs in North America. Their membership includes Dover Chemicals.
    - Novacke Chemické Závody in Slovakia.
    - S.C. OLTQUINO in Romania.
- Published reports, notably the EU risk assessment on SCCPs (EC (2000) and EC (2008)) and reports published in relation to the activities of the Helsinki Commission and the Stockholm Convention.
- A search of the internet including manufacturers' websites.
- A search of various on-line databases including Business Source Corporate, TOC Premier and Current Abstracts amongst others.

Much of the information used is taken from EC (2000) and EC (2008). The information basis for this substance in these reports has been evaluated a number of times during the production of the risk assessment reports, and conclusions are drawn in those reports. Where no specific source for a conclusion, for example on the level of imported substance, is given here it is based on the published risk assessment reports.

1.1 *Manufacturing sites and manufacturing processes*

It is understood that there are six main producers of chlorinated paraffins in the EU, located in Italy, the United Kingdom, Germany, Spain, Slovakia, and Romania. Of these, it is thought that at least three, possibly four, supply SCCPs. The main producers of SCCPs in the EU in recent years are thought to be the following companies.

Caffaro in Italy
INEOS ChlorVinyls in the UK
Novacke Chemické Závody in Slovakia
S.C. OLTQUINO in Romania

Given that there has been a marked reduction in use of SCCPs over recent years (see Section 2.1 and confidential information), and particularly in 2008 when SCCPs were identified as a potential substance of very high concern (SVHC) it is not clear if all these plants are still producing SCCPs at this time.

Published information on the current production or production capacities of individual producers of SCCPs in the EU is scarce. UBA (2007) gives some information on production of SCCPs in the mid-1990s at the various plants operating at that time. These are shown in Table 1. Production of SCCPs in Germany ceased at the end of 1995 (HELCOM (2002), POPRC (2007 and 2008) and UBA (2007)).

Table 1 Production of SCCPs in the EU in the mid-1990s

Company	**Location**	**Year**	**Production (tonnes/year)**
Hoechst[b]	Germany	1993	16,600
		1994	19,300[a]
ICI (now INEOS ChlorVinyls)	UK and France[c]	1994/1995	8,000-11,000
Caffaro	Italy	1994/1995	1,000-2,000

Note: a) Of this amount, 10,000 tonnes were sold by Hoechst and 9,300 tonnes were exported.
b) Production at this site ceased in 1995.
c) Currently only in the UK.

The amounts of SCCPs produced in Slovakia are reported to be 560, 354, 480 and 410 tonnes/year for 2004, 2005, 2006 and 2007 respectively (POPRC (2008) and SAŽP (2008)). POPRC (2007) gives a similar range for production of SCCPs in Slovakia of 100-584 tonnes/year. Novacke Chemické Závody (2007) gives the amounts of SCCPs produced in Slovakia as 560 tonnes/year in 2004, 354 tonnes/year in 2005 and 380 tonnes/year in 2006, and indicated that a dramatic decrease in production was anticipated for 2007.

The amounts of SCCPs currently produced at the INEOS Chlor and Caffaro sites are confidential. Figures for the amounts of SCCPs supplied by Euro Chlor member companies[1] have been provided previously by Euro Chlor over the period 1994 to 2004 for the EU Risk Assessment (EC (2000 and 2008)). Some of these data have been reported previously (for example in EC (2000)) but Euro Chlor have requested that the more recent data are considered confidential. The confidential data are summarised in Table C 2 of the confidential annex to this report. The amounts supplied in the EU25 in 2004 were <600 tonnes and the amounts supplied in the EU27 in 2007 were <1,000 tonnes.

No information has been located on the amounts of SCCPs currently produced at the plant in Romania (this company is not a member of Euro Chlor and so is not included in the supply figures given in the previous paragraph). Based on confidential information calculations have been made that take into account the known amounts of SCCPs supplied by other producers and very crude estimates for the amount of SCCPs that may be supplied to the EU27. The most probable estimate is likely to be up to around 400-500 tonnes/year. A similar confidential estimate was obtained from Euro Chlor (personal communication, 2008a).

In summary, SCCPs are produced at four sites in the EU. The production at the site in Slovakia is of the order of 400-500 tonnes over recent years (POPRC (2008)). The

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[1] Caffaro, INEOS ChlorVinyls and Novacke Chemické Závody.

current production at the remaining three sites is not known precisely, but is expected to be of a similar order of magnitude as this figure. The available confidential information on the production and supply of SCCPs in the EU is summarised in the confidential annex.

SCCPs are manufactured by the chlorination of an n-paraffin feedstock, typically with a mixture of chain lengths between C_{10} and C_{13}. The process involves addition of chlorine gas directly to the n-paraffin at a temperature of around 80-100°C (no solvent is used) (EC, 2000). Visible light is often used to initiate the reaction but no catalyst is necessary in the process. The vessel is cooled during the reaction.

The production of chlorinated paraffins can be carried out in either a batch or continuous process but batch processes are generally preferred as they allow more accurate specification of the different grades to be achieved (EC, 2000).

SCCPs are transported from the production sites to the formulating sites (or user sites) in road tankers and drums depending on the quantity required (EC, 2000).

1.2 *Import and export of the substance on its own or in preparations*

Producers of SCCPs exist in Asia and North America. According to Euro Chlor, imports of SCCPs into the EU from sources in the United States and Asia are very small compared with the EU production (EC (2008) and Euro Chlor (2008)). HELCOM (2002) reported that no information was available on the amount of SCCPs imported into the EU either as a substance itself or in imported articles.

Information on the consumption of SCCPs in the EU is considered in Section 2.2. The amounts of SCCPs exported outside of the EU by EU manufacturing companies is unknown. For comparison Defra (2008) indicates that for medium-chain chlorinated paraffins around 60% of the amount of chlorinated paraffin produced is sold into the EU, with the remainder being exported outside of the EU.

From the submissions to POPRC it appears that the whole tonnage produced in Slovakia is sold for use outside the country (Novacke Chemické Závody (2007) and SAŽP (2008)). Direct contact with the company has indicated that the supply is mainly to two other EU countries (see confidential annex). Therefore the use of SCCPs in Slovakia itself would appear to be limited.

The Ministry of the Environment of the Republic of Lithuania (2007) report that Lithuania is not a producer of SCCPs and that there are no data available indicating whether or not SCCPs are imported or used in Lithuania.

Some limited information is available on the production of SCCPs in companies outside of the EU. This is summarised below.

The only current producer of chlorinated paraffins (including SCCPs) in the United States is Dover Chemical Corporation. The total chlorinated paraffin production capacity of this production plant has been reported to be 90 million pounds/year in the early 1990s (~40,000 tonnes/year) (CMR, 1996). The same reference also gives the demand for chlorinated paraffins in the United States as 90 million pounds/year (~40,000 tonnes/year) in 1995 with a small predicted increase in demand to 92 million pounds/year (~42,000 tonnes/year) by 1996 and 100 million pounds/year (~45,000 tonnes) by 2000. The use pattern for chlorinated paraffins (no distinction was made between the uses of the different types of chlorinated paraffins) was given as 50% in metal working fluids, 25% in plastics, 10% in rubber, 10% in caulks, sealants and adhesives and 5% other uses.

POPRC (2007 and 2008) indicates that 150 tonnes/year of SCCPs are produced in Brazil and the annual consumption of SCCPs in Brazil is around 300 tonnes/year. Based on these figures it is unlikely that significant imports of SCCPs to the EU are occurring from Brazil as Brazil appears to be a net importer of SCCPs. The same reference indicates that there are around 20 manufacturers of chlorinated paraffins (of all types) in India, with a combined capacity of 110,000 tonnes.

SCCPs are no longer produced in Canada (POPRC, 2007 and 2008). Therefore there will be no current import of SCCPs from Canada. Environment Canada (2008) indicates that around 2,800 tonnes of all chlorinated paraffins were used in Canada in 2001 (1,200 tonnes/year in metal working fluids, 1,200 tonnes in PVC and around 400 tonnes in paints and coatings, adhesives and sealants and rubber and elastomers) but the majority of the chlorinated paraffins used were medium-chain chlorinated paraffins with a smaller amount of long-chain chlorinated paraffins and SCCPs.

NICNAS (2004) reported that around 360 tonnes of SCCPs were imported into Australia, mainly from the United Kingdom and the United States, over a two year period between March 1998 and March 2000 but that the use had since reduced markedly to around 25 tonnes/year (mainly in the metal working industry). NICNAS (2004) reported that SCCPs were generally being replaced by medium-chain chlorinated paraffins and long-chain chlorinated paraffins.

1.3 *Import and export of articles containing the substance*

No data on the import and export of articles containing the substance to and from the EU have been located. HELCOM (2002) reported that no information was available on the amount of SCCPs imported into the EU either as a substance itself or in imported articles. Based on the 2004 consumption of SCCPs, the total volume of articles and products (i.e. rubber products, paints and painted products, textiles and sealants and adhesives containing SCCPs) manufactured in the EU can be estimated at <6,000 tonnes/year (assuming an average SCCP content of 10% by weight in the manufactured article or product). This means that such products containing SCCPs are likely to make only a very small fraction of the total amount of rubber products, paints, textiles and sealants manufactured in the EU.

As an indicative example, consider the case of rubber conveyor belts (this is a major use of SCCPs; see Section 2.1.1). The total volume of rubber conveyor belts produced and sold in the EU27 in 2007 was around 237,880 tonnes/year (data taken from the Eurostat Prodcom data base under the code 25.13.40.50 – rubber conveyor belts (see Section 2.1.1)) and so products containing SCCPs would be <2.5% of this total[2]. The imports and exports of conveyor belts to and from the EU are presented in the

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[2] Assuming <6,000 tonnes of rubber articles are produced in the EU each year. The actual figure will be lower than this as it does not take into account the amounts that will be used in sealants, paints and adhesives.

ComExt database. This data base does not have a specific entry for rubber conveyor belts but has entries for “conveyor belts or belting” which is likely to cover rubber conveyor belts (but may also include conveyor belts made from other materials, for example PVC). The reported exports from the EU27 of this category of conveyor belt in 2007 were around 52,280 tonnes and the imports into the EU27 were 25,858 tonnes[3]. This gives a net export from the EU of around 26,400 tonnes/year of conveyor belts (rubber and other materials). Thus the net export of all conveyor belts from the EU is around 11% of the total amount of rubber conveyor belts produced and supplied in the EU.

Based on this example, it can be assumed that the imports and exports of such products containing SCCPs will be very small in total tonnage terms. However it cannot be totally ruled out that articles and products containing SCCPs will be imported into the EU, given that there are a relatively large number of potential suppliers of SCCPs worldwide, or exported from the EU.

In terms of the significance to this evaluation, if there was a net import of articles containing SCCPs into the EU, this would affect mainly the estimate of emissions from articles over their service life and disposal outlined in Section 2.3.5 (there would be a proportionate increase in these estimates if there was a net import of SCCPs in articles, or a proportionate decrease if there was a net export of SCCPs in articles). As these estimates are already very uncertain, and worst case, the lack of information on possible imports and exports of articles containing SCCPs probably has limited impact on the overall estimates.

1.4 *Releases from manufacture*

1.4.1.1 Releases into the working environment

The occupational exposure of workers at short-chain chlorinated paraffin manufacturing plants has been considered in EC (2000). Here it was estimated that about 50-100 employees may be potentially exposed to SCCPs within the EU at manufacturing sites. As the production of SCCPs involves the use of closed systems and batch production measures, occupational exposure is expected to be intermittent and may occur during sampling, plant cleaning, filter cleaning, drumming and tanker loading operations.

The inhalation exposure was estimated using the EASE Model (EC, 2000). This predicted that airborne concentrations are likely to be negligible (equivalent to an exposure of 0-0.1 ppm (0-2.1 mg/m^3) 8 hour TWA) owing to the low vapour pressure of SCCPs.

Dermal exposure to the hand and forearm was predicted to be in the range 0.1-1 mg/cm^2/day, again predicted using the EASE Model (EC, 2000). EC (2000) notes that dermal exposure will be considerably reduced by the use of personal protective equipment.

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[3] The largest imports were from China at 14,865 tonnes.

1.4.1.2 Releases into the environment

The maximum releases to the environment of SCCPs from the manufacturing sites in the EU are thought to be less than 9.9 to 26.7 kg/year at each site. These figures are taken from EC (2008) and are based on confidential information from three production sites operating in the EU at that time (it is thought that one of these sites may no longer be producing SCCPs). Since these estimates were produced, there are two further sites that produce chlorinated paraffins that are now in the EU (as a result of the enlargement of the EU). These are in Slovakia and Romania.

The emissions from the production plant in Slovakia are reported to be effectively zero as the plant uses '*zero discharge technology*' (Novacke Chemické Závody (2007) and SAŽP (2008)).

It is understood that most, if not all, chlorinated paraffin production sites in the EU would fall under the Integrated Pollution Prevention and Control (IPPC) regime (see Section 2.3.7).

No quantitative emission information is available for the remaining site.

2 Information on uses and releases from uses

The information in this Section has been gathered from the following sources.

- Consultation with Euro Chlor.
- Consultation with relevant EU-wide and national-level trade associations covering the manufacture and main areas of use of SCCPs (rubber, textiles, sealants and adhesives, and paints and coatings). Some of these associations also contacted their member companies for the purposes of this study.
- Published reports, notably the EU risk assessment on SCCPs (EU (2000) and EU (2008)) and reports published in relation to the activities of the Helsinki Commission and the Stockholm Convention.
- A search of the internet.
- A search of various on-line databases including Business Source Corporate, TOC Premier and Current Abstracts amongst others.

Much of the information used is taken from EU (2000) and EU (2008). The information basis for this substance in these reports has been evaluated a number of times during the production of the risk assessment reports, and conclusions are drawn in those reports. Where no specific source for a conclusion is given here it is based on the published risk assessment reports.

2.1 *Identification of uses*

The uses are presented in decreasing order of the amounts of SCCPs supplied to them based on the known consumption in the EU25 in 2004 (see Section 2.2 and Table C 2 in the confidential annex).

2.1.1 Rubber

SCCPs are used as a flame retardant in rubber. According to EC (2000) the SCCPs used tend to be towards the higher chlorination end of the range (typically 63-71% by weight Cl). They are generally used at an application rate of between 1 and 10% by weight (although higher concentrations can be used for some applications) of the rubber in conjunction with other flame retarding additives such as antimony trioxide and aluminium hydroxide. SCCPs are additive flame retardants and so are physically incorporated (mixed) into the rubber matrix[4]. Therefore there is a potential for SCCPs to leach or volatilise from the rubber during use of the rubber article.

The major application of rubber containing SCCPs is in high density conveyor belts used in the mining industry (EC, 2000). The lifetime of such belts is around 10 years and the belts are increasingly being recycled by reduction to powder and subsequent formation of belts, mats and building materials. Little information is currently available on the actual articles made from the recycling of conveyor belts containing SCCPs however it is possible that articles other than conveyor belts could be made (for example mats, building materials, paving materials) and so this could result in an additional source of widespread use of, and hence diffuse exposure from, SCCPs.

Other uses of rubber containing SCCPs could be in the production of technical products such as gaskets and hoses (EC, 2000).

The results of a survey of the use of medium-chain chlorinated paraffins in rubber in the EU have been reported by Defra (2008). This survey found that a large proportion of the companies manufacturing rubber products (e.g. conveyor belts) containing medium-chain chlorinated paraffins were based in Germany accounting for around 40% of the total EU market share. It was also noted that the companies manufacturing these types of products were generally large companies and the production using medium-chain chlorinated paraffins only occurred on an intermittent basis.

Further information on the uses of SCCPs in rubber is given in EC (2008). In particular this reports the results of a survey of the use of chlorinated paraffins amongst members of the British Rubber Manufacturers' Association Ltd carried out in 2001. This survey covered three main sectors within the rubber industry; the new tyre sector; the general rubber goods sector; and the polyurethane foam sector. Responses to the survey were received from 25 companies (this corresponded to about 30% of the membership). Of these, 15 companies reported using chlorinated paraffins of one type or another (most of these were medium- and long-chain chlorinated paraffins but some use of SCCPs was also evident). The main areas of use were found to be in the rubber goods sector with the main use of SCCPs being in conveyor belts at loadings of around 10 to 17% by weight.

Information provided by Euro Chlor reported in EC (2008) indicates that the SCCPs supplied for use in rubber generally have very high chlorine contents (around 70-71% by weight) and that an important use for the treated rubber is in conveyor belts for use in mines where specific safety requirements need to be met.

Based on the above surveys and published information it appears that the main application of SCCPs in rubber is in the manufacture of conveyor belts, although it is possible that other uses could occur.

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[4] The SCCPs are not changed chemically or chemically bonded into the rubber matrix and so are effectively present as a discrete substance "dissolved" within the rubber matrix.

According to Pabst (1990) underground rubber mining belts are based on polychloroprene rubber and a typical formulation may contain zinc borate, aluminium trihydrate, antimony oxide along with the chlorinated paraffin. The same reference indicates that in the UK, the strict conditions of certain tests for mining belts (e.g. the drum friction test) can usually only usually be met by PVC-belts and the flame-retarded polychloroprene rubber belts are used in the UK only for steel corded reinforced belts (these were not required to pass this test). Pabst (1990) indicates that in other countries the conditions of the drum friction test are sometimes less severe than those used in the UK and so can be met by flame-retarded polychloroprene rubber belts.

Statistics on the production of conveyor belts in the EU are collected as part of the Eurostat Prodcom database (Eurostat, 2008) under the code 25.13.40.50 – rubber conveyor belts. In 2007 the total sold volume in the EU was 237,880 tonnes, with the highest production of such belts occurring in Germany (approximately 22.4%), Poland (16.4%), Greece (10.1%) and Romania (8.6%). No production of such belts was reported in Cyprus, Lithuania, Luxembourg, Malta, and Sweden. The remainder of the production was spread around the various other EU countries[5].

Information on the imports and exports of conveyor belts in EU countries is given in the ComExt database[6] (Eurostat, 2008). Combining these import and export data with the above production data provides an indication on the EU countries with the highest use of conveyor belts. Based on the information in ComExt there was a net export from the EU27 to countries outside of the EU27 of around 26,422 tonnes in 2007. Combining this with the above figure for the amount of rubber conveyor belts produced in the EU27 of 237,880 tonnes gives an estimated EU27 usage of such belts of 211,438 tonnes. Taking into account the intra-EU27 trade figures reported in ComExt, then the countries with the highest usage of conveyor belts are Germany (72,850 tonnes), Poland (23,062 tonnes), Romania (17,279 tonnes), Spain (11,003 tonnes), Greece (around 7,831 tonnes), France (around 7,697 tonnes), Italy (around 6,704 tonnes), Sweden (3,647 tonnes), Finland (3,237 tonnes) and Denmark (around 1,756 tonnes)). Other countries with significant use of conveyor belts[7] appear to be Portugal (net import of around 41,400 tonnes), Czech Republic (net import of 7,805 tonnes), United Kingdom (net import of 5,891 tonnes) Austria (net import of 2,845 tonnes), Ireland (net import of 1,178 tonnes).

The International Institute of Synthetic Rubber Producers have indicated that, as far as they are aware, SCCPs are not consumed in the production stage for synthetic rubber. It was thought that, if SCCPs are used, they are most likely to be as flame retardant additives that are added to rubber during the further processing of the rubber into the final rubber article. (IISRP, 2008).

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[5] According to the Prodcom database the production figures for Belgium, Czech Republic, Ireland, Latvia, Austria, Portugal, Solvenia and Slovakia are confidential and data are not given for the Netherlands or the United Kingdom.

[6] This data base does not have a specific entry for rubber conveyor belts but has entries for “conveyor belts or belting” which is likely to cover rubber conveyor belts (but will also include conveyor belts made from other materials, for example PVC).

[7] For these countries it is not possible to give the precise quantity of conveyor belts used as data are only available on imports and exports.

The relevant use descriptors for this application are as follows.

Sector of use	SU11 – Manufacture of rubber products
Product category	PC32 – Polymer preparations and compounds
Process categories	PROC3, PROC4, PROC5, PROC6, PROC14
Article category	AC15 – Other general rubber products

The relevant NACE code is 25.1: Manufacture of rubber products.

2.1.2 Sealants and adhesives

The function of SCCPs in sealants is to act as a plasticiser in order to modify the hardness and elasticity of the final sealant (EC, 2000). They can also be used as a flame retardant in the sealant. The SCCP is physically incorporated (mixed) into the sealant[8]. Therefore there is a potential for SCCPs to leach or volatilise from the sealants over the lifetime of the sealant.

Chlorinated paraffins in general (all types) are used in several types mainly for building and construction (Houghton, 1993), and also double and triple glazing (EC, 2008). Examples of the sealant types that may contain chlorinated paraffin include polysulphide, polyurethane, acrylic and butyl sealants (Houghton, 1993). Chlorinated paraffins with high chlorine contents are also used in sealants for double- and triple-glazed windows. The chlorinated paraffin is typically added at a concentration of 5-14% by weight, but concentrations up to 20% by weight can also be used in exceptional cases (EC, 2008).

The main use of SCCPs is thought to be in sealants rather than adhesives (EC, 2008) although it should be noted that the distinction between an adhesive and a sealant is a little blurred in that some sealants can be used as adhesives and *vice versa*.

SCCPs have been used in both 1-part and 2-part sealants (EC, 2008). A typical formulation process is a batch mixing process with a batch size of around 1,000 kg. The mixing is usually carried out at room temperature but gentle heat (up to 40°C) can sometimes be used. As many sealants are moisture sensitive the process is generally carried out under vacuum. Once formulated the sealant is pumped directly from the mixing vessel to cartridges (for 1-part sealants) or tins (for 2-part sealants).

FEICA (the Association of European Adhesives and Sealants Manufacturers) have indicated that, based on consultation of their members, SCCPs do not appear to be currently used, or are in the process of being phased out, in sealants and adhesives in Europe (FEICA, 2008). Similarly the British Adhesives and Sealants Association also considered that there was little current use of SCCPs in sealants and adhesives (BASA, 2008), with again their use being either phased out or in the process of being phased out. This information appears to contradict information provided by Euro Chlor that SCCPs are still being sold in the EU for use in sealants[9]. A possible explanation for this is that the information provided by Euro Chlor represents sales in

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[8] The SCCPs are not changed chemically or chemically bonded into the sealant and so are effectively present as a discrete substance “dissolved” within the sealant.

[9] Euro Chlor indicates that the producers of SCCPs sell most of their SCCPs via distributors rather than directly to end users and the information provided by Euro Chlor on the amounts used in each application is obtained by the SCCPs producers via their respective distributors.

2007, whereas the information from FEICA (2008) and BASA (2008) may represent the current (November 2008) position now that SCCPs are on the candidate list. There may also be downstream users who are not members of the organisations consulted, or members who could not be consulted within the timeframe of this project.

The relevant use descriptors for this application are as follows.

Sector of use	SU10 – Chemical formulation and/or re-packaging or SU19 – Building and construction work
Product category	PC1 – Adhesives, sealants
Process categories	PROC3, PROC4, PROC5, PROC9, PROC13, PROC19
Article categories	AC18.1 – Constructional articles and building material for indoor use AC18.2 – Constructional articles and building material for outdoor use

The relevant NACE code is 25.1: Manufacture of rubber products.

2.1.3 Paints and coatings

Short-chain chlorinated paraffins are used as plasticisers for paints. The main types of paints that are likely to contain chlorinated paraffins are those based on chlorinated rubber and vinyl copolymers (Houghton, 1993). Chlorinated rubber-based paints are typically used in aggressive environments such as marine and industrial applications. Vinyl copolymer-based paints are used mainly for exterior masonry.

The main function of chlorinated paraffins in paints in general is as a plasticiser but they can also be used to improve water resistance, chemical resistance and the non-flammability of paints (EC, 2000). The paints are used mainly in industrial/specialist applications such as marine primer paints, fire retardant paints and paints for road markings (EC, 2000).

The application rate of chlorinated paraffins in paints is between 1 and 10% by weight in paints based on resins such as chlorinated rubber, vinyl copolymers and acrylics, with 10% being considered typical for most paint types (EC, 2000). The SCCP is mixed into the paint during the formation step and becomes physically entrained in the coating once applied[10]. Therefore there is a potential for SCCPs to leach or volatilise from the painted surface over the life-time of the painted article.

EC (2000) indicates that the predominant types of chlorinated paraffins used in paints are the longer chain-length grades, however SCCPs are used in some applications, mainly in acrylic based coatings.

EC (2008) reports the results of a survey of the use of chlorinated paraffins in general in paints and coatings in the United Kingdom. The survey was carried out in 1999 by the British Coatings Federation. A total of 141 companies were contacted in the survey and responses were received from 106 of these. The focus of the survey was on obtaining information on medium-chain chlorinated paraffins but some

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[10] The SCCPs are not changed chemically or chemically bonded into the paint and so are effectively present as a discrete substance “dissolved” within the paint film.

information was also provided on the use of SCCPs. A total of 22 companies reported that they used medium-chain chlorinated paraffins or other chlorinated paraffins and a more detailed response was obtained from 12 of these companies. The survey found that the chlorine content of the SCCPs, where used, was generally in the range 65-70% by weight.

The survey reported in EC (2008) also gives information on the typical types of paint that may contain chlorinated paraffin. These are summarised below (Note: these refer to all types of chlorinated paraffins and not just SCCPs).

- Organic solvent borne chlorinated rubber primers and topcoats.
- Organic solvent borne chlorinated rubber systems for swimming pools/fishponds.
- Organic solvent borne zinc rich (epoxy) primers.
- Organic solvent borne acrylic container coatings.
- Organic solvent borne chemical and water resistant coatings.
- Organic solvent borne vacuum metallising lacquers.
- Organic solvent borne flame retardant coating for wood.
- Organic solvent borne intumescent coating for structural steel.
- Organic solvent borne floor paints.
- Organic solvent borne water-proofing coatings for walls.

EC (2008) also gives information from Euro Chlor that the typical level of chlorinated paraffin in a paint formulation would be 4-15% by weight but after application (evaporation of the solvent) the chlorinated paraffin content of the coating would be around 5-20% by weight.

As part of this study CEPE (the trade association representing paints and coatings manufacturers in Europe) has been contacted. CEPE (2008) indicated that the results of a survey of the use of SCCPs in paints and coatings were included in the EU Risk Assessment Report on SCCPs. This survey concluded that there was only a negligible use of SCCPs in this area. CEPE (2008) considers that the use in this area will have now decreased further as SCCPs are proposed as a PBT substance. Therefore CEPE (2008) considers that there is now little or no use of SCCPs in paints and coatings in the EU.

One major formulator of paints and coatings in Sweden has indicated that a 100% reduction in use of chlorinated paraffins has been achieved in their products (Akzo Nobel, 2003 and 2006).

The relevant use descriptors for this application are as follows.

Sector of use	SU10 – Chemical formulation and/or re-packing
Product category	PC9– Coatings and paints, fillers, putties, thinners
Process categories	PROC5, PROC7, PROC9, PROC10, PROC11
Article category	AC18.2 – Construction articles and building material for outdoor use.

The relevant NACE code is 24.3: Manufacture of paints, varnishes and similar coatings, printing inks and mastics.

2.1.4 Textiles

According to EC (2000) SCCPs with high chlorine contents are used in the production of flame-retarding, water repelling and rot-preventing textile finishes. The major historic use of chlorinated paraffins was in military tenting but according to EC (2000) this use no longer occurs in the EU.

The more recent uses of SCCPs in textiles are as a flame retardant for the back coating of textiles with a small amount also being used in other textile treatments such as waterproofing (EC, 2000). EC (2008) indicates that the SCCPs supplied in the EU for backcoating of textiles generally have chlorine contents in the range 56-60% by weight. The actual types of textiles for which short-chain chlorinated paraffins are used as a flame retardant are unclear. However, based on a comparison with the known usage of other flame retardants that are used in the backcoating of textiles (for example decabromodiphenyl ether (EC, 2002) and hexabromocyclododecane (EC, 2008b), it is likely that they may find application in textiles for furniture upholstery, seating upholstery in transport applications, and interior textiles such as blinds and curtains. EC (2000) also indicates that there may also have been a use of SCCPs in industrial protective clothing.

In the backcoating process, the SCCP is applied to the back of the textile in a viscous polymer latex, which is then cured (usually by heating to 130-140°C for a few seconds to drive off water). Once cured the SCCP is effectively physically incorporated in a polymer matrix on the back of the textile[11]. Therefore there is a potential for SCCPs to leach or volatilise from the treated textile over the life-time of the textile.

EC (2002) reported that there were three to four major compounders (formulators) of textile backcoatings within the UK along with three or four smaller ones. There were also thought to be two major formulators in Germany and three or four other formulators that imported into the UK (giving the total number of formulation sites as up to 14). EC (2002) also gives some information on the number of sites that apply backcoatings to textiles. There were thought to be four large contract coating sites and six smaller ones, along with two in house weaver/coaters, in the UK and between 20-30 others dealing with flame retardant coatings in the rest of the EU (giving the total number of textile backcoating sites as up to 42) It should be noted that not all of these sites will use SCCPs and so the number of formulation site and backcoating sites currently using SCCPs will be smaller than indicated in EC (2002).

The relevant use descriptors for this application are as follows.

Sector of use	SU5 – Manufacture of textiles, leather, fur
Product category	PC34 – Textile dyes, finishing and impregnating products
Process categories	PROC3, PROC4, PROC5, PROC6, PROC 10, PROC13
Article category	AC15 – Other general rubber products

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[11] The SCCPs are not changed chemically or chemically bonded into the polymer matrix and so are effectively present as a discrete substance “dissolved” within the polymeric coating.

The relevant NACE code is 17.3: Finishing of textiles.

2.1.5 Historic uses

Two other uses for chlorinated paraffins have occurred in the recent past. These are use as an extreme pressure additive in metal working fluids and as a fat liquoring agent in leather processing. As discussed below, these uses have now been effectively banned in the EU since the 6th January 2004 through Directive 2002/45/EC[12]. The confidential consumption figures for the EU confirm that there is no current use of SCCPs in these applications. Therefore these uses are not considered further in this evaluation. However it should be noted that, as the lifetime of leather goods could be several years, there may still be leather goods containing SCCPs in use within the EU.

Directive 2002/45/EC restricts the marketing and use of SCCPs for metal working fluids and fat liquoring as substances or as constituents of other substances or preparations in concentrations higher than 1%. Therefore it is theoretically possible for SCCPs still to be used in these applications provided that the concentration present is less than 1%. However such use would not be expected because of technical limitations. For example, for the SCCP to be effective concentrations of around typically 5-10% are needed in oil-based metal cutting fluids and typically 20% of the leather fat liquoring mix (EC, 2000). Thus it is doubtful that any products are supplied for these applications with SCCP contents <1%. One possible exception to this is in emulsion-based metal working fluids where the final chlorinated paraffin concentration in the final emulsified fluid can be <l% (BUA (1992) and EC (2005)). However the supplied lubricants typically have chlorinated paraffin contents of typically 5% and up to around 8% and are then diluted before use and so again it is unlikely that lubricants supplied with <1% SCCP contents would be effective after dilution. Therefore although it cannot be completely ruled out that SCCPs are still supplied in products for leather fat liquoring or metal working this possibility is considered unlikely. It should be noted that traces of SCCPs may still be present in metal cutting fluids and leather fat liquoring as a result of trace impurities of SCCPs in medium-chain chlorinated paraffin products used for these applications (see Section 2.3.6).

A small amount of SCCPs may have been used in PVC in the late 1990s (for example figures reported to the Economic and Social Committee Review of the 20th Amendment to the Marketing and Use Directive suggested a very small use of SCCPs in PVC in 1998). However, as discussed in EC (2008) it appears that this was an error in the reported figures and Euro Chlor confirmed that SCCPs had not been used in PVC over the period for which data are available (1994 to present).

Both PlasticsEurope (representing plastics producers in Europe) and ISOPA (representing polyurethane producers in Europe) have confirmed that none of their member companies now use short-chain chlorinated paraffins in the products they place on the market (PlasticsEurope, 2008).

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[12] Directive 2002/45/EC of the European Parliament and the Council of 25 June 2002 amending for the twentieth time Council Directive 76/769/EEC relating to the restrictions on the marketing and use of certain dangerous substances and preparations (short-chain chlorinated paraffins). O.J. No. L 177, 06/07/2002, p. 0021-0022.

According to EC (2008) another reported small scale use of SCCPs in the late 1990s was in lava lamps. This use was thought to have effectively ceased although this is not entirely clear. Given the nature of this type of product (an enclosed lamp) the potential for release from this use appears to be very small.

2.2 *Quantification of uses*

Information on the amounts of SCCPs used in the EU are presented in EC (2000 and 2008), HELCOM (2002) and OSPAR (2001). The non-confidential data are summarised in Table 2**Error! Reference source not found.** below.

Table 2 Consumption of SCCPs in the EU

Use area	**Estimated tonnage used in the EU (tonnes/year)**						
	1994 (EU15)	**1995 (EU15)**	**1998 (EU15)**	**2001[b] (EU15)**	**2003[b] (EU15)**	**2004[b] (EU25)**	**2007 (EU27)**
Metal working	9,381	8,500	2,018				
Rubber	1,310	na	638			<600	Major use
Paints	1,150	na	726[c]			<100	Minor use
Sealants and adhesives	695	na				<300	Major use
Leather	390	na	45				
Textiles – backcoating Textiles – waterproofing	163 20	32				<100	Minor use
Other[a]	100	5	648				
Total	13,203	na	4,075	<3,000	<1,000	<600	<1,000

Note: a) The other category reflects main sales to distributors who then supply for the above uses.
b) The actual figures are confidential.
c) Combined total for paints, coatings and sealants.

The EU consumption data for 2001, 2003, 2004, 2007 are considered to be confidential by Euro Chlor. The trends in consumption between 1994 and 2004 are discussed in EC (2008) and show a marked decrease in supply in the EU over recent years compared with the situation in the mid-1990s (EC, 2008). For example, the amounts supplied in the EU decreased from 13,203 tonnes in 1994 to <600 tonnes in 2004**Error! Reference source not found.**. This has been partly driven by the implementation of marketing and use restrictions on two uses (metal working and fat liquoring of leather) through Directive 2002/45/EC[13].

For 2001, the data show that the use of SCCPs in metal working fluids and leather fat liquors in the EU had reduced markedly (>90% reduction) compared with the

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[13] Directive 2002/45/EC of the European Parliament and the Council of 25 June 2002 amending for the twentieth time Council Directive 76/769/EEC relating to the restrictions on the marketing and use of certain dangerous substances and preparations (short-chain chlorinated paraffins). O.J. No. L 177, 06/07/2002, p. 0021-0022.

situation in 1994 (EC, 2008). For the other uses, the 2001 data suggested a similar, but slightly reduced level of usage in the EU in sealants and adhesives, rubber and textiles, and a marked reduction (>60% reduction) in use in paints and coatings compared with 1994. The data for 2003 show that a further reduction in use occurred in the EU in 2003 compared with the situation in 2001 (the use in textiles and rubber had decreased by a factor of three and the consumption in paints and sealants and adhesives decreased by a factor of two compared with 2001). A further decrease in consumption (particularly in use in textiles, paints and sealants and adhesives) occurred in the EU in 2004. A small use of SCCPs in metal working fluids in the EU15 was evident in 2003 but this was expected to have ceased by 2004.
The EU27 consumption of SCCPs in 2007 was of a similar order to that in the EU25 in 2004 indicating that supply for the remaining uses appears to have been reasonably stable over the period 2004 to 2007.

As well as EU-wide restrictions on the use of SCCPs in metal working and fat liquoring of leather through Directive 2002/45/EC, the Netherlands has, since 1999, further restricted the use of SCCPs through national provisions[14,15] (VROM (2008) and OSPAR (2006)). These national provisions implement PARCOM Decision 95/1[16] and effectively mean that SCCPs (with a chlorination degree of not less that 48%) cannot be used at concentrations of 1% or above in the Netherlands in the following applications[17].

- Use as a plasticiser in paints, coatings or sealants.
- Use as a flame retardant in rubber or textiles.

On this basis there would expected to be no use of SCCPs in the Netherlands or any import of articles containing 1% or more of SCCPs.

OSPAR (2006) indicates that production of SCCPs in Spain has now ceased and that a substitution of the use of SCCPs has taken place (as a result of Directive 2002/45/EC and voluntary measures). As a result it was thought that the use of SCCPs in Spain had effectively been phased-out.

Information on trends in consumption of SCCPs in some EU countries has been published by the HELCOM (2002). This showed a 69% reduction in consumption of SCCPs in Denmark between the early 1990s (consumption was 75 tonnes/year) and the late 1990s (consumption was 23 tonnes/year; 20 tonnes/year in metal cutting fluids and 3 tonnes/year in other applications). The consumption of SCCPs in Finland

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[14] Commission Decision 2004/1EC of 16 December 2003 concerning national provisions on the used of short-chain chlorinated paraffins notified by the Kingdom of the Netherlands under Article 95(4) of the EC Treaty. OJ L1, 3.1.2004, pp20-36.

[15] Commission Decision 2007/395/EC of 7 June 2007 concerning the national provisions on the use of short-chain chlorinated paraffins notified by the Kingdom of the Netherlands under Article 95(4) of the EC Treaty. OJ L148, 9.6.2007, pp17-23.

[16] PARCOM Decision 95/1 requires Contracting Parties to phase-out the use of SCCPs as plasticisers in paints, coatings and sealants, as flame retardants in rubber, plastics and textiles, and their use in metal working fluids by 31 December 1999, except for uses as plasticiser in sealants in dams and as flame retardant in conveyor belts for underground mining (these latter two uses should be phased-out by 31 December 2004.

[17] SCCPs could be continued to be used in dam sealants or as flame-retardants in conveyor belts for use in mining up until 31 December 2004.

decreased from 840 tonnes/year in 1988 to 27 tonnes/year in 1997 (97% decrease) and the consumption of SCCPs in Sweden decreased by 90% between 1990 and 1998 and an almost total phase-out of use of SCCPs in Sweden was achieved by 2001.

Further information on the consumption of SCCPs in Sweden is given in OSPAR (2006). This indicates that a 90% reduction in the use of SCCPs in metal working fluids occurred between 1990 and 1995. A further decrease in the total use of SCCPs of 95% occurred between 1995 and 2003. The total amount of chlorinated paraffins (of all types) reported to be used in Sweden in 2003 was between 250 and 300 tonnes, with 3% of this figure being SCCPs (i.e. 7.5 to 9 tonnes/year). OSPAR (2006) indicates that the producers, importers and users of SCCPs were continuing to work, often in partnership with the regulatory authorities, to replace the few remaining uses of SCCPs. Similarly EC (2008) indicates that the use of SCCPs in Sweden reduced by 56% between 1988 and 2001. The major use in Sweden in 2001 was in paints and coatings (accounting for around 75% of the total), with a small use in metal working fluids (15% of the total) and no use in leather fat liquors.

Some information on the use of SCCPs in preparations is available in the SPIN (Substances in preparations in Nordic Countries) database[18].

The figures for 2006 are summarised below.

In Denmark, the total use of SCCPs in preparations reported in the database for 2006 was 7.1 tonnes in 20 preparations. The preparations included fillers[19] (seven products containing <0.1 tonnes of SCCPs), lubricants and additives (four products containing 6.1 tonnes of SCCPs) and paints, laquers and varnishes (four products containing 0.1 tonnes of SCCPs).

For Sweden, the total use of SCCPs in preparations reported in the database for 2006 was 10.0 tonnes in 18 preparations. The preparations included cutting fluids (three products containing 1.0 tonnes) and paints, laquers and varnishes (seven products containing 8.0 tonnes).

For Finland, the total use of SCCPs in products reported in the database for 2006 was apparently zero.

A decreasing trend was apparent in the consumption of SCCPs in preparations in all Nordic countries as shown in Table 3 below.

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[18] http://195.215.251.229/DotNetNuke/default.aspx.

[19] It is presumed that this represents sealant use.

Table 3 Information on use of SCCPs from the SPIN database

Country	Parameter	Year							
		1999	2000	2001	2002	2003	2004	2005	2006
Denmark	Number of products		29	28	28	24	25	26	20
	Amount of SCCPs (tonnes)		23.5	20.6	20.6	17.1	11.0	11.0	7.1
Finland	Number of products		5	5	5	6	6	4	
	Amount of SCCPs (tonnes)			5.5	16.3	13.7	3.5	0.6	0
Sweden	Number of products	50	35	32	27	25	22	21	18
	Amount of SCCPs (tonnes)	72.0	21.0	36	18.0	14.0	12.0	12.0	10.0
Norway	Number of products		12	9	7	5			
	Amount of SCCPs (tonnes)		8.0	3.9	3.3	6.2	0	0	

SFT (2008) indicates that there is no current production or use of SCCPs in Norway. A national regulation has been in place since 2002 prohibiting the production, import, export and use of SCCPs, and the production, import, export and use of mixtures or products containing 0.1% of SCCPs by weight. An exemption was made for the use of SCCPs in dam sealants and conveyor belts for mining until the 1st January 2005. In addition waste with a SCCP content of 0.25% or greater is treated as hazardous waste. EC (2008) reports that the use of SCCPs in Norway was reduced from 16 tonnes/year in 1998 to 4 tonnes/year in 2001. The uses reported in 2001 in Norway included metal working fluids and paints and rust inhibitors.

POPRC (2007 and 2008) indicates that reductions in use of SCCPs have also occurred in some other non-EU countries. For example the consumption of SCCPs in Switzerland was reported to have reduced by 80% from the situation in 1994 (where 70 tonnes/year were used). Similarly the use of SCCPs in Australia has decreased by 80% from 1998/2000 to 2002. BAFU (2008) indicates that a regulation is now in force in Switzerland[20] (which came into force in August 2006) that bans the use of SCCPs at concentrations >1% in paints and varnishes, sealants, plastics and rubbers, textiles, leather fat liquors and metal working lubricants. However the same source also indicates that manufacturers and importers of SCCPs and preparations containing more than 0.25% SCCPs have an obligation to notify the national authorities of the intended uses and annual quantity supplied of such products. BAFU (2007) indicates that, at that time, the amounts of SCCPs imported into Switzerland in goods and articles were largely unknown except for rubber products (2 tonnes/year) and lava lamps (0.3 tonnes/year).

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[20] Ordinance on Risk Reduction related to the use of certain particularly dangerous substances, preparations and articles (Ordinance on Risk Reduction related to Chemical Products (ORRChem) of 18 May 2005.

A trend analysis of the use of SCCPs in products on the Swiss market has been carried out in 2002 (OSPAR (2006) and BUWAL (2003)). The analysis was based on the results of random sampling of different product groups. The survey included products such as paints, inks, lubricants, sealants, cleaning agents, etc. that were supplied both for public and professional use. SCCPs were not found in any of the 170 products sampled. A further study reported in OSPAR (2006) investigated the presence of SCCPs in sealants in buildings in Switzerland. This survey showed that SCCPs were used in sealants from 1971 to 1990 (where they were used as a substitute of PCBs) and after 1990 SCCPs appeared to have been replaced by medium-chain chlorinated paraffins. Based on the results of these surveys it was concluded that SCCPs were not used in Switzerland and had been replaced by medium-chain chlorinated paraffins or other plasticisers.

Overall, this information points to a reducing consumption of SCCPs in the EU and several other countries.

The consultation carried out for this report with a number of downstream user organisations indicates that there appears to be currently (2008) little or no use of SCCPs in the EU (see Section 2.1). It appears that most companies have either replaced SCCPs with alternatives or are in the process of carrying out this replacement. This appears to have been driven by the fact that SCCPs has been identified as a potential SVHC substance. This makes it difficult to describe the current distribution of possible point emission sources around the EU.

The information obtained from downstream users appears to contradict the information provided by Euro Chlor that showed SCCPs were still being sold in the EU for use in rubber, sealants and adhesives, paints and textiles. A possible explanation for this is that the information provided by Euro Chlor may represent sales in 2007, whereas the information from downstream users may represent the current (November 2008) position now that SCCPs are on the candidate list. There may also be downstream users who are not members of the organisations consulted, or members who could not be consulted within the timeframe of this project. Hence it cannot be ruled out that SCCPs are still currently being used in the various applications.

In addition, although the current use of SCCPs in the EU appears to be declining markedly, emissions to the environment will still occur as articles containing SCCPs will be present in use in the EU for several years and so SCCPs applied to articles in the past (e.g. sealants in buildings, rubber articles, painted articles and treated textile articles) will still have the potential for emission to the environment. These articles are expected to be widely distributed throughout the EU and act as diffuse sources of emission.

2.3 *Quantification of releases from uses*

The quantification of the release of SCCPs from use is based on the information reported in EC (2000) and EC (2008). Brief details of the methodology and assumptions used are given here but these reports should be consulted for more details of the methodologies used. The estimates are based on the known use pattern of SCCPs in the EU25 in 2004. It should be noted that some of the emission estimates are confidential. In these cases the figures are reported as a limit value based on the upper limit of the tonnage range assumed for each use. The actual emission figure is given in the confidential annex. More up to date information (as of 2007) on the use pattern of SCCPs has been obtained from Euro Chlor.and is summarised in Table C 2 of the confidential annex. This information shows a broadly similar level of usage in the EU27 in 2007 (<1,000 tonnes/year) compared with the EU25 in 2004 (<600 tonnes/year), with the main areas of use again being rubber and sealants, with small amounts being used in the other areas.

2.3.1 Use as a flame retardant in rubber formulations

2.3.1.1 Releases into the working environment

The manufacture of rubber products involves the formulation (mixing) of the SCCPs into the rubber before it is formed into sheets/articles. The process generally involves the use of closed systems and batch production measures and so occupational exposure is expected to be intermittent and occur mainly during operations such as charging of mixers, sampling and plant cleaning (EC, 2000).

EC (2000) estimated the inhalation exposure of workers at sites manufacturing rubber products using the EASE Model. This predicted airborne exposures of 0.5-3 ppm (11-63 mg/m^3) as an 8 hour TWA taking into account that the processing temperatures could be in the range 180-200°C and assuming the use of local exhaust ventilation.

Estimates for dermal exposure, again based on the EASE Model, are also given in EC (2000). Here the predicted dermal exposure to hands and forearms was estimated to be in the range 0.1-1 mg/cm^2/day and it was expected that this value would be considerably reduced by the use of personal protective equipment.

Further moulding, cutting and shaping of rubber products once the SCCP is incorporated into the rubber matrix is considered unlikely to lead to significant inhalation or dermal exposure (EC, 2000).

According to EC (2000) the number of people occupationally exposed to SCCPs in the EU is unknown. However, EC (2000) estimated that the numbers occupationally exposed during all formulation processes (rubber, textiles, paints and coatings and adhesives and sealants) in the EU at that time could be of the order of several thousands.

2.3.1.2 Releases into the environment

The methodology used to estimate the emissions from this use is based on the Emission Scenario Document on Plastics Additives (OECD, 2004). The emission estimate considers three steps: raw materials handling, compounding and conversion. The first two of these can be essentially considered to be a formulation step whereby the chlorinated paraffin is added to the rubber. The third can be considered effectively a processing step whereby the rubber is “shaped” into the final article.

The estimates assume a typical loading of around 10-17% by weight in the rubber. The amount of rubber used on a site is estimated assuming a site uses around

50 tonnes/year (this figure is based on the survey of the rubber industry that was carried out in EC (2008)).

The losses from raw material handling are assumed to be 0.01% to waste water of the amount of SCCP used as a result of spillage etc. based on OECD (2004). The loss from compounding is assumed to be 0.005% to air and 0.005% to waste water. Based on these figures, EC (2008) estimated the total losses from a generic worst case rubber formulation site to be around 7.5 kg/year to waste water and 2.5 kg/year to air.

The corresponding emissions at the total EU level are confidential but are estimated to be <100 kg/year to waste water and <100 kg/year to air.

For the conversion step, emission figures of 0.005-0.025% to air and 0.005-0.025% to waste water are assumed for sites where air emission control is present (assumed to be 80% of the sites) and 0.05-0.25% to waste water and 0.05-0.25% to air at sites where no air emission control is present (assumed to be 20% of the sites). These emission factors are again based on OECD (2004). Using these figures EC (2008) estimated the loss from a generic worst case rubber conversion site to be around 2.5-12.5 kg/year to waste water and 2.5-12.5 kg/year to air.

The corresponding emissions at the total EU level in 2004 are confidential but are estimated to be <500 kg/year to air and <500 kg/year to waste water.

Based on the information reported in Section 2.1.1, the main use of SCCPs in rubber is in conveyor belts for mining. The highest production of rubber conveyor belts appears to occur in Germany, Poland, Greece and Romania (see Section 2.1.1) and so the highest use (or number of sites of use) would be expected to occur in these countries. However, conveyor belts are produced in the majority of EU countries and so use in other countries is also likely. The number and location of sites currently manufacturing conveyor belts containing SCCPs, and the number of locations where such treated belts are currently used is unclear.

2.3.2 Sealants and adhesives

2.3.2.1 Releases into the working environment

The formulation of sealants and adhesives is generally a low temperature (up to 40-50°C) mixing process (EC, 2000). However, EC (2000) indicates that one exception to this may be hot melt adhesives, where temperatures up to 180-200°C may be used.

EC (2000) estimated the inhalation exposure of workers at sites formulating sealants and adhesives the EASE Model. This predicted airborne exposures of 0-0.1 ppm (0-2.1 mg/m^3) as an 8 hour TWA for low temperature mixing processes (the majority of cases) and 0.5-3 ppm (11-63 mg/m^3) as an 8 hour TWA for formulation of hot melt adhesives.

Estimates for dermal exposure during sealant and adhesive formulation, again based on the EASE Model, are also given in EC (2000). Here the predicted dermal exposure to hands and forearms was estimated to be in the range 0.1-1 mg/cm^2/day and it was expected that this value would be considerably reduced by the use of personal protective equipment.

Occupational exposure during the industrial use of sealants is expected to be insignificant as SCCPs have very low vapour pressures (EC, 2000). However, EC (2000) did consider a scenario where sealants may be applied by spray. The inhalation exposure for this scenario was estimated to be of the order of 0.32 mg/m^3 (based on information on inhalation exposure from metal working fluids applied by continuous jet or spray) and the dermal exposure to the hands and forearms was estimated to be 0.01-0.1 mg/cm^2/day.

According to EC (2000) the number of people occupationally exposed to SCCPs in the EU is unknown. However, EC (2000) estimated that the numbers occupationally exposed during all formulation processes (rubber, textiles, paints and coatings and adhesives and sealants) in the EU at that time could be of the order of several thousands. Similarly, EC (2000) estimated that the number of people occupationally exposed during the industrial use of paints, adhesives and sealants would be of the order of thousands.

2.3.2.2 Releases into the environment

Sealants are formulated by mixing the required additives (including SCCPs) with a viscous liquid polymer using either low or high shear mixers (EC, 2008). Most sealants are moisture sensitive (especially one-part sealants); as a result no water is usually used in the process and consequently release to waste water from formulation of sealants is likely to be very low.

Solid waste (scrap material and from cleaning of the mixer) can be generated during the formulation process and this was estimated in EC (2008) to be up to 5% of the sealant. EC (2008) reports that cleaning between batches is minimised by using dedicated equipment or by starting with the lighter coloured products through to darker coloured products. Removal of the waste solid material from the mixer is usually carried out by hand; although solvent cleaning of the mixer can also occur (in this case the solvents are collected and disposed of at the end of their useful life by registered contractors).

The losses during application of the sealants are also expected to be as solid waste (EC, 2008). One-part sealants are supplied in the form of cartridges typically containing around 500 g of sealant. EC (2008) estimated that after use around 2-3 cm^3 of sealant would remain in the cartridge nozzle and tube and this will quickly skin over (cure) and so remain within the packaging. The discarded cartridges would be disposed of as waste to landfill. Two-part sealants are supplied in tins. In use, a curing agent is firstly mixed with the sealant in the tin and then the sealant is then filled into a cartridge on-site for application. Similar to the one-part sealant, any unused material will quickly cure and will be disposed of as solid waste in an appropriate manner. EC (2008) notes that in the UK, sealants for industrial applications are treated as special (hazardous) waste rather than general building waste.

Overall, EC (2008) concluded that the emissions of SCCPs to waste water and air from the formulation and use of sealants will be very low. However, SCCPs may be disposed of as solid waste.

The number and location of sites where SCCPs are used in the formulation of sealants and adhesives is unknown. The information reported in Section 2.1.2 suggests that there is currently little or no use of SCCPs in this application and so the number of formulation sites is likely to be very low. However, SCCPs were still being supplied for this application in 2007 and so there may still be companies producing sealants containing SCCPs.

The application of sealants is expected to be widespread throughout the EU. Thus if SCCPs are used in sealants the potential number of sites of use would be expected to be relatively large and widespread throughout the EU. We believe that most sealants are used in the construction industry, although it cannot be ruled out that they could be present in consumer products.

2.3.3 Paints and coatings

2.3.3.1 Releases into the working environment

The formulation of textile treatments is a low temperature (up to 40-50°C) mixing process (EC, 2000).

EC (2000) estimated the inhalation exposure of workers at sites formulating paints and coatings using the EASE Model. This predicted airborne exposures of 0-0.1 ppm (0-2.1 mg/m^3) as an 8 hour TWA.

Estimates for dermal exposure during formulation of paints, again based on the EASE Model, are also given in EC (2000). Here the predicted dermal exposure to hands and forearms was estimated to be in the range 0.1-1 mg/cm^2/day and it was expected that this value will be considerably reduced by the use of personal protective equipment.

Occupational exposure during the industrial use of paints was considered in EC (2000) for a scenario where paints and coatings are applied by spraying. The inhalation exposure for this scenario was estimated to be of the order of 0.32 mg/m^3 (based on information on inhalation exposure from metal working fluids applied by continuous jet or spray) and the dermal exposure to the hands and forearms was estimated to be 0.01-0.1 mg/cm^2/day.

According to EC (2000) the number of people occupationally exposed to SCCPs in the EU is unknown. However, EC (2000) estimated that the numbers occupationally exposed during all formulation processes (rubber, textiles, paints and coatings and adhesives and sealants) in the EU at that time could be of the order of several thousands. Similarly, EC (2000) estimated that the number of people occupationally exposed during the industrial use of paints, adhesives and sealants would be of the order of thousands.

2.3.3.2 Releases into the environment

EC (2008) estimated the releases to the environment of SCCPs from formulation and processing (application) of paints using a combination of information provided by industry, an Emission Scenario Document on paints and coatings (EA, 2003) and the default methodology presented in the Technical Guidance Document for the Existing Substances Regulation.

The emission factors for formulation of solvent-borne coatings given in EA (2003) are as follows.

		Standard size batch (~1,000 litres)	Large size batch (~10,000 litres)
Waste generation	equipment leftovers	0.5% recycled 0.5% to disposal	0.25% recycled 0.25% to disposal
	packaging waste	0.5% to disposal	0.5% to disposal
Emissions to air		0% for low volatility liquids	0% for low volatility liquids
Emissions to water		0% for liquids	0% for liquids

The main source of emission to waste water identified in EA (2003) is from wash-off of dust from workshop areas. As the SCCPs used in paints are generally liquids at or near room temperature, such sources of emission are unlikely to occur. Similarly the emissions to air for substances with low vapour pressures (as is the case with SCCPs) are likely to be very low.

The main loss from the recycling process is likely to result from waste. EC (2008) indicates that any solvent-borne paint or coating remaining in the manufacturing equipment after formulation is washed out using organic solvent and either recycled back into the formulation process or is disposed of (by either incineration or as hazardous waste). Packaging waste will also be disposed of similarly. Thus, little or no release of SCCPs to the environment should occur.

Based on this information, EC (2008) concluded that the local and total EU emissions to waste water and air from the formulation of solvent borne paints and coatings containing SCCPs are likely to be negligible from well controlled sites.

Little specific information is available on the losses to the environment during the application of paints and coatings. EC (2008) used the default methodology from the Technical Guidance Document for existing substances to estimate the emissions from this process. The default emission factors assumed for SCCPs for the application of paints are 0% to air and 0.1% to waste water.

EA (2003) and EC (2008) indicate that a considerable amount of paint containing SCCPs may be disposed of during application (the estimates ranged from 2.5% to 60.5% depending on the coating type and the mode of application).

Based on the 2004 consumption data, this would lead to a low emission of <10 kg/year to waste water for a (large) generic industrial site where paint is applied and a negligible release for domestic application.

The corresponding emissions at the total EU level in 2004 are confidential but are estimated as <100 kg/year to waste water. There was also estimated to be a considerable amount of SCCPs disposed of in unused/waste paint.

EC (2008) estimated that in 1999 the total number of sites manufacturing paint containing chlorinated paraffins of all types in the UK was around 30 based on a survey carried out by the British Coatings Federation. The same survey attempted to determine the number of sites where coatings containing chlorinated paraffins may be used, however this proved to be impossible. Instead it was considered that the major users of such paints are professional painters and specialist applicators, although it is possible that some DIY paints containing chlorinated paraffins may be used by the general public. Based on this it was estimated for the United Kingdom that there would be around 40,000 users of coatings containing chlorinated paraffins for water proofing of walls, and around 1,000-1,500 users of paints and coatings containing chlorinated paraffins for other uses. It should be noted that no distinction was made between SCCPs, medium-chain length or long-chain length chlorinated paraffins in these surveys and the number of sites refers to those using any chlorinated paraffin and not just SCCPs. The number using SCCPs would be expected to be lower than given here.

Based on the information reported in Section 2.1.2, it appears that there is currently little or no use of SCCPs in paints and coatings in the EU and so the number of current formulation sites is likely to be very low.

The application of paints and coatings is expected to be widespread throughout the EU. Thus if SCCPs are used in paints and coatings the potential number of sites of use would be expected to be relatively large and widespread throughout the EU.

2.3.4 Textiles

2.3.4.1 Releases into the working environment

The formulation of textile treatments is a low temperature (up to 40-50°C) mixing process (EC, 2000).

EC (2000) estimated the inhalation exposure of workers at sites formulating textile backcoatings using the EASE Model. This predicted airborne exposures of 0-0.1 ppm (0-2.1 mg/m^3) as an 8 hour TWA.

Estimates for dermal exposure during formulation of textile backcoatings, again based on the EASE Model, are also given in EC (2000). Here the predicted dermal exposure to hands and forearms was estimated to be in the range 0.1-1 mg/cm^2/day and it was expected that this value would be considerably reduced by the use of personal protective equipment.

Occupational exposure to SCCPs can also occur during the application of textile backcoatings. Inhalation exposure from this process is expected to be low (0-0.1 ppm (0-2.1 mg/m^3) as an 8 hour TWA based on estimates using the EASE Model) as SCCPs have very low vapour pressures (EC, 2000). Intermittent dermal exposure of the hands and forearms could occur, and EC (2000) estimated the exposure could be in the range 0.03-0.3 mg/cm^2/day, again using the EASE Model. EC (2000) noted that the predicted dermal exposure would be considerably reduced by the use of personal protective equipment.

EC (2000) also considered the potential of occupational exposure through textiles in use (for example from use in protective industrial clothing and tarpaulins). It was concluded that occupational exposure would be very low (negligible) as exposure would be very intermittent and, if protective clothing that had been treated with SCCPs was actually used in practice; it would be worn over other garments.

According to EC (2000) the number of people occupationally exposed to SCCPs in the EU is unknown. However, EC (2000) estimated that the numbers occupationally exposed during all formulation processes (rubber, textiles, paints and coatings and adhesives and sealants) in the EU at that time could be of the order of several thousands.

2.3.4.2 Releases into the environment

The emission estimates for the formulation of textile backcoatings and application of the backcoatings to textiles are based on industry information used in EC (2008). Based on this report, the major sources of release during the formulation of backcoatings are likely to be from dust formation (solid additives only) during loading of the mixing tank and washing out of the formulation mixing tank. As the SCCPs used in this application are generally liquids at or near room temperature, dust emissions are not expected. The emission from washing out of the vessel was estimated to be around 0.5% of the formulation, of which the SCCP will make up a percentage (up to around 15-20% of the wet formulation).

Based on this emission factor, a local emission to waste water was estimated for a generic textile backcoating formulation site using the 2004 consumption data; however the emission estimate is confidential (EC, 2008).

The corresponding emissions at the total EU level in 2004 are confidential but are estimated as <500 kg/year to waste water.

It should be noted that the formulation emitted will be in the form of a viscous mixture of SCCP with the backcoating polymer. Many sites will have a solid extraction system in place before the effluent is discharged from the site and this is likely to remove the SCCP as a “paint-like” film and so the actual releases of SCCPs are likely to be much lower than estimated using this emission factor.

The losses to the environment from the backcoating process are thought to occur during the initial set up of the coating equipment and washing down of the coating equipment between batches. EC (2008) estimated this loss as around 1 kg of formulation between each batch (equating to a loss of 0.15-0.2 kg of SCCP per batch). It is also possible that a small emission of SCCP to air could occur during the curing process but it was not possible to quantify this.

Based on this emission factor, a local emission to waste water was estimated for a generic textile backcoating application site using the 2004 consumption data; however the emission estimate is confidential (EC, 2008).

The corresponding emissions at the total EU level in 2004 are confidential but are estimated as <500 kg/year to waste water or landfill.

Little information is available on the other uses of SCCPs in the textile industry. It is possible that for some applications (such as waterproofing of textiles) the SCCP is applied in emulsion form and so releases to water could occur. However the quantities involved appear to be small.

Based on the information reported in Section 2.1.4, the main areas of the EU where backcoating is carried out include the UK and Germany but the process is also likely to be carried out in other parts of the EU. The total number of sites of use is estimated at <14 for formulation sites and <42 for sites applying backcoatings (processing sites) (see Section **Error! Reference source not found.**). The current amounts of SCCPs supplied for use for textile backcoating in the EU is unclear.

2.3.5 Release into the environment from articles over their service life and disposal

A number of articles or products containing SCCPs may have a substantial service life. For example SCCPs will be present in painted surfaces, treated textiles, rubber products and sealants and so losses through volatilisation, leaching and erosion/particulate losses over the entire service life of the article are possible.

These losses have been quantified in EC (2008) using a relatively crude, worst case approach. The exact details of the methodology used are confidential but the methodology essentially assumed the following emission factors.

- Volatile loss – 0.05% over the article lifetime for rubber products.
  – 0.125% over the article lifetime for textiles
  – 0.4% per year over a 5-7 year lifetime for painted articles
  – 0.25% over the article lifetime for sealants and adhesives

- Leaching loss – 0.25% over the article lifetime for rubber and textiles
  – 1% over the article lifetime for paints
  – 0.75% per year over a 10-30 year lifetime for sealants

- Erosion/particulate losses – 2% over the article lifetime for rubber and textiles
  – 2-6.5%[21] over the article lifetime for painted articles
  – 2-5% over the article lifetime for sealants and adhesives
- Erosion/particulate loss – 2% at disposal for rubber and textile articles
  – 2-5% at disposal for sealants and adhesives

The methodology assumes that all of the chlorinated paraffin used the EU in sealants and adhesives, paints and coatings, textiles and rubber will be used to make an article (for example sealants used in windows or buildings, a treated textile, a painted article or a conveyor belt) and that these articles will be subjected to volatile loss, leaching

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[21] The factors used here also include the emission at disposal.

loss and erosion/particulate loss over their entire lifetime, and erosion/particulate loss during disposal operations (for example during dismantling, crushing and other physical treatments of articles prior to disposal via landfill or incineration or recycling).

Using these factors, the total EU loss was estimated to be in the range 630-1,770 kg/year to air, 7,400-19,600 kg/year to waste water, 4,740-9,520 kg/year to surface water and 8,700-13,900 kg/year to urban/industrial soil.

It should be noted that these estimates are based on the estimated amount of SCCPs use in the EU. Any import of articles containing SCCPs would add to these emissions.

Waste generated during the industrial use of SCCPs is likely to be treated as hazardous waste and disposed of accordingly. For several uses of SCCPs (rubber, textiles, painted articles and sealants) the majority of the SCCPs used in the application will still be present in the article at the end of its service life and so it is relevant to consider the disposal of the article.

For rubber articles, particularly conveyor belts, it is possible the article will be recycled at the end of its useful life (see Section 2.1.1). This could lead to the presence of SCCPs in a wider range of articles (though at a lower concentration) and could provide a further source of diffuse exposure. Any articles not recycled are likely to be disposed of as industrial waste.

Disposal of used treated textiles articles is most likely to occur to municipal waste, and through that to landfill or to incineration. Most of the use of these treated materials is likely to be in the UK and Ireland, which have specific regulatory requirements for use of flame-retarded textiles. In these countries the main route of disposal for municipal solid waste is landfill (86% in the UK, 100% in Ireland).

For use in sealants and adhesives and paints and coatings most of the final fate of most of the SCCP present is likely to be as construction waste, which is likely to be landfilled. Other articles will be disposed of into municipal waste, and the eventual fate of this material will also be to landfill or incineration. The proportion which is disposed of by each route will depend on the Member State in which this occurs (no information on the geographical distribution has been located) – the overall figures (2006) for the EU-27 are 68% to landfill, 32% to incineration (Eurostat, 2008).

Based on the properties of SCCPs (low water solubility and high log Kow (EC, 2000)) it is considered likely that SCCPs will have a very low mobility in soil, with strong sorption to organic matter. Hence is it very unlikely that SCCPs will be leached in significant quantities from landfills. Incineration is likely to completely destroy the SCCP.

2.3.6 Other sources

SCCPs are present as minor impurities in medium-chain chlorinated paraffins (EC, 2002). The actual levels of SCCPs in the medium-chain chlorinated paraffins are low at <1% (and frequently much lower than this limit[22]). Therefore small amounts of

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[22] Euro Chlor indicates that it is being investigated to reduce this to <0.1%.

SCCPs can be released to the environment as a result of the use of medium-chain chlorinated paraffins. A rough estimate of the emission from this source has been carried out in EC (2008) based on the known estimated amounts of medium-chain chlorinated paraffins released to the environment and assuming a maximum SCCP content of 1% in the medium-chain chlorinated paraffin. The estimated amount of medium-chain chlorinated paraffins released in the EU has been estimated in EC (2005) along with the estimated amount of SCCPs that may be contained within these emissions.

Medium-chain chlorinated paraffin emissions (EC, 2005)	**SCCP emission**
172 tonnes/year to air	<1,720 kg/year
1,310 tonnes/year to waste water	<13,100 kg/year
885 tonnes/year to surface water	<8,850 kg/year
973 tonnes/year to urban industrial soil	<9,730 kg/year
Total	**<33,400 kg/year**

2.3.7 Other information on emissions of SCCPs to the environment for the EU

Denier van der Gon *et al.* (2007) have published an emission inventory for SCCPs covering the UNECE-Europe region. The estimates were carried out for the year 2000 and were based on the methodologies given in EC (2000). The uses of SCCPs considered in the estimates were use in metal working fluids, paints, sealants, leather finishing, rubber, textiles and PVC. For the EU15 countries the estimates were based on data for 1998 assuming that the non-metal working applications had remained stable to 2000 but that there was a 17% reduction of use in metal working applications by 2000 as a result of industry-government agreements. For the non-EU15 countries, it was assumed that the applications are distributed by population assuming a similar use pattern throughout the UNECE but assuming that there was no reduction in use in metal working applications by 2000. The estimates for each country are summarised below. Given that two of the uses of SCCPs that lead to significant emissions to the environment (i.e. use in metal working fluids and leather fat liquors) have been restricted since these estimates have been made, the actual emission figures given by Denier van der Gon *et al.* (2007) will have limited relevance to the current emissions in the EU. However, one assumption that could be made is that the current distribution of use of SCCPs amongst the various EU countries, and hence distribution of emissions, is similar to that assumed by Denier van der Gon *et al.* (2007). Thus the percentage of the total emission for each country is shown in Table 4. It should be noted that these percentage figures are highly uncertain as they effectively assume that the use pattern of SCCPs is broadly similar across all countries and that the use of SCCPs is related to population. Thus the percentage figures should be seen as rather crude estimates.

Table 4 Estimated emission of SCCPs by country for the year 2000

Country	**Emission estimate for year 2000 (kg/year)**	**Percentage of total EU27+Norway**
Austria	92	0.3%
Belgium	116	0.4%
Denmark	61	0.2%
Finland	59	0.2%
France	673	2.3%
Germany	932	3.2%
Greece	120	0.4%
Ireland	43	0.1%
Italy	654	2.2%
Luxembourg	5	0.02%
The Netherlands	180	0.6%
Portugal	114	0.4%
Spain	0	0%
Sweden	101	0.3%
United Kingdom	675	2.3%
Total EU 15	3,825	[13.0%]
Bulgaria	1,957	6.6%
Cyprus	190	0.6%
Czech Republic	2,570	8.7%
Estonia	358	1.2%
Hungary	2,537	8.6%
Latvia	0	0%
Lithuania	906	3.1%
Malta	No estimate given	-
Poland	9,672	32.8%
Romania	5,619	19.1%
Slovakia	1,352	4.6%
Slovenia	482	1.6%
Norway	0	0%
Total EU27 + Norway	**29,468**	

The European Pollutant Emission Register contains information on the emissions of SCCPs from four sites within the EU in 2004. These are summarised in Table 5.

Table 5 Information from the European Pollutant Emission Register

Company	Location	Main activity	Reported emission
Caffaro Srl	Italy	Production of SCCPs	0.00 tonne/year indirect discharges (transfer to an off-site waste water treatment facility)
Daimler Chrysler Espana	Spain	Manufacture of motor vehicles	0.00 tonne/year indirect discharges (transfer to an off-site waste water treatment facility)
Derypol, SA	Spain	Manufacture of plastics	0.01 tonne/year indirect discharges (transfer to an off-site waste water treatment facility)
Ecologia Ambiente Srl	Italy	Collection and treatment of waste	0.01 tonne/year direct release to water

In Germany, certain halogen-containing containing wastes, for example metal working fluids with >2 g halogen/kg and halogen-containing plasticisers, are classified as potentially hazardous waste and are incinerated.

Halogenated wastes are generally classified as hazardous wastes under the European Waste Catalogue[23] (Defra, 2008). This includes, for example, organic halogenated solvents, washing liquids, mother liquids and halogenated filter cakes/spent absorbents from manufacture, formulation, storage and use of basic organic chemicals, fine chemicals, plastics/rubber, as well as shaping of metals. Thus, any similar waste generated containing SCCPs will be treated as hazardous waste and the companies producing the waste will have an obligation to ensure that the waste is disposed of or recovered properly.

Short-chain chlorinated paraffins are classified as a ‘priority hazardous substance’ under the Water Framework Directive (Directive 2000/60/EC). This places a requirement on Member States to ensure a cessation or phase-out of discharges, emissions and losses of the substance (Defra, 2008).

It is understood that sites producing chlorinated paraffins in the EU are likely to be covered under the Integrated Pollution Prevention and Control (IPPC) regime (Defra, 2008). In addition it is possible that some of the uses of SCCPs may be covered by IPPC, dependent on the size of the site. These possibilities are summarised in Table 6 (based on Defra (2008)).

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[23] Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste. O.J. L226, 6.9.2000, p3.

Table 6 Processes involving SCCPs that are likely to be covered by IPPC

Sector	Process	Covered by IPPC
Manufacture of SCCPs	Production	Yes
Paints	Formulation	Not likely to be covered except where production of basic chemicals also takes place.
	Industrial application	Large companies (with a consumption capacity of more than 150 kg per hour or 200 tonnes per year) may be covered.
Rubber	Production/processing	Larger facilities may be covered where production of synthetic rubber takes place alongside the subsequent processing.

Defra (2008) indicates that there is anecdotal evidence that some companies have ceased using SCCPs in applications that are not restricted under Directive 2002/45/EC because there is a perception that all uses are controlled.

2.3.8 Summary of releases to the environment

The release of SCCPs estimated to occur to the environment based on 2004 consumption data for the EU25 are summarised in Table 7.

More recent (confidential) information from industry indicates that the level of use of SCCPs in the EU27 in 2007 is broadly similar to those in the EU25 in 2004 (on which the emission estimates are based). Hence it would be expected that the releases from the EU27 in 2007 would be of the same order as those in the table (the information does not allow a detailed revised calculation).

Table 7 Summary of estimated releases to the environment for SCCPs

Lifecycle stage	**Estimated release (tonnes/year)**			
	Surface water	**Waste water**	**Air**	**Industrial/ urban soil**
Manufacture	<0.037			
Formulation of rubber		<0.1	<0.1	
Formulation of sealants		negligible	negligible	
Formulation of paints		negligible	negligible	
Formulation of textile backcoatings		<0.5		
Processing of rubber		<0.5	<0.5	
Use of sealants		negligible	negligible	
Industrial application of paints		<0.1		
Processing (application) of textile backcoatings		<0.5 (to waste water or waste)		
Substance in articles (rubber goods, building and construction materials (sealants), textiles, and articles painted with paints and coatings)	4.7-9.5	7.4-19.6	0.6-1.8	8.7-13.9
Consumer use of preparations (paints and sealants)		negligible	negligible	
Total from SCCPs lifecycle	**4.7-9.5**	**7.4-19.6**	**0.6-1.8**	**8.7-13.9**
Unintentional formation (impurity in medium-chain chlorinated paraffins)	<8.9	<13.1	<1.7	<9.7
Overall total	**<13.6-<18.4**	**<20.5-<32.7**	**<2.3-<3.5**	**<18.4-<23.6**

3 Information on alternatives

3.1 *Identification of alternative substances and techniques*

SCCPs are part of a wider group of chlorinated paraffins that includes also medium-chain chlorinated paraffins and long-chain chlorinated paraffins. As both medium-chain chlorinated paraffins and long-chain chlorinated paraffins are also used in rubber, paints, textiles[24] and sealants and adhesives (EC, 2005 and Brooke *et al.*, 2008) it is likely that both medium-chain chlorinated paraffins and long-chain chlorinated paraffins can be considered as potential alternatives for many, if not all, uses of SCCPs.

OSPAR (2006) reports the progress made by Contracting Parties in implementing PARCOM Decision 95/1. As part of this Decision Contracting Parties were requested to report on acceptable substitutes for SCCPs. No information was reported on this aspect.

As indicated in Section 1 the use of SCCPs in the EU has declined in many countries in recent years. Euro Chlor (personal communication, 2008a) commented that sales of SCCPs are decreasing due to substitution mainly by MCCPs, and the classification as a POP by UNECE would reinforce this trend even if the substance is not prioritised for inclusion on Annex XIV. CPIA (personal communication, 2008a) comments that in their view the change to MCCPs has already occurred for the majority of uses for which this is possible.

3.1.1 Rubber

As the main function of SCCPs in rubber applications is as a flame retardant, in theory any other flame retardant that is recommended for use in rubber could be considered as an alternative to SCCPs. This could include the following.

Medium-chain chlorinated paraffins
Long-chain chlorinated paraffins

HELCOM (2002) and OSPAR (2001) suggest that as well as medium-chain and long-chain chlorinated paraffins, alternatives to SCCPs in rubber include phosphate-containing compounds. From Section 2.1.1, and from communication with producers of aryl phosphates, for use in coal mine belting this may relate to use in PVC rather than in rubber.

A possible critical use of SCCPs is in conveyor belts for underground mining (CPIA, 2008b). It is not clear if alternatives to SCCPs exist in this application. However, both medium-chain and long-chain chlorinated paraffins are used in rubber applications, and the amount of SCCPs used in this application has fallen in recent years. This therefore suggests that alternatives are available, at least in part, for this application.

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[24] According to EC (2005) there was no use of medium-chain chlorinated paraffins in textiles in the EU at that time however the report did identify that some of the medium-chain chlorinated paraffins supplied to the PVC industry were used for coating applications, including textiles. Long-chain chlorinated paraffins are used for backcoating textiles.

Defra (2008) considered the potential non-substance related alternatives to the use of medium-chain chlorinated paraffins and many of the considerations are also relevant to SCCPs. This report concluded that no non-substance alternatives to the use of chlorinated paraffins in rubber could be identified for the main uses of MCCPs (in conveyor belts in mining, bellows for buses/metros or fireproof doors).

3.1.2 Textiles

Possible alternatives to SCCPs could include the following.

Medium-chain chlorinated paraffins
Long-chain chlorinated paraffins
Decabromodiphenyl ether
Hexachlorocyclodecane
Ethane, 1,2-bis(pentabromophenyl)

HELCOM (2002) and OSPAR (2001) suggest that as well as long-chain chlorinated paraffins, alternatives to SCCPs in textiles include phosphate-containing compounds.

Other than the long-chain chlorinated paraffins, the main products used in flame retardant backcoatings are halogenated flame retardants such as decabromodiphenyl ether and HBCDD in combination with antimony trioxide.

Examples of brominated flame retardants that can be used as flame retardants in textiles are summarised in Table 8. Of these decabromodiphenyl ether, ethane, 1,2-bis(pentabromophenyl) and hexabromocyclododecane are used most commonly for the backcoating of textiles and so would appear to be the most likely alternatives for SCCPs. Information on these three is included in Section 3.2.1.2.

Table 8 Examples of brominated flame retardants that could be used as flame retardants in textiles

Name	CAS No.	Source of information
Decabromodiphenyl ether	1163-19-5	Great Lakes/Chemtura Albermarle
Ethane, 1,2-bis(pentabromophenyl)	84852-53-9	Albermarle
Ethylenebistetrabromophthalimide	32588-76-4	Albermarle
Hexabromocyclododecane (HBCDD)	25637-99-4 (3194-55-6)	Great Lakes/Chemtura Albermarle
Tetrabromophthalate ester	26040-51-7	Great Lakes/Chemtura
Bis (tribromophenoxy) ethane	37853-59-1	Great Lakes/Chemtura
Tribromophenyl allyl ether	3278-89-5	Great Lakes/Chemtura
Dibromostyrene	125904-11-2	Great Lakes/Chemtura
Tetrabromophthalate diol	77098-07-8	Great Lakes/Chemtura
Tetrabromophthalic anhydride	632-79-1	Albermarle

3.1.3 Sealants and adhesives

The alternative substances that are thought to be generally used as replacements for SCCPs depend on the original function of SCCPs. These are summarised below.

Flame retardant function

Medium-chain chlorinated paraffins
Long-chain chlorinated paraffins

Plasticising function

Phthalate plasticisers

HELCOM (2002) and OSPAR (2001) suggest that as well as medium-chain and long-chain chlorinated paraffins, alternatives to SCCPs in sealants include phthalate esters.

BAFU (2008) indicates that SCCPs use sealants has been mainly in those based on polysulphide, polyurethane and butyl rubber but report that silicone sealants currently have the highest market share. SCCPs are not used in silicone sealants (these are based on polydimethylsiloxanes).

A possible critical use of SCCPs is in dam sealants (CPIA, 2008b). It is not clear if alternatives to SCCPs exist in this application. However, both medium-chain and long-chain chlorinated paraffins are used in sealant applications, and the amount of SCCPs used in this application has fallen in recent years. This therefore suggests that alternatives are available, at least in part, for this application.

Environment Canada (2008) indicates that technical barriers may exist for some potential (non-chlorinated paraffin) alternatives in that they may be more prone to bleeding from the sealant and hence may affect the durability of the sealant.

From the available information on the use of phthalates in sealants, it is not possible to determine which phthalates can be used in those sealants in which SCCPs are or have been used. Information is included in Section 3.2.1.3 on three of the most commonly used phthalates, having relatively low vapour pressures and therefore potentially less prone to loss from the sealant. These substances also have information readily available from published assessments. This does not preclude the possible use of other substances.

3.1.4 Paints and coatings

Possible alternatives for SCCPs in paints and coatings include the following.

Medium-chain chlorinated paraffins
Long-chain chlorinated paraffins

HELCOM (2002) and OSPAR (2001) suggest that as well as medium-chain and long-chain chlorinated paraffins, alternatives to SCCPs in paints and coatings could include phthalate esters, polyacrylate esters, diisobutyrate as well as phosphate and boron-containing compounds (the latter presumably where flame-retardancy of the final paint is important). The technical and economic feasibility of some of these suggested alternatives is unclear.

3.2 *Information on alternatives*

3.2.1 Human health and environmental effects

3.2.1.1 Alternatives for use in rubber

Human health effects

Medium Chain Chlorinated Paraffins

14-day studies were conducted by the Working Party of the Chlorinated Paraffin Manufacturers Toxicology Testing Consortium where F344 rats were administered a medium chain chlorinated paraffin (MCCP) (C_{14-17}, 52% Cl) in the diet. The no-observed-effect-level (NOEL) was 500 ppm or 30 mg/kg bw day, based on increases in liver weight and diffuse hepatocellular hypertrophy (Serrone *et al.* 1987).

A NOEL of 10 mg/(kg bw day) (more appropriately a NOAEL since an increase in liver weight was observed at this dose) was reported in F344 rats following administration of a MCCP (C_{14-17}, 52% Cl) by gavage in corn oil or in the diet for 90 days (Serrone *et al.*, 1987). There were increases in liver and kidney weights, increases in the incidence of hepatocellular hypertrophy, increases in thyroid-parathyroid weights, and hypertrophy and hyperplasia of the thyroid. There were also high incidences of trace-to-mild chronic nephritis in the kidneys of male rats and increased pigmentation of the renal tubules in female rats.

In another 90-day study, a MCCP (C_{14-17}, 52% Cl) was administered in the diet, where dose-related proliferation of the smooth endoplasmic reticulum in the hepatic cells of rats at 500 ppm and above {NOEL = 250 ppm [12.5 mg/(kg bw day)], LOEL = 500 ppm [25 mg/(kg bw day)] } was reported (Birtley *et al.* 1980). In beagle dogs exposed to the same compound in the diet, exposure-related effects were confined principally to male dogs receiving 100 mg/(kg bw day). The effects were significant increases in serum alkaline phosphatase activity and liver weight-to-body-weight ratios. Electron microscopy also revealed an increase in the smooth endoplasmic reticulum of hepatocytes in all exposed animals [(NOEL = 10 mg/(kg bw day), LOEL = 30 mg/(kg bw day)].

Available limited data on the genotoxicity of MCCPs indicate that they are not mutagenic in bacterial assays *in vitro* with or without metabolic activation (Birtley *et al.*, 1980). They were also negative in *in vitro* assays of cell transformation (Birtley *et al.*, 1980) and in the only identified *in vivo* study (the complete report of which was not available for this assessment). Oral administration of a MCCP did not increase the frequency of chromosomal aberrations in bone marrow cells in rats (Serrone *et al.*, 1987).

One reproductive study has been identified in which rats were exposed to a MCCP (C_{14-17}, 52% Cl) (IRDC, 1985; Serrone *et al.*, 1987). There were no dose-related differences in appearance, fertility, body weight gain, food consumption, or reproductive performance in the parental generation. However, there were adverse effects on body weight and condition, and possibly haematological parameters in the pups at all doses (100 to 6,250 ppm) [LOEL = 100 ppm or 5.7 mg/(kg bw day) for the males and 7.2 mg/(kg bw day) for the females]. Observations in pups included bruised areas, decreased activity, laboured breathing, pale discolouration, and/or blood around the orifices. Pup survival was also decreased at doses > 1,000 ppm in the diet. Observations at necropsy in pups that died during the study included pale liver, kidneys, and lungs, and blood in the cranial cavity, brain, stomach, and intestines. The authors suggested that these effects were more likely attributable to lactational rather than *in utero* exposure and added that, based on preliminary results from a cross-fostering study, mortality in pups exposed via milk was greater than that in pups exposed only *in utero* (Serrone *et al.*, 1987).

In a series of developmental studies conducted for the Chlorinated Paraffins Manufacturers Toxicology Testing Consortium, the number and location of viable and nonviable foetuses, early and late resorptions, the number of total implantations and corpora lutea, and the incidence of foetal malformations were examined following administration of a MCCP (C_{14-17}, 52% Cl) by gavage in corn oil to pregnant Charles River rats on days 6 to 19 of gestation and pregnant Dutch Belted rabbits on days 6 to 27 of gestation. Teratogenic effects were not observed and embryo- or foeto-toxic effects were observed only at doses greater than those that were toxic to the mothers [lowest NOAEL in mothers was 30 mg/(kg bw day) in rabbits and in offspring, 100 mg/(kg bw day) in rabbits] (IRDC, 1983a; 1984a).

Data were not identified on the neurotoxicity or immunotoxicity of MCCPs.

Table 9 Summary of human health effects of MCCPs

Name of substance	Medium Chain Chlorinated Paraffins	
Abbreviation	MCCPs	
CAS No.	85535-84-9	
Endpoint	Value	Reference
NOAEL mg/kg bw	No data	
LD50	No data	
Reproductive toxicity Adverse effects on pup body weight and condition in rats (LOEL) Foetal toxicity in rabbits NOEL	 5 mg/kg/day 100 mg/kg/day	 Serrone *et al.*, 1987 IRDC, 1983b; 1984a
Repeated dose Toxicity, NOAEL Effects on liver and kidney in rats	10 mg/kg/day	Serrone *et al.*, 1987; Birtley *et al.* 1980
Genotoxicity	Negative	Serrone *et al.*, 1987; Birtley *et al.* 1980
Carcinogenicity	No information	
Critical endpoint	Effects on newborn in rats	Dose 5 mg/kg/day - LOEL
Preliminary DNEL	DNEL for critical endpoint	Remarks
Workers, oral	1.4 mg/day	Default assessment factors plus x5 for LOEL rather than NOEL
General population, oral	0.7 mg/day	
Workers, inhalation	0.14 mgm^{-3}	
General population, inhalation	0.35 mgm^{-3}	

Long Chain Chlorinated Paraffins

Following administration of a long chain chlorinated paraffin (LCCP) (C_{23}, 40% Cl) by gavage in corn oil for 16 days, no compound-related clinical signs or gross pathological effects were observed in F344 rats or B6C3F1 mice. The NOELs were considered to be the highest doses [3,750 mg/(kg bw day) for the rats and 7,500 mg/(kg bw day) for the mice (NTP, 1986b; Bucher *et al.*, 1987)].

In 14-day studies in F344 rats conducted by the Working Party of the Chlorinated Paraffin Manufacturers Toxicology Testing Consortium, the NOELs were considered to be 3,000 mg/(kg bw day) for a LCCP (C_{20-30}, 43% C1) administered by gavage in corn oil and 15,000 ppm [1,715 mg/(kg bw day)] for another LCCP (C_{22-26}, 70% Cl) administered in the diet, respectively. This was based on a lack of observed compound-related effects on clinical signs or organ weights or in the tissues examined microscopically (IRDC, 1981a; 1981b; Serrone *et al.*, 1987).

Based on the results of a well documented, 13-week study, a NOEL for a LCCP (C_{23}, 43% Cl) administered to mice by gavage was reported to be 7,500 mg/(kg bw day), based on no effects noted at any dose (Bucher *et al.*, 1987; NTP, 1986b). In rats, the same LCCP caused a dose-related granulomatous inflammation of the liver in all exposed females [LOEL = 235 mg/(kg bw day)]. Serrone *et al.* (1987) reported similar hepatic lesions in female rats following administration by gavage of another LCCP (C_{20-30}, 43% Cl). In addition, mild nephrosis was observed in the kidneys of male rats as was mineralization in the kidneys of female rats administered 3,750 mg/(kg bw day). [The authors considered the NOEL to be 3,750 mg/(kg bw day) for males, though this is more appropriately a NOAEL, based on observed effects in the kidneys.] A NOEL could not be established for the females [LOEL = 100 mg/(kg bw day)]. In similar studies in which a LCCP (C_{22-26}, 70% Cl) was administered in the diet, hepatocellular hypertrophy and cytoplasmic fat vacuolation in the liver and increases in serum hepatic enzymes of both sexes were observed at 3,750 mg/(kg bw day) [NOEL was 900 mg/(kg bw day)].

In the study conducted by the National Toxicology Program (NTP, 1986b; Bucher *et al.*, 1987), the carcinogenic response following exposure to the LCCP (C_{23}, 43% Cl), administered to rats and mice under identical conditions to those of the SCCP, was not as clear as that for the SCCP; however, there were some increases in tumour incidence in both species. Doses administered were 0, 1,875, or 3,750 mg/(kg bw day) to male rats; 0, 100, 300, or 900 mg/(kg bw day) to female rats; and 0, 2,500, or 5,000 mg/(kg bw day) to male and female mice. There were no significant differences in survival and clinical signs of toxicity between exposed and control groups in both sexes and species. Mean body weights of rats were similar in exposed and control animals but both male and female mice in the low-dose group gained less weight than those in the control or high-dose groups. There was a statistically significant increase in the incidence of malignant lymphomas in male mice, a marginal (not statistically significant) increase of hepatocellular carcinomas in female mice, and adenomas or carcinomas (in both males and females). There was a positive trend for increased incidence of phaeochromocytomas of the adrenal medulla with increased dose in female rats.

The primary non-neoplastic lesion related to administration of this LCCP included a diffuse lymphohistiocytic inflammation in the liver and in the pancreatic and mesenteric lymph nodes of male and female rats. Splenic congestion was a secondary effect. These lesions occurred earlier in female rats and at lower doses than in male rats [LOAEL = 100 mg/(kg bw day)]. No significant non-neoplastic lesions were attributed to exposure in mice; however, for female mice, 60 to 70% of the early deaths in each group were attributed to utero-ovarian infection and this may have decreased the sensitivity of the study to detect a carcinogenic effect. Under the conditions of these two-year gavage studies, the NTP concluded that there was no evidence of carcinogenicity for male F344/N rats, equivocal evidence of carcinogenicity for female F344/N rats and female B6C3F1 mice, and clear evidence of carcinogenicity for male B6C3F1 mice. Members of the NTP Peer Review Panel commented that, although the high viscosity of the vehicle may have prevented administration of maximum tolerated doses (as indicated by the lack of observed effects on survival or body weight gain), the linear increase in liver weight and increases in serum enzyme levels in concurrent six-month and one-year studies in rats indicated achievement of a biologically effective dose.

Available limited data on the genotoxicity of long chain CPs indicate that these compounds are not mutagenic in bacterial assays *in vitro* with or without metabolic activation (Birtley *et al.*, 1980; NTP, 1986b). They have been negative in an *in vitro* assay of cell transformation (ICI, 1982) and, in the only identified *in vivo* study, the complete report of which was not available for this assessment; oral administration of the long chain CPs did not increase the frequency of chromosomal aberrations in bone marrow cells in rats (Serrone *et al.,* 1987).

In a series of developmental studies conducted for the Chlorinated Paraffins Manufacturers Toxicology Testing Consortium, the number and location of viable and nonviable foetuses, early and late resorptions, the number of total implantations and corpora lutea, and the incidence of foetal malformations were examined following administration of one LCCP (C_{20-30}, 43% Cl) by gavage in corn oil and another (C_{22-26}, 70% Cl) in 1% carboxymethyl cellulose to pregnant Charles River rats on days 6 to 19 of gestation and pregnant Dutch Belted rabbits on days 6 to 27 of gestation. Teratogenic effects were not observed and embryo- or foeto-toxic effects were observed only at doses greater than those that were toxic to the mothers [lowest LOEL in mothers = 100 mg/(kg bw day) in rabbits exposed to the C_{22-26}, 70% Cl CP; lowest NOEL in offspring = 1,000 mg/(kg bw day) in rabbits exposed to the C_{22-26}, 70% C1 CP] (IRDC, 1983b,c; 1984c).

Data have not been identified on the neurotoxicity and immunotoxicity of the long chain chlorinated paraffins.

Table 10 Summary of human health effects of LCCPs

Name of substance	Long Chain Chlorinated Paraffins	
Abbreviation	LCCPs	
CAS No.	85535-86-0	
Endpoint	Value	Reference
LD50	No information	
NOAEL mg/kg bw	No information	
Reproductive toxicity Foetal toxicity observed at dose causing maternal toxicity LOAEL in rabbits	100 mg/kg/day	IRDC, 1983c; 1981d; 1983d; 1982
Repeated dose Toxicity Granulomatous inflammation of the liver in female rats LOEAL NOAEL in mice	275 mg/kg/day 7500 mg/kg/day	NTP, 1986b; Bucher *et al*., 1987
Genotoxicity	Negative	Birtley *et al*., 1980; NTP, 1986b; ICI, 1982; Serrone et al., 1987
Carcinogenicity LOEL – benign lesions in the spleen - rats	Carcinogenic in animals 100 mg/kg/day	NTP, 1986b; Bucher *et al*., 1987
Critical endpoint	Possible carcinogenicity and reproductive effects	Dose - 100 mg/kg/day - rats
Preliminary DNEL	DNEL for critical endpoint	Remarks
Workers, oral	28 mg/day	Default assessment factors plus ×10 for LOEL rather than NOEL (to take account of severity of endpoint)
General population, oral	14 mg/day	
Workers, inhalation	2.8 mgm^{-3}	
General population, inhalation	0.7 mgm^{-3}	

Cresyl diphenyl phosphate (CDP)

The following information is provided in the SIDS initial assessment profile (OECD, 1997).

Acute toxicity
Oral/Rat: LD$_{50}$: 6,400 mg/kg
Inhalation/Sheep: LC$_{50}$: >0.37 mg/l/1h
Dermal/Rabbit: LD$_{50}$: >5,000 mg/kg

Repeated dose toxicity
In an OECD Combined Repeated Dose and Reproductive/Developmental Screening Toxicity Test in rats, salivation, reduced body weight gain and increased water intake were observed in both sexes, and increased food consumption was observed in male rats at 300 mg/kg/day. This was combined with enlargement and cortical vacuolation of the adrenals, enlargement of the liver and fatty change of the proximal tubular epithelium were found in both sexes. In addition, reduction of fatty change of the

hepatocytes, increase in hyaline droplets and basophilic changes in the proximal tubular epithelium, erosion or focal necrosis in mucosa of stomach and atrophy of seminiferous tubular were found in male rats, and clear cell change of hepatocytes, atrophy of thymus, hypertrophy and hyperplasia of the interstitial cells in the ovaries were found in female rats. Anaemia and an increase of leukocytes were also observed in male rats at 300mg/kg together with an increase in total cholesterol and decreases in GOT, albumin, A/G ratio, cholinesterase activity and triglycerides. In urinalysis, decreases in pH and specific gravity, an increase of urine volume were found at 300 mg/kg in male rats. At 60 mg/kg/day, reduced body weight gain was observed in females and enlargement and cortical vacuolation of the adrenals were found in both sexes. In addition, an increase of total cholesterol, a decrease of cholinesterase activity, and enlargement of the liver were found in male rats, and histopathological changes in the liver, kidneys and the thymus were found in female rats. The NOELwas identified as12 mg/kg/day.

Reproduction/developmental toxicity
In an OECD Combined Repeated Dose and Reproductive/Developmental Screening Toxicity Test in rats, reduced fertility and implantation rates were observed at 300 mg/kg/day. These were probably caused by dysspermatogenesis. A birth index tended to low. There were no effects on the reproductive or developmental parameters of copulation, pregnancy, parturition or lactation. In an observation of neonates, no effects were found on the values for live pups, mean pup weights, sex ratio, abnormal pups or loss of offspring.

These results indicate that the no effect levels for reproduction or development are 60 mg/kg for sires, and 300 mg/kg for dams and offsprings.
NOEL for P generation: 60 mg/kg
NOEL for F1 generation: 300 mg/kg
NOEL for F2 generation: not applicable

Genetic toxicity
Bacterial test: Negative results in *S. Typhimurium* TA100, TA1535, TA98, TA1537 and *E. coli* WP2 uvrA with and without metabolic activation (Japanese TG).
Chromosomal Aberration in vitro: Marginal positive result in Chinese hamster liver (CHL) cells with metabolic activation (Japanese TG).
Micronucleus Test: Negative result (Japanese TG).

Table 11 Summary of human health effects of cresyl diphenyl phosphate

Name of substance	Cresyl diphenyl phosphate	
Abbreviation		
CAS No.	26444-49-5	
Endpoint	Value	Reference
LD50	6400 mg/kg (rat, oral)	OECD, 1997
NOAEL mg/kg bw	No information	
Reproductive toxicity	Reduced fertility at 300 mg/kg/day, NOEL 60 mg/kg/day	OECD, 1997
Developmental toxicity	None (NOEL 300 mg/kg/day)	OECD, 1997
Repeated dose Toxicity, NOEL rat	12 mg/kg/day	OECD, 1997
Genotoxicity	Negative	OECD, 1997
Carcinogenicity	No information	
Critical endpoint	Toxicity to liver, kidney and blood	Dose (NOEL) 12 mg/kg/day
Preliminary DNEL	DNEL for critical endpoint	Remarks
Workers, oral	8.4 mg/day	Default assessment factors Based on NOEL in repeated dose experiments
General population, oral	4.2 mg/day	
Workers, inhalation	0.84 mgm^{-3}	
General population, inhalation	0.21 mgm^{-3}	

<u>tertButylphenyl diphenyl phosphate (TBPDPP)</u>

The following information is summarised in the EPA HPV summary (US EPA, 2004).

Acute toxicity
In rats given a single 5,000 mg/kg oral gavage dose of butylated triphenyl phosphate and observed daily for 14 days, there was no mortality. Signs of toxicity included depression, diarrhoea, and stains on the fur and around the nose. The animals' behaviour and appearance returned to normal by day 6. No gross abnormalities were observed at necropsy.

Chronic toxicity
In rats exposed to tertButylphenyl diphenyl phosphate in their diet for three months at doses of 100, 400, or 1,600 ppm, there were no treatment related effects on body weights, food consumption, hematology, clinical chemistry, or on cholinesterase values. There were no gross or microscopic lesions or anomalies. There was a significant increase in the absolute and relative mean weights of livers in the high dose male rats, the mean relative liver weights of the high dose female animals, the mean kidney weights of the high dose male rats, and the mean absolute weights of the adrenal glands from the high dose female rats. While increases in specific absolute and/or relative organ weights in some animals, there was no corresponding increase in

histopathological changes in these organs. No treatment-related alterations were seen in any of the treated animals. Since increased organ weights were observed in certain male and female rats that received the high dose, the NOEL in this study is 400 ppm. Based on typical food intakes, this equates to a dose of 1.6 mg/kg/day.

Genotoxicity

Five tester strains of Salmonella typhimurium, TA-1535, TA-1537, TA-1538, TA-98, and TA-100, were exposed to tertButylphenyl diphenyl phosphate in the presence and absence of a metabolic activating system. The positive control chemicals significantly increased the number of revertants per plate, confirming that the assay was sensitive to, and responsive to, mutagenic chemicals. TertButylphenyl diphenyl phosphate did not increase the number of revertants per plate and thus did not cause mutation in the test system, either in the presence or absence of a metabolic activating system.

tertButylphenyl diphenyl phosphate was evaluated for gene mutation in mouse lymphoma L5178Y cells in the presence and absence of an induced rat liver metabolic activating system. The doses used in this test were 0.975, 15.6, 3 1.3,62.5, and 125 m/ml. tertButylphenyl diphenyl phosphate did not induce gene mutations in mouse lymphoma L5 178Y cells, either in the presence or absence of a metabolic activating system.

tertButylphenyl diphenyl phosphate was evaluated for the ability to cause chromosomal aberrations and/or sister chromatid exchanges in the mouse lymphoma cytogenetic assay, in the presence and absence of an induced rat liver metabolic activating system. The doses used in this assay were 0.625, 1.25, 2.50, 5.0, 10.0, and 20 nl/ml. tertButylphenyl diphenyl phosphate did not induce chromosomal aberrations or sister chromatid exchanges in this assay.

Reproductive toxicity

Twelve male and 12 female rats received tertbutylphenyl diphenyl phosphate by oral gavage daily for 2 weeks prior to mating, during the 2 week mating period, and through gestation and lactation. Doses administered were 0, 50,250, or 1000 mg/kg/day. The daily administration of tertButylphenyl diphenyl phosphate to male and female rats did not result in clinical signs in toxicity, or in changes in food consumption, body weights, body weight gain, or in organ weights. There were no treatment- related histological changes in the reproductive organs. Further, there were no significant differences in litter size or the number of live pups on postnatal days 0 and 4. The NOAEL for reproductive toxicity is 1,000 mg/kg/day.

Groups of 30 pregnant rats received 0, 100,400, or 1,000 mg/kg/day of tertButylphenyl diphenyl phosphate by oral gavage from gestation day 6 through gestation day 20. The dams expressed minimal clinical signs during treatment. In general, mean body weights of the treated rats were not significantly different from those of the control group. Five animals in the high dose group showed significantly reduced body weights between gestation days 6 - 16. The terminal body weights for these animals were not significantly different from control values. Food consumption was significantly reduced in the high dose animals. No treatment-related gross lesions were observed at necropsy. A significant increase in liver weights was observed in all treatment groups, showing a dose-response. This increase was considered an adaptive effect, rather than a toxic response to the chemical. Uterine weights were unaffected.

There were no treatment-related effects on the number of corpora lutea, implants, resorption sites, or live foetuses per dam. Mean foetal weight for the high dose litters was significantly reduced by eight percent, a reduction most probably due to and secondary to maternal toxicity. There was no effect on litter size or foetal weights for the mid and low dose groups. There were no significant increases in external, soft tissue, or skeletal anomalies in any treatment group.

Table 12 Summary of human health effects of *tert*butylphenyl diphenyl phosphate

Name of substance	*tert*Butylphenyl diphenyl phosphate	
Abbreviation		
CAS No.	56803-37-3 and 68937-40-6	
Endpoint	Value	Reference
LD50	>5000mg/kg	US EPA (2004)
NOAEL		US EPA (2004)
Reproductive toxicity – no effects on fertility	NOAEL (rat) 1000mg/kg/day	US EPA (2004)
Developmental toxicity – reduced foetal weight as a result of maternal toxicity	NOAEL (rat) 400 mg/kg/day	
Repeated dose Toxicity, NOEL rat	1.6 mg/kg/day	US EPA (2004)
Genotoxicity	Negative	US EPA (2004)
Carcinogenicity	No information	
Critical endpoint	Possible liver, kidney, adrenal toxicity	Dose: 1.6 mg/kg/day
Preliminary DNEL	DNEL for critical endpoint	Remarks
Workers, oral	1.12 mg/day	Default assessment factors Based on NOEL in repeated dose experiments
General population, oral	0.56 mg/day	
Workers, inhalation	0.112 mgm^{-3}	
General population, inhalation	0.028 $mgm-^{3}$	

Isopropylphenyl diphenyl phosphate (IPPDPP)

Test data from the IUCLID data sheet (IUCLID, 2000) suggests that the substance is non-irritating and is not a sensitiser.

Acute toxicity
No mortality was observed in rats given one oral dose of 5,000mg/kg and observed for 14 days. Significant clinical signs included tremors, oral discharge, ataxia, decreases locomotion, chromorhinorrhea, chromodacryorrhea and abdominogenital staining. Animals returned to normal by day 11.

Hamsters given one dose orally of 5,000mg/kg were observed for 14 days for signs of toxicity. No mortalities were observed.

Genotoxicity

In an Ames test with Salmonella strains TA98, TA100 and TA1537, concentrations of 2, 6, 18, 54 and 162 µg/0.1mL DMSO produced no back mutations.

In a DNA damage and repair assay, rat hepatocytes were exposed to concentrations of 0.6, 3, 15 and 75 nl/mL in DMSO. Isopropylphenyl diphenyl phosphate did not cause unscheduled DNA repair.

In a mammalian cell gene mutation assay with Balb/c-3T3 cells, concentrations of 0.04, 0.2, 1 and 5 µg/mL did not induce cell transformations.

In a mouse lymphoma assay, L5178Y TK+/- cells were exposed to 0.0013 – 0.1 µL/mL of isopropylphenyl diphenyl phosphate. Without S-9 activation, the test was negative. With S-9 activation the results were equivocal. There was evidence of a dose response, but none of the cultures exhibiting more than 10% total growth had mutant frequencies which were two-fold greater than background.

An extensive array of tests for mutagenicity, primary DNA damage and chromosome aberrations on isopropylated triaryl phosphates were negative.

Repeated dose toxicity

There is no information about IPPDPP itself. There is limited information about the toxicity of related compounds.

In a 28 day experiment in rats with Reofos 65, reduced food consumption, body weight (females only), red and white blood cell counts and increased liver weights were observed at a dose of 1% in the diet (approximately 400 mg/kg/day based on standard food intakes). Food consumption was also reduced at 0.5% in the diet (females only).

A 28 day experiment involving dermal exposure of rats to Reolube HYD 46 gave rise to a slight inhibition in plasma cholinesterase activity in females and a decrease in testicular weight at a dose of 1,000 mg/kg/day. The NOEL was 200 mg/kg/day.

Table 13 Summary of human health effects of isopropylphenyl diphenyl phosphate

Name of substance	isopropylphenyl diphenyl phosphate	
Abbreviation	IPPDP	
CAS No.	28108-99-8	
Endpoint	Value	Reference
LD50	>5000 mg/kg	IUCLID data sheet
NOAEL mg/kg bw	No information	
Reproductive toxicity	No information	
Repeated dose Toxicity, NOEL rat – related compounds	200 mg/kg bw (dermal) 0.5% diet	IUCLID data sheet
Genotoxicity	No	IUCLID datasheet
Carcinogenicity	No information	
Critical endpoint	Low toxicity, possible effects on liver and haematology	Dose: approximate NOEL 200 mg/kg/day
Preliminary DNEL	DNEL for critical endpoint	Remarks
Workers, oral	4.7 mg/day	Default assessment factors Based on NOEL in repeated dose experiments for related substance plus a factor of 10 to allow for uncertainty in substance similarity and anticipated lower levels of absorption following dermal exposure than following inhalation or oral exposure.
General population, oral	2.3 mg/day	
Workers, inhalation	0.47 mgm^{-3}	
General population, inhalation	0.12 mgm^{-3}	

Environmental effects

Long chain chlorinated paraffins (LCCPs)

Identity and properties

CAS number	85422-92-0 ($C_{\geq18}$) and 63449-39-8 (C_{18-32})
Water solubility	5 µg/l at 20°C for all LCCPS (EA, 2008)
Vapour pressure	2.5×10^{-4} Pa at 25°C for C_{18-20} liquids (typically 40-52% wt. Cl) 2.5×10^{-5} Pa at 25°C for $C_{>20}$ liquids (typically 40-54% wt. Cl) 1.5×10^{-14} Pa at 25°C for $C_{>20}$ solids (typically 70% wt. Cl) (EA, 2008)*
Log Kow	9.7 for C_{18-20} liquids (typically 40-52% wt. Cl) 10.3 for $C_{>20}$ liquids (typically 40-54% wt. Cl) 17 for $C_{>20}$ solids (typically 70% wt. Cl) (EA, 2008)*

* Vapour pressure and log kow values given above have been selected for use in the risk assessment for the three groups of long chain chlorinated paraffins considered (EA, 2008).

Fate data

Biodegradability	Unlikely to be readily or inherently biodegradable (EA, 2008)
Bioconcentration factor	BCF 1,096 l/kg for C_{18-20} liquids BCF 192 l/kg for $C_{>20}$ liquids BCF < 1 l/kg for $C_{>20}$ solids (estimated values) (EA, 2008)

Aquatic effects

Species	**Effect**	**Value**	**Reference**
Fish (*Alburnus alburnus*)	14 d NOEC	≥125 µg/l for C_{18-26} 49% wt. Cl (no effects were seen at solubility).	EA, 2008
Fish (*Oncorhynchus mykiss*)	60 d NOEC	≥4 mg/l for C_{22-26} 43% wt. Cl ≥3.8 mg/l for $C_{>20}$ 70% wt. Cl (no effects were seen at solubility).	EA, 2008
Invertebrates (*Daphnia magna*)	21 d NOEC	29 µg/l for C_{18-20} liquid 52% wt. Cl	EA, 2008
Invertebrates (*Daphnia magna*)	21 d NOEC (reproduction)	≥55 µg/l for $C_{>20}$ liquid 43% wt. Cl (no effects were seen on reproduction).	EA, 2008

Based on the above data, the following PNECs have been derived for aquatic organisms using the long term NOECs from studies with *Daphnia magna*, and an assessment factor of 10:

C_{18-20} liquid $PNEC_{water}$ = 2.9 µg/l
$C_{>20}$ liquid $PNEC_{water, screening}$ = 5.5 µg/l
$C_{>20}$ solids $PNEC_{water, screening}$ = 5.5 µg/l

LCCPs are considered to potentially meet the persistent or very persistent criterion. They do not meet the toxic or bioaccumulative criterion. LCCPs are not listed in Annex 1 of Directive 67/548/EEC (EA, 2008).

Relative emissions: the emissions of SCCPs from industrial use in rubber are related to the vapour pressure. LCCPs have similar or much lower vapour pressures and so emissions from the same processes would be expected to be lower. Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. LCCPs have lower solubilities and lower vapour pressures (in some cases) and so emissions would be expected to be lower. LCCPs are not readily or inherently biodegradable, so are not expected to be degraded significantly in wwtps or to degrade in the environment.

LCCPs are currently used in rubber belting (EA, 2008).

Medium chain chlorinated paraffins (MCCPs)

Identity and properties

CAS number	85535-85-9 (C_{14-17})
Water solubility	0.027 mg/l for 51% wt. Cl (measured)* (EC, 2005)
Vapour pressure	2.7×10^{-4} Pa at 20°C for 45 and 52% wt. Cl* (EC, 2005)
Log Kow	5.52 - 8.21 for 45% wt. Cl 5.47 - 8.01 for 52% wt. Cl 7 (middle point of range of measured values)* (EC, 2005)

Fate data

Biodegradability	Not readily biodegradable (EC, 2005).
Bioconcentration factor	BCF 1,087 l/kg* (EC, 2005).

* Values used in the risk assessment as representative values for a commercial product (EC, 2005).

Aquatic effects

Species	**Effect**	**Value**	**Reference**
Fish (*Oncorhynchus mykiss*)	60 d NOEC	No adverse effects at 4.5 mg/l over 60 days for C_{14-17} 52% wt. Cl mixed with n-pentadecane-8-^{14}C 51% wt. Cl.	EC, 2005
Fish (*Oryzias latipes)*	20 day embryo-larval study	No adverse effects on embryos or larvae up to 1.6 and 3.4 mg/l over 20 days (two substances tested: $C_{14}H_{23.3}Cl_{6.7}$ 55% wt. Cl and $C_{14}H_{24.9}Cl_{5.1}$ 48% wt. Cl).	EC, 2005
Invertebrates (*Daphnia magna*)	21 d NOEC (reproduction)	10 µg/l for C_{14-17} 52% wt. Cl mixed with n-pentadecane-8-^{14}C 51% wt. Cl.	EC, 2005
Crustacean (*Gammarus pulex*)	96 hr LC_{50}	>1.0 mg/l for C_{14-17} 52% wt. Cl.	EC, 2005
Harpacticoid (*Nitocra spinipes*)	96 hr LC_{50}	9.0 mg/l for C_{14-17} 45% wt. Cl >10,000 mg/l for C_{14-17} 52% wt. Cl.	EC, 2005
Mussel (*Mytilus edulis*)	60 d NOEC	0.22 mg/l or C_{14-17} 52% wt. Cl mixed with n-pentadecane-8-^{14}C 51% wt. Cl.	EC, 2005
Algae (*Selenastrum capricornutum*)	96 hr NOEC (biomass) 72 hr NOEC (growth rate)	0.1 mg/l for C_{14-17} 52% wt. Cl mixed with n-pentadecane-8-^{14}C 51% wt. Cl (96 hr E_bC_{50} >3.2 mg/l) 0.049 mg/l for C_{14-17} 52% wt. Cl mixed with n-pentadecane-8-^{14}C 51% wt. Cl. (72 hr E_rC_{50} >3.2 mg/l).	EC, 2005

Long-term no observed effect concentrations (NOECs) have been reported for fish, *Daphnia*, mussels and algae. Effects have almost exclusively been observed on *Daphnia* (EC, 2005).

A PNEC of 1 µg/l has been derived for aquatic organisms by applying an assessment factor of 10 to the long-term NOEC of 10 µg/l obtained from the 21-day reproductive study with *Daphnia magna* on the basis that it is the most sensitive substance (EC, 2005).

MCCPs are classified with respect to their effects on the environment as R50-53. No PBT assessment is included in the published version of the risk assessment (EC, 2005).

Relative emissions: the emissions of SCCPs from industrial use in rubber are related to the vapour pressure. MCCPs have similar vapour pressures and so emissions from the same processes would be expected to be similar. Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. MCCPs have lower solubilities and similar vapour pressures and so overall emissions would be expected to be lower. MCCPs are not readily or inherently biodegradable, so are not expected to be degraded significantly in wwtps or to degrade in the environment.

Isopropylphenyl diphenyl phosphate (IPPDPP)

Identity and properties

CAS number	28108-99-8
Water solubility	2.2 mg/l at room temperature (ca. 20°C)* (Saeger *et al.* 1979)
Vapour pressure	1.5×10^{-4} Pa at 25°C (estimated from reduced pressure boiling point) (Boethling and Cooper, 1985)
Log Kow	5.3 (Saeger *et al.* 1979)

* This value is based on the total concentration of all components of the commercial product. The actual solubility of the isopropylphenyl diphenyl phosphate component may be lower.

Fate data

Biodegradability	Readily biodegradable (Saeger *et al.* 1979).
Bioconcentration factor	495 l/kg Muir (1984), Boethling and Cooper (1985).

Aquatic effects

Species	**Effect**	**Value**	**Reference**
Fish (*Oncorhynchus mykiss*)	96 hr LC_{50}	0.65 mg/l	Nevins and Johnson 1978
Fish (*Pimephales promelas*)	30 d NOEC (growth)	0.024 mg/l	Cleveland *et al*. 1986
Invertebrates (*Daphnia magna*)	48 hr LC_{50} (mortality and immobilisation)	0.25 mg/l	Ziegenfuss *et al.* 1986
Invertebrates (*Daphnia magna*)	21 d NOEC (reproduction)	0.006 mg/l	Sanders *et al.* 1985
Algae (species unknown)	96 hr IC_{50}	>1,000 mg/l (no effects seen when tested as a WAF)	Great Lakes Chemical Corporation 2002

The PNEC for aquatic organisms based on the above data would be 0.6 µg/l, derived by applying an assessment factor of 10 to the long-term NOEC for *Daphnia magna.*

Based on the above data, isopropylphenyl diphenyl phosphate does not meet the P or B criteria, so is not a PBT substance. Isopropylphenyl diphenyl phosphate is not included on Annex 1 of Directive 667/548/EEC.

Relative emissions: the emissions of SCCPs from industrial use in rubber are related to the vapour pressure. IPPDPP has a lower vapour pressure than most SCCPs and so emissions from the same processes would be expected to be lower. Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. IPPDPP has a higher solubility but a lower vapour pressure and so a simple comparison cannot be made. IPPDPP is readily biodegradable, and so is expected to be degraded significantly in wwtps and to degrade in the environment.

IPPDPP is used as a flame retardant in coal mine belting (personal communication, EU supplier). The belt material may be PVC rather than the chlorinated rubber in which SCCPs are used.

Tertbutylphenyl diphenyl phosphate (TBPDPP)

Identity and properties

CAS number	56803-37-3
Water solubility	3.2 mg/l at 25°C* (Saeger *et al.* 1979)
Vapour pressure	1.6×10^{-4} Pa at 20°C (value extrapolated from data obtained at elevated temperatures) (Dobry and Keller, 1957)
Log Kow	5.12 (Saeger *et al.* 1979)

* This value is based on the total concentration of all components of the commercial product. The actual solubility of the tertbutylphenyl diphenyl phosphate component may be lower.

Fate data

Biodegradability	Readily biodegradable, not meeting the 10-day window (Saeger *et al.* 1979).
Bioconcentration factor	778 l/kg (Muir *et al.* 1983).

Aquatic effects

Species	**Effect**	**Value**	**Reference**
Fish (*Ictalurus punctatus*)	96 hr LC_{50}	0.8 mg/l	Cleveland *et al.* 1986
Fish (*Pimephales promelas*)	90 d NOEC (growth) 90 d NOEC (mortality)	0.194 mg/l 0.093 mg/l	Cleveland *et al.* 1986
Invertebrate (*Chironomus tentans*)	48 hr LC_{50}	0.15 mg/l	Ziegenfuss *et al.* 1986
Invertebrate (*Daphnia magna*)	21 d NOEC (survival) 21 d NOEC (reproduction)	0.01 mg/l 0.01 mg/l	Sanders *et al.* 1985
Algae (*Selenastrum capricornutum*)	96 hr LC_{50} (biomass)	2.6 mg/l	IUCLID, 2001

The PNEC for aquatic organisms based on the above data would be 1 µg/l, derived by applying an assessment factor of 10 to the long-term NOEC for *Daphnia magna.*

Tertbutylphenyl diphenyl phosphate is not currently included on Annex I of Directive 67/548/EEC. However, some suppliers provisionally classify the substance as dangerous to the environment (N) and very toxic to aquatic organisms (R50) (IUCLID 2001). Based on the above data, tertbutylphenyl diphenyl phosphate does not meet the P or B criteria, so is not a PBT substance.

Relative emissions: the emissions of SCCPs from industrial use in rubber are related to the vapour pressure. TBPDPP has a lower vapour pressure than most SCCPs and so emissions from the same processes would be expected to be lower. Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. TBPDPP has a higher solubility but a lower vapour pressure and so a simple comparison cannot be made. TBPDPP is readily biodegradable, and so is expected to be degraded significantly in wwtps and to degrade in the environment.

TBPDPP is used as a flame retardant in coal mine belting (personal communication, EU supplier). The belt material may be PVC rather than the chlorinated rubber in which SCCPs are used.

Cresyl diphenyl phosphate (CDP)

Identity and properties

CAS number	26444-49-5
Water solubility	2.6 mg/l at room temperature (Saeger *et al.*, 1979)
Vapour pressure	6.3×10^{-5} Pa at 25°C (estimated from several values at elevated temperatures)
Log Kow	4.51 (Saeger *et al.*, 1979)

Fate data

Biodegradability	Readily biodegradable (IUCLID, 2000)
Bioconcentration factor	200 (Bengtsson *et al.*, 1983)

Aquatic effects

Species	**Effect**	**Value**	**Reference**
Fish (*Oryzias latipes*)	96 hr LC_{50}	1.3 mg/l	UNEP, 2002
Invertebrate (*Daphnia magna*)	24 hr LC_{50}	3.7 mg/l	UNEP, 2002
Invertebrate (*Daphnia magna*)	21 d NOEC (reproduction)	0.12 mg/l	UNEP, 2002
Algae	72 hr EC_{50}	0.99 mg/l	UNEP, 2002
Algae	72 hr NOEC	0.55 mg/l	UNEP, 2002

The PNEC for aquatic organisms based on the above data would be 2.4 µg/l, derived by applying an assessment factor of 50 to the *Daphnia* NOEC.

Based on the above data, the substance does not meet the P, B or T criteria. Cresyl diphenyl phosphate is not included on Annex 1 of Directive 67/548/EEC.

Relative emissions: the emissions of SCCPs from industrial use in rubber are related to the vapour pressure. CDP has a lower vapour pressure than most SCCPs and so emissions from the same processes would be expected to be lower. Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. CDP has a higher solubility but a lower vapour pressure and so a simple comparison cannot be made. CDP is readily biodegradable, and so is expected to be degraded significantly in wwtps and to degrade in the environment.

CDP is used as a flame retardant in coal mine belting (personal communication, EU supplier). The belt material may be PVC rather than the chlorinated rubber in which SCCPs are used.

3.2.1.2 Alternatives for use in textiles

Human health effects

Health effect information for MCCPs and LCCPs is included in Section 3.2.1.1.

Decabromodiphenyl ether

Studies of toxicokinetics of Decabromodiphenyl ether (decaBDE) reveal that the chemical can be absorbed by the oral route to a limited extent, does not accumulate in tissues, and undergoes clearance, largely as a result of metabolism in the liver and excretion in the bile.

Short-term and subchronic studies demonstrated low toxicity from oral exposure to decaBDE with NOAELs of 3,000 mg/kg-day or higher. NTP (1986a) conducted a chronic toxicity and carcinogenicity dietary study in F344 rats. DecaBDE caused an increase in the incidence of thrombosis in the liver in high-dose male rats (2,240 mg/kg-day). A dose-dependent, but insignificant, increase in the incidence of degeneration of the liver was also observed in treated male rats. In the spleen, a dose-dependent increase (statistically significant in the high-dose group) in the incidence of fibrosis was observed in males. In the mandibular lymph node, lymphoid hyperplasia increased in males in a dose-dependent manner, but the incidence reached statistical significance only at the high dose. Histopathology examination also revealed a dose-dependent increase in the incidence of neoplastic nodules in the liver in both male and female rats. Female rats appeared to be refractory to the systemic toxicity of decaBDE at the doses used in this study.

The observed toxicity of decaBDE in the 2-year study in rats is further supported by the 2-year mouse study conducted by NTP (1986a). Significant increases in the incidence of centrilobular hypertrophy were observed in the liver of treated male mice. In the thyroid gland, a dose-dependent and statistically significant increase (at all dose levels) in the incidence of follicular cell hyperplasia was observed in male mice. In the females, the incidence increased in the low- and high-dose groups compared with the control group, but the increase was not statistically significant at any dose level. Female mice in the high-dose group exhibited a significant increase in the incidence of stomach ulcers. In addition, there were significant increases in the combined incidence of hepatocellular adenomas or carcinomas at both low and high doses in male mice. In the thyroid gland, follicular cell adenomas or carcinomas (combined) were slightly, but not significantly, increased in treated mice of both sexes. Similar to female rats, female mice appeared to be refractory to the systemic toxicity of decaBDE.

DecaBDE also has been shown to induce behavioural changes in several studies in mice and rats (Viberg *et al.*, 2007, 2003; Rice *et al.*, 2007). In the principal study selected, Viberg et al. (2003) investigated the neurotoxic effects of decaBDE on spontaneous motor behaviour of adult NMRI male mice when these animals were exposed to a single oral dose as neonates on PND 3, 10, or 19 (i.e., at different stages of neonatal mouse brain development). Pair-wise testing between adult mice exposed on PND 3 and control groups indicated significant dose-related changes in all three spontaneous behaviour variables at 2, 4, and 6 months of age. Adult mice exposed neonatally up to 20.1 mg on either PND 10 or 19 did not show any significant differences in any of the variables. These data suggested that there was a critical window for the induction of behavioural disturbances, and the neurotoxic effect of neonatal decaBDE exposure was persistent and also worsened with age in male mice.

The appropriate hazard descriptor for decaBDE is ‘suggestive evidence of carcinogenic potential’ (U.S. EPA, 2005a, b). DecaBDE was not mutagenic or genotoxic in several in vitro studies. In the International Agency for Research and Cancer (IARC, 1990) evaluation, it was concluded there was limited evidence for the carcinogenicity of decaBDE in experimental animal and classified it as Group 3: "Not classifiable as to its carcinogenicity to humans". In the EU RAR for DecaBDE, a cautious approach was followed, and a LOAEL for carcinogenicity of 1,120 mg/kg/day was stated based on the increased incidence of liver neoplastic nodules from the lowest tested dose (1,120 mg/kg/day).

Table 14 Summary of human health effects of decabromodiphenyl ether

Name of substance	Decabromodiphenylether	
Abbreviation	DecaBDE	
CAS No.	1163-19-5	
Endpoint	Value	Reference
LD50 (rat, oral)	2000 mg/kg	RTECS
NOAEL mg/kg bw		
Reproductive toxicity Effects on neurobehavioural development	20.1 mg/kg/day	Viberg *et al.* (2007)
Repeated dose Toxicity, LOAEL in male rats	2,240 mg/kg-day	
Genotoxicity		
Carcinogenicity	LOAEL for carcinogenicity of 1,120 mg/kg/day in animals “not classifiable in humans”	RAR IARC, 1990
Critical endpoint	Effects on neurobehavioural development	Dose 20.1 mg/kg/day
Preliminary DNEL	DNEL for critical endpoint	Remarks
Workers, oral	5.6 mg/day	Default assessment factors plus x5 for LOEL rather than NOEL
General population, oral	2.8 mg/day	
Workers, inhalation	0.56 mgm^{-3}	
General population, inhalation	0.07 mgm^{-3}	

Hexabromocyclododecane (HBCDD)

The EU RAR 2008 (EC, 2008b) summarised the human health effects of HBCDD as follows:

Acute toxicity
The minimum lethal dose is greater than 20 g/kg for both dermal and oral routes of administration, and greater than 200 mg/l from inhalation for 4 hours.

Irritation
The substance is mildly irritating to the eye, but should not be classified as an eye irritant according to EU criteria. HBCDD is not irritating or corrosive to skin.

Sensitisation
Available data indicates that at least certain commercial (Japanese) brands of

HBCDD are potential skin sensitizers. However, the HBCDD available on the EU-market has been negative in both a Magnuson-Kligman test and in a Local Lymph Node assay, leading to the conclusion that there is no concern for sensitisation for the HBCDD occurring in the EU. No information is available on respiratory sensitisation.

Repeated dose toxicity

No repeated dose studies with inhalation or dermal exposure as route of administration are available. A 90-days toxicity study with oral exposure to a suspension of HBCDD particles has shown effects on the liver, the thyroid and the prostate. As from doses of 100 mg/kg/day, a dose-dependent increase in liver weight that was not accompanied by any clear pathological signs was noted, as well as effects on the thyroid hormone system. The liver weight increase was slowly reversible upon cessation of exposure. All other repeated dose studies on HBCDD have also shown the liver to be the target organ. In addition, the prostate weight was statistically increased at exposure to 1,000 mg/kg/day. A LOAEL of 100 mg/kg/day is deduced for repeated dose toxicity based on liver weight increases (18-24 %). In addition, a disturbed thyroid hormone system (T4↓ and TSH↑) was observed after 90 days oral exposure to HBCDD, potentially being secondary to the liver effect. The use of a suspension of HBCDD particles in most toxicity studies has likely led to a low absorption rate. Therefore, based on an assumed conservative oral absorption of 10-20% for this suspension, the study LOAEL of 100 mg/kg/day is transformed into a corrected LOAEL of 10-20 mg/kg/day. A 2-generation reproductive toxicity study has also shown the liver and thyroid system to be target organs. However, also in this study HBCDD particles were administered to the rats, although this time mixed into ground food. Because of dosing HBCDD-particles, with the absorption kinetics likely being dependent on particle size and amount of particles administered, the actual doses received at the top doses are uncertain. The mid dose (<101-141 mg/kg/day) can thus be considered a LOAEL for effects on the liver, but considering the big dose spacing, the low dose (10-14 mg/kg/day) is a very conservative NOAEL. For effects on the thyroid system, the mid dose (<101-141 mg/kg/day) is a clear effect level, with decreased thyroid follicle size and increased serum TSH. The most recent 28 days study is performed using a benchmark model design and oral administration of dissolved HBCDD. The study mainly shows effects on the liver, the thyroid, and the pituitary, with a NOAEL/BMD-L of 22.9 mg/kg/day for liver weight increase.

Mutagenicity

The preponderance of evidence from available studies indicates that HBCDD lacks significant genotoxic potential in vitro and in vivo.

Carcinogenicity

Based on the only available lifetime bioassay, it is not possible to assess the carcinogenic potential of HBCDD.

Reproductive toxicity

Fertility

A NOEAL of 10 mg/kg/day has been deduced in a two generation reproductive toxicity study in rats (EPA, 2008). The NOAEL is based on a dose-dependent decrease in fertility index observed in both generations (8-14 % in the mid and high dose groups) (with a statistically significant trend in F0). A reduced number of primordial follicles in the mid and high dose groups was also evident (30 %, only measured in F1). In addition, a high and dose-dependent pup mortality during lactation was observed in the F2 generation (increased by 35 % in the high dose group and 15 % in the mid dose group), although only being statistically significant in the high dose group.

Developmental toxicity
Two ordinary developmental toxicity studies have failed to demonstrate any foetotoxicity, teratogenic potential, or adverse effects from HBCDD on development postpartum. However, increased pup mortality during lactation was observed in a 2-generation study, with a NOAEL of 10 mg/kg/day. A study on developmental neurotoxicity in adult mice exposed to HBCDD as pups at day 10 postpartum was recently conducted. It indicated that HBCDD may cause statistically significant changes in spontaneous behaviour, learning and memory defects. An indicative LOAEL of 0.9 mg/kg/day can be deduced from this latter study.

Table 15 Summary of human health effects of hexabromocyclododecane

Name of substance	Hexabromocyclododecane	
Abbreviation	HBCDD	
CAS No.	3194-55-6/25637-99-4	
Endpoint	Value	Reference
LD50	>20000mg/kg (oral)	EC 2008b
NOAEL mg/kg bw	500-700 mg/kg bw	EC 2008b
Reproductive toxicity , LOAEL	0.9 mg/kg/day	EC 2008b
Repeated dose Toxicity, NOAEL	22.9 mg/kg bw/day	EC 2008b
Genotoxicity	Negative	EC 2008b
Carcinogenicity	Insufficient data	EC 2008b
Critical endpoint	Developmental	LOAEL 0.9 mg/kg/day
Preliminary DNEL	DNEL for critical endpoint	Remarks
Workers, oral	0.25 mg/day	Default assessment factors, ×5 for LOAEL rather than NOAEL
General population, oral	0.13 mg/day	
Workers, inhalation	0.025 mgm^{-3}	
General population, inhalation	0.0063 mgm^{-3}	

Ethane, 1,2-bis(pentabromophenyl) (EBP)

Ethane, 1,2-bis(pentabromophenyl) (EBP; CAS no. 84852-53-9) dose levels of 0, 100, 320 and 1000 mg/kg/day administered to rats by gavage in corn oil for 90 consecutive days produced no compound-related clinical signs of systemic toxicity, ocular lesions, or alterations in urinalysis, clinical chemistry, and haematology values in the treated or recovery groups. No biologically or toxicologically significant differences were observed in body weights, body weight gains, and food consumption. Statistically significant differences were found between control and high-dose animals in mean absolute or relative liver weights. Histomorphological evaluation showed in male rats low-grade liver changes consisting of minimal to slight hepatocellular vacuolation (high-dose males) and minimal to slight centrilobular hepatocytomegaly (high- and possibly mid-dose males). These changes had resolved by the end of the 28-day recovery period. No treatment-related changes were found in the livers of female rats. No treatment-related histomorphologic changes were present in any of the other tissues examined in either sex, except for evidence of aspirated test article in individual rats. The 90-day EBP NOAEL in the rat was ≥1,000 mg/kg/day, and was consistent with that of the preceding 28-day study (no-effect level ≥1250 mg/kg/day). EBP's lack of toxicity is likely related to poor bioavailability due to its high molecular weight and low solubility (Hardy, 2002).

Table 16 Summary of human health effects of ethane, 1,2-bis(pentabromophenyl)

Name of substance	Ethane, 1,2-bis(pentabromophenyl)	
Abbreviation	DecaBDEthane	
CAS No.	8452-53-9	
Endpoint	Value	Reference
LD50	No information	
NOAEL mg/kg bw	No information	
Reproductive toxicity	No information	
Repeated dose Toxicity, NOAEL rat	≥1000 mg/kg bw	Hardy, 2002
Genotoxicity	No information	
Carcinogenicity	No information	
Critical endpoint	Not known	
Preliminary DNEL	DNEL for critical endpoint	Remarks
Workers, oral	700 mg/day	Default assessment factors Based on NOEL in repeated dose experiments
General population, oral	350 mg/day	
Workers, inhalation	70 mgm^{-3}	
General population, inhalation	17.5 mgm^{-3}	

Environmental effects

MCCPs

Data on the environmental effects of MCCPS are included in Section 3.2.1.1.

According to EC (2005) there was no use of medium-chain chlorinated paraffins in textiles in the EU at that time; however the report did identify that some of the medium-chain chlorinated paraffins supplied to the PVC industry was used for coating applications, including textiles. A limitation on the use of MCCPs in this area may be that the maximum chlorine content achievable is lower than for SCCPs and LCCPs.

Relative emissions from textiles: the emission estimates for SCCPs from use in textiles are based on a fixed percentage estimate of release. Hence as an initial estimate a similar level of release could be assumed (providing the level of use in the textile is the same). Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. MCCPs have lower solubilities and similar vapour pressures and so overall emissions would be expected to be lower. MCCPs are not readily or inherently biodegradable, so are not expected to be degraded significantly in wwtps or to degrade in the environment.

LCCPs

Data on the environmental effects of LCCPs are included in Section 3.2.1.1.

Relative emissions: the emission estimates for SCCPs from use in textiles are based on a fixed percentage estimate of release. Hence as an initial estimate a similar level of release could be assumed (providing the level of use in the textile is the same). Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. LCCPs have lower solubilities and lower vapour pressures (in some cases) and so emissions would be expected to be lower. LCCPs are not readily or inherently biodegradable, so are not expected to be degraded significantly in wwtps or to degrade in the environment.

LCCPs are currently used in flame retardant textile coatings (EA, 2008).

Decabromodiphenylether

Identity and properties

CAS number	1163-19-5
Water solubility	<0.1 µg/l at 25°C (EC, 2002)
Vapour pressure	4.63×10^{-6} Pa at 21°C (EC, 2002)
Log Kow	6.27 (measured value) (EC, 2002))

Fate data

Biodegradability	Not readily biodegradable (EC, 2002).
Bioconcentration factor	Appears to have a low bioaccumulation potential, although there is a lack of consistent evidence (EC, 2002).

Aquatic effects

Species	**Effect**	**Value**	**Reference**
Fish (*Oryzias latipes*)	48 hr LC_{50}	>500 mg/l (well in excess of substance's solubility).	EC, 2002
Fish (*Oncorhynchus mykiss*)	120 day feeding experiment (dose of 7.5-10 mg/kg bw/day)	Increased liver weights and lactate levels in blood after 120 days. Significance of these effects unknown.	EC, 2002
Invertebrates (*Daphnia magna*)	21 d NOEC	No information for deca-. Study carried out for octa-. No effects on survival, growth or reproduction up to 2 µg/l.	EC, 2002
Algae (*Skeletonema costatum and Thalassiosira pseudonona*) *Chlorella* sp.	72 hr E_rC_{50} 96 hr E_rC_{50}	At the highest concentration tested (1mg/l), growth reduced by <50%. Not clear if any toxic effects were seen. EC_{50} cannot be determined.	EC, 2002

It is not possible to derive a true PNEC for the aquatic compartment as no effects are expected at concentrations up to the water solubility of decabromodiphenylether.

A tentative PNEC of >1 µg/l can be estimated based on an EC_{50} >1 mg/l from the algal studies, using an assessment factor of 1,000. Alternatively, a tentative PNEC of >0.2 µg/l can be derived based on the 21 d NOEC for *Daphnia magna* with octabromo-diphenylether (no effects were seen up to the solubility limit of 2 µg/l). This approach assumes that deca- has a similar toxicity to octa- in long-term tests (EC, 2002).

Decabromodiphenylether is persistent. No significant toxicity has been observed. A conclusion on bioaccumulation cannot be drawn based on the current evidence (EC, 2002). This substance is not currently classified for environmental or health effects.

Relative emissions: the emission estimates for SCCPs from use in textiles are based on a fixed percentage estimate of release. Hence as an initial estimate a similar level of release could be assumed (providing the level of use in the textile is the same). Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. Decabromodiphenylether has a lower solubility and a lower vapour pressure and so emissions would be expected to be lower. Decabromodiphenylether is not readily or inherently biodegradable so is not expected to be degraded significantly in wwtps or to degrade in the environment.

Decabromodiphenylether is used in flame retarded textile coatings (EC, 2002).

Hexabromocyclododecane (HBCDD)

Identity and properties*

CAS number	25637-99-4* (3195-55-6 also used)
Water solubility	**66 µg/l at 20°C** (sum of α-, β- and γ-HBCDD) (EC, 2008b) 48.8 µg/l α-HBCDD 14.7 µg/l β-HBCDD 2.10 µg/l γ-HBCDD
Vapour pressure	6.3×10^{-5} Pa at 21°C (EC, 2008b)
Log Kow	**5.62** (technical product) (EC, 2008b) 5.07 ± 0.09 α-HBCDD 5.12 ± 0.09 β-HBCDD 5.47 ± 0.10 γ-HBCDD

*HBCDD is a mixture of mainly three diastereomers termed α- β- and γ-HBCDD. The final distribution of the diastereomers in technical HBCDD is about 70-95 % γ-HBCDD, 5-30 % α- and β-HBCDD.

Fate data

Biodegradability	Not readily biodegradable (EC, 2008b)
Bioconcentration factor	18,100 l/kg (EC, 2008b)

Aquatic effects

Species	Effect	Value	Reference
Fish (*Oncorhynchus mykiss*)	96 hr LC_{50}	6.8 µg/l (no mortalities or other effects were observed throughout the test)	EC, 2008b
Fish (*Oncorhynchus mykiss*)	NOEC (early life stage toxicity test)	≥3.7 µg/l (for larvae, fry survival and growth)	EC, 2008b
Invertebrates (*Daphnia magna*)	48 hr EC_{50}	>3.2 µg/l	EC, 2008b
Invertebrates (*Daphnia magna*)	21 d NOEC 21 d LOEC	3.1 µg/l (no effects seen on survival, reproduction or growth) 5.6 µg/l (reduced length)	EC, 2008b
Algae (*Selenastrum capricornutum*)	72 hr EC_{50}	>2.5 µg/l (no effects seen)	EC, 2008b
Algae (marine) (*Skeletonema costatum*)	72 hr EC_{50} (growth rate)	52 µg/l	EC, 2008b

The PNEC for aquatic organisms based on the above data is 0.31 µg/l, derived by applying an assessment factor of 10 to the 21 d NOEC for *Daphnia magna* (3.1 µg/l).

Based on the above data, hexabromocyclododecane overall fulfils the PBT-criteria of the TGD (EC, 2008b). The substance is currently not included in Annex 1 of Directive 67/548/EEC.

Relative emissions: the emission estimates for SCCPs from use in textiles are based on a fixed percentage estimate of release. Hence as an initial estimate a similar level of release could be assumed (providing the level of use in the textile is the same). Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. HBCDD has a lower solubility and a lower vapour pressure and so emissions would be expected to be lower. HBCDD is not readily biodegradable, so is not expected to be degraded significantly in wwtps or to degrade in the environment.

HBCDD is used as a flame retarding additive in polymers in four principal product types: EPS and XPS (insulation panels/boards for building construction), HIPS (electrical and electronic parts such as appliance housings) and in back-coating for textiles (EC, 2008b).

Ethane, 1,2-bis(pentabromophenyl) (EBP)

Identity and properties

CAS number	84852-53-9
Water solubility	~ 0.72 µg/l at 25°C (measured value) (EA, 2007)#
Vapour pressure	~ 1×10^{-6} Pa at 25°C (nominal value to indicate low volatility) (EA, 2007)
Log Kow	No value selected (a more reliable measurement is needed) (EA, 2007)

There is evidence from predictive models and analogues that the true water solubility of this substance could be much lower (EA, 2007).

Fate data

Biodegradability	Not readily biodegradable (EA, 2007).
Bioconcentration factor	25 l/kg (limit value used in calculations for the assessment for illustrative purposes) (EA, 2007).

Aquatic effects

Species	Effect	Value	Reference
Fish (*Oncorhynchus mykiss*)	96 hr LC_{50}	No effects seen at the highest loading rate of 110 mg/l*.	EA, 2007
Fish (*Cyprinus carpio*)	8 wk bioaccumulation study	No abnormalities observed at exposure concentrations of 0.5 and 0.05 mg/l.	EA, 2007
Invertebrates (*Daphnia magna*)	48 hr EC_{50}	No effects seen at the highest loading rate of 110 mg/l*.	EA, 2007
Algae (*Selenastrum capricornutum*)	96 hr EC_{50}	No effects seen at the highest loading rate of 110 mg/l*.	EA, 2007

* Given the excess of substance used to prepare the WAF in these studies, it is assumed that the water solubility limit of ~ 0.72 µg/l at 25°C was reached.

No toxic effects were seen in any of the tests with fish, invertebrates or algae. Therefore, it is not possible to derive a PNEC for aquatic organisms (freshwater or marine).

Based on screening information only, ethane, 1,2-bis(pentabromophenyl) is considered to be potentially persistent. A firm conclusion on bioaccumulation potential cannot be drawn due to the lack of reliable data. The substance does not meet the toxicity criterion. Ethane, 1,2-bis(pentabromophenyl) is not classified for either environmental or human health hazards on Annex 1 of Directive 67/548/EEC (EA, 2007).

Relative emissions: the emission estimates for SCCPs from use in textiles are based on a fixed percentage estimate of release. Hence as an initial estimate a similar level of release could be assumed (providing the level of use in the textile is the same). Losses of SCCPs from textiles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. Ethane, 1,2-bis(pentabromophenyl) has a lower solubility and a lower vapour pressure and so emissions would be expected to be lower. Ethane, 1,2-bis(pentabromophenyl) is not readily biodegradable, so is not expected to be degraded significantly in wwtps or to degrade in the environment.

Ethane, 1,2-bis(pentabromophenyl) is a general purpose additive flame retardant for a variety of polymer applications and textiles (EA, 2007).

3.2.1.3 Alternatives for use in sealants and adhesives

Human health effects

Health effect information for MCCPs and LCCPs is included in Section 3.2.1.1.

NICNAS published a hazard compendium of 24 *ortho*-phthalate esters. The findings for three potential alternatives to SCCPs are summarised in the table.

Table 17 Summary of human health effects for DEHP, DINP and DIDP

Phthalate	Oral LD50 (mg/kg bw)	Dermal LD50 (mg/kg bw)	Inhalation LC50 (mg/L)	Skin sensitisation	gentoxicity	Repeat dose toxicity: LOAEL/NOAEL (mg/kg bw/d) and target organs	Carcinogencity: doses (mg/kg bw/d) and tumour type	Fertility: lowest LOAEL (mg/kg bw/d) and effects	Development: Lowest LOAEL (mg/kg bw/d) and effects
DEHP	Rat: 30600->40000	Rabbit: 24750	Rat: >10.62	-ve	Non-genotoxic	Rat: LOAEL = 146.6 NOAEL = 28.9; Liver, kidneys LOAEL = 37.6 NOAEL = 3.7; testes	F344 rat: LOAEL = 146.6 NOAEL = 28.9; adenomas, carcinomas, MCL Sprague-Dawley rat: adenomas, carcinomas, benign Leydig cell tumours Mouse: LOAEL = 292 NOAEL = 98; adenomas and carcinomas Syrian golden hamster: Inhalation -ve	140: decrease in fertility	14: decrease in testes wt, seiminiferous tubule atrophy
DINP	Rat: >10000 (CAS 68515-48-0); >40000 (CAS 28553-12-0)	Rabbit: >3160 (CAS 68515-48-0)	Rat, 4h: >4.4	-ve	Non-genotoxic	Rat: LOAEL = 358-442 (m-f) NOAEL = 88-108 (m-f); Liver, kidney	Rat: LOAEL = 358-442 (m-f) NOAEL = 88-108 (m-f); Increase in MCL Mouse: LOAEL = 335 (f) & 742 (m) NOAEL = 112 (f) & 275 (m); increase in hepatocellular adenomas and	Mouse: 742 (m); decrease in testes weight Rat: 966: decrease in live birth and survival indices	Rat: 159-395 (m-f): decrease in pup weight at weaning

Phthalate	Oral LD50 (mg/kg bw)	Dermal LD50 (mg/kg bw)	Inhalation LC50 (mg/L)	Skin sensitisation	gentoxicity	Repeat dose toxicity: LOAEL/NOAEL (mg/kg bw/d) and target organs	Carcinogencity: doses (mg/kg bw/d) and tumour type	Fertility: lowest LOAEL (mg/kg bw/d) and effects	Development: Lowest LOAEL (mg/kg bw/d) and effects
							carcinomas combined +ve in vitro (1 of 7 studies)		
DIDP	Rat: >29100	Rat: >2910	Rat, 4h: >12.54	-ve	Non-genotoxic	Rat: LOAEL = 120 NOAEL = 60; liver, kidney Dog: LOAEL = 75 mg/kg bw/d; increase in liver weight (low reliability study)	+ve in vitro (1 of 2 studies)	NE	134-352: decrease in pup survival in F2

Environmental effects

MCCPs

Data on the environmental effects of MCCPS are included in Section 3.2.1.1.

Relative emissions: the emission estimates for SCCPs from sealant and adhesive use are to solid waste, with negligible emissions to air or water. The properties of MCCPs mean that the same will apply for this substance (EC, 2005). Losses from service life are related to the vapour pressure and solubility; these are of the same order or lower for MCCPs than for SCCPs, hence the emissions would be expected to be lower.

MCCPs are currently used in adhesives and sealants (EC, 2005).

LCCPs

Data on the environmental effects of LCCPs are included in Section 3.2.1.1.

Relative emissions: the emission estimates for SCCPs from sealant and adhesive use are to solid waste, with negligible emissions to air or water. The properties of LCCPs mean that the same will apply for this substance (EA, 2008). Losses from service life are related to the vapour pressure and solubility; these are of the same order or lower for LCCPs than for SCCPs, hence the emissions would be expected to be lower.

LCCPs are currently used in adhesives and sealants (EA, 2008).

Bis(2-ethylhexyl)phthalate (DEHP)

Identity and properties

CAS number	117-81-7
Water solubility	3 µg/l at 20°C (EC, 2008a)
Vapour pressure	3.4×10^{-5} Pa at 20°C (EC, 2008a)
Log Kow	7.5 (EC, 2008a)

Fate data

Biodegradability	Readily biodegradable failing the 10-day window (EC, 2008a)
Bioconcentration factor	840 l/kg (fish)* (EC, 2008a) 2,500 l/kg wwt (invertebrates, mussels) 2,700 l/kg wwt (invertebrates, amphipods)

*A fish eating animal is normally selected in the standard scenario on secondary poisoning. However, fish show relatively low BCF values compared to invertebrates. Therefore, invertebrate eating animals are probably a more critical target group.

Aquatic effects

Species	Effect	Value	Reference
Fish (*Pimephales Promelas*)	96 hr LC_{50}	>0.16 mg/l (mortality)	EC, 2008a
Fish (*Salvelinus fontinalis*)	150 d LOEC 150 d NOEC	0.0037 mg/l no effect on growth (endpoint: reduced vertebral collagen levels, increased hydroxyproline levels in collagen).	EC, 2008a
Invertebrates (*Daphnia magna*)	48 hr LC_{50} 48 hr NOEC	>0.16 mg/l (limit values) 0.16 mg/l no adverse effects seen.	EC, 2008a
Invertebrates (*Daphnia magna*)	21 d NOEC 21 d LOEC	0.1 mg/l (survival) no effects seen. >0.1 mg/l (reproduction)	EC, 2008a
Algae (*Selenastrum Capricornutum*)	96 hr NOEC 96 hr EC_{50}	0.1 mg/l >0.1 mg/l (growth inhibition)	EC, 2008a

There are no reliable long-term studies indicating effects on organisms exposed to DEHP in water at concentrations below the water solubility. Hence a PNEC for aquatic organisms cannot be derived. However, a NOEC of 160 mg/kg food (ww) has been derived from two studies where effects of DEHP (administered via food) on gonadal development of Atlantic salmon were found. A $PNEC_{food}$ of 16mg/kg was derived by applying an assessment factor of 10 (EC, 2008a).

Bis(2-ethylhexyl)phthalate is not classified for the environment according to Annex 1 of Directive 67/548/EEC (EC, 2008a).

A PBT assessment has not been carried out for this substance.

Bis(2-ethylhexyl)phthalate is used as a plasticiser in polymers, mainly PVC products. It is also used in other polymers such as other vinyl resins and cellulose ester plastics. Non-polymer applications of DEHP include adhesives and sealants, lacquers and paints, printing inks for paper and plastics, printing inks for textiles, rubber and ceramics for electronic purposes and use as a dielectric fluid in capacitors (EC, 2008a).

Relative emissions: the emission estimates for SCCPs from sealant and adhesive use are to solid waste, with negligible emissions to air or water. The properties of DEHP mean that the same will apply for this substance (EA, 2008). Losses from service life are related to the vapour pressure and solubility; these are lower for DEHP than for SCCPs, hence the emissions would be expected to be lower.

1,2-Benzenedicarboxylic acid, di-C_{8-10}-branched alkyl esters, C_9-rich and di-“isononyl” phthalate (DINP)

Identity and properties

CAS number	68515-48-0 (alternative CAS No. 28553-12-0)
Water solubility	0.6 µg/l at 20°C (EC, 2003a)
Vapour pressure	6.0×10^{-5} Pa at 20°C (EC, 2003a)
Log Kow	8.8 (EC, 2003a)

Fate data

Biodegradability	Readily biodegradable (EC, 2003a)
Bioconcentration factor	840 l/kg (fish) for DEHP* (EC, 2003a) 4,000 l/kg wwt (invertebrates, mussels) for DIDP

*Since there are very few data available regarding the bioaccumulation of DINP in biota, the relevant results obtained with DIDP and DEHP are also taken into consideration (EC, 2003a).

Aquatic effects

Species	**Effect**	**Value**	**Reference**
Fish (*Pimephales promelas*)	96 hr LC_{50}	≥0.14 mg/l (no acute effects observed at the limit of solubility in the test system)	EC, 2003a
Fish (*Ictalurus punctatus)*	7 d NOEC	30 µg/l (mortality at post hatching))	EC, 2003a
Invertebrates (*Paratanytarsus parthenogenetica*)	48 hr EC_{50}	≥0.12 mg/l (no effects observed at the limit of solubility)	EC, 2003a
Invertebrates (*Daphnia magna*)	21 d NOEC	0.034 mg/l#	EC, 2003a
Algae (*Selenastrum capricornutum*)	120 hr EC_{50} 120 hr NOEC	>2.8 mg/l (limit values) ≥2.8 mg/l (growth rate)	EC, 2003a

#This effect is due to the physical entrapment of daphnids at the surface. Physical entrapment is not considered as a toxic effect; therefore the concentration of 0.034 mg/l is not taken into account in the effect assessment.

No effects were demonstrated at the limit values given above. It is not possible to derive a PNEC for aquatic organisms since no chemical toxic effects were seen in any of the long-term tests with fish, invertebrates or algae. A two-generation test with *Oryzias latipes* showed that oral intake of 20 mg/kg had no adverse effect upon reproduction and growth. It can be tentatively concluded that DINP does not cause adverse chemical effects towards fish (EC, 2003a).

DINP is not classified according to Annex 1 of Directive 67/548/EEC (EC, 2003a).

A PBT assessment has not been carried out for this substance.

DINP is mainly used in PVC applications. Non-PVC applications include polymer related-uses (such as rubber) and non-polymer uses, including inks and pigments, adhesives, sealants, paints and lacquers and lubricants (EC, 2003a).

Relative emissions: the emission estimates for SCCPs from sealant and adhesive use are to solid waste, with negligible emissions to air or water. The properties of DINP mean that the same will apply for this substance (EA, 2008). Losses from service life are related to the vapour pressure and solubility; these are lower for DINP than for SCCPs (some SCCPs have vapour pressures similar to that of DINP); hence the emissions would be expected to be lower.

1,2-benzenedicarboxylic acid, di-$_{C9-11}$-branched alkyl esters, C_{10}-rich and di-“isodecyl” phthalate (DIDP)

Identity and properties

CAS number	68515-49-1 (alternative CAS No. 26761-40-0)
Water solubility	0.2 µg/l at 20°C (EC, 2003b)
Vapour pressure	5.1×10^{-5} Pa at 25°C (EC, 2003b)
Log Kow	8.8 (EC, 2003b)

Fate data

Biodegradability	Readily biodegradable without a 10-day window criterion (EC, 2003b)
Bioconcentration factor	4,000 l/kg wwt (invertebrates, mussels) (EC, 2003b)

Aquatic effects

Species	**Effect**	**Value**	**Reference**
Fish (*Cyprinodon variegatus*)	96 hr LC$_{50}$	≥0.47 mg/l (limit value)	EC, 2003b
Invertebrates (*Mysidopsis bahia*)	48 hr EC$_{50}$	≥0.15 mg/l (limit value)	EC, 2003b
Invertebrates (*Daphnia magna*)	21 d NOEC	0.03 mg/l* (entrapment)	EC, 2003b
Algae (*Selenastrum capricornutum*)	196 hr EC$_{50}$ 196 hr NOEC	≥1.3 mg/l ≥1.3 mg/l (limit values)	EC, 2003b

*This effect is due to the physical entrapment of daphnids at the surface. Physical entrapment is not considered as a toxic effect; therefore the concentration of 0.03 mg/l is not taken into account in the effect assessment.

No effects were demonstrated at the limit values given above. It is not possible to derive a PNEC for aquatic organisms since no chemical toxic effects were seen in any of the long-term tests with fish, invertebrates or algae. No NOECs could be derived. Furthermore, a two-generation test with *Oryzias latipes* showed that oral intake of 20 mg/kg had no adverse effect upon reproduction and growth. It can be tentatively concluded that DIDP does not cause adverse chemical effects towards the aquatic ecosystem (EC, 2003b).

DIDP is not classified according to Annex 1 of Directive 67/548/EEC (EC, 2003b).

A PBT assessment has not been carried out for this substance.

DIDP is mainly used as a plasticiser in PVC. It is also used in non-PVC applications in other vinyl resins, cellulose ester plastics, pressure sensitive adhesives and printing inks. The non-PVC applications of phthalates are very small compared to the PVC application. DIDP is also used in non-polymer applications, such as anti-corrosion and anti-fouling paints (EC, 2003b).

Relative emissions: the emission estimates for SCCPs from sealant and adhesive use are to solid waste, with negligible emissions to air or water. The properties of DIDP mean that the same will apply for this substance (EA, 2008). Losses from service life are related to the vapour pressure and solubility; these are lower for DIDP than for

SCCPs (some SCCPs have vapour pressures similar to that of DIDP), hence the emissions would be expected to be lower.

3.2.1.4 Alternatives for use in paints and coatings

Human health effects

Health effect information for MCCPs and LCCPs is included in Section 3.2.1.1.

Environmental effects

MCCPs

Data on the environmental effects of MCCPS are included in Section 3.2.1.1.

Relative emissions from paints: the emission estimates for SCCPs from use in paints are based on a fixed percentage estimate of release. Hence as an initial estimate a similar level of release could be assumed (providing the level of use in the textile is the same). Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. MCCPs have lower solubilities and similar vapour pressures and so overall emissions would be expected to be lower. MCCPs are not readily or inherently biodegradable, so are not expected to be degraded significantly in wwtps or to degrade in the environment.

MCCPS are currently used in solvent-based paints (EC, 2005).

LCCPs

Data on the environmental effects of LCCPs are included in Section 3.2.1.1.

Relative emissions from paints: the emission estimates for SCCPs from use in paints are based on a fixed percentage estimate of release. Hence as an initial estimate a similar level of release could be assumed (providing the level of use in the textile is the same). Losses of SCCPs from articles during their service life are based on a combination of fixed factors and estimates related to vapour pressure and solubility. LCCPs have lower solubilities and lower vapour pressures (in some cases) and so emissions would be expected to be lower. LCCPs are not readily or inherently biodegradable, so are not expected to be degraded significantly in wwtps or to degrade in the environment.

LCCPs are currently used in paints (EA, 2008).

3.2.2 Technical and economical feasibility and availability

3.2.2.1 Alternatives for use in rubber

Medium-chain chlorinated paraffins (MCCPs)

MCCPs are likely to be technically suitable for use as alternatives to many of the uses where SCCPs are currently used, given a similar use profile (e.g. conveyor belts and tubes for compressed air in the mining industry; bellows for buses, metros and trains; and profiles for fireproof doors (Defra, 2008)). However, it cannot be ruled out that application areas exist where MCCPs would not provide the same degree of technical performance.

Both Euro Chlor (personal communication, 2008a) and CPIA (personal communication, 2008a) consider MCCPs to be the most suitable alternative for SCCPs in this application.

The raw material price of MCCPs is expected to be broadly comparable to that of SCCPs. Data from 1998 suggest fairly small price increases of around 5% for use of MCCPs as compared to SCCPs when replacing SCCPs in metalworking fluids (RPA, 1997). However, there would also be costs associated with reformulation of products and with product approval (it has not been possible to quantify these). If, as was expected with metalworking fluids, increased loading of MCCPs were to be required compared to that for SCCPs, the raw material costs could also be increased significantly.

Assuming a price of say €500 per tonne of SCCPs, an increased raw material cost of 5% per unit weight for use of MCCPs and an increase of 10% loading, increased raw material costs could be around €8,000 per year for every 100t of SCCPs used in this application (some of these costs may be passed on to downstream users). One-off costs of product reformulation, etc. could be significantly higher than this by analogy with replacing MCCPs with LCCPs (see below).

However, given the existing trend away from use of SCCPs, the additional costs above the baseline situation may be less significant.

The above estimates should be treated as tentative because they are subject to significant uncertainty (including applicability to this use and because they are based on relatively old data).

Long-chain chlorinated paraffins (LCCPs)

The draft risk reduction strategy for MCCPs (Defra, 2008) considered replacement of MCCPs with LCCPs for use in rubber and polymers other than PVC. It is likely that certain LCCPs would be suitable as a replacement for at least some of the uses of SCCPs in these applications; for example, they are currently used in rubber belting (EA, 2008). However, by analogy with MCCPs, it is likely that LCCPs may not be suitable as a replacement for some applications; for example, LCCPs were indicated as being unsuitable for use in bellows for buses according to information in Defra (2008).

A possible requirement for replacement of MCCPs with LCCPs (Defra, 2008) was estimated, based on data from industry, to lead to €6 million one-off redevelopment costs for the industry as a whole and €375 million per year in increased raw material costs. The use of MCCPs in this application is significantly higher than current use of SCCPs (use of MCCPs was around 3,500 tonnes in 2003). However, it is possible to infer that increased raw material costs for using LCCPs as a replacement for MCCPs based on data in Defra (2008) could be around €100 per tonne. Increased raw material costs compared to SCCPs could therefore be perhaps €20,000 per 100t of SCCP used in this application[25].

As with MCCPs, one-off costs of product reformulation, etc. could be significantly higher than this. However, given the existing trend away from use of SCCPs, the additional costs above the baseline situation may be less significant.

The above estimates should be treated as tentative because they are subject to significant uncertainty (because they are based on relatively old data and because they do not relate directly to replacement of SCCPs with LCCPs).

Cresyl diphenyl phosphate (CDP)

No information has been obtained on the technical suitability of this substance as compared to SCCPs in this application. CDP is supplied for use as a flame retardant in coal mine belting (personal communication, EU supplier). The belt material may be PVC rather than the chlorinated rubber in which SCCPs are used.

Data from RPA (2002) suggest that “other organophosporus” flame retardants cost significantly more than “other chlorinated” flame retardants (€4.2/kg compared to €1.4/kg). Based on the ratio between the two and an assumed price per tonne of €500 for SCCPs, raw material costs could be expected to increase significantly through use of such alternatives e.g. by a factor of three (e.g. €100,000 per year for every 100t of SCCPs used in this application as a basis for comparison with the estimates for MCCPs and LCCPs above).

As with other potential alternatives, one-off costs of product reformulation, etc. could be significantly higher than this (particularly given uncertainties associated with technical suitability).However, given the existing trend away from use of SCCPs, the additional costs above the baseline situation may be less significant.

The above estimates should be treated as tentative because they are subject to significant uncertainty.

Tertbutylphenyl diphenyl phosphate (TBPDPP)

No information has been obtained on the technical suitability of this substance as compared to SCCPs in this application. TBPDPP is supplied for use as a flame retardant in coal mine belting (personal communication, EU supplier). The belt material may be PVC rather than the chlorinated rubber in which SCCPs are used. The above *tentative* conclusions on economic feasibility (for CDP) also apply to this substance.

Isopropylphenyl diphenyl phosphate (IPPDPP)

No information has been obtained on the technical suitability of this substance as compared to SCCPs in this application. IPPDPP is supplied for use as a flame

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[25] Assuming 10% increase in loading for use of LCCPs and additional raw material price increase of €106 between MCCPs and LCCPs (additional to price increase between SCCPs and MCCPs). Note that cost estimates in this section have not been normalised to a common (current) price; some are based on relatively old information and so present costs would tend to be higher.

retardant in coal mine belting (personal communication, EU supplier). The belt material may be PVC rather than the chlorinated rubber in which SCCPs are used. The above *tentative* conclusions on economic feasibility (for CDP) also apply to this substance.

3.2.2.2 Alternatives for use in Textiles

Medium-chain chlorinated paraffins (MCCPs)

Little information has been obtained on the technical suitability of this substance as compared to SCCPs in this application. According to EC (2005) there was no use of medium-chain chlorinated paraffins in textiles in the EU at that time; however the report did identify that some of the medium-chain chlorinated paraffins supplied to the PVC industry was used for coating applications, including textiles. A limitation on the use of MCCPs in this area may be that the maximum chlorine content achievable is lower than for SCCPs and LCCPs. However, both Euro Chlor (personal communication, 2008a) and CPIA (personal communication, 2008a) consider MCCPs to be the most suitable alternative for SCCPs in this application.

The above *tentative* conclusions on economic feasibility (for use in rubber) also apply to this application.

Long-chain chlorinated paraffins (LCCPs)

No specific information has been obtained on the technical suitability of this substance as compared to SCCPs in this application, but it is understood that LCCPs are currently used in flame retardant textile coatings.

The above *tentative* conclusions on economic feasibility (for use in rubber) also apply to this application.

Decabromodiphenyl ether

No information has been obtained on the technical suitability of this substance as compared to SCCPs in this application. However, as mentioned previously, decabromodiphenylether is used in certain flame retarded textile coatings (EC, 2002).

Based on information from RPA (2002), brominated flame retardants are expected to be significantly more expensive than chlorinated flame retardants (€4.4/kg compared to €1.4/kg based on 1999 data quoted therein). Using a similar approach to that applied for use of CDP in rubber, increased raw material costs could be up to around €110,000 per year per 100t of SCCP replaced.

As with other potential alternatives, one-off costs of product reformulation, etc. could be significantly higher than this (particularly given uncertainties associated with technical suitability). However, given the existing trend away from use of SCCPs, the additional costs above the baseline situation may be less significant.
The above estimates should be treated as tentative because they are subject to significant uncertainty.

Hexabromocyclododecane

As indicated above, HBCDD is reported to be used in back-coating for textiles (EC, 2008b). However, no specific information has been identified related to the technical suitability of this substance as an alternative in this specific application.

No information is available on the economic implications of using HBCDD as an alternative to SCCPs in this application. However, the additional costs would be expected to be comparable in magnitude to those for replacement with decabromodiphenyl ether or slightly higher (costs of using the latter are expected to be less than for other brominated flame retardants, at least when used in other applications such as HIPS (Danish EPA, 2007)).

Ethane, 1,2-bis(pentabromophenyl)

As indicated above, ethane, 1,2-bis(pentabromophenyl) is a general purpose additive flame retardant for a variety of polymer applications and textiles (EA, 2007). However, no specific information has been identified related to the technical suitability of this substance as an alternative to SCCPs in this specific application.

No information is available on the economic implications of using ethane, 1,2-bis(pentabromophenyl) as an alternative to SCCPs in this application. However, the additional costs would be expected to be comparable in magnitude to those for replacement with decabromodiphenyl ether or slightly higher (though costs of using the latter are expected to be less than for other brominated flame retardants, at least when used in other applications such as HIPS (Danish EPA, 2007)).

3.2.2.3 Alternatives for use in sealants, adhesives, paints and coatings

Medium-chain chlorinated paraffins (flame retardant function)

No specific information has been obtained on the technical suitability of this substance as compared to SCCPs in these applications, but it is understood that MCCPs are currently used in sealants, adhesives and solvent-based paints. Both Euro Chlor (personal communication, 2008a) and CPIA (personal communication, 2008a) consider MCCPs to be the most suitable alternative for SCCPs in these applications. The above *tentative* conclusions on economic feasibility (for use in rubber) also apply to these applications.

Long-chain chlorinated paraffins (flame retardant function)

No specific information has been obtained on the technical suitability of this substance as compared to SCCPs in these applications, but it is understood that LCCPs are currently used in sealants, adhesives and paints.

The above *tentative* conclusions on economic feasibility (for use in rubber) also apply to these applications.

Phthalate plasticisers (plasticising function)

No information has been obtained on the technical suitability of these substances as compared to SCCPs in this application. These substances may not be technically suitable for use where certain fire prevention standards are required, unless used in conjunction with flame retardants other than SCCPs.

Phthalates as potential alternatives to MCCPs have been considered in the risk reduction strategy for that substance (Defra, 2008). This is for use in PVC though the reasons for use in PVC are likely to be similar for use of SCCPs in sealants, adhesives, paints and coatings. This study suggests that the price of phthalates such as di-isononyl phthalate could be significantly higher than use of MCCPs (around €800 per tonne for DINP compared to around €500 for MCCPs). By analogy for SCCPs, the increase in raw material costs could therefore be of the order of €30,000 per 100t of SCCPs used in this application.

As with other potential alternatives, one-off costs of product reformulation, etc. could be significantly higher than this (and these substances would not necessarily be suitable where fire resistant properties are required). However, given the existing trend away from use of SCCPs, the additional costs above the baseline situation may be less significant.

The above estimates should be treated as tentative because they are subject to significant uncertainty (they are based on analogy with MCCPs and related to use in a different application).

3.3 *Summary of information on alternatives to SCCPs*

The information on possible alternatives is summarised in Table 18. There appear to be technically viable alternatives for all of the use areas of SCCPs; although it is not clear whether this is the case for all specific applications of SCCPs.

Table 18 Summary of information on possible alternatives to SCCPs

Use	Alternative	Toxicity	Ecotoxicity	Cost	Availability	Use pattern	Performance
Rubber	MCCPs	Reproductive toxicant, effects on liver, kidney	R50-53; not readily biodegradable	Similar cost of substance, possible higher use rate; additional one-off costs	Commercially available	Similar to SCCPs	Technically viable alternative
	LCCPs	Possible carcinogenicity and reproductive effects	Not readily biodegradable; does not meet B and T criteria	Higher cost of substance; additional one-off costs.	Commercially available	Similar to SCCPs	Technically viable alternative
	Cresyl diphenyl phosphate	Toxicity to liver, kidney and blood	Does not meet P, B or T criteria	Significantly higher substance costs; additional one-off costs	Commercially available	Probable use in PVC rather than rubber	Currently used in PVC belting
	Tertbutylphenyl diphenyl phosphate	Possible liver, kidney and adrenal toxicity	Does not meet P and B criteria; provisional classification R50	Significantly higher substance costs; additional one-off costs	Commercially available	Probable use in PVC rather than rubber	Currently used in PVC belting
	Isopropylphenyl diphenyl phosphate	Low toxicity	Does not meet P and B criteria; acute aquatic toxicity <1 mg/l	Significantly higher substance costs; additional one-off costs	Commercially available	Probable use in PVC rather than rubber	Currently used in PVC belting
Textiles	MCCPs	Reproductive toxicant, effects on liver, kidney	R50-53; not readily biodegradable	Similar cost of substance, possible higher use rate; additional one-off costs	Commercially available	Similar to SCCPs, possible higher use rate	Technically viable alternative
	LCCPs	Possible carcinogenicity and reproductive effects	Not readily biodegradable; does not meet B and T criteria	Higher cost of substance; additional one-off costs.	Commercially available	Similar to SCCPs	Technically viable alternative

Use	Alternative	Toxicity	Ecotoxicity	Cost	Availability	Use pattern	Performance
	Decabromodiphenylether	Neurotoxicant	Not readily biodegradable , low to moderate bioaccumulation potential	Significantly higher substance cost than SCCPs; additional one-off costs. Requires diantimony trioxide	Commercially available	25% by weight (in conjunction with ATO)	Technically viable alternative
	Hexabromocyclododecane	Developmental effects	Meets the PBT criteria	Significantly higher substance cost than SCCPs; additional one-off costs. Requires diantimony trioxide	Commercially available	25% by weight (in conjunction with ATO)	Technically viable alternative
	Ethane, 1-2 bis(pentabromophenyl)	Limited data, but likely to be of low toxicity	Not readily biodegradable, may be persistent	Significantly higher substance cost than SCCPs; additional one-off costs. Requires diantimony trioxide	Commercially available	Typical loading 10-30 g/m^2	Technically viable alternative
Sealants, adhesives, paints, coatings	MCCPs	Reproductive toxicant, effects on liver, kidney	R50-53; not readily biodegradable	Similar cost of substance, possible higher use rate; additional one-off costs	Commercially available	Similar to SCCPs	Technically viable alternative
	LCCPs	Possible carcinogenicity and reproductive effects	Not readily biodegradable; does not meet B and T criteria	Higher cost of substance; additional one-off costs.	Commercially available	Similar to SCCPs	Technically viable alternative
	Phthalates	Possible developmental effects	Readily biodegradable; generally no effects at solubility		Commercially available		Do not provide flame retardancy

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5 Disclaimers

Third Party Disclaimer

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Annex 1: Summary of information on manufacture, import, export, uses and releases

Table A1: Overview of information on manufacture, trade and releases from manufacture

Manufacture, trade and formation	**Process** (narrative description)	**Locations** (number of M sites; spatial distribution) [2]	**Tonnage manufactured, imported, exported or formed**	**Releases to working environment** [3]	**Releases to environment** (t/y released to air, wastewater or to waste)
Manufacture EU Process A	Chlorination of n-paraffin	4 sites in 4 countries	<600 t/y total EU25 supply in 2004	Inhalation exposure 0-2.1 mg/m^3 8 hour TWA. Dermal exposure 0.1-1 mg/cm^2/day.	<0.010-<0.027 t/y to surface water
Total Manufacture			<600 t/y EU25 supply in 2004 and <1,000 t/y EU27 supply in 2007 based on figures provided by Euro Chlor. There one further possible EU manufacturer not included in these totals. There has been a marked decrease in EU consumption over the years 1994 to 2004 (>95% decrease over this period) but the supply appears to have been reasonably stable between 2004 and 2007.	Inhalation exposure 0-2.1 mg/m^3 8 hour TWA.. Dermal exposure 0.1-1 mg/cm^2/day.. The data are based on EASE predictions. The dermal exposure estimates will be considerably reduced in practice by the use of personal protective equipment.	Total release is <0.037 t/year to surface water. Data are not currently available for two further possible production sites in the EU
Import subst. on its own			Not clear – thought to be low		
Import subst. in preparations			Not clear – thought to be low. Could be imported in paints and sealants.		
Import subst. in articles [2]			Not clear – thought to be low. SCCPS could be present in the following articles: rubber goods (particularly belts for mining), building and construction materials where a sealant containing SCCPs has been used, flame retarded textiles, and articles painted with chlorinated-rubber or vinyl-		

			copolymers-based paints and coatings (e.g. marine primer, fire retardant, chemical and water resistant paints and coatings). Imports are most likely to occur from India and China.		
Import into EU (total)			Not clear – thought to be low		
Export subst. on its own			Not clear – thought to be low		
Export subst. in preparations			Not clear – thought to be low		
Export subst. in articles [1]			Not clear – thought to be low		
Export from EU (total)			Not clear – thought to be low		
Global manufacture			Not clear for SCCPs. The global production of all chlorinated paraffins is thought to be around 300,000 t/y		
Unintentional formation during incineration (EU)				Not relevant	0 t/y
Unintentional formation in processes (EU)	Impurity in medium-chain chlorinated paraffins			As the SCCP content of medium-chain chlorinated paraffins is <1% the occupational exposure of SCCPs from use of medium-chain chlorinated paraffins would be expected to be very low.	<33.4 t/y
Unintentional formation by transformation/degradation (EU)				Not relevant	0 t/y
Total unintentional formation (EU)				Negligible	<33.4 t/y

1 A list of article types in which the substance is included shall be provided in addition.

2 In quantitative or geographical terms exact specifications are only required if the number of sites is low. If there are many sites a semi-quantitative or qualitative description of the manufacturing structure and spatial distribution of manufacturing sites (e.g. in which Member States, regions, etc.) may suffice.

3 In case a quantification of releases is not possible a qualitative description of the emission situation at the workplace(s) shall be given and a semi-quantitative estimate of the exposure situation provided (e.g. no exposure – very high exp.).

Table A2: Overview on uses and releases from use

Uses	**Use Process** (description: narrative and by use descriptor system)	**Amount used** (t/y)	**Number of sites of use**[1] (#)	**Spatial distribution of emission sites**[1]	**Releases to working environment**[3]	**Releases to environment** (t/y released to air, wastewater or to waste)
Formulation						
Formulation 1	Formulation of rubber	<600	Not clear – likely to be limited	Use of chlorinated paraffins in general in rubber is likely to be widespread but the number of sites currently using SCCPs is unclear.	Inhalation exposure 11-63 mg/m^3 8 hour TWA. Dermal exposure 0.1-1 mg/cm^2/day.	<0. t/y1 to air <0.1 t/y to waste water
Formulation 2	Formulation of sealants	<300	Not clear – likely to be limited	Use of chlorinated paraffins in general in sealants is likely to be widespread but the number of sites currently using SCCPs is unclear.	Inhalation exposure 0-2.1 mg/m^3 8 hour TWA (low temperature process). Inhalation exposure 11-63 mg/m^3 8 hour TWA (high temperature process). Dermal exposure 0.1-1 mg/cm^2/day.	Negligible to air and water. Significant amount of solid waste.
Formulation 3	Formulation of paints	<100	Not clear – likely to be limited	Use of chlorinated paraffins in general in sealants is likely to be widespread but the number of sites currently using SCCPs is unclear.	Inhalation exposure 0-2.1 mg/m^3 8 hour TWA. Dermal exposure 0.1-1 mg/cm^2/day .	Negligible to air and water
Formulation 4	Formulation of textile backcoatings	<100	<14	Possibly in UK, Germany and other parts of the EU. According to EC (2002) there were thought to be around 14 formulators of textile backcoatings in the EU at that time (the number of these using SCCPs at that time is	Inhalation exposure 0-2.1 mg/m^3 8 hour TWA. Dermal exposure 0.1-1 mg/cm^2/day.	<0.5 t/y to waste water

				unknown). The number and location of sites currently using SCCPs is not clear but it is unlikely that SCCPs are used at all the above sites and so the number of sites using SCCPs is estimated to be <14.		
∑ Formulation		<600 t/y in the EU25 in 2004 and <1,000 t/y in the EU27 in 2007. The actual figure is confidential. The underlying trend is a marked year-on-year reduction in overall use of SCCPs since the mid-1990s until 2004 but the usage in 2007 appears to have been similar to 2004.	Not clear – likely to be limited	Use of chlorinated paraffins in general in sealants is likely to be widespread but the number of sites currently using SCCPs is unclear. The sites using SCCPs are likely to be limited in number.	The data are based on EASE predictions or extrapolation of data from other similar processes. The dermal exposure estimates will be considerably reduced in practice by the use of personal protective equipment.	The actual emission is confidential. The underlying trend is a reduction in overall use, and hence emission, of SCCPs in the EU. The emission estimates are generic estimates using a combination of industry-specific information, emission scenario documents and default assumptions and are therefore uncertain.
End uses						
End Use 1	Rubber processing	<600	Not clear – likely to be limited	Use of chlorinated paraffins in general in rubber is likely to be widespread but the number of sites currently using SCCPs is unclear.	Inhalation exposure 11-63 mg/m^3 8 hour TWA Dermal exposure 0.1-1 mg/cm^2/day. Negligible exposure from subsequent moulding,	<0.5 t/y to air <0.5 t/y to waste water

					cutting and shaping of the rubber products.	
End Use 2	Use of sealants	<300	Potentially large	Likely to be widespread.	Generally negligible. Inhalation exposure 0.32 mg/m^3 8 hour TWA for spraying scenario. Dermal exposure 0.01-0.1 mg/cm^2/day for spraying scenario.	Negligible to air and water Some solid waste
End Use 3	Industrial application of paints	<100	Potentially large	Likely to be widespread.	Inhalation exposure 0.32 mg/m^3 8 hour TWA for spraying scenario. Dermal exposure 0.01-0.1 mg/cm^2/day for spraying scenario.	<0.1 t/y to waste water
End Use 4	Application of textile backcoatings	<100	<42	Possibly in UK and other parts of the EU. According to EC (2002) there were thought to be around 32-42 companies involved in textile backcoating in the EU at that time (the number of these using SCCPs at that time is unknown). The number and location of sites currently using SCCPs is not clear but it is unlikely that SCCPs are currently used by all of these companies and so the number of sites using SCCPs is estimated to be <42.	Inhalation exposure 0-2.1 mg/m^3 8 hour TWA Dermal exposure 0.03-0.3 mg/cm^2/day.	<0.5 t/y to waste water or waste
∑ End Uses		<600 t/y in the EU25 in 2004 and <1,000 t/y in the EU27 in	Potentially a large number of sites using sealants and	Likely to be widespread use of sealants and paints. The textile back backcoating sites and	The data are based on EASE predictions. The dermal exposure estimates will be	The actual emission is confidential. The underlying trend is a reduction in overall use, and hence

		2007. The actual figure is confidential. The underlying trend is a marked year-on-year reduction in overall use of SCCPs since the mid-1990s until 2004 but the usage in 2007 appears to have been similar to 2004.	paints. Likely to be a smaller number for the other end uses.	rubber processing sites are likely to be more limited in number.	considerably reduced in practice by the use of personal protective equipment.	emission, of SCCPs in the EU. The emission estimates are generic estimates using a combination of industry-specific information, emission scenario documents and default assumptions and are therefore uncertain.
Consumer use						
Substance in articles [2]		<600	Potentially large	SCCPS could be present in the following articles: rubber goods (particularly belts for mining), building and construction materials where a sealant containing SCCPs has been used, flame retarded textiles, and articles painted with chlorinated-rubber or vinyl-copolymers-based paints and coatings (e.g. marine primer, fire retardant, chemical and water resistant paints and coatings). These may be widespread throughout the EU.,		Emissions estimated over the service life of articles are as follows. 0.6-1.8 t/y to air 7.4-19.6 t/y to waste water 4.7-9.5 t/y to surface water 8.7-13.9 t/year to urban/industrial soil.

Substance in preparations		<600	Potentially large	May be widespread in paints and sealants. Although most of the paints and sealants containing SCCPs are for industrial/professional use it is probable that some are also used by consumers.		Negligible amounts will be released to air and waste water from consume use of both paints and sealants. Waste containing SCCPs is likely to be generated.
∑ consumer use of subst. in articles and preparations		<600 t/y in the EU25 in 2004 and <1,000 t/y in the EU27 in 2007. The actual figure is confidential. The underlying trend is a marked year-on-year reduction in overall use of SCCPs since the mid-1990s until 2004 but the usage in 2007 appears to have been similar to 2004.				0.6-1.8 t/y to air 7.4-19.6 t/y to waste water 4.7-9.5 t/y to surface water 8.7-13.9 t/year to urban/industrial soil. These estimates are based on a large number of assumptions and are very uncertain. The underlying trend is a reduction in overall use, and hence emission, of SCCPs in the EU.

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1 In quantitative or geographical terms exact specifications are only required if the number of sites is low. If there are many sites a semi-quantitative or qualitative description of the use structure and spatial distribution of sites of release (e.g. in which Member States, regions, etc.) may suffice.

2 A list of article types with the substance included and used by consumers shall be provided as well.

3 In case a quantification of releases is not possible a qualitative description of the emission situation at the workplace(s) shall be given and a semi-quantitative estimate of the exposure situation provided (e.g. no exposure – very high exp.).