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Releases of selected alkylphenols and alkylphenol ethoxylates and use in consumer products

A LOUS 2012-2015 follow-up project

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Releases of selected alkylphenols and alkylphenol ethoxylates and use in consumer products

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Content

Preface

The Danish Environmental Protection Agency's List of Undesirable Substances (LOUS) is intended as a guide for enterprises. It indicates substances of concern whose use should be reduced or eliminated completely. Over the period 2012-2015 all 40 substances and substance groups on LOUS will be surveyed. The surveys include collection of available information on the use and occurrence of the substances, internationally and in Denmark, information on environmental and health effects, on alternatives to the substances, on existing regulation, on monitoring and exposure, and information regarding ongoing activities under REACH, among others.

The survey for alkylphenols and alkylphenol ethoxylates (AP/APE) was published in 2012 and the Danish EPA has on the basis of the survey developed a strategy for measures for further reducing the risks from the substances.

As part of the strategy, the Danish EPA has initiated a survey of emissions of alkylphenols and alkylphenol ethoxylates from all life cycle stages of the substances and a survey of the use of the substances in consumer products.

The main objectives of the surveys are:

- to establish an overview of the releases of the AP/APE to the environment and the significance of the different sources, and
- to establish an overview of the use of AP/APE in consumer products as background for considerations regarding the potential for consumer exposure.

This report presents the results of the surveys undertaken from August 2013 to August 2014.
The surveys have been undertaken by COWI A/S in co-operation with the National Centre for Energy and Environment (DCE), Aarhus University.

The project has been followed by a steering group consisting of:

- Sidsel Dyekjær, Danish EPA
- Carsten Lassen, COWI A/S
- Patrik Fauser, DCE

Summary and conclusion

This report on releases of selected alkylphenols (AP) and alkylphenol ethoxylates (APE) and use of the substances in consumer products is a follow up to a survey of the use of alkylphenols and alkylphenol ethoxylates published by the Danish EPA in 2012. This study is one of the activities of the Danish EPA's risk reduction strategy which includes obtaining further knowledge on these substances with the aim of assessing the need for further reducing the risks associated with their use.

For the study data have been collected from the following sources: EU Risk Assessments and REACH Annex XV dossiers, registrations under REACH, Emission Scenario Documents, emission factors for REACH Specific Environmental Release Categories (SPERC) developed by trade organisations, the Danish Product Registers and other Products Register, Safety Data Sheets, Manufacturers' websites and direct contact to trade organisations and market actors.

The survey of emissions covers all life cycle stages of the selected substances. For four of the substance groups, nonylphenols (NP) and their ethoxylates (NPE) and octylphenol (OP) and their ethoxylates (OPE), activity rates and emission factors have been expressed by uncertainty intervals and emissions are calculated with uncertainties using Monte Carlo modelling. The estimates are presented as the mean value and the low and high limits of a 90% confidence interval.

Nonylphenols (NP)

Use and release of NP - The total consumption of NP in the EU is estimated at approximately 42,000 t/y. NP is almost entirely (98%) used as intermediate in the manufacture of nonylphenol ethoxylates (NPE), tri-(4-nonylphenyl) phosphite (TNPP), epoxy and phenol/formaldehyde resins, phenolic oximes and other plastic stabilizers. The epoxy and phenol/formaldehyde resins contain a residual content of NP of approximately 3-4% and this residual content represents the major quantity of NP in end-uses such as paint and varnishes, adhesives and articles with phenolic plastic based on phenolic resins. A part of the residual NP content is, depending on the actual application, transformed by the subsequent curing of the resins.

“Resins” are polymeric materials and the basis for phenolic plastics, coating, adhesives, etc. They may be transparent, hard materials or thick liquids that harden into transparent solids. Phenol formaldehyde resins (PF) are synthetic polymers obtained by the reaction of phenol or substituted phenol with formaldehyde.

The major primary source of release of NP to surface water is estimated to be the manufacture of NPE, whereas the major secondary sources are discharges from waste water treatment and discharges of NP formed from NPE by waste water treatment. The major source of NP to soils is NP in sewage sludge formed from NPE by the waste water treatment. The major sources of NP to waste water are estimated to be residual NP in imported textiles and discharges from NP in paint and varnishes, adhesives, fillers and sealants (sources of NPE is described under NPE). With the exception of NP in textiles, the same uses are major sources of NP to solid waste. Due to uncertainties (typically ranges of a factor of 15 between the lower and higher limits for each source) it is not possible to point at which sources to waste water are the most significant, but it is quite certain that releases to solid waste and waste water from manufacture and formulation processes are small compared to releases from end-uses. It is also quite certain that formation of NP from NPE by waste water treatment accounts for a significant part of the total release to surface water and soil and that degradation of NP during treatment of solid waste and waste water accounts for significant removal of NP. The results are further discussed below together with the results for NPE.

Use of NP in consumer products – NP is present at typical concentrations of 1-5% in the hardener component of epoxy speciality paints for professional use and many epoxy sealants, foams, adhesives, grouting material, etc. Some of the products can be purchased by consumers and may to a limited extent be used by consumers. In the Swedish Product Register (which contrary to the Danish Product Register includes consumer products), consumer products account for about 5% of the total number of products (and likely a smaller percentage of the tonnage). On this basis it is estimated that consumer applications account only for a very small part of the total NP quantity in mixtures and articles.

Nonylphenol ethoxylates (NPE)

Use and release of NPE - The use of NPE in the EU is regulated via the REACH Regulation, which stipulates that the substances cannot be used for a range of applications. It is estimated that the total consumption in the EU has decreased from 118,000 t/y in 1997 to approximately 18,000 t/y in 2011. The major applications are synthesis of nonylphenol ether sulphates and nonylphenol ether phosphates, formulation of flotation agents for mining and formulation of polymer dispersions for emulsion polymerization (process where the polymerization takes place in a dispersion e.g. in a paint). The polymer dispersions are used for paints (major application), inks, adhesives, and some textile coatings applied in closed systems.

The main sources of releases to surface water are estimated to be waste water treatment (major source) and the use of NPE in flotation agents for mining. The application as flotation agent is not well described and the uncertainty of the estimated release from this source is quite high. NPE in imported textiles is the major source of NPE to WWTPs accounting for 80% of the total discharges to surface water, using the mean estimate. Imported textiles is the main source even if the lower estimate for this source is applied. Other sources of significance at EU level, but estimated with high uncertainties (typically a factor of 20 between the upper and lower estimates), are synthesis of NPE derivatives, use of paint and inks, use of degreasers and maintenance agents and use of technical textiles (non-clothing). In Denmark, synthesis of NPE derivatives and use in flotation agents are not relevant sources, and end-uses account for nearly 100% of all sources to waste water.

Use of NPE in consumer products – In the Swedish Product Register 165 consumer products with NPE are registered and consumer products account for about 24% of the total number of registered products. This indicates a widespread use of NPE in consumer products.

NPE is present in many decorative building paints based on acrylic and alkyd binders for both indoor and outdoor applications. The NPE content is typically 1-5%. Many of the paints are sold in paint shops for professional and consumer application. According to information from Danish manufacturers, NPE is not common in paints used by consumers. However, a number of available datasheets indicate that the paints are used for building applications, and the relevant types of paints may be used by consumers. To a lesser extent, NPE is present in some epoxy-based two component paints. These paints are usually intended for industrial and professional applications, but may be used by consumers.

NPE may be present in some primers for floors and walls, sealants for ceramic tiles and mosaics and wood adhesives. The products are mainly intended for professional use but may to a limited extent be used by consumers.

According to the REACH regulation, NPE is not to be used in cleaning agents but NPE may be used in some degreasers and maintenance agents. Degreasers are used to remove oil and grease on various surfaces (e.g. car engines or kitchens) and may to some extent be used by consumers. Maintenance agents registered in the Danish Product Register include polishes and waxes for various applications (e.g. for metal, floors, plastics, rubbers) but some cleaning agents (e.g. lime remover) are registered for which it is difficult from the description to determine whether the agents are covered by the current restriction on NPE in cleaning agents.

The use of NPE in the manufacture of textiles in the EU is prohibited (except for processing in closed systems with no release into waste water), but NPE may be present in imported textiles. The NPE is used during the processing of the textiles and normally removed from the textiles, but the textiles may contain a residual content of NPE. Surveys have demonstrated detectable levels of NPE in about 60% of all clothing with an average concentration of all analysed samples of 107 mg/kg.

NPE may also be present in various coated textiles e.g. used for tents, back coatings to stabilize fabrics (upholstery, automotive), blackout drapery coatings and coated carpet. In these textiles the NPE is included in the polymer emulsions and still present in the final coating. The typical concentration of the NPE in the coating of these textiles ranges from 500 to 15,000 mg/kg. Concentrations as high as 45,000 mg/kg have been detected in some printed areas (coated areas) of clothing.

Analyses show that 20% of leather manufactured in China contains NPE in the range of 11-1,500 mg/kg. No data on NPE in leather articles imported to the EU have been identified. As a significant part of the leather articles marketed in the EU are imported from China and other countries outside the EU it is likely that a significant part of the leather articles used by consumers contain NPE.

Summary on releases of NP and NPE

Significance of releases of NPE for the NP levels in the environment – NPE contributes to the environmental load of NP as some of the NPE treated in WWTPs is degraded to NP and released as NP from the WWTP. At EU level, the release of NP from WWTP to surface water from the direct uses of NP is estimated at 7.8 (2-28) t/y while the releases from degradation of NPE in the WWTP are estimated at 10 (9-14) t/y. In addition, some of the NPE released will be degraded to NP in the environment. The EU Risk Assessment Report (RAR) for NP estimates that 2.5% of the NPE released to the environment will eventually will be degraded to NP. Based on this it is estimated that the NPE released to the environment eventually will result in a NP load of further 5 (3-9) t/y. It should be noted that the total direct releases of NP and NPE to the surface water is highly dependent on both the efficiency of the WWTPs and the percentage of the waste water discharged directly to surface water without treatment in WWTPs.

Releases in Denmark - The indirect sources of NP and NPE via waste water and the direct sources of releases of the substances to the environment in Denmark are shown in Table 0 below. NPE is designated as NP equivalents, NP_{eq} by multiplying the quantities of NPE with 2/5 (see section 1,2 for the background for the ratio). The calculated NP_{eq} indicates the potential for formation of NP from NPE, but does not reflect the actual formation of NP from degradation of NPE in WWTPs and in the environment, which is significantly lower.

When the estimated releases are compared with actual monitoring data in Denmark the most pronounced difference is that the releases of NP to waste water estimated in this study are considerably lower than estimates based on actual measurements of NP concentrations in the inlet to WWTPs (expressed as national mean concentrations). At the same time, the estimated releases of NPE to WWTPs are slightly higher than the estimated sum of the lower-ethoxylated NPEs, NP1EO and NP2EO in the inlet to the WWTPs based on actual concentration measurements.

This difference for the NPEs may be explained by the fact that the higher-ethoxylated NPEs are not included in the national means concentrations. A possible explanation for the relatively high quantities of NP and relatively low quantities of NPE found in the inlet to the WWTPs as compared to the estimated releases may be that NPE is degraded to NP already in the sewer system. Data are, however, not available to document to what extent this degradation actually occurs. When estimating the emissions in Denmark, the data have not been represented by intervals indicating the uncertainties. The estimates at EU levels show that the uncertainties on the estimates for each source are quite high, and the differences between the estimated releases and measured values may quite well be within the uncertainties of the estimations.

TABLE O
SOURCES OF RELEASES OF NP AND NPE TO WASTE WATER, SOIL AND SURFACE WATER IN DENMARK IN 2013 (AVERAGE FIGURES) *1

Application area Indirect sources via waste water	Releases to waste water, tonnes/year				% of releases to waste water as NP_{eq}
	NP	NPE	NPE as NP_{eq} *1	Total NP_{eq} *1	
Formulation of paint, inks and adhesives	-	0.215	0.086	0.086	3%
End-uses of mixtures and articles:					
Paints, lacquers and varnishes (incl. surface treatment)	0.032	0.027	0.011	0.043	1%
Adhesives, sealants and filling agents (incl. hardeners)	0.059	0.009	0.004	0.063	2%
Articles of phenolic resins	0.013	-	-	0.013	0%
Textiles (incl. technical textiles)	0.080	6.016	2.406	2.486	76%
Degreasers	-	0.425	0.170	0.17	5%
Cleaning and maintenance agents	-	1.025	0.410	0.41	13%
Leather products	-	0.012	0.005	0.005	0%
Other	-	0.005	0.002	0.002	0%
Total to waste water	**0.184**	**7.734**	**3.094**	**3.278**	**100%**

Direct sources	Surface water			Soil		
	NP	NPE as NP_{eq} *1	% of total as NP_{eq} *1	NP	NPE as NP_{eq} *1	% of total as NP_{eq} *1
Waste water treatment of NP	0.021	-	1%	0.035		7%
Waste water treatment of NPE *1	0.194	1.215	99%	0.332	-	69%
Use of NPE in degreasers	-	-	-	-	0.034	7%
Use of NPE in cleaning and maintenance agents	-	-	-	-	0.082	17%
Use of NPE in other products	-	-	-	-	0.001	0.2%
Total	**0.215**	**1.215**	**100%**	**0.367**	**0.117**	**100%**

*1 NPE is expressed as NP_{eq} by multiplying the quantities of NPE with 2/5 (see section 1.2). The calculated NP_{eq} quantities indicates the potential for formation of NP from NPE, but do not reflect the actual formation of NP from degradation of NPE in WWTPs and in the environment which is significantly lower.

*2 The releases of NP to surface water and soil (via sewage sludge) from the waste water treatment of NPE is due to degradations of the NPE to NP by the management.

Octylphenols (OP)

Use and release of OP - The substance 4-*tert*-OP accounts for nearly 100% of the consumption of OP and the description of the use and releases of OP concerns consequently 4-*tert*-OP. The total EU consumption is approximately 23,000 t/y. The use of OP and OPE is not restricted. OP is mainly used for manufacture of phenol/formaldehyde resins and a small quantity is used for manufacture of OPE. The phenol/formaldehyde resins contain a residual content of OP of approximately 3-4% and non-reacted OP may be present in mixtures and articles made of the resins. A part of the residual OP content, depending on the application, is transformed by the subsequent curing of the resin.

The major sources of OP releases to surface water are estimated to be tyres (where the OP may be bound in abraded rubber particles) and waste water treatment. The uncertainty of the releases from the tyres is very high, because the OP is present in the core of the tyres and it is quite uncertain to what extent OP-containing rubber is actually released by use. The formation of OP from OPE in the WWTPS seems to be small compared to the direct discharges of OP to the WWTPs. Contrary to the situation for NP/NPE, formation of OP from OPE in WWTPs seems not to be a significant source of releases of OP to the environment at EU level.

Use of OP in consumer products –Consumer products with residual content of 4-*tert*-OP only tyres and some marine paints. An average tyre produced in the EU contains between 0,007 % and 0,012 % of 4-*tert*-OP. The direct exposure to 4-*tert*-OP in tyres is considered to be low because the substance is bound in the rubber matrix and furthermore, the 4-*tert*-OP is typically only present in the core parts of the tyre. The marine paints are mainly designed for professional applications, but may be used by owners of leisure boats.

Octylphenol ethoxylates (OPE)

Use and release of OPE – The total consumption of OPE at EU level is approximately 1,000 t/y and thus relatively small compared with the consumption of NPE. The current consumption of OPE is less than 1% of the consumption of NPE in 1999 (before the restriction) and the available data do not indicate that OPE significantly has substituted for NPE in cleaning agents and other historic applications of NPE. The major applications areas of OPE are synthesis of octylphenol ether sulphates and formulation of polymer dispersions for emulsion polymerization. The polymer dispersions are used for paints, adhesives and sealants and for formulation of textile and leather auxiliaries.

At EU level the main sources of OPE to surface water are discharges from WWTPs and from the use of OPE in pesticides and biocides. The major sources of OPE to the WWTPs are estimated to be formulation and application of textiles and leather auxiliaries, end-use of water-based paints, and end-use of textiles (washing).

The releases of OPE to soil are significantly higher than the releases to waste water, surface water and air, and originate from OPE in pesticides used in agriculture. The OPE released to soil may either be degraded within the soil or may end up in surface water by drainage.

Use of OPE in consumer products – Compared to the NPE, OPE is much less used in consumer products. In the Swedish Product Register a total of only 5 products with OPE were registered (16% of all registered products with OPE) whereas there are 165 registered consumer products with NPE. One of the main applications of OPE is in acrylic paint which is used for both industrial and building applications. The total number of products within the product group paints, lacquers and varnishes registered in the Danish Product Register is 68 (for professional applications) indicating that the OPE is common in paints, but not as common as NPE (158 products). The acrylic paints used for building applications may to some extent be sold from DIY shops and paint stores and used by consumers. As indicated by the Swedish data, consumer application is, however, not common.

OPE is also present in some types of stone impregnation agents and floor finish which may be used by consumers.

OPE act as emulsifier in some finishing agents used to cover textiles and leather with a thin polymer film to make the material more resistant to water, dust and light. Furthermore, OPE may be used in textile printing. In non-coated and non-printed textiles the average concentrations are low as compared to NPE concentrations. Measurements in printed sections of textiles demonstrated that the OPE concentration in these sections may be up to 650 mg/kg. No studies exist of the extent of the use of OPE in coated/printed textiles and leather, but most probably OPE is present in some clothing and leather articles used by consumers.

OPE are present in a few products within the product group "cleaning, washing, and maintenance agents". Compared with the registered consumption of NPE, the use of OPE in consumer products is limited and the total registered consumption in the Danish Product Register was less than 0.1% of the registered consumption of NPE in 2012. The result indicates that OPE has not to any significant extent substituted for NPE in cleaning and maintenance agents. It has not been possible to identify any specific OPE-containing cleaning, washing or maintenance agents for consumer application, but it cannot be ruled out that products to a limited extent are marketed for consumer use.

Summary of releases of OP and OPE in Denmark
A summary of the estimated releases of OP and OPE in Denmark is shown in Table 00. The distribution between sources is quite different from the distribution at EU level because OP and OPE are not manufactured in Denmark and only to a very limited extent used for formulation processes. Furthermore, the use of OPE in pesticides and biocides seems to be lower than the EU average. As a result OP in tyres is considered the main source of releases to surface water and soil. The estimate is derived from the EU average figures but it should be noted that the EU figures are estimated with very high uncertainty.

4-*tert*-butylphenol (4-*tert*-BP)

Use and release of 4-*tert*-BP - Of the butylphenols, 4-*tert*-BP represents the major tonnage and the applications with the expected highest releases. The total consumption in the EU is approximately 27,000 t/y. The substance is nearly 100% used as intermediate for the manufacture polycarbonates, alcohols and phenolic and epoxy resins. The concentration of residual 4-*tert*-BP in resin is around 3-4%, but a part of this is - depending on the application - transformed by the subsequent curing of the resins.

According to the estimates of the European Risk Assessment Report (RAR) for 4-*tert*-BP, manufacture and use of epoxy resins represent the major sources of releases to the air, while manufacture and use of phenolic resins and epoxy resins represent the major sources of releases to waste water. The releases to air are significantly higher than the direct releases to surface water and must be considered the major pathway for releases to the environment.

Releases from the use of products with a residual content 4-*tert*-BP in resins are according to the RAR for4-*tert*-BP low or negligible because the residual 4-*tert*-BP content of cured resins and polycarbonate is small.

TABLE 00
RELEASE OF OP AND OPE TO WASTE WATER, SOIL AND SURFACE WATER IN DENMARK IN 2013 *1

Application area Indirect sources via waste water	Releases to waste water, tonnes/year				% of releases to waste water as OP_{eq}
	OP	OPE	OPE as OP_{eq} *1	Total OP_{eq} *1	
Formulation of paint, inks and adhesives	-	0.004	0.002	0.002	1%
End-uses of mixtures and articles:					
Tyres	0.006	-	-	0.083	49%
Paints and inks	-	0.011	0.004	0.004	2%
Lubricants	-	0.002	0.001	0.001	1%
Surface coated textiles	-	0.075	0.03	0.03	18%
Other textiles	-	0.095	0.038	0.038	22%
Cleaning and maintenance agents	-	0.005	0.002	0.002	1%
Leather products	-	0.026	0.010	0.010	6%
Total to waste water	**0.006**	**0.218**	**0.087**	**0.093**	**100%**

Direct sources	Surface water			Soil		
	OP	OPE as OP_{eq} *1	% of total as OP_{eq} *1	OP	OPE as OP_{eq} *1	% of total as OP_{eq} *1
Waste water treatment of OP	0.001	-	1%	0.001	-	1%
Waste water treatment of OPE *1	-	0.015	15%	-	-	-
Use of OP in tyres	0.083	-	83%	0.083	-	86%
Use of OPE in lubricants	-	-	-	-	0.001	1%
Use of OPE in pesticides and biocides	0.001	0.0004	1%	-	0.011	11%
Use of OPE in cleaning and maintenance agents	-	-	-	-	0.0004	0.4%
Total	**0.085**	**0.015**	**100%**			**100%**

*1 OPE is expressed as OP_{eq} by multiplying the quantities of OPE with 2/5 (see section 1.2). The calculated OP_{eq} indicates the potential for formation of NP from NPE, but do not reflect the actual formation of OP from degradation of OPE in WWTPs and in the environment which is much lower and further discussed in the report.

*2 The releases of OP to surface water and soil (via sewage sludge) from the waste management of OPE is due to degradations of the OPE to OP by the management.

Use of 4-*tert*-BP in consumer products – 4-*tert*-BP is present in some types of epoxy-based adhesives, paint and varnishes in concentrations from 1% of to 50%. The products are mainly for industrial and professional use, but some products are sold it in DIY shops and may to some extent be used by consumers.

Consumers may furthermore be exposed to residual 4-*tert*-BP in polycarbonate and phenolic and epoxy resins. However, the RAR for 4-*tert*-BP estimated the potential exposure to 4-*tert*-BP in polycarbonate and epoxy resins to be approx. 100 times lower than the potential exposure to the substance in adhesives.

Dodecylphenols (DP) and dodecylphenol ethoxylates (DPE)

Use and release of DP - At EU level, around 99% of the consumption volume of DP of approximately 50,000 t/y is used in the production of oil and lubricant additives. The dodecylphenol is present in the additives and the final lubricants at low concentrations. The major source of DP releases to the environment is spillage and leakages of crankcase lubricants which is estimated to represents more than 99% of the total releases of DP to soil, surface water and WWTPs. Total releases at EU level have been estimated at 3.3 t/y to surface water, 22.3 t/y to soil and 23.3 t/y to WWTP.

In Denmark, fuels and fuel additives represent 97% of the volume registered in the Product Register whereas the lubricants and lubricant additives represent only a few percent. Is it estimated that most likely the use pattern in Denmark resembles the general EU use pattern but the majority of the lubricants and lubricant additives are not registered in the Product Register. If the releases in Denmark are similar to the releases at EU level, the releases of DP to surface water and to soil can be considered significant when compared to releases of other alkylphenols. No data on actual measurements of DP and DPE in WWTPs in Denmark have been identified. In a survey of AP/APE in the Nordic environment it was found that DP levels may be in the same range as the concentration of NP in some environments e.g. close to towns and the DP was among the AP/APE found in the highest concentrations in sewage sludge samples.

Use and release of DPE – The consumption of DPE at EU level is estimated to be less than 1,000 t/y; mainly used as anti-rust agent in lubricants. No data on the releases of DPE at EU level is available. Most likely spillage and leakage of lubricants used for vehicles is the main source of releases.

Around 9 t/y of DPE was registered in the Product Register as used in lubricants and lubricant additives. Similar to the situation at EU level, spillage and leakage of lubricants used for vehicles is assumed to be the main source of releases.

Use of DP and DPE in consumer products – Both DP and DPE may be present in crankcase and engine oils for vehicles. The DP is present in the oils in concentrations of up to 1.5% while the concentration of DPE is below 0.5%. Whereas consumers would normally not change the crankcase oil of vehicles it may happen that consumers top-up engine oils of cars and to some extent also change the engine oil of the cars.

Several safety data sheets of epoxy hardeners with DP have been identified. The identified products seem mainly to be used for industrial or professional applications, and these products are most likely only to a very limited extent used by consumers.

Sammenfatning og konklusion

Denne rapport om udledninger af udvalgte alkylphenoler (AP) og alkylphenolethoxylater (APE) og brugen af disse stoffer i forbrugerprodukter er en opfølgning på en kortlægning af AP/APE udgivet af Miljøstyrelsen i 2012 som led i Miljøstyrelsens kortlægninger af stoffer og stofgrupper på Listen over Uønskede Stoffer (LOUS). Denne undersøgelse er én af aktiviteterne i Miljøstyrelsens strategi for risikohåndtering af AP/APE med henblik på at få yderligere viden om disse stoffer og at vurdere behovet for yderligere at mindske risiciene fra stofferne.

Dataene, som anvendes i undersøgelsen er indsamlet fra forskellige kilder: EU risikovurderinger og REACH bilag XV-dossierer, registreringer i henhold til REACH, emissionsscenariedokumenter, emissionsfaktorer for specifikke miljømæssige udslipskategorier i relation til REACH (SPERC) udviklet af brancheforeninger, Produktregistret og andre landes produktregistre, sikkerhedsdatablade, producenternes hjemmesider og direkte kontakt til brancheforeninger og markedsaktører.

Undersøgelsen af emissioner omfatter emissioner fra alle faser af de udvalgte stoffers livscyklus. For fire af stofgrupperne, nonylphenoler (NP) og deres ethoxylater (NPE) samt octylphenol (OP) og deres ethoxylater (OPE), er aktivitetsrater og emissionsfaktorer angivet med usikkerhedsintervaller og emissionerne er beregnet med usikkerheder ved hjælp af Monte Carlo modellering. Estimaterne er angivet med middelværdi, samt øvre og nedre grænse i et 90% sikkerhedsinterval.

Nonylphenoler (NP)
Anvendelse og udslip af NP - Det samlede forbrug af NP i EU anslås til cirka 42.000 t/år. NP anvendes næsten udelukkende (98%) som mellemprodukt til fremstilling af nonylphenolethoxylater (NPE), tri (4-nonylphenyl) phosphit (TNPP), epoxy og phenol/formaldehydharpikser, phenoloximer og andre plaststabilisatorer. Epoxy og phenol/formaldehydharpikser har et restindhold af NP på ca. 3-4%, og dette restindhold udgør den største mængde af NP til slut-anvendelser såsom maling og lak, lim og artikler med phenolplast, baseret på phenolharpikser. En del af restindholdet af NP vil - afhængigt af den aktuelle anvendelse - omsættes ved den efterfølgende hærdning af harpikserne.

"Harpikser" (også betegnet resiner eller kunstharpiks) er polymere materialer og grundlaget for phenolplast, overfladebehandlingsmidler, lim, etc. De kan være gennemsigtige, hårde materialer eller tykke væsker, der hærder til gennemsigtige faste stoffer. Phenol/formaldehydharpikser (PF) er syntetiske polymerer, der er opnået ved en reaktion mellem phenol eller substitueret phenol og formaldehyd.

Den vigtigste primære kilde til NP i overfladevand skønnes at være fremstilling af NPE, mens de vigtigste sekundære kilder er udledninger fra spildevandsbehandling og udledninger af NP dannet ud fra NPE i forbindelse med behandling af spildevand. Den største kilde til NP til jord er NP i spildevandsslam dannet ud fra NPE ved behandling af spildevand. De vigtigste kilder til NP til spildevand skønnes at være restindhold af NP i importerede tekstiler og udledninger, som stammer fra NP i maling og lak, klæbemidler, fyldstoffer og fugemasser (kilder til NPE er beskrevet under NPE). Med undtagelse af NP i tekstiler vil de samme anvendelser af NP være de vigtigste kilder til NP i fast affald. På grund af usikkerhederne (med typiske intervaller på en faktor 15 mellem de øvre og nedre grænser for hver kilde) er det ikke muligt at pege på, hvilke kilder til spildevand, der er af størst betydning, men det er ret sikkert, at afgivelser til fast affald og spildevand fra fremstilling- og formuleringsprocesser er små i forhold til udslip fra slutanvendelser. Det er også ret sikkert, at dannelsen af NP fra NPE ved spildevandsbehandling udgør en væsentlig del af de samlede udslip til overfladevand og jord, og at nedbrydning af NP i affalds- og spildevandsbehandling repræsenterer en væsentlig fjernelse af NP. Resultaterne er yderligere beskrevet nedenfor sammen med resultaterne for NPE.

Anvendelse af NP i forbrugerprodukter - NP er til stede i typiske koncentrationer på 1-5% i hærder-komponenten af epoxy specialmalinger til professionelt brug, og i hærder-komponenten af mange epoxy fugemasser, skum, lime, opfyldningsmidler, mv. Nogle af produkterne kan købes af forbrugere og vil i et vist omfang blive anvendt af forbrugere. I det svenske Produktregister (som i modsætning til det danske Produktregister omfatter forbrugerprodukter), tegner forbrugerprodukter sig for omkring 5% af det samlede antal produkter og sandsynligvis en mindre andel af tonnagen. Det anslås på den baggrund, at forbrugeranvendelser tegner sig for en meget lille del af den samlede mængde af NP i blandinger og artikler.

Nonylphenolethoxylater (NPE)
Anvendelse og udslip af NPE - Anvendelsen af NPE i EU er reguleret via REACH-forordningen, der foreskriver, at NPE ikke må anvendes til en række formål. Det anslås, at det samlede forbrug i EU er faldet fra 118.000 t/år i 1997 til cirka 18.000 t/år i 2011. De største anvendelsesområder er syntese af nonylphenolethersulfater og -fosfater, fremstilling af flotationsmidler til minedrift samt formulering af polymerdispersioner til emulsions-polymerisation (proces, hvor polymeriseringen foregår i en emulsion f.eks. i en maling). Polymerdispersionerne bruges til maling (største anvendelsesområde), trykfarver, klæbestoffer og nogle tekstilbelægninger, som pålægges i lukkede systemer.

De vigtigste kilder til udledninger til overfladevand skønnes at være spildevandsbehandling (største kilde) og anvendelse af NPE i flotationsmidler til minedrift. Anvendelsen som flotationsmiddel er ikke velbeskrevet og usikkerheden på estimaterne af udledningerne fra denne kilde er ganske høj. NPE i importerede tekstiler er den største kilde til NPE i renseanlæg, og tegner sig for 80% af de samlede udledninger til overfladevand, hvis middelestimater anvendes. Importerede tekstiler er den væsentligste kilde, selv når den lave værdi for denne kilde anvendes. Andre kilder af betydning på EU-plan, men som estimeres med stor usikkerhed (typisk en faktor 20 mellem den øvre og nedre grænser), er syntese af NPE-derivater, brug af maling og blæk, brug af affedtningsmidler og vedligeholdelsesmidler og brug af tekniske tekstiler (ikke-beklædning). I Danmark er syntese af NPE derivater og brug ad NPE i flotationsmidler ikke relevante kilder, og slutanvendelser tegner sig for næsten 100% af alle kilder til spildevand.

Anvendelse af NPE i forbrugerprodukter - I det svenske Produktregister er der registreret 165 forbrugerprodukter med NPE og forbrugerprodukter tegner sig for omkring 24% af det samlede antal af registrerede produkter. Dette indikerer en udbredt anvendelse af NPE i forbrugerprodukter.

NPE er til stede i mange bygningsmalinger baseret på akryl- og alkydbindemidler til både indendørs og udendørs anvendelser. Indholdet af NPE er typisk 1-5%. Mange af malingerne sælges i malerforretninger til såvel professionelle som forbrugeranvendelser. Ifølge oplysninger fra danske producenter anvendes NPE almindeligvis ikke i maling, som anvendes af forbrugere, men der er fundet en del datablade som angiver at NPE-holdige malinger anvendes til at byggeformål, og de pågældende typer malinger kan også anvendes af forbrugere. NPE er i mindre grad til stede i nogle epoxybaserede to-komponentmalinger. Denne type maling vil normalt være beregnet til industrielle og professionelle anvendelser, men kan i et vist omfang anvendes af forbrugere.

NPE kan være til stede i nogle primere til gulve og vægge, fugemasser til keramiske fliser og mosaikker og trælime. Produkterne er hovedsageligt til professionelt brug, men kan i et vist omfang anvendes af forbrugere.

NPE må i følge REACH forordningen ikke anvendes til rengøringsmidler, men NPE må anvendes i nogle affedtning- og vedligeholdelsesmidler. Affedtningsmidler anvendes til at fjerne olie og fedt på forskellige overflader (f.eks. bilmotorer eller køkkener) og kan til en vis grad kan anvendes af forbrugerne. Vedligeholdelsesmidler registreret i det danske Produktregister omfatter polish og voks til forskellige anvendelser (f.eks. til metal, gulve, plast og gummi), men der er også registreret nogle rengøringsmidler (f.eks. kalkfjernere), for hvilke det er vanskeligt ud fra beskrivelsen at bestemme om midlerne er omfattet af den nuværende begrænsning af NPE i rengøringsmidler.

NPE må i EU ikke anvendes til fremstilling af tekstiler (undtagen fremstilling i lukkede systemer uden udledning af spildevand), men NPE kan være til stede i importerede tekstiler. NPE anvendes ved selve fremstillingen af tekstilerne og fjernes normalt fra tekstilerne, men tekstiler kan indeholde et restindhold af NPE. Undersøgelser har påvist indhold af NPE i omkring 60% af alt tøj med en gennemsnitlig koncentration af alle analyserede prøver på 107 mg/kg.

NPE kan også være til stede i forskellige coatede tekstiler som eksempelvis bruges til telte, bagsidebelægninger til at stabilisere stof (møbelpolstring, køretøjer), belægninger på mørklægningsgardiner og belægninger på tæpper. I disse tekstiler indgår NPE i den påførte polymeremulsionen og er stadig til stede i den færdige coating. Den typiske koncentration af NPE i coatingen af disse tekstiler er fra 500 til 15.000 mg/kg. Koncentrationer på op til 45.000 mg/kg er blevet påvist i coatede/påtrykte dele af tøj.

Analyser viser, at 20% af læder fremstillet i Kina indeholder NPE i intervallet 11-1,500 mg/kg. Der er ikke fundet oplysninger om NPE i lædervarer importeret til EU. Da en væsentlig del af lædervarer, som markedsføres i EU, er importeret fra Kina og andre lande uden for EU er det sandsynligt, at en betydelig del af de lædervarer, der anvendes af forbrugere, indeholder NPE.

Sammenfatning af udslip af NP og NPE

Betydningen af udslip af NPE for NP niveauerne i miljøet - NPE bidrager til den samlede NP belastning af miljøet idet en del af den NPE, der behandles i renseanlæg, nedbrydes til NP og udledes fra renseanlæggene som NP. Udledningerne af NP fra renseanlæg til overfladevand, som stammer fra de direkte anvendelser af NP, er anslået til 8 (2-28) t/år, mens udledningerne fra nedbrydning af NPE i renseanlæg er anslået til 10 (9-14) t/år. Hertil kommer, at en del af den NPE der udledes vil nedbrydes til NP i miljøet. EU risikovurderingen for NP anslår, at 2,5% af den NPE, der udledes til miljøet, ultimativt vil nedbrydes til NP. Baseret på dette skønnes det, at NPE som udledes til miljøet, ultimativt vil resultere i en NP belastning af miljøet på yderligere 5 (3-9) t/år. Det skal bemærkes, at de samlede direkte udledninger af NP og NPE til overfladevand er meget afhængige af rensningseffektiviteten i renseanlæggene og andelen af spildevand som udledes direkte til overfladevand uden forudgående rensning i renseanlæg.

Udledninger i Danmark - De indirekte kilder af NP og NPE via spildevand og de direkte kilder til udledninger til miljøet i Danmark er vist i Tabel 0 nedenfor. NPE er angivet som NP-ækvivalenter, NP_{eq} ved at gange mængderne af NPE med 2/5 (se selve rapporten for en nærmere forklaring af denne ratio). De beregnede NP_{eq} angiver potentialet for dannelse af NP fra NPE, men udtrykker ikke den faktiske dannelse af NP ved nedbrydning af NPE i renseanlæg og i miljøet, som er signifikant mindre.

Når de skønnede udledninger sammenlignes med faktiske overvågningsdata i Danmark, er den mest markante forskel, at udslippene af NP til spildevand, som skønnes i denne undersøgelse, er betydeligt lavere end estimater baseret på faktiske målinger af NP-koncentrationer i indløbet til renseanlæg (udtrykt som nationale middelkoncentrationer). Samtidig er de estimerede bidrag af NPE til renseanlæg lidt højere end den anslåede sum af de lavere ethoxylerede NPE, NP_1EO og

NP_2EO i indløbet til renseanlæg baseret på faktiske målinger af koncentrationen af disse stoffer i indløbsvand. Denne forskel for NPE kan forklares ved, at de højere ethoxylerede NPE ikke er medtaget i de nationale middelkoncentrationer. Forklaringen på de relativt store mængder af NP og relativt lave mængder af NPE fundet i indløbet til renseanlæggene i forhold til de estimerede udledninger kan muligvis forklares ved en nedbrydning af NPE til NP allerede i kloaksystemet. Der findes dog ingen data der kan belyse, i hvilket omfang en sådan nedbrydning finder sted. I opgørelserne af emissioner i Danmark er der ikke anvendt intervaller, der angiver usikkerhederne. Opgørelserne på EU plan viser, at der kan være ganske store usikkerheder på opgørelserne for de enkelte kilder, og forskellene mellem beregnede og målte mængder kan derfor meget vel være inden for usikkerhederne på opgørelserne.

TABEL O
KILDER TIL UDLEDNINGER AF NP OF NPE TIL SPILDEVAND, JORD OG OVEFLADEVAND I DANMARK I 2013 (GENNEMSNITSVÆRDIER) *1

Anvendelsesområde Indirekte kilder via spildevand	Udledninger til spildevand, tons/år				% af udledninger til spildevand, NP_{eq}
	NP	NPE	NPE som NP_{eq} *1	Total NP_{eq} *1	
Formulering af maling, trykfarver og lime	-	0,215	0,086	0,086	3%
Slutanvendelser af blandinger og artikler:					
Maling, lakker og fernis (inkl. overfladebehandling)	0,032	0,027	0,011	0,043	1%
Lime, fugemasser og udfyldningsmidler	0,059	0,009	0,004	0,063	2%
Artikler af phenolharpiks	0,013	-	-	0,013	0%
Tekstiler (inkl. tekniske tekstiler)	0,080	6,016	2,406	2,486	76%
Affedtningsmidler	-	0,425	0,170	0,17	5%
Rengørings- og vedligeholdelsesmidler	-	1,025	0,410	0,41	13%
Læderprodukter	-	0,012	0,005	0,005	0%
Andet	-	0,005	0,002	0,002	0%
I alt til spildevand	**0,184**	**7,734**	**3,094**	**3,278**	**100%**

Direkte kilder	Overfladevand			Jord		
	NP	NPE som NP_{eq} *1	% af samlet NP_{eq} *1	NP	NPE som NP_{eq} *1	% af samlet NP_{eq} *1
Spildevandsbehandling af NP	0,021	-	1%	0,035		7%
Spildevandsbehandling af NPE *1	0,194	1,215	99%	0,332	-	69%
Brug af NPE i affedtningsmidler	-	-	-	-	0,034	7%
Brug af NPE i rengørings- og vedligeholdelsesmidler	-	-	-	-	0,082	17%
Brug af NPE i andre produkter	-	-	-	-	0,001	0,2%
I alt	**0,215**	**1,215**	**100%**	**0,367**	**0,117**	**100%**

*1 NPE er angivet i NP_{eq} ved at gange mængderne af NPE med 2/5 (se afsnit 1.2). De beregnede NP_{eq} mængder angiver potentialet for dannelse af NP fra NPE, men udtrykker ikke den faktiske dannelse af NP ved nedbrydning af NPE i renseanlæg og i miljøet, som er væsentligt mindre.

*2 Udledningerne af NP til overfladevand og jord (via spildevandsslam) fra spildevandsbehandling af NPE skyldes nedbrydning af NPE til NP ved spildevandsbehandlingen.

Octylphenoler (OP)

Anvendelse og udslip af OP - Stoffet 4-*tert*-OP tegner sig for næsten 100% af forbruget af OP og beskrivelse af anvendelsen og udslip af OP drejer sig derfor om 4-*tert*-OP. Det samlede forbrug i EU er ca. 23.000 t /år. Der er ingen anvendelsesbegrænsninger for OP og OPE. OP anvendes primært til fremstilling af phenol/formaldehyd-harpikser og en lille mængde anvendes til fremstilling af OPE. Phenol/formaldehydharpikser har et restindhold af OP på ca. 3-4% og ikke-reageret OP kan være til stede i blandinger og artikler fremstillet af disse harpikser. En del af det resterende OP-indhold vil - afhængigt af anvendelsen - omsættes ved den efterfølgende hærdning af harpiksen.

De vigtigste kilder til udledninger af OP til overfladevand skønnes at være restindhold af OP i dæk (hvor OP kan være bundet i afslidte gummipartikler) og spildevandsbehandling. Usikkerheden på udledninger fra dækkene er meget høj, fordi OP er til stede i kernen af dækkene, og det er usikkert, i hvilket omfang det OP-holdige gummi faktisk afgives ved brug. Dannelsen af OP fra OPE i renseanlæg synes at være beskeden sammenlignet med de direkte tilledninger af OP til renseanlæggene. I modsætning til situationen for NP/NPE, synes dannelse af OP fra OPE i renseanlæg således ikke at være en væsentlig kilde til udslip af OP til miljøet på EU niveau.

Brug af OP i forbrugerprodukter - Forbrugerprodukter med et restindhold af 4-*tert*-OP er dæk og nogle marine malinger. Et gennemsnitlig dæk produceret i EU indeholder mellem 0,007% og 0,012% 4-*tert*-OP. Den direkte eksponering til 4-*tert*-OP i dæk anses at være lav, fordi stoffet er bundet i gummimassen, og desuden er 4-*tert*-OP typisk kun er til stede i kernen af dækket. De marine malinger er primært beregnet til professionelle anvendelser, men kan også bruges af ejere af lystbåde.

Octylphenolethoxylater (OPE)

Anvendelse og udslip af OPE - Det samlede forbrug af OPE på EU-plan er cirka 1.000 t/år og dermed relativt lille sammenlignet med forbruget af NPE. Det nuværende forbrug af OP er mindre end 1% af forbruget af NPE i 1999 (før anvendelsesbegrænsningen), og de foreliggende data tyder ikke på, at OPE i væsentligt omfang har erstattet NPE i rengøringsmidler og andre historiske anvendelser af NPE. De vigtigste anvendelsesområder for OPE er syntese af octylphenolethersulfater og formulering af polymerdispersioner til emulsionspolymerisation. Polymerdispersionerne bruges til maling, lim og fugemasser og til formulering af tekstil- og læderbehandlingsmidler.

På EU-plan er de vigtigste kilder af OPE til overfladevand udledninger fra renseanlæg og brug af OPE i pesticider og biocider. De vigtigste kilder til OPE i renseanlæg skønnes at være fremstilling og anvendelse af tekstiler og læderbehandlingsmidler, slutanvendelse af vandbaserede malinger, og slutanvendelse af tekstiler (vask).

Udslip af OPE til jord er betydeligt større end udledningerne til spildevand, overfladevand og luft, og stammer fra OPE i pesticider, der anvendes i landbruget. OPE frigivet til jord kan enten nedbrydes i jorden eller kan ende i overfladevand ved dræning.

Anvendelse af OPE i forbrugerprodukter - Sammenlignet med NPE, anvendes OPE i langt mindre grad i forbrugerprodukter. I det svenske Produktregister er der alt registreret 5 varer med OPE (16% af alle registrerede produkter med OPE) mens der er 165 registrerede forbrugerprodukter med NPE. En af de vigtigste anvendelser af OPE er i akrylmaling, som anvendes til både industrielle anvendelser og bygningsanvendelser. Det samlede antal af produkter inden for produktgruppen maling, lak og fernis registreret i det danske Produktregister er 68 (til professionelle formål), hvilket viser, at OPE er almindeligt anvendt i maling, men ikke så almindeligt som NPE (158 produkter). Akrylmalinger, der bruges til at bygningsanvendelser, kan i et vist omfang blive solgt fra byggemarkeder og malingforretninger og anvendes af forbrugerne. Som det fremgår af de svenske data, er forbrugeranvendelser dog ikke almindelige. OPE er også til stede i nogle typer af imprægneringsmidler til sten og i gulv finish, som kan anvendes af forbrugere.

OPE fungerer som emulgeringsmiddel i visse efterbehandlingsmidler, som anvendes til at dække tekstiler og læder med en tynd polymerfilm for at gøre materialet mere modstandsdygtigt over for vand, støv og lys. Desuden kan OPE anvendes i tekstiltryk. I tekstiler uden belægning og påtryk er de gennemsnitlige koncentrationer lave sammenlignet med koncentrationerne af NPE. Målinger i trykte områder på tekstiler viste, at koncentrationen af OPE i disse områder kan være op til 650 mg/kg. Der findes ingen undersøgelser af omfanget af brugen af OPE i coatede/påtrykte tekstiler og læder, men sandsynligvis er OPE til stede i nogle beklædningsgenstande og lædervarer, der anvendes af forbrugerne.

OPE er til stede i nogle få produkter inden for produktgruppen "rengøring, vask og vedligeholdelsesmidler". Sammenlignet med det registrerede forbrug af NPE, er forbruget af OPE i forbrugerprodukter begrænset, og det samlede registrerede forbrug i Produktregistret var mindre end 0,1% af den registrerede forbrug af NPE i 2012. Resultatet indikerer, at OPE ikke i nogen større udstrækning har erstattet NPE i rengørings- og vedligeholdelsesmidler. Det har ikke været muligt at finde specifikke OPE-holdige rengørings-, vaske- og vedligeholdelsesmidler til forbrugeranvendelse, men det kan ikke udelukkes, at sådanne i et begrænset omfang markedsføres til brug af forbrugere.

Sammenfatning af udledninger af OP og OPE i Danmark
En sammenfatning af de estimerede udledninger af OP og OPE i Danmark er vist i Tabel 00. Fordelingen mellem kilderne er ganske forskellig fra fordelingen på EU-niveau fordi OP og OPE ikke produceres i Danmark og kun i meget begrænset omfang anvendes til formuleringsprocesser. Hertil kommer, at forbruget af OPE i pesticider og biocider tilsyneladende er lavere end EU-gennemsnittet. Som et resultat udgør OP i dæk den største kilde til udledninger til overfladevand og jord. Estimatet er udledt fra de gennemsnitlige værdier på EU plan, men det skal noteres at disse værdier er anslået med meget stor usikkerhed.

4-*tert*-butylphenol (4-*tert*-BP)
Anvendelse og udslip af 4-*tert*-BP - 4-*tert*-BP repræsenterer den største tonnage af butylphenolerne samt anvendelser med de forventede højeste udledninger. Det samlede forbrug i EU er omkring 27.000 t/år. Stoffet benyttes næsten 100% som mellemprodukt til fremstilling af polycarbonater, alkoholer og phenol- og epoxyharpikser. Restindholdet af 4-*tert*-BP harpiks er omkring 3-4%, men en del af dette vil - afhængigt af anvendelsen - omsættes ved den efterfølgende hærdning af harpiksen.

I følge estimaterne i EUs risikovurdering for 4-*tert*-BP repræsenterer fremstilling og anvendelse af epoxyharpikser den største kilde til udslip til luft, mens fremstilling og anvendelse af phenolplast og epoxyharpikser repræsenterer den største kilde til udledning til spildevand. Udledningerne til luft er betydeligt højere end de direkte udledninger til overfladevand og må betragtes som den vigtigste vej for udledninger til miljøet.

Udledninger fra anvendelsen af produkter med et restindhold af 4-*tert*-BP i harpikser er i ifølge EUs risikovurdering lav eller ubetydelig, fordi det resterende indhold af 4-*tert*-BP i hærdede harpikser og polycarbonat er lille.

TABEL 00
UDSLIP AF OP OG OPE TIL SPILDEVAND, JORD OF OVERFLADEVAND I DANMARK I 2013 *1

Anvendelsesområde Indirekte kilder via spildevand	Udledninger til spildevand, tons/år				% af udledninger til spildevand, OP_{eq}
	OP	OPE	OPE som OP_{eq} *1	Total OP_{eq} *1	
Formulering af maling, trykfarver og lime	-	0,004	0,002	0,002	1%
Slutanvendelser af blandinger og artikler:					
Dæk	0,006	-	-	0,083	49%
Maling og trykfarver	-	0,011	0,004	0,004	2%
Smøremidler	-	0,002	0,001	0,001	1%
Overfladecoatede tekstiler	-	0,075	0,03	0,03	18%
Andre tekstiler	-	0,095	0,038	0,038	22%
Rengørings- og vedligeholdelsesmidler	-	0,005	0,002	0,002	1%
Læderprodukter	-	0,026	0,010	0,010	6%
I alt til spildevand	**0,006**	**0,218**	**0,087**	**0,093**	**100%**

Direkte kilder	Overfladevand			Jord		
	OP	OPE som OP_{eq} *1	% af samlet, OP_{eq} *1	OP	OPE som OP_{eq} *1	% af samlet, OP_{eq} *1
Spildevandsbehandling af OP	0,001	-	1%	0,001	-	1%
Spildevandsbehandling af OPE *1	-	0,015	15%	-	-	-
Brug af OP i dæk	0,083	-	83%	0,083	-	86%
Brug af OPE i smøremidler	-	-	-	-	0,001	1%
Brug af OPE i pesticider og biocider	0,001	0,0004	1%	-	0,011	11%
Brug af OPE i rengørings- og vedligeholdelsesmidler	-	-	-	-	0,0004	0.4%
Total	**0,085**	**0,015**	**100%**			**100%**

*1 OPE er angivet i OP_{eq} ved at gange mængderne af OPE med 2/5 (se afsnit 1.2). De beregnede OP_{eq} mængder angiver potentialet for dannelse af OP fra OPE, men udtrykker ikke den faktiske dannelse af OP ved nedbrydning af OPE i renseanlæg og i miljøet.

*2 Udledningerne af OP til overfladevand og jord (via spildevandsslam) fra spildevandsbehandling af OPE skyldes nedbrydning af OPE til OP ved spildevandsbehandlingen.

Anvendelse af 4-*tert*-BP i forbrugerprodukter - 4-*tert*-BP er til stede i visse typer af epoxybaserede lime, maling og lak i koncentrationer fra 1% til 50%. Produkterne er primært til industriel og erhvervsmæssig brug, men nogle produkter sælges i byggemarkeder og kan i et vist omfang anvendes af forbrugerne.

Forbrugere kan endvidere blive udsat for restindhold af 4-*tert*-BP i polycarbonat og phenol- og epoxyharpikser. Men EU risikovurderingen for 4-*tert*-BP anslår, at den potentielle eksponering for 4-*tert*-BP i polycarbonat og epoxyharpikser er ca. 100 gange lavere end den potentielle eksponering for stoffet i lime.

Dodecylphenoler (DP) og dodecylphenol ethoxylater (DPE)

Anvendelse og udslip af DP - På EU-plan anvendes omkring 99% af forbruget af DP på ca. 50.000 t/år i produktionen af tilsætningsstoffer til olier og andre smøremidler. Dodecylphenol er til stede i lave koncentrationer i tilsætningsstofferne og i de endelige smøremidler. Den største kilde til frigivelse af DP til miljøet er spild og udslip af gearolier, der skønsmæssigt udgør mere end 99% af de samlede udslip af DP til jord, overfladevand og rensningsanlæg. Den samlede udledning på EU-plan er blevet anslået til 3,3 t/år til overfladevand, 22,3 t/år til jord og 23,3 t/år til renseanlæg.

I Danmark udgør brændstoffer og brændstoftilsætninger 97% af den mængde, der er registreret i Produktregistret, mens smøremidler og tilsætningsstoffer til smøremidler udgør et par procent. Det vurderes at forbrugsmønstret i Danmark højst sandsynligt svarer til forbrugsmønstret generelt i EU, men de fleste af smøremidlerne og tilsætningsstoffer til smøremidler er ikke registreret i Produktregistret. Hvis udslippene i Danmark svarer til udslippene på EU-plan, kan udslip af DP til overfladevand og jord betragtes som væsentlige sammenlignet med udslip af andre alkylphenoler. Der er ikke fundet data fra faktiske målingerne af DP og DPE i renseanlæg i Danmark, men i en undersøgelse af AP/APE i det nordiske miljø fandt man, at DP-niveauerne kan være af samme størrelsesorden som koncentrationen af NP i nogle miljøer f.eks. tæt på byerne, og DP var blandt de AP/APE, der blev fundet i de højeste koncentrationer i prøver af spildevandsslam.

Anvendelse og udslip af DPE - Forbruget af DPE på EU-niveau skønnes at være mindre end 1000 t/år; hovedsagelig anvendt som anti-rust-tilsætningsstof i smøremidler. Der er ikke fundet data om udslip af DPE på EU-plan. Mest sandsynligt vil spild og lækage af smøremidler, der anvendes til køretøjer, være den vigtigste kilde til udslip.

Der er registreret et forbrug af DPE på omkring 9 t/år i Produktregistret. Dette anvendes i smøremidler og tilsætningsstoffer til smøremidler. I lighed med situationen på EU-plan, formodes spild og lækage af smøremidler, der anvendes til køretøjer, at være den vigtigste kilde til udslip.

Brug af DP og DPE i forbrugerprodukter - Både DP og DPE kan være til stede i gearolier og motorolier til køretøjer. DP er til stede i olierne i koncentrationer op til 1,5%, mens koncentrationen af DPE er under 0,5%. Forbrugere vil normalt ikke selv skifte gearolier på køretøjer, mens det sker, at forbrugerne påfylder motorolier på biler, og til en vis grad også skifter motorolie på bilerne. Der er fundet en adskillige sikkerhedsdatablade for epoxyhærdere med DP. De fundne produkter synes hovedsagelig at bruges til industrielle eller professionelle formål, og disse produkter anvendes mest sandsynligt kun i meget begrænset omfang af forbrugere.

1. Introduction and methodology

1.1 Objective of the survey

As part of the strategy for reducing the risks of alkylphenols and alkylphenol ethoxylates, the Danish EPA has initiated a survey of emissions of alkylphenols and alkylphenol ethoxylates from all life cycle stages of the substances and a survey of the use of the substances in consumer products.

The main objectives of the surveys are:

- to establish an overview of the releases of the AP/APE to the environment and the significance of the different sources, and
- to establish an overview of the use of AP/APE in consumer products as background for considerations regarding the potential for consumer exposure.

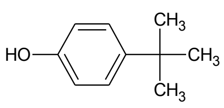
1.2 The substance groups

Alkylphenols (AP) and alkylphenol ethoxylates (APE) are two broad groups of substances.

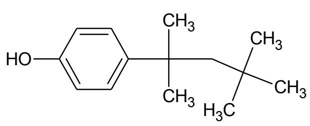
An alkylphenol is a phenol derivative wherein one or more of the ring hydrogens have been replaced by one or more alkyl groups. An alkyl group is a functional group or side-chain that consists solely of single-bonded carbon and hydrogen atoms. A wide variety of alkylphenol structures are possible, but many are not commercially important. Alkylphenols of the greatest commercial importance have alkyl groups ranging in size from one (methyl) to twelve carbons (dodecyl) (Lassen *et al.,* 2012). The alkylphenols are often named after their chain length e.g. nonylphenol (9 carbon atoms) and dodecylphenol (12 carbon atoms).

Three examples of AP addressed in this survey are shown below (from Lassen *et al.*, 2012).

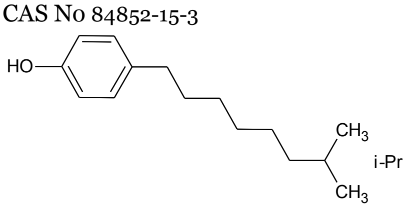
4-*tert*-Butylphenol
CAS No 98-54-4



4-(1,1,3,3-Tetramethylbutyl)phenol (4-*tert*-octylphenol)
CAS No 140-66-9



4-Nonylphenol, branched
CAS No 84852-15-3

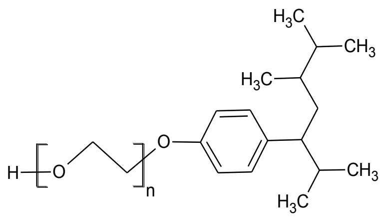


The alkylphenol ethoxylates (APE) are produced from alkylphenols. Only ethoxylates of octylphenol, nonylphenol and dodecylphenol have been identified as used in the EU. Two examples are shown below (from Lassen *et al.*, 2012).

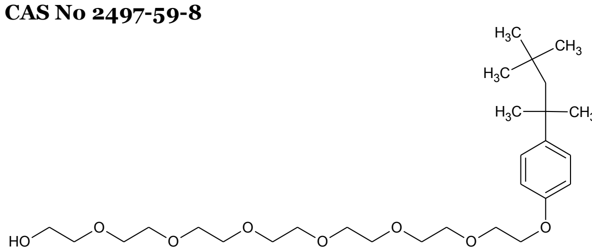
APEs are manufactured by the addition under pressure of ethylene oxide (C_2H_4O) to the alkylphenol. The length of the ethoxylate chain can be controlled by regulating the ratio of the alkylphenol and the ethylene oxide and by the reaction time. Commercial APEs are a mixture of ethoxylated APs with differing ethoxy units. The chemical and toxicological properties are dependent on the ethoxy chain length. The APEs may be degraded in the environment to shorter chain APEs and the parent AP.

As the commercial APEs are mixtures of ethoxylated APs with varying ethoxy units, it is not possible to exactly calculate the potential for degradation to APs of the mixture. For the calculation of NPE in terms of NP equivalents (NP_{eq}) in this report, a NP:NPE ratio of 2:5, corresponding to a NPE with 8 ethoxy units, is used in accordance with the NP equivalency calculations in the Annex XV restriction report for NP and NPE in textiles (KemI, 2013).

Nonylphenol, branched, ethoxylated
CAS No 127087-87-0



20-[4-(1,1,3,3-Tetramethylbutyl)phenoxy]-3,6,9,12,15,18-hexaoxaicosan-1-ol (octylphenol ethoxylate)
CAS No 2497-59-8



The Danish EPA published in 2012 a survey of AP/APE with a description of the different subgroups of the AP/APE (Lassen *et al.*, 2012). On the basis of the survey, the Danish EPA developed a strategy for measures for further reducing the risks from the substances.

For this survey, the following groups of OP/OPE have been selected:

- Nonylphenol and nonylphenol ethoxylates (NP and NPE);
- Octylphenol and octylphenol ethoxylates (OP and OPE);
- 4-*tert*-Butylphenol (4-*tert*-BP);
- Dodecylphenol and dodecylphenol ethoxylates (DP and DPE).

1.3 Mass flow and release estimation model

Mass flow model

A mass flow is set-up for each substance. The general mass flow includes all life-cycle stages in t/y: manufacture of substance, import/export, industry use as intermediate and for formulation and processing, consumer use of mixtures and articles, waste management and releases to environmental compartments from each of these life-cycle stages, see Figure 1 below for an example showing the estimated flow of nonylphenol (NP) in the EU as mean values. The values will be commented later.

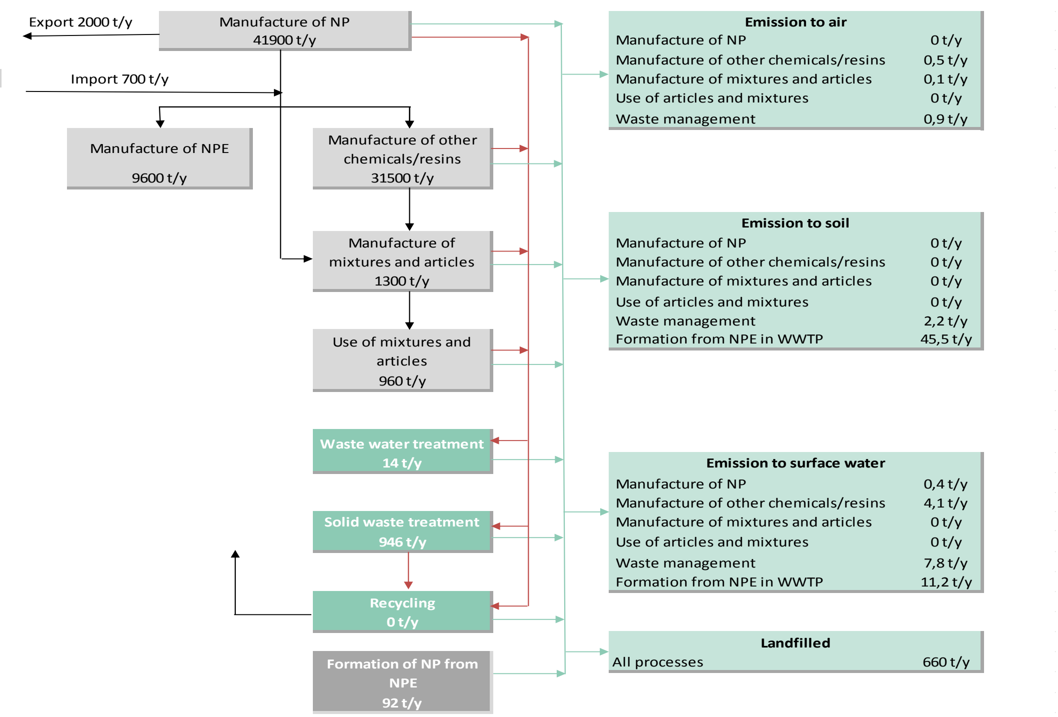


FIGURE 1
OVERALL FLOW OF NP IN THE EU IN 2012 (MEAN VALUES)

Release estimation, activity data and emission factors
The inflow of the substance to each life-cycle stage is termed activity data (AD) in t/y. Activity data for each life-cycle stage are compiled in tables, see Table 3 in section 2.1.1 as an example. For each of the activity data, the background for the estimated figures is described.

The activity data are defined by a mean value and a 90% confidence interval, which represents the range within which the authors estimate that the true value will be with a probability of 90%.

Releases from each stage of the mass flow are calculated to air, surface water, soil, waste water, solid waste and landfill from the equation:

$$Release(j) = \sum_{i=1}^{n} EF(i,j) * AD(j) \qquad (1)$$

where releases are given in t/y, *j* is a stage in the mass flow, *i* refers to an environmental compartment or waste media, *n* is number of compartments and waste media, *EF(i,j)* is the emission factor to compartment or waste media *i* from stage *j*, *AD(j)* is the activity data for stage *j*.

When the substance is part of an end-product (an article or mixture), the ideal case would be to have access to activity data such as consumed amount of products. Furthermore, to know the substance content in these products and to have data from measurements and/or estimates of emission factors for the substance under the given conditions of product use. Realising that not all data is available and that assumptions and simplifications are necessary, EFs can be given in one or more of the following ways:

- g released (AP/APE)/(g used product) on an aggregated level
- g released (AP/APE)/(year or day)
- g released (AP/APE)/(g(AP/APE) in product)

- In the ideal case the one can be derived from the other. Preference should be given to g released (AP/APE)/(g(AP/APE) in product).

In the tables and figures below the EFs are given in %, i.e. g released (AP/APE)/g (AP/APE) in product or process.

Waste management
Releases to waste management (waste water and solid waste) will ultimately result in releases to air, surface water, soil and landfill.

The flows to the waste media (waste water and solid waste) are further distributed using distribution factors for waste management and the flows are terminated by estimating the flows to the environmental compartments (air, surface water and soil) and to landfill. Even though the substances directed to landfill in the long term may be released to the environment it is within the model applied considered a terminal destination of the substances. The actual releases to surface water from landfill effluents are included in the mass flow model to the extent monitoring data are available.

When a substance is mineralised or transformed into another substance, e.g. through microbial degradation in a waste water treatment plant, the degradation/formation fraction will be included in the EF. In this way there will only be one EF for each stage and compartment in the mass flow.

Uncertainties and Monte Carlo modelling
Release calculations are performed in conjunction with the uncertainty assessment as a Monte Carlo type analysis (see e.g. Wikipedia for a description of this type of analyses). Releases and uncertainties will be calculated in MS Excel by a program coded in Visual Basic. The program is designed and used for the Danish emission inventory (DCE NIR, 2014).

By the Monte Carlo analysis the computations are repeated in our case 10,000 times in order to obtain the whole spectrum of possible flow events by including the full range of the distributions representing each activity data and emission factor.

EF and AD are assumed to be log-normal distributed and the method allows for accounting the amount of substance at each stage in the mass flow by setting the sum of EFs to environmental compartments and waste management to unity:

$$\sum_{i=1}^{n} EF(i) = 1 \qquad (2)$$

where *i* is the environmental compartment or waste management media, *EF(i)* is the associated emission factor, *n* is the number of environmental compartments and waste management media.

The total releases to environmental compartments are calculated as a sum of direct (primary) releases from mass flow stages and secondary releases from waste management media.

EFs and AD are uncertain parameters and are represented by one figure (mean value) with 90%-confidence interval limits. It is common to represent each figure by a distribution; depending on the nature of the uncertainty it may be a normal distribution, lognormal, uniform or other kind of distribution. For this survey, all EFs and ADs are represented by log-normal distributions as used in the national Danish emission inventory.

When only one or two figures define an EF or AD, the uncertainty will be assessed from expert judgment, and indicated as an "uncertainty factor" representing the 90% confidence interval ranging from (mean value/uncertainty factor) to (mean value * uncertainty factor). When more than two figures define an EF or AD, the mean value and 90% confidence interval is calculated from these by conventional statistics. In some cases the upper and lower intervals are set to the minimum and maximum values, respectively, from the available dataset.

Please note that the uncertainty ranges represent the uncertainty on the average figures. For a specific source category (e.g. manufacture of paints), the variation in emission factors between the specific industrial facilities is significantly higher.

An uncertainty calculation is made for each stage in the mass flow where releases to all environmental compartments and waste management media are included, see Equation 1. The output format corresponds to the input parameter format, i.e. a mean value and 90% confidence interval, see Table 4.

The relative contributions to the uncertainty from the different environmental compartments and waste management media will be calculated and discussed.

Substances with few applications and releases sources
For 4-*tert*-butylphenol, dodecylphenol and dodecylphenol ethoxylate with few applications and a few sources of releases, the release estimates are based on release estimates undertaken in other studies on the basis of a description of the life-cycle of the substances. For these substances no attempts have been done for estimating uncertainties as relatively few sources account for nearly 100% of the releases.

Uncertainty and data sources
The data sources used such as the EU Risk Assessments Reports (RAR) and the OECD emission scenario documents (ESD) do not indicate uncertainties. The objective of the Risk Assessments, with regard to the environment, is to assess whether the use of the substances for the different applications may in a "worst case" or "realistic worst case" result in exposure of the environment at local, regional or continental level that could constitute a risk. The assessments do not compare the emission sources e.g. on total EU level.

The objective of this survey is to identify the main sources of releases of the alkylphenols and their ethoxylates and an analysis of the uncertainties is introduced in order to assess the significance of the estimated differences between the sources. Analysis of the uncertainties is e.g. common in national emission inventories, and in mass balance studies to identify critical stages with high uncertainties.

Activity data in the risk assessments and other data sources are usually based on actual information on uses and are usually considered a "best estimate" and not "worst case". In this survey the figures are used as the mean values.

For the EFs, different sources uses EFs that are in general considered "worst case", "reasonable/realistic worst case", "reasonable/realistic" or "actual" (based on actual data).

"Worst case" – The Technical Guidance Document (TGD) provide default "worst case" EFs which are used in the EU Risk Assessments if no information on actual emission is known. Similar default "worst case" EFs are provided for the predefined Environmental Release Categories (ERCs) in Table R.16-23 in the REACH guidance on information requirements and chemical safety assessment "Chapter R.16: Environmental Exposure Estimation" (ECHA 2012a). The default "worst case" emission factors represent the potential emission if no Risk Management Measures (RMMs) for emission control is in place. In this survey, if the "worst case" emission factors are derived from the data sources, they are considered to represent the upper value of the 90% uncertainty interval.

"Reasonable/realistic worst case" – The OECD Emission Scenario Documents (ESDs) uses in general "reasonable worst case" default EFs. If there is specific information that particular controls (Risk Management Measures) are implemented then this should be taken into account when using these default EFs. The EFs from the ESDs are to some extent used for deriving the SPERCs mentioned below. Default EFs for industrial processes from the ESDs are in general like the "Worst case" EFs in this survey used as the upper value of the 90% uncertainty interval.

"Reasonable/realistic" – For the standardized supply chain communication of environmental assessments under REACH, a number of industry sector groups and trade associations have developed Specific Release Categories (SPERCs) which describe typical operational conditions that are relevant with regard to the emissions of substances to the environment (CEFIC, 2012). Whereas the ERC (mentioned above) as defaults use "worst case" and risk management options (RMO) are not included, the SPERCs represent "good practice" and RMOs are considered (CEFIC, 2012). The different trade organisations, however, use slightly different approaches. For some SPERCs, the initial release factors define the primary emissions from a process ("reasonable worst case"). The risk management measures are explicitly addressed by accounting for their efficiency. This efficiency defines the degree by which the emissions are reduced. For a number of SPERCs (e.g. those of Eurometaux) the effect of the risk management measures is already accounted for in the initial release factors. (CEFIC 2012). The uncertainty estimates in this survey consider which type of SPERCs is used.

For emission from diffuse sources, such as releases from the application of paints, the emission factors from ESDs, Risk Assessments, SPERCs and other sources are generally considered realistic/reasonable and are in this survey used as the mean value.

"Actual" – The Risk Assessments provide for some source categories an estimate based on the actual values provided by industry. The actual values are in the Risk Assessments used for estimating local, regional and continental releases. In this survey the EFs are estimated from the actual releases as the ratio of the total regional and continental releases (=total releases in the EU) and the quantities of the substances used for the application concerned. These emission factors are used as mean values.

In fact, the uncertainties of the emission factors are in general not known as it would require detailed information on how the emission factors are derived and information on how the emission factors between different sources within the same source category typically vary. In this survey the uncertainties are estimated by "expert estimates" with a side glance to the uncertainties of similar emission factors used in national emission inventories. Each of the "expert estimates" may in fact be questioned, and the uncertainties of the total mass flow may rather be considered a scenario: "if the uncertainties of the input parameters are of this size, then the uncertainties of the output would be of this size".

Degradation and formation

Besides the direct flows of the substances through the life cycle, the substances may be degraded to other substances or formed from other substances.

The degradation typically takes place during the waste management stage where the substances may be mineralised (degraded to its basic components) by solid waste incineration or degraded to other organic substances by waste water treatment. In the mass flows the degradation is indicated as a specific pathway, by including an EF of the waste management unit as a difference between total inputs and outputs.

The alkylphenols may be formed from the corresponding alkylphenol ethoxylates by degradation during use of products or during waste treatment (e.g. formed in waste water treatment plants). The volumes generated are included in the mass flows as an additional input at the different stages of the mass flow.

Mass of substance in articles in use in the society
The actual release from articles in use in a certain year is in fact not a function of the consumption the year concerned, but a function of the total mass of the substances in articles in use in the society. The total quantities in articles in use can be calculated from historic consumption figures combined with information on the life-time distribution of the articles. Such information is in general not available and the releases of the substances are consequently based on the actual consumption figures assuming a "steady state" situation, i.e. the estimated releases correspond to the releases if the consumption is continued for many years at the current level. The methodology is in accordance with the methodology used for release estimations in the EU Risk Assessments.

1.4 Collection of activity data and emission factors

Activity data and emission factors have been collected from various data sources.

Risk Assessments and Emission Scenario Documents

SPERCs
As mentioned above a number of industry sector groups and trade associations have developed Specific Release Categories (SPERCs) which describe typical operational conditions that are relevant with regard to the emissions of substances to the environment (CEFIC, 2012). SPERCs from the following organisations have been reviewed and considered for use in this survey:

- CEPE (paint and printing inks)
- FEICA (adhesives and sealants)
- VCI (construction chemicals)
- AISE (detergents)
- ETRMA (rubber)
- Atiel (lubricants)
- Eurometeaux (metal processing)
- ESIG/ESVOC (solvents)
- ECPA (plant protection products)
- ACEA (European Automobile Manufacturers Association)

The Danish Product Register
Data on the use of AP/APE in mixtures in Denmark were retrieved from the Danish Product Register.

The Danish Product Register includes substances and mixtures used occupationally and which contain at least one substance classified as dangerous in a concentration of at least 0.1% to 1% (depending on the classification of the substance). Of the concerned AP/APE only NP and 4-*tert*-OP are classified as dangerous. For the other non-classified substances, the registration will only occur if they are constituents of mixtures which are classified and labelled as dangerous due to the presence of other constituents. Polymer compounds and masterbatches are not covered by the notification scheme. The data consequently do not provide a complete picture of the presence of the substances in mixtures placed on the Danish market. As stated above, the amounts registered are for occupational use only. However, for substances used for the manufacture of mixtures in Denmark, the data may still indicate the quantities of the substances in the finished products placed on the market both for professional and consumer applications.

The representativeness of the registered substances is discussed for each application in the survey

1.5 Distribution factors for the fate of the waste fractions

In the model applied, substances directed to waste water and solid waste is distributed by the different pathways by use of average distribution factors for Denmark and the EU, respectively. As an example 4% of the sewage is directly discharged to surface water by WWTP overflows. This distribution factor is the same for all AP/APE. Within the WWTP, the substances are distributed to surface water (effluent), air or sewage sludge, soil, incineration, landfill or they are degraded. For this distribution, substance specific distribution factors are used, and these factors are indicated for each substance in the next chapter. The distribution of the generated sewage sludge by pathway will be the same for all substances and included in the table below.

TABLE 1
COMMON DISTRIBUTION FACTORS FOR WASTE FRACTIONS. VALID FOR ALL AP/APE.

Name of parameter	Pathway	Distribution factor	Remark
Denmark:			
Sewage treatment	WWTP	96%	DANVA (2009b): Water in figures (in Danish)
	Surface water WWTP overflows (due to heavy rain and flood, overflows escaping WWTP treatment processes) – direct discharge to surface water	4%	In the absence of general EU distribution figures, the Danish figures are used as the best estimate
Sewage sludge disposal	Agricultural soils Incineration Landfill	55% 45% 0%	The figures differ from year to year, and from source to source. Estimated average figures. (DANVA, 2009a; Kirkeby *et al.*, 2005; DEPA, 2009)
MSW not recycled (exc. paper, glass, metals, etc. which is recycled)	Incineration Landfilling	93% 7%	EEA, 2013 The distribution of MSW which is not recycled – the quantities recycled is assessed for each of the substances in the following chapter In total incineration 54%, landfilling 4 % and recycling 42%
Incinerated waste, fate of AP/APE	Air Landfill (residues) Degraded	0-0,1% 0-1% 99-100%	No data are available on the fate of AP/APE by incineration but most probably the substances are nearly 100% degraded. The majority of the substances which are not degraded is expected to end up in residues Same emission factors are used for sewage sludge incineration

EU:			
Sewage treatment	WWTP Surface water WWTP overflows (due to heavy rain and flood, overflows escaping STP treatment processes) – direct discharge to surface water	78% 22%	According to AMEC (2013) the percentage of households that are connected to municipal WWTP is estimated to be 78% based on Eurostat data of population connected to UWWT plants and demographic data
Sewage sludge disposal	Agricultural soils Incineration Landfill Surface water Unaccounted	54% 24% 19% 1% 2%	New data on the sewage sludge disposal across the EU have not been identified. The newest data from the EEA concerns 2005 (EEA, 2014) The unaccounted data will be distributed on the other pathways
MSW not recycled	Incineration Landfilling	32% 68%	The distribution of MSW which is not recycled – the quantities recycled is assessed for each of the substances in the following chapter EEA, 2013

2. Releases of nonylphenols (NP) and nonylphenol ethoxylates (NPE)

Nonylphenols (NP) and nonylphenol ethoxylates (NPE) are the most widely used members of the larger alkylphenol and alkylphenol ethoxylate family of non-ionic surfactants. They are produced in large volumes, with uses that lead to widespread release to the aquatic environment.

The consumption of the two substance groups, releases and fate in the environment is interrelated as the NPE is manufactured from NP and to some extent is degraded to NP during product life, waste management and in the environment.

Substances identified in the LOUS survey and included in the list of pre-registered substances under REACH are listed in Table 2.

The table further indicates tonnage bands for substances which have been registered in the EU, and Tonnage registered in the Danish Product Register with a total of import and production and accounting for export.

TABLE 2
NONYLPHENOLS AND NONYLPHENOL ETHOXYLATES (UPDATED, BASED ON LASSEN *ET AL.*, 2012)

CAS No	EC No	Substance name	Carbon atoms in alkyl chains	Registered, tonnage band , t/y *1	Danish Product Register, t/y *2
NP					
84852-15-3	284-325-5	phenol, 4-nonyl-, branched	9	10,000 - 100,000	1.4
104-40-5	203-199-4	4-nonylphenol	9	n.r.	
-	440-740-5	4-(4-trans-propylcylohexyl)phenol	9	intermediate use only	n.r.
136-83-4	205-263-7	*o*-nonylphenol	9	n.r.	n.r.
139-84-4	205-376-1	m-nonylphenol	9	n.r.	n.r.
11066-49-2	234-284-4	isononylphenol	9	n.r.	n.r.
17404-66-9	241-427-4	4-(1-methyloctyl)phenol	9	n.r	n.r.
25154-52-3	246-672-0	nonylphenol	9	n.r.	33
26543-97-5	247-770-6	4-isononylphenol	9	n.r.	n.r.
27938-31-4	248-741-0	*o*-isononylphenol	9	n.r.	n.r.

CAS No	EC No	Substance name	Carbon atoms in alkyl chains	Registered, tonnage band , t/y *1	Danish Product Register, t/y *2
30784-30-6	250-339-5	4-(1,1-dimethylheptyl)phenol	9	n.r.	n.r.
52427-13-1	257-907-1	4-(1-ethyl-1-methylhexyl)phenol	9	n.r.	n.r.
90481-04-2	291-844-0	phenol, nonyl-, branched	9	n.r.	n.r.
NPE					
9016-45-9	500-024-6	nonylphenol, ethoxylated	C9-ethox	1-10	120
20427-84-3	243-816-4	2-[2-(4-nonylphenoxy)ethoxy]ethanol	C9-ethox	n.r.	n.r.
26027-38-3	500-045-0	4-nonylphenol, ethoxylated	C9-ethox	n.r.	0.01
37205-87-1	609-346-2 *3	poly(oxy-1,2-ethanediyl), α-(isononylphenyl)-ω-hydroxy-	C9-ethox	n.r.	5.0
68412-54-4	500-209-1	2-{2-[4-(2,4,5-trimethylhexan-3-yl)phenoxy]polyethoxy}ethanol	C9-ethoxylate	1,000 - 10,000	44.0
127087-87-0	500-315-8	4-nonylphenol, branched, ethoxylated	C9-ethox	n.r.	0.5

*1 As indicated in the lists of pre-registered and registered substances at ECHA's website August 2014. For substances indicated as "Intermediate use only" no tonnage band is reported.

*2 Tonnage indicates the registered import + manufacturing in the Danish Product Register July 2012. n.r. = not registered.

*3 The substance has no EC number, but has been given a list number in the EC format through the preregistration. Chemical name from preregistration is indicated.

Five NPEs were in 2010 registered in the SPIN database of the Nordic product registers (total volume for all countries indicated in brackets) (Johansson *et al.*, 2012):

- CAS No 68412-54-4 (194 tonnes);
- CAS No 9016-45-9 (172 tonnes);
- CAS No 37205-87-1 (10 tonnes);
- CAS No 127087-87-0 (2 tonnes);
- CAS No 37205-87-1 (<2, excluding conf. inf.)

It is notable that the total use of 9016-45-9 was relatively high considering that the registered tonnage of the substance is 1-10 t/y

2.1 Use and releases of NP in the EU

2.1.1 Manufacture and overall use of NP in the EU

Activity data for the use of NP in the EU in 2011 are shown in Table 3 which also provides the background for the estimates.

The most comprehensive description of the use of NP and NPE in the EU is presented in the EU Risk Assessment Report (NP RAR) from 2002 presenting 1997 data (ECB, 2002).

EU-wide marketing and use restrictions of NP and NPE were introduced in 2004 and the consumption of NP and NPE has decreased markedly since then. For nonylphenol, the restriction primarily means that the consumption for manufacturing of NPE has decreased due to the restriction on the use of NPE, whereas the other major application areas have not been restricted.

The background for the estimates is indicated in the table. However, for some of the applications which are interrelated, a short description is provided below.

NP use in paint, varnishes, adhesives, fillers, etc.

The NP RAR only briefly mentions that NP is used in speciality paints but include an assessment of the use of NPE in paints. An Annex XV SVHC dossier for nonylphenol and their ethoxylates from 2012 (ECHA, 2012b) lists a number of applications for which NP and NPE are still used. Nonylphenols or their ethoxylates are mainly used in paints used on wet-room floors, water-based paints and varnishes for indoor use, printer’s ink, concrete floor paint, metal coating and anticorrosive paints. (ECHA, 2012b) In 1997, 4,000 t/y were used for paint and varnishes. (ECHA, 2012b)

In a number of Safety Data Sheets (SDS's) identified, NP is present in the hardener for epoxy paints, epoxy sealants, epoxy adhesives and similar mixtures (see section 6.2). In epoxy-based paints the NP is typically present in the hardener in concentrations of 3-10% but the concentration may be as high as 50%. The concentration is so high that the NP present is not a residual content of NP of the resins as described for the phenolic resins used in paints, adhesives, etc.

The RAR for NP quantifies the amounts of NP used for epoxy resins, but the further applications of the resins are not indicated. It is not clear to what extent the RAR for NP includes the formulation of paints, sealants and adhesives in the manufacture of epoxy resins. In this study it is assumed that the major part is not included in the manufacture of epoxy resins as this production is indicated under the headline "polymer industry". As the NP RAR do not quantify the amounts used in epoxy based paints and adhesives, it is assumed that some of the quantities indicated for epoxy resins is used for manufacture of the hardener component of two-component paints and adhesives (see the Table 3 for further details).

Residual AP in products and articles made from phenol/formaldehyde resins

4-NP is together with 4-*tert*-octylphenol (4-*tert*-OP) and 4-*tert*-butylphenol (4-t-BP) used in the production of different phenolic resins and they share some common issues regarding residual content of the alkylphenols (APs) in the resins and in the final cured (hardened) products (if the resins are further cross-linked). The residual quantities are used for estimating activity data for those applications where the resins are used.

Most of the alkylphenols (APs) in the resins is chemically bound and cannot be released even on subsequent chemical or biological degradation, but the resins may also contain a small proportion of unreacted APs. Environment Agency for England and Wales (2005) indicates that ~3-4% of the 4-*tert*-OP present in the resins are unreacted.

This may be the case for resins used in the manufacture of e.g. tyres and in resins in a wide range of mixtures made of phenol/formaldehyde-resins such as printing inks, paints, adhesives and others. The resins may later be cured by the manufacture of the articles or by curing of paints and adhesives and the residual AP content of the final material may be considerably lower than the concentration in the resin. How much lower seems to be dependent on the curing conditions e.g. the temperatures, formation of crosslinks and to what extent the AP reacts by other constituents by the curing process.

According to the NP RAR, consumer products may contain low levels of residual, unreacted nonylphenol and in certain products the derivative compound may break down to release small amounts of nonylphenol. Due to the lack of information on residual content of NP in the resins the NP RAR does not include consumer exposure and releases from consumer use of the products.

Very limited data on the content of residual APs in the final articles are available.

According to Environment Agency (2005), the AP-based resins are added to rubber in amounts up to 1.5% of the rubber formulation (based on data from the German UBA, 2001 quoted in the report), though the maximum figure for the percentage of resin in rubber used for tyres is 10%. If the 4-*tert*-OP concentration of the resin is approximately 3% this result in concentrations up to 0.3%. The typical concentration would be lower; up to 0.045% if the quoted German UBA information is used. In response to the Annex XV report for 4-*tert*-OP (ECHA, 2012c), the European Tyre & Rubber Manufacturers' Association (ETRMA, 2011) indicates that the resins used for tyres generally contain free 4-*tert*-OP monomer impurity of between 1 and 5%. According to company data on annual use of 4-*tert*-OP-based resins and tyre production, and assuming an average content of 3% free impurity 4-*tert*-OP in the resins, it has been calculated that an average EU tyre contains between 0.007 % and 0.012 % of 4-*tert*-OP (ETRMA, 2011). All estimates above assume that the residual content of 4-*tert*-OP is about 3%; the differences concern the assumed content of resin of the tyre. ETRMA notes that the estimate takes a highly conservative assumption that all impurity 4-*tert*-OP would remain even after the extensive processing and high temperatures of the manufacturing processes.

Relatively few analyses of 4-*tert*-OP in the final rubber are available. 4-*tert*-OP has been detected in three samples of recycled rubber granules used in Norwegian football fields in concentrations between 19.6 and 33.7 mg/kg (=0.002-0.003%) (Byggforsk, 2004; extraction method not indicated). Nilsson *et al.* (2008) found 4-*tert*-OP in 2 out of 6 analysed artificial turf in concentrations of 56-57 mg/kg (0.006%) (Extraction in dichloromethane). The concentrations in the tyres were slightly below the concentrations of 0.007 % to 0.012 % indicated by ETRMA. This indicates that the majority of the residual 4-*tert*-OP is still present in the tyres when they are disposed of.

Regarding the use of the resins in ink, Environment Agency for England and Wales (Environment Agency, 2005) notes that the ink production process actually involves some reaction between the components. There are no significant traces of 4-*tert*-octylphenol left in the finished inks. Hence there will be no significant releases from the printing process, or from the recycling of paper printed with these inks. The same is the situation as concern the use of resins in varnishes. This requires further cross-linking and reaction, and so can be considered as a polymer-processing step with the resin acting as a cross-linking agent. (Environment Agency, 2005)

Residual AP in products made from epoxy resins

The 4-NP, 4-*tert*-OP and 4-t-BP are all used for epoxy resins. Only data on residual 4-t-BP are identifed, but they may indicated to what extent residual NP is present.

According to the EU Risk Assessment Report for 4-t-BP (ECB, 2008), in the use as an accelerator in hardening agents for epoxy resins, following the hardening process the concentration of residual 4-t-BP is in the range of 4.6 – 6.7 %. The Association of Plastic Manufacturers in Europe (APME) has for BP RAR commented that *"the statement that cured systems still contain 4.6-6.7 % unreacted 4-*

tert-BP seems to be very high, but we have no data". If used as an accelerator in the hardening process without heating residual 4-*tert*-BP is not chemically/covalently bound in the matrix but closely bound in the matrix

4-t-BP is used to a limited extent as chain modifier in the manufacturing of certain epoxy resins (ECB, 2008). 4-t-BP modified epoxy resins are used as polymeric binder in industrial corrosion protective coatings (ambient cured epoxy coatings, epoxy powder coatings, heat cured coatings). In this application, the 4-t-BP is fully reacted to the epoxy backbone and residual levels of unreacted 4-t-BP in the epoxy resin are extremely low (typically in the ppm range).

In general, high temperature cured epoxy formulations are not expected to release significant quantities because of low residual amounts of free 4-t-BP (ECB, 2008). This applies especially to can coatings, where food approval requirements have to be fulfilled. However, it is state-of-the-art knowledge that ambient cured epoxies have significantly lower level of through-cure than epoxies cured at high temperatures.

TABLE 3
ACTIVITY DATA FOR THE USE OF NP IN THE EU IN 2011

Application	Activity , t/y	Uncertainty factor	Remark
Manufacture of NP	41,900	1.3	According to the EU Risk Assessment (ECB, 2002), the EU production of NP in 1997 was 73,500 tonnes. With an overall net import, around 78,500 tonnes of NP were used in Europe in 1997. CEPAD has provided an overview of the flow of NP and NPE in the EU (+Switzerland and Norway) in 2010 presented in the LOUS review that confirms that NP is still used for the main application areas described in the EU Risk Assessment, but provides very limited information on quantities. According to the registration of branched 4-nonylphenol (CAS nr. 84852-15-3), the total import and production of NP is in the 10,000-100,000 t/y range (ECHA, 2012e). Considering that 40% of the consumption of 78,500 tonnes in 1999 was for unrestricted uses and that a small part is still used for production of NPE, the total consumption in 2011 was likely in the range of 30,000-50,000 tonnes. With a total import of NP and OP of approximately 4,000 tonnes, the data indicated that around 90% of the NP used was also manufactured in the EU.
Import/export of NP	Import 2.000 Export 700	2	Import of octylphenol, nonylphenol and their isomers; salts thereof was 4,020 t/y in 2011 while the export was 1.400 t/y. It is not indicated how much of this was NP. (Lassen *et al.*, 2013)
Manufacture of other chemicals/resins:			In 1997 the NP was used for production of nonylphenol ethoxylates (60% of total), production of resins, plastics, stabilizers etc. (37%) and production of phenolic oximes (3%). The 29,000 t/y used in the polymer industry was split between the different application areas as follows: phenolic resin production (22,500 t/y), 4-nonylphenyl phosphite (TNPP) production (4,000 t/y), catalyst in epoxy resin production (1,500 t/y) and use in other plastic stabilizers (1,000 t/y). Apart from the use for production NPE the 1997 consumption for the different applications are used as a best estimate for the consumption in 2011. For each of the application areas it is roughly estimated that the range is ±50% The consumption figures are interlinked in the way that the total is within the range indicated for the total consumption.

Application	Activity , t/y	Uncertainty factor	Remark
Manufacture of NPE	9,600	2	The registration of NPE (CAS No 68412-54-4) indicates that the manufactured volume of NPE is in the 1,000-10,000 t/y range (ECHA, 2012e) but higher molecular weight ethoxylated NPs are not registered because they are considered polymers. The production of NPE is estimated at 24,000 tonnes (see section on NPE) and consequently, roughly estimated, some 9.600 t/y NP are used for the production of NPE assuming the same NP/NPE ratio as used in the Risk Assessment (ECB, 2002).
Manufacture of phenol/formaldehyde resins	22,500	2	"Resins" are polymeric materials of short chain length and used for rubbers, coating, adhesives, etc. Phenol formaldehyde resins (PF) are synthetic polymers obtained by the reaction of phenol or substituted phenol with formaldehyde.
Manufacture of TNPP	4,000	2	Tri-(4-nonylphenyl) phosphite (TNPP) is used as a secondary antioxidant in polymer formulations. It is widely used in the stabilisation of natural and synthetic rubbers, vinyl polymers, polyolefins and styrenics. The principal use of TNPP is in food packaging. TNPP may contain up to 3% free nonylphenol. Releases to the environment during use of TNPP are thought to be negligible and not estimated in the RAR due to lack of data.
Manufacture of epoxy resins	1,500	2	NP is according to the RAR used for epoxy resins, but the further use of the resins is not indicated. It is not clear if the RAR includes the formulation of paints, sealants and adhesives in the manufacture of epoxy resins, but it will here be assumed that the major part is not included in the manufacture of epoxy resins as this production is indicated under the headline "polymer industry".
Manufacture of other plastic stabilizers	1,000	2	No specific information on the use in the RAR, but it is assumed that the NP is not used as a stabilizer itself. The NP is used as intermediate in the manufacture of plastic stabilizers (Brooke *et al.*, 2005)
Manufacture of phenolic oximes	2,500	2	Phenolic oximes are used as a reagent for the extraction and purification of copper from ore and all of the produced volume was exported to countries outside the EU.
Formulation and processing			The RAR do not quantify any use of NP for formulation of mixtures, but mention that NP may be used in some paint and adhesives, but do not include any estimates of releases from the formulation and application of the mixtures.
Formulation of paint and varnishes	600	3	According to the RAR, NP is used in a hardeners for two pack chemical- and abrasion- resistant protective coating for industrial applications (ECB, 2009), but the RAR does not include any estimates on the use for formulation or releases of NP from the formulation and applications of paints.. In a number of SDS's identified NP is present in the hardener for epoxy paints, epoxy sealants, epoxy adhesives and similar mixtures (see section 6.2. According to data for 2011 from the Product Registers in Denmark and Sweden the total consumption of NP in paint are 20 t/year and 7 t/year, respectively. Up scaled to the entire EU it would correspond to some 350-2.000 t/y, indicating that these mixtures could represent a significant part of the applications of NP for epoxy resins. It will here be estimated that the total consumption in the EU for these applications are in the range of 200-1800 t/y The NP is typically used in the hardener for epoxy systems and in the final product presumably reacted into the final polymer structure.

Application	Activity , t/y	Uncertainty factor	Remark
Formulation of adhesives, sealants and filling agents	200	3	According to the RAR, NP is used in hardener for two-component adhesives (ECB, 2009), but the RAR does not include any estimates on the use for formulation or releases of NP from the formulation and applications of adhesive, sealants and filling agents. In a number of SDS's identified NP is present in the hardener for epoxy sealants, epoxy adhesives and similar mixtures (see section 6.2. According to data for 2011 from the Product Registers in Denmark and Sweden the total consumption of NP in adhesives, sealants and filling agents are 6 t/year and <1 t/year, respectively. Up scaled to the EU it may corresponds to <51 – 600 t/y. It will here be estimated that the value is within the range of 65-600 t/y. The NP is typically used in the hardener for epoxy systems and in the final product presumably reacted into the final polymer structure.
Use of phenolic resins for further processing	675 NP residual content	3	According to the RAR, no information about residual levels of nonylphenol in the final articles was available, and therefore only releases from the polymerisation process was included in the RAR. Some 3-4% of the AP is present as of unreacted AP (Environment Agency, 2005) in the resins. Environment Agency, 2005 use 3% as the best estimate. It means that the resins are produced from 22,500 tonnes NP. With an average content of 3% it corresponds to 675 tonnes. Nonylphenol/formaldehyde resins are used as adhesives and tackifiers in the rubber industry (including tyres), paper coating resins and as intermediates for coating formulations, rosin modified resins for printing inks, electrical varnishes and as a modifier in several other applications. Nonylphenol/formaldehyde resins may also be ethoxylated for use in oil recovery.
Stabilizers in plastics	-	-	NP is used as intermediate in the manufacture of stabilizers. NP may to some extent be present as residual raw material, but no data are available. The EU RAR does not consider any NP in the manufactured stabilizers and does not include any release estimates for the use of the manufactured stabilizers.
End-uses:			
Paint and varnishes	600	3	It is here assumed that the total content in the final mixtures correspond to the consumption for formulation processes in the EU (see above)
Adhesive, sealants and filling agents	200	3	It is here assumed that the total content in the final mixtures correspond to the consumption for formulation processes in the EU (see above)
Articles based on phenolic resins	150 NP residual content	3	The phenolic resins may be used to make other products e.g. rubber products, carbonless copy paper, adhesives, etc. According to the RAR, consumer products may therefore contain very low levels of residual, unreacted nonylphenol and in certain products the derivative compound may break down to release small amounts of nonylphenol. Due to the lack of information on residual content of NP in the resins the RAR do not included consumer exposure and releases from consumer use of the products. Whereas the resins may contain ~3-4% of unreacted AP (Environment Agency, 2005), the resins are further reacted by crosslinking and the NP content of the final product may be significantly lower as discussed in the body text. It is here roughly estimated that the resins in the final products contain 0.2-2% residual NP (the concentration of NP in the entire product will be much lower depending on the resin content).

Application	Activity , t/y	Uncertainty factor	Remark
Residual NP content of textiles	10	3	According to KemI (2013) the import of textiles to the EU in 2010 was 6,037,526 tonnes with an average concentration of NPE in textile at 107 mg/kg. The dossier does not indicate the content of NP in the textiles. A new Danish study found a mean concentration in textiles of 1.5 mg/kg (Rasmussen *et al.*, 2013), which is here used as a best estimate.

2.1.2 Emission factors

Emission factors for use of NP in industrial processes, use of NP in articles and mixtures and by waste management are shown in Table 4 and the background for the emission factors are briefly described in the table.

TABLE 4
DERIVED EMISSION FACTORS FOR THE RELEASE ESTIMATIONS FOR NP

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Manufacture of NP and use of NP for the manufacture of other chemicals/resins					
Manufacture of NP	Surface water	0.001%	3	Estimated from the indicated consumption and emission figures. One plant was responsible for nearly all emissions	ECB, 2002
Manufacture of NPE	Air Surface water	0.001% 0.03%	3 3	Estimated from the indicated consumption of NP for manufacture of NPE and the estimated total releases from the plants the emission factors cab be estimated at: Air: 0.001% Surface water: 0.1% The emission factor for surface waste is totally dependent on the releases from one plant where the total releases of NP and NPE conservatively is assumed all to be NP. The emissions from the other plants were significantly lower and 5 of the 9 plants had no releases to waste water. The emission factor of 0.1 is considered very conservative and has been adjusted to represent the upper limit in the range. It is quite likely that the emissions from the process has ceased.	ECB, 2002
Manufacture of phenol/formaldehyde resins	Air Surface water	0.001% 0.0003%	3	Based on the EU RAR	ECB, 2002

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Manufacture of epoxy resin	Air Surface water	0.01% 0.003%	3	Based on the EU RAR	ECB, 2002
Manufacture of other plastics stabilizers	Surface water	0.02%	3	Based on the EU RAR	
Manufacture of TNPP	All pathways	0%	-	Based on the EU RAR	ECB, 2002
Manufacture of phenolic oximes	Surface water	0.038%	3	Based on the EU RAR	ECB, 2002
Formulation and processing					
Formulation of paint and varnishes	Waste water	0.0097%	3	The RAR does not include the formulation of mixtures. Applied emission factors: CEPE SPERC 2.4c.v1, - formulation - liquid coatings and inks (where specific formulation not known) - solids	CEPE, 2013
Formulation of adhesives	Air Waste water	0.01% 0.005%	3	The RAR does not include the formulation of mixtures. Applied emission factors: FEICA SPERC 2.1a.v2 Formulation of Solventless/Solvent Borne Adhesives Solids Based on OECD Emission Scenario Document, Series No. 22 Coating Industry (Paints, lacquers and varnishes), and July 2009 as FEICA assumes similar emission factors are applicable. FEICA (2013) indicates the emission factor for emissions to 0.01 (1%) but the actual factor in the OECD document after air cleaning is 0.01%.	FEICA, 2013
Use of phenolic resins for further processing (residual NP)	Air Surface water	0.01% 0.005%	3	The RAR does not include this step of the uses of the resins with residual content of NP. The resins are used for various applications such as rubbers, paints and adhesives, and the same emission factors as used above for formulation of paint and adhesives are applied.	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	**Emission factor % of quantity used in the process**	**Uncertainty factor**		
Stabilizers in plastics	Surface water	-	-	Stabilizers used in plastics industry. Wide dispersive indoor use of reactive substances in open systems : 1% Wide dispersive indoor use of long-life articles and materials with low release: 0.1% The NP is used as an intermediate in the manufacture of the stabilizers. It is from the available information not clear to what extent NP is present in stabilizers for the plastics industry. and in the absence of activity rates, the emission factors are not applied.	KemI, 2013
End-uses:		**Percentage of quantity used in the product *1**			
All other consumer uses than mixtures				The RAR for NP/NPE states that releases during private use are not thought to be applicable for nonylphenol. Furthermore it is stated that direct disposal of nonylphenol to the environment is unlikely to occur. It is more likely that nonylphenol will reach the environment as part of a product.	ECB, 2002
Paint and varnishes	Air Waste water Solid waste	0.1% 0.5% 99,4%	3 3 1.01	CEPE SPERCs use different emissions factors for paint used by consumers, professionals and industry, and applies the following emission factors: Consumer use, all applications and professional application by brush and roller: 1% to waste water and 0.5% to soil for applications outdoors. Professional application by spray: 2.2% to air, 2% to waste water, Soil indicated as "to be advised" The emission factors applied in this study assume that the paints are applied by various application methods - and for the releases to air it is assumed that only a minor part is applied by spray.	KemI, 2013
				Hansson *et al.*, 2008 as cited by OECD, 2011 applies for paint 0.005 kg NP release to waste water pr. kg in paints used (0.5 %)	Hansson *et al.*, 2008 as cited by OECD, 2011
				The Annex XV (KemI, 2013) report applies emission factors of 0.5-1.0% for NP depending on the type of paint and the application area.	KemI, 2013

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Mixtures and articles based on phenolic resins (residual NP)	Waste water Solid waste	0.5 99.5	3 1.01	The resins are used for various applications such as rubbers, paints and adhesives, and the same emission factors as used above for formulation of paint and adhesives are applied.	
Adhesives	Waste water Solid waste	1% 99%	3 1.01	FEICA SPERC 8c.3.v2- Wide dispersive Use of Substances other than Solvents in Adhesives and Sealants: 1.5% to waste water (same for solvent and water-based adhesives) FEICA SPERC 5.1a.v2 and 5.1b.v2 for use in industrial settings for solvent borne adhesives applies an emission factor of 0% to waste water and 1.7% to air (before air pollution control). Other identified factors: 0.01 kg NP release per kg in adhesives used (1 %) to waste water Emission to waste water: Wide dispersive indoor use of reactive substances in open systems: 1% Wide dispersive indoor use of long-life articles and materials with low release. 0.01% An amalgamated emission factors of 1% to waste water is applied in this study as best estimate	FEICA, 2013 Hansson *et al.*, 2008 as cited by OECD, 2011 KemI, 2013
Residual NP content of textiles	Waste water Solid waste	80% 20%	1.2 remaining	In a new Danish study, the mean concentration of NP in the textiles decreased by 35% after one washes (Rasmussen *et al.*, 2013). In some of the wash tests, the NP concentration increased which may indicate that NP also to some extent is formed from NPE by the washing. The mean release rates were lower for NP than for NPE and it is roughly assumed that not all NP will be released by washing during the textiles life. Hansson *et al.*, 2008 (as cited by OECD, 2011) applies an emission factor of 0.250 kg/t released to "water" for detergents and auxiliaries in textile and leather products. This factor is in this study considered to be unrealistically low.	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Plastic toys Plastic packages	-	-	--	2.78*10-12 kg/m² (hard plastics) 4.64*10-12 kg/m² (soft plastics) The weight of PVC plastics can be assumed to be 2000 g for an area of 1 m² with a thickness of 1.5 mm, no distinction between product groups. It is not clear from the data source what type of plastics have been considered, and the emission factors are not further assessed	Hansson *et al.*, 2008 as cited by OECD, 2011
Additives in pesticides	-	-	-	Soil:85%; Surface waters:10%; Air:1% NP in pesticides are is restricted and no data on NP in pesticides are available and the emission factor is consequently not applied	Hansson *et al.*, 2008 as cited by OECD, 2011
Concrete	-	No activity data identified	-	0.2 mg/m² According to COHIBA (2012) nonylphenol ethoxylate and phosphate esters of nonylphenol have been used in concrete for formation of air pores in the material. According to a study cited in Andersson and Sörme (2004, as cited in COHIBA, 2013) NP and nNPA can leach from concrete in amounts of 0.14-0.19 mg/kg, corresponding to 20-30% of the added amount. No data on the use of NP in the concrete are available – the emission factor is not applied.	Same
Waste management:		**Percentage of NP in waste/ waste water**			

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Sewage treatment	Air Surface water Sewage sludge Degraded	8% 44% 36% 12%	1.3 1.3 1.3 1.3	Note this is the fate of the fraction of the sewage reaching the WWTP – the further fate of the NP ending up in the sewage sludge is estimated using the general distribution factors listed in Table 1 The NP RAR has estimated the distribution of emissions dependent on the biodegradability of the NP. NP is "not readily biodegradable: Air – 7% Surface water – 35% Sewage sludge – 34% Degraded – 24% NP is "Inherently" degradable: Air – 10% Surface water – 53% Sewage sludge – 38% Degraded – 0% The Annex XV report (KemI, 2013) assumes different from the RAR that NP directed to WWTP nearly predominantly ends up in the sludge	ECB, 2002
	DK values: Air Surface water Sewage sludge Degraded	 8% 8% 36% 48%		See discussion in section 2.3.2	Kjølholt *et al.*, 2011
Municipal solid waste incineration	Air Landfill Degradation	0.01% 0.1% 99-100%	1.1 1.1 remaining	It is assumed that the NP nearly 100% is degrade d by the municipal solid waste incineration	
Landfill	Surface water			No data on discharges of NP from landfills have been identified.	
Releases from degradation of NPE		**Percentage of quantity of NPE used for the application/in the waste stream *1**			

Waste water treatment - anaerobic conditions	Surface water	2.5%	The RAR for NP estimates as a worst case that 2.5% of the NPE directed to WWTPs is transformed in the plant and released to surface water as NP (= under anaerobic conditions). In the summaries of regional and continental emissions (Table 3.3 and 3.4) the releases is allocated to each of the applications of NPE which are sources of NPE to WWTPs. In the current model the releases from WWTP are allocated to the WWTPs and not the sources. An indication of the sources of NPE to waste water is provided in the section on NPE.	ECB, 2002 KemI, 2013
	Sludge	19.5%	The RAR estimates as a worst-case that 19.5% of the NPE in the waste water ends up as NP in de digested sludge. The further fate of the NP in the sludge depends on the actual disposal of the sludge (soil, incineration, landfill)	ECB, 2002

*1 Total quantity of NP in products placed on the market the reference year

2.1.3 Overall flow of the NP and releases to the environment

The overall flow of NP in the EU is shown in Figure 2 below. By the use of the NP in processes the majority of the NP is converted into other chemicals and polymers and consequently the total quantities decrease through the product chain. A major part of the NP content of articles and mixtures are due to residual NP in resins used for various applications.

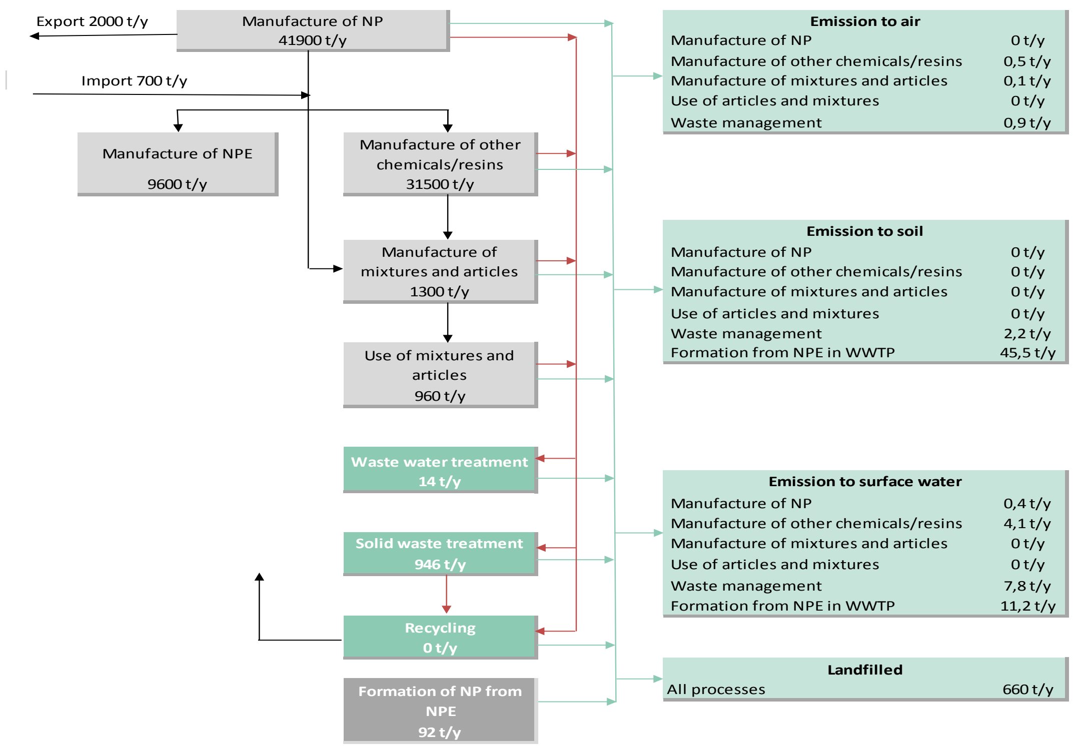


FIGURE 2
OVERALL FLOW OF NP IN THE EU (MEAN VALUES)

Total releases of NP to the different environmental compartments and landfill are shown in the table overleaf. Please note that the total quantities released to solid waste and waste water are further terminated in the lower part of the table.
Releases to air - Direct releases to the air are small as compared to the releases to surface water and not further discussed.

Releases to waste water and surface water - The major source of NP to surface water and soil when the mean values are considered is NP formed from NPE by waste water treatment. As shown in section 2.2.3, the main four sources of NPE to waste water are imported textiles (major source, not included in the RAR for NP), technical textiles, paints and synthesis of NPE derivatives. Considering the uncertainties, it seems to be very certain that textiles is the major source, whereas it is less certain which of the other three sources are most significant, and other sources such as degreasers, maintenance agents, synthesis of NPE and formulation of paints may also be among the major sources. It is quite certain that releases from use of end-products represent the major part of the releases. See section 2.2.3 for further discussion of the result for NPE.

Besides the contribution from waste water treatment of NPE, the major releases of NP to surface waste is waste water treatment and manufacture of NP (the latter is very uncertain). Other sources are relatively small. The sources of releases of NP to waste water are use of end-products: Paint and varnishes, adhesives, sealants, fillers, etc., articles based on phenol/formaldehyde resins and NP in textiles. NP in textiles is the main source when considering the main values, but all the estimates are quite uncertain and the differences between the sources are not significant. Compared to analyses of NPE in imported textiles only few data are available on NP in textiles which render the estimates relatively uncertain. Using the average figures, the NP in the textiles contribute to releases to surface water of approximately 5 tonnes (multiplying the contribution to the sources of NP to waste water with the releases from the WWTPs), while NPE contributes 12 tonnes, indicating that the NP content of the textiles in fact contributes significantly. This estimate is however sensitive to the efficiency of the WWTPs in the degradation of the substances and in detaining the substances in the sewage sludge.

The use of paint and varnishes may be a significant source of NP releases to waste water whereas the releases from the formulation of formulation of paint and varnishes are not. The uncertainties are quite high because both activity data and EPs are quite uncertain

NP releases to soil - NP in sludge from the degradation of NPE in waste water is by far the main source of NP to soil.

The significance of NPE for the NP levels in the environment - NPE released to the environment may be degraded to NP. The RAR for NP (ECB, 2002) estimates that 2.5% of the NPE released to the environment will eventually end up as NP.

The total NPE released from WWTPs is estimated at 549 (324-927) t/y (See section 2.2.3). If 2.5% is degraded to NP and the NP:NPE ratio is 2:5, some 5 (3-9) t/y, released as NPE to surface waste may eventually be degraded to NP in the environment. Compared with the contribution from NPE to the releases of NP from the WWTPs of 11.5 (8.6-14.1) t/y, the estimates indicate that the main contribution of NPE to the NP levels in the environment is via the degradation in WWTPs (and perhaps the sewage system before the WWTPs).

TABLE 5
RELEASE OF NP IN THE EU FROM ALL LIFE CYCLE STAGES

Life cycle stage	Total releases (mean value and 90% confidence interval) (tonnes/year):						
	Air	Surface water	Landfill	Soil	Solid waste	Waste water	Degraded
Industry - Manufacture of chemical:							
Manufacture of NP	0 (0-0)	0.4 (0.1-1.7)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	
Industry - Manufacture of other chemicals/resins (intermediate use):							
Manufacture of NPE	0.1 (0-0.5)	2.9 (0.6-13.7)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	
Manufacture of phenol/formaldehyde resins	0.2 (0-1.1)	0.1 (0-0.3)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	
Manufacture of TNPP	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	
Manufacture of epoxy resins	0.2 (0-0.7)	0 (0-0.2)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	
Manufacture of other plastic stabilisers	0 (0-0)	0.2 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	
Manufacture of phenolic oximes	0 (0-0)	1 (0.2-4.5)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	
Industry - Formulation and processing:							
Formulation of paint and varnishes	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0.1 (0-0.4)	
Formulation of adhesives, sealants, fillers, etc.	0 (0-0.1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0.1)	
Use of phenolic resins	0.1 (0-0.3)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0.2)	
End use of mixtures and articles:							
Paint and varnishes	0.6 (0.1-2.4)	0 (0-0)	0 (0-0)	0 (0-0)	596.4 (154.9-2300.9)	3 (0.8-11.7)	
Adhesives, sealants, fillers, etc.	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	198 (49.5-784.3)	2 (0.5-7.8)	
Articles based on phenol/formaldehyde resins	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	149.3 (37.3-591.2)	0.8 (0.2-2.9)	
NP in textiles	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	2 (0.5-7.9)	8 (2-31.1)	
Sum to wastewater and solid waste					945.7 (466.6-2801.6)	13.8 (7.3-39.3)	
Waste management:							
Recycling	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)			
Solid waste management	0 (0-0.1)	0 (0-0)	643.3 (170.4-2433.8)	0 (0-0)			302.3 (79.7-1157.4)

Life cycle stage	Total releases (mean value and 90% confidence interval) (tonnes/year):						
	Air	Surface water	Landfill	Soil	Solid waste	Waste water	Degraded
Waste water treatment	0.9 (0.2-3.1)	7.8 (2.2-27.8)	0.7 (0.2-2.7)	2.2 (0.6-7.7)			2.2 (0.6-8.2)
Formation of NP from NPE in WWTP In sludge	0 (0-0)	0.6 (0.4-0.7)	10.8 (8.5-13.8)	31.9 (24.9-40.9)			13.7 (15.3-24.9)
Formation of NP from NPE in WWTP To surface water	0 (0-0)	7.3 (5.7-9.3)	0 (0-0)	0 (0-0)			
Total	2 (1.2-5.1)	20.3 (13.9-43.4)	654.9 (182-2445.4)	34.1 (26.9-44.6)	as above	as above	318.2 (95.6-1173.4)

2.2 Use and releases of NPE in the EU

Nonylphenol (NP) and nonylphenol ethoxylates (NPE) are the most widely used members of the larger alkylphenol and alkylphenol ethoxylate family of non-ionic surfactants. They are produced in large volumes, with uses that lead to widespread release to the aquatic environment.

The consumption of the two substances, releases and fate in the environment is interrelated as the NPE is manufactured from NP and to some extent is degraded to NP during product life, waste management and in the environment. The environmental fate of the substances is beyond the scope of the current study.

2.2.1 Manufacture and overall use of NPE in the EU

The applied activity data are summarised in Table 6. The EU-production of NPEs in 1997 was estimated at 118,000 tonnes. The EU consumption was 77,600 tonnes. At that time, the most important sector of use was the industrial and institutional cleaning sector, including domestic cleaning, which consumed 30% of the total (23,000 tonnes).

Uses which are not (or partly not) restricted today included emulsion polymerisation (12%, 9000 tonnes – a part of the emulsions were used for paper coating, which is now restricted), chemical industry, for example synthesis of nonylphenol ether sulphates and nonylphenol ether phosphates (9%, 7,000 tonnes) and paints (4%, 4,000 tonnes). Furthermore, 9% (7,000 tonnes) was used for "other niche markets" in the photographic industry, electronic industry, mineral fuel and oil industry and civil engineering industry. The RAR concludes that the quantities used for "other niche markets" may in fact be accounted for by some of the other mentioned applications. It is on the basis of the description difficult to assess whether they are restricted today. The end-uses of the NPE used in emulsion polymerisation were, according to the RAR, paper production (now restricted) and formulation of paint (also separately accounted for). The total use for unrestricted applications was consequently rather some 12,000-20,000 tonnes.

For the major use areas of NPE in 1997, the substances are currently restricted: cleaning agents (except for controlled closed dry-cleaning systems and cleaning systems with certain special treatment), leather and textile auxiliaries (except processing with no release into waste water, and systems with certain special treatment), agriculture, metal industry (except uses in controlled closed systems where the washing liquid is recycled or incinerated) and pulp and paper.

The registration of NPE (CAS No 68412-54-4) indicates that the manufactured volume of NPE is in the 1,000-10,000 t/y range with the use as flotation agent in mining operations as the only indicated application of the substance (ECHA, 2014). This application is indicated in a table of applications in the RAR, but otherwise not addressed in the RAR or Annex XV dossiers.

AMEC (2013) mention that according to the trade organisation CEPAD, in 2010 in the enlarged EU (e.g. EU-27, Norway and Switzerland) the production of alkylphenol ethoxylates (APEs) was approximately 32,000 tonnes, of this NPE accounted for approximately 26,000 tonnes. Of the 26,000 tonnes, approximately 8,000 tonnes was used for captive uses (production of other chemicals) while the remaining 18,000 tonnes was used for different uses not further specified.

According to CEPAD, the higher molecular weight ethoxylated NPs are not registered because they are considered polymers. This explains that the registered volume is only 1,000-10,000 t/y. In the absence of registration of the major uses of NPE, estimates on the total EU consumption has to be based on other sources.

The 26,000 tonnes is used as a best estimate for the total production and use of the substances in the EU.

Emulsion polymerisation

Nonylphenol ethoxylates are used as processing aids in the formulation of a number of emulsion polymers including polyvinyl acetates and acrylic acids. The ingredients in a typical emulsion polymerization include water (as the continuous phase), monomers, surfactants (as stabilizers and emulsifiers), initiators and possibly specialty ingredients (ECP, 2002).The surfactant is employed to stabilize the monomers by forming emulsified monomer droplets dispersed in water; the surfactant also plays a critical role in stabilizing the polymer particles. Many polymer dispersions contain alkyl phenol ethoxylates as surfactants used in the manufacturing process.

The end applications for NPE-containing polymer dispersions included according to the RAR for NP formulation of paints, paper, inks, adhesives, and carpet backings. The use of NPE for paper production is banned today. The available information indicates that NPE-containing polymer dispersions are mainly used for formulation of paint and inks, formulation of adhesives, sealants, etc. and coating of textiles (including carpet backing).

TABLE 6
ACTIVITY DATA FOR THE USE OF NPE IN THE EU IN 2011

Application	Activity, t/y	Uncertainty factor	Remark
Manufacture and import of NPE	18,300	1.3	NPE is registered by joint submissions for two CAS Numbers. CAS No 68412-54-4 is registered by a joint submission at 1,000-10,000 t/y with the use as flotation agent in mining operations as the only indicated application of the substance (ECHA, 2014). In 2012, the substance was registered by two submissions each with registered volumes in the 1,000-10,000 t/y band (total 2,000-20,000 t/y). CAS No 9016-45-9 is registered by one company with a total production and import in the 1-10 t/y range with the use as reducing agent in metal surface treatment (ECHA, 2014). Other NPEs are not registered. AMEC (2013) mention that according to the trade organisation CEPAD, in 2010 in the enlarged EU (e.g. EU-27, Norway and Switzerland) the production of alkylphenol ethoxylates (APEs) was approximately 26,000 tonnes. CEPAD has for this study reported that the higher molecular weight ethoxylated NPs are not registered because they are considered polymers. The joint registration of the NP (CAS no 84852-15-3) indicates that end-uses of the substance among others are paints containing NPE and use of ethoxylate in emulsion polymerization. The total quantity as estimated in this study corresponds to the total consumption for synthesis of other chemicals, and industrial formulation of flotation agents and polymer dispersions for emulsion polymerization
Export of NPE	no data	-	No updated data on the import/export og NPE has been identified. The import/export is assumed to be relatively small compared with the high uncertainties on the total consumption of NPE in the EU
Manufacture of other chemicals/resins:			
Synthesis of other chemicals: nonylphenol ether sulphates and nonylphenol ether phosphates (captive use)	7,000	2	No specific data on the use for the synthesis – 7000 tonnes was used in 1997 (ECB, 2002)

Application	Activity, t/y	Uncertainty factor	Remark
Formulation and processing:			The RAR do not quantify any use of NP for formulation of mixtures, but mention that NP may be used in some paint and adhesives, but do not include any estimates of releases from the formulation and application of the mixtures.
Industrial formulation of mining products (flotation agents) containing NPE	3,300	3	Indicated as 1,000-10,000 t/y in joint submission (ECHA, 2014). The use of NPE for flotation agents is mentioned in a list og functional use categories of NPE in the RAR, but otherwise not addressed in the RAR or in any of the Annex XV dossiers.
Formulation of polymer dispersions for emulsion polymerization	8,000	2	Nonylphenol ethoxylates are used as processing aids in the formulation of a number of emulsion polymers including polyvinyl acetates and acrylic acids. Many polymer dispersions contain alkyl phenol ethoxylates as surfactants used in the manufacturing process. The end applications for polymer dispersions included according to the RAR formulation of paints, paper, inks, adhesives, and carpet backings. As describe below, a significant part may be used for coating technical textiles. The quantities used for the formulation of polymer dispersions were consequently further used in the formulation of these end products.
Formulation of paint and inks	4,000	2	Nonylphenol ethoxylates are used in the preparation of paint resin (polyvinyl acetates - PVA) and also as a paint mixture stabilizer. Typical formulations contain 0.6-3% nonylphenol ethoxylates. In decorative emulsions nonylphenol ethoxylates are used in the manufacture of the emulsion (for emulsion polymerization) and directly as emulsifiers and dispersants in water-based paints. Nonylphenol ethoxylates are used in industrial coatings Other possible uses of nonylphenol ethoxylates in the coatings industry include in the formulation of inks for laser jet printers and in the formulation of 'blanket wash' chemicals for use with lithographic printers. The RAR estimates that about 4,000 t/y was used for paints – a part of this also accounted for by the previous step in the product chain "formulation of polymer dispersions". The registered NPE quantities in paints and binders for paints in the Danish and Swedish Product Registers in 2011 was 12 t/y and 6 t/y, respectively. Extrapolated to the EU this may correspond to some 300-1.200 t/y.
Formulation of adhesives, sealants, etc.	300	3	Nonylphenol ethoxylates are according to the RAR added to acrylic esters used for some adhesives. They act as dispersants and aid the stability of the formulation. A number of safety data sheet of adhesives, sealants and filling materials were identified (section 6.3.2) The registered NPE quantities in these mixtures in the Danish and Swedish Product Registers in 2011 was confidential and 1-2 t/y, respectively. Extrapolated to the EU, the total consumption is likely not more than some hundred t/y.
Formulation of biocides pesticides	-	-	NPE in co-formulants in pesticides and biocides is restricted. However, national authorisations for pesticides or biocidal products containing nonylphenol ethoxylates as co-formulant, granted before 17 July 2003, shall not be affected by this restriction until their date of expiry. The registered NPE quantities in biocides and pesticides in the Danish and Swedish Product Registers in 2011 were 13 t/y and 5 t/y, respectively. Extrapolated to the EU this may correspond to some 250-1.300 t/y. It cannot be excluded that some of this has not been adequately updated and the actual figures are lower. The national authorisations expire usually within 5-10 yeas and should consequently have expired before July 2013. On this basis the total use today is expected to be 0 t/y

Application	Activity, t/y	Uncertainty factor	Remark
Use of textile and leather axillaries in closed systems for manufacture of technical textiles	1,000	5	The use of NPE for textile and leather processing is prohibited unless used in processing with no release into waste water or systems with special treatment where the process water. According to Amec (2013), consultation with industry has indicated that a number of companies in Europe continue to use NPEs in the manufacture of certain textiles. In Germany, a small number of companies are known to use NPE in polymeric dispersions for coating technical textiles (for use in, for example, tents) (Amec (2013). The coatings are applied to the surface of textiles to confer particular technical functions to the textiles NPEs remain in a residue on the surface of the textile. In a comment to Environment Canada's consideration in developing its Risk Management Strategy for the Wet Processing Textile Industry, the Emulsion Polymers Council (EPC, 2002) describes the use of NPE in emulsion polymers for textiles. According to the Council, textile coatings are typically based on emulsion polymers. Coating products based on emulsion polymers are generally applied to be permanently affixed to the textile in order to impart specific performance characteristics such as flame retardancy, back coatings to stabilize fabrics (upholstery, automotive), blackout drapery coatings and coated carpet. The emulsion polymer-based coating, including any surfactant present, attaches to the textile substrate during the coating process. Typical concentrations of NPE in an emulsion polymer range from 0.2 - 5%, and the level of NPE in the finished coating ranges from 0.05 - 1.5% (500-15,000 mg/kg) (ECP, 2002). The Anglo-Welsh Environment Agency also indicated that a number of companies in the UK use NPEs in the same application. According to Amec (2013) the German textile association, TEGEWA, estimates that up to 5,000 t/y of NPEs may be used in Europe for such uses, however the exact statement was <<5000 t/y (i.e. much less than 5,000 t/y) (TEGEWA, 2014). On this basis a range from 200 to 5000 t/y has been estimated. A part of this may also be accounted for under formulation of polymer dispersions for emulsion polymerization.
End-uses:			
Used as flotation agent in mining operations (without offshore industries)	3,300	3	Se above under "Industrial formulation of mining products". It is in the registration indicated that the NPE is used in a mixture in
Paints and inks	4,000	2	See background for estimate above.
Adhesive, sealants and filling agents	300	3	See background for estimate above.
Lubricating oils and metal working fluids (in closed systems) and	100	2	The registered NPE quantities in lubricants in the Danish and Swedish Product Registers in 2011 were 1 t/y and 3 t/y, respectively. Extrapolated to the EU this may correspond to some 100-150 t/y.
Technical textiles	800	5	As described above, some companies are known to use NPE in polymeric dispersions for coating technical textiles (for use in, for example, tents). According to the comment from the Emulsion Polymers Council (EPC, 2002 95-99% of the applied NPE stays in the coating of the technical textiles. Besides some technical textiles manufactures outside the EU may be used.
Other textiles (imported)	650	2	The RAR does not include release from textiles. The Annex XV dossier (KemI, 2013) estimate the total NPE content of imported textiles at 642 t/y based on an average concentration of 107 mg/kg.

Application	Activity, t/y	Uncertainty factor	Remark
Leather products (imported)	12	3	The use of NPE in leather processing in the EU is prohibited but NPE may be present in imported leather. In 1997 the consumption of NPE within the EU for leather auxiliaries was about 3,000 t/y while about 5,000 t/y was used for textiles. NPE was used for wet degreasing of hides in the leather industry (ECB, 2002). The NPE was not, as described for OPE, used in a polymeric finishing of the leather. This indicates that the content of NPE in imported leather potentially may be significant. Ma and Cheng (2010) measured NP and NPE_n in sheep-skin and goat skin leather for garment and cattle-hide for shoes and furniture. According to the authors, the leather may also be representative of the leather in the finished leather articles. A total of 90 different leathers were analysed in this study. The samples were obtained from sixteen tanneries in China for quality control. 18 of the 90 samples were found to contain NPE_n and 3 OPE_n, but no NP or OP was detected. The detected concentrations ranged from 11 to 1,500 mg/kg for NPE (normalised to NPE9 with 9 ethoxy units) and 21 to 1,100 mg/kg for OPE (normalised to OPE9 with 9 ethoxy units). The detection limits were 1.2, 0.5, 2.8 and 1.3 mg/kg for NP, OP, NPE9 and OPE9, respectively. The highest concentration of NPE (1500 mg/kg) was in a cattle-hide leather designed for furniture. Mean and median values are not reported. The majority of the detected concentrations seem to be in the 50-200 mg/kg range and considering 80% of the samples were below the detection level, the average values are probably in the range of 10-40 mg/kg. The total content of leather in articles placed on the market in the EU is not known, but is according to an Annex XV report on Cr (VI) in leather it is likely about 500,000 t/y (DEPA, 2012). Assuming an average concentration of 10-40 mg/kg, the total NPE content can be estimated to be 5-20 t/y. This is used as best estimated with additional uncertainties for the representativeness of the available data.
Degreasers	60	3	NPE is prohibited in cleaning agents, but may still be used in some maintenance agents and degreasers. The registered NPE quantities in degreasing and cleaning agents in the Swedish Product Register in 2011 were 0.5 t/y. The consumption of degreasers in the Danish Product Register in 2011 was 2 t/y. Extrapolated to the EU this may correspond to some 25-200 t/y.
Maintenance agents	50	3	The consumption registered in the Danish Product Register in 2012 was 53 t/y for "Cleaning agents, polish and maintenance agents" (Lassen *et al.* 2013). An update of the registered quantities revealed that the majority of the registered quantities were outdated. According to the update, still some 4 tonnes in various cleaning and maintenance agents were registered. Some of the registered products are within areas where the use of NPEs is restricted so a part of the registered volume is probably still due to inadequate update. The data from the Swedish, Norwegian and Finnish Product Registers in 2010 (SPIN database) did not indicate any use in cleaning and maintenance agents. The data from the Danish Product Register indicates that NPE are still used in some maintenance agents and the total EU consumption is roughly estimated at 15-150 t/y.

Application	Activity, t/y	Uncertainty factor	Remark
Pesticides and biocides	-	-	NP and NPE are prohibited as co-formulants in pesticides and biocides. However, national authorisations for pesticides or biocidal products containing nonylphenol ethoxylates as co-formulant, granted before 17 July 2003, shall not be affected by this restriction until their date of expiry. The authorization of for pesticides or biocidal products would usually expire in 5-10 years, and consequently it is expected that all authorisations have expired before July 2013, and that the consumption for this application areas is zero today. NPE in pesticides and biocides were in 2011 still registered in the Swedish and Danish Product Registers, but it is expected that all applications have ceased today. After an update of the notifications in Denmark, still a consumption of 0.1 tonnes was registered.

2.2.2 Emission factors

Emission factors for use of NPE in industrial processes, use of NPE in articles and mixtures and by waste management are shown in Table 4 and the background for the emission factors are briefly described in the table.

TABLE 7
DERIVED EMISSION FACTORS FOR THE RELEASE ESTIMATIONS OF NPE

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Manufacture of NPE and use of NPE for the manufacture of other chemicals:					
Manufacture of NPE	Surface water Waste water	0.000004% 0.033% In percentage of NPE produced	5	Estimated on the basis of activity rates and indicated emission in the RAR	ECB, 2002
Synthesis of other chemicals: nonylphenol ether sulphates and nonylphenol ether phosphates (captive use)	Waste water	0.2%	3	The RAR for NP applies on the basis of default worst case emission factors from the TGD, the following factors: Waste water: 0.7% This emission factor used in this study as the upper emission factor in the uncertainty range.	ECB, 2002
Formulation and processing:					
Industrial formulation of mining products (flotation agents) containing NPE	Air Surface water	0.05% 0.06 %	5 5	No data available – in the absence of actual data, the same emission factors as for the formulation of other mixtures are applied (see below). Default emission worst case factor for the ERC is 2% to waste water. (ECHA, 2012)	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Formulation of polymer dispersions for emulsion polymerization	Air Surface water	0.05% 0.06 %	3 3	The RAR for NP applies on the basis of default worst case emission factors from the TGD, the following factors: Air 0.25% Surface water: 0.3% These factors are used in this study as the upper emission factor in the uncertainty range.	ECB, 2002
Formulation of paints and inks	Waste water	0.14%	3	The RAR for NP applies a conservative release factor of 0.5% released to waste water which is identical to the default emission factor, applied for aqueous dispersion coatings in the OECD ESD for the Coating Industry. Environment Agency (2005) applies an emission factor for releases of OPE to waste water of 0.14%. Indicated as adopted from the OECD ESD, CEPE SPERC 2.2c.v1- formulation - water borne coatings and inks – solids applies an emission factor consisting of (CEPE, 2013): - indirect emissions via dust deposition and subsequent wet cleaning of surfaces: 0.005% - emissions via equipment cleaning and subsequent discharge to waste water : 0.005% No emission to air is expected. It is not indicated in the SPERC factsheet why an emission factor of 0.005% for equipment cleaning instead of the 0.5% from the OECD ESD is applied.	
Formulation of adhesives, sealants, etc.	Surface water Waste water	0.0075% 0.14	3 3	The RAR does not specifically include estimates on the emission from the formulation of adhesives, sealant, etc. FEICA SPERC 2.2b.v2 Formulation of Water Borne Adhesives – Solids, emission factors are based on OECD (2007) ESD on the Coating Industry as FEICA assumes similar emission factors are applicable. FEICA (2013) indicates the emission factor for emissions to air for solids at 1%. As the NPE is not used as powder, the releases to air are expected to be negligible. In this study, the same emission factors as applied for formulation of paints above, is used.	FEICA, 2013 OECD, 2007
Textile and leather auxiliaries used in closed systems	0	0		The use of NPE is only allowed in closed systems and it is expected that emissions are insignificant	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
End-uses:		**Percentage of quantity used in the product *1**			
Used as flotation agent in mining operations (without offshore industries)	Surface water (after onsite waste water treatment)	2%	10	No data available In flotation, the separation of minerals is accomplished by utilising the differences in their physico-chemical surface properties. For instance, after conditioning with reagents, some particles become water repellent or hydrophobic (or aerophilic), while other particles remain hydrophilic. (BREF, 2009) The EU BREF (2009) document of management of tailings and waste-rock in mining activities describe the flotation process, but do not indicate the levels of releases of the surfactants used in flotation to the environment. The registrants have been requested information on releases, and some information has been obtained from downstream users.	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Paint and inks	Air Waste water	0.1% 1% Remaining part to solid waste	5 2	The RAR applies emission factors for industrial use of the paints of zero % to air and 0.5% to waste water. The emission factors for industrial use are applied for all uses. NPE is according to the RAR mainly used in decorative emulsions but small volumes are also used in other applications such as water-based 'refinish' paints for vehicle re-coating. It is not indicated how much is use for the different application areas. Available SDS indicate that NPE is both used in decorative coa-tiong (in bildings) and in industrial applicases. The decorative coatings are indicated to be applied by brush, roller or spray (see section 6.3.1). CEPE SPERCs use different emis-sions factors for paint used by con-sumers, professionals and industry, and applies the following emission factors: Consumer use, all applications and professional application by brush and roller: 1% to waste water and 0.5% to soil for applications outdoors. Professional application by spray: 2.2% to air, 2% to waste water, Soil indicated as "to be advised" As a part of the paint is used by consumers and professionals the default emission factors for industrial is considered to be too low as an average. The emission factors applied in this study assume that the paints are applied by various application meth-ods - and for the releases to air it is assumed that only a minor part is applied by spray.	CEPE, 2013

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Adhesive, sealants and filling agents	Waste water	0.9% Remaining part to solid waste	2	RAR does not include any emission factors for application of adhesive, sealants and filling agents Different emission factors for industrial use and wide dispersive use: FEICA SPERC 8c.3.v2- Wide dispersive Use of Substances other than Solvents in Adhesives and Sealants: 1.5% to waste water (same for solvent and water-based adhesives) FEICA SPERC 5.1c.v2 - Industrial Use of Substances other than Solvents in water borne adhesives: 0.3% to waste water An amalgamated emission factors of 0.9% is applied in this study as best estimate (same as indicated by FEICA with reference to OECD Emission Scenario Document	FEICA, 2013

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Lubricating oils and metal working fluids (in closed systems)	Air Waste water Soil	0.01% 0.05% 0.05%	3 3 3	For the metal-working fluids in closed systems the releases are considered insignificant For lubricants ATIEL-ATC (2012) applies different emission factors for the different SPERCs. ATIEL-ATC SPERC 9.Bc.v1 Consumer use of lubricant and greases in open systems (use of lubricants and greases in vehicles or machinery). Air: 0.5% Waste water: 0.05% Soil: 0.05% ATIEL-ATC SPERC 4.Bi.v1Industrial use of lubricants and greases in vehicles or machinery: Air: 0.005% Waste water: depends on physico-chemical properties of RDS Soil: 0.0% ATIEL-ATC SPERC 9.Bp.v1 , Professional use of lubricant and greases in vehicles or machinery Air: 0.01% Waste water: 0.05% Soil: 0.3% The amalgamated emission factor for all applications are in this study assumed to be: Air: 0.01% Waste water: 0.05% Soil: 0.05% The uncertainties both include the uncertainty of the actual emission for the different applications and the split of the activity rate between the different applications.	ATIEL-ATC, 2012

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Technical textiles	Waste water Solid waste	1% Remaining part to solid waste	3	The technical textiles in question are not generally assumed to be washed in the same way as clothes, but may be wetted (e.g. through rain), leading to at least some release to the environment. AMEC (2013) assumed that, over an average 10 year lifetime, 5% of the remaining NPE in the textile articles is released to surface water/waste water each year (note exponential decrease). The remainder is assumed to remain in the textiles during disposal. The Emulsion Polymers Council (EPC, 2002) states that experimental data indicates that less than 1% of the NP/NPE used in a textile coating can, under worst-case conditions, be released from the fabric. Releases were determined by washing a sample for 1 hour in a Launder-O-Meter at 72 °C (160°F) wash temperature using stainless steel balls and deionized water in the tumbling mode. By the test, 0.114% of the available NPE was extracted. Based on the actual measurements it is considered unlikely that the releases should be as high as estimated by AMEC. Besides the leaching, some losses may be due to abrasion and losses of material in the environment. The EU RAR for the phthalate DEHP, estimates a particulate emission from coated fabric applied outdoors of 4% over the service life of the products (ECB, 2008). Based on the available information it is estimated that the releases to waste water from the use of technical textiles is likely in the range og 0.3-3%.	AMEC, 2013 EPC, 2002
Other textiles (mainly imported)	Waste water	95% Remaining part to solid waste	1.05	The Annex XV restriction report (KemI, 2013) provides information suggesting that 100% of the NPE in textiles is releases to waste water by wash. However, some textiles are not washed or only washed a few times and the emission factor has been adjusted accordingly. A recent Danish study found that removal of NPE by a single washing varied from 25% up to 99.9%. Most NPE was removed by washing the bed linen at 60°C (Rasmussen *et al.*, 2013)	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Leather products (mainly imported)	Waste water Soil	10% 2%	3 3	No emission factors for NPE in leather have been identified. NPE were formerly used for wet degreasing of hides in the leather industry (ECB, 2002). The NPE was not (as described for OPE) used in a polymeric finishing of the leather. KemI (2012) indicates that leather articles are excluded from the scope of the proposed restriction, since leather articles are not normally washed in water, and the release to the waste water from this source is considered very limited. According to the Annex XV report on Cr (VI) in leather, the main release route from the articles of leather to the environment is releases from shoes in wet weather and releases to waste water when articles of leather are washed off or wiped off (DEPA, 2012). Shoes is the major application of leather and represent nearly half of the leather in finished articles (DEPA; 2012) No data on the actual release of NPE from leather is available. As the NPE is water soluble, for some applications it may be a significant part, but for others it would still be insignificant. The emission factor is roughly estimated with high uncertainty.	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Degreasers	Waste water Soil	25% 5%	2 2	KemI (2012) applies different emission factors for release of NPE to waste water from the use of degreasing agents. The factors range from 2% to 90% depending on applications areas. Detergents, cleaners: 48% to waste (waste water and surface water) – in this study calculated as waste water. 14% to soil Degreasers are used for industrial, agricultural, marine, automotive and domestic application. They may be applied with a spray, sponge, mop or soft brush. Manufacturers recommend wiping clean with a damp cloth or rinsing with clean water. Is must be expected that a significant part, both by consumer and professional applications, is released to waste water if the degreased part is rinsed with water. By application outdoors (e.g. degreasing vehicle engines) a part of the NPE may furthermore be released to soil. The applied emission factor is considered to be relatively uncertain.	KemI (2012) SFT, 2004 as cited by OECD, 2011
Maintenance agents	Waste water Soil	25% 5%	2 2	No emission factors have been identified for maintenance agents. Only a few products which may be considered maintenance agents have been identified. The emission factors are roughly estimated assuming that for some of the maintenance agents such as polish a significant part ends up in waste water KemI (2013) applies an emission factor for emission of NPE to waste water from car shampoo at 50%	KemI (2013)
Waste management:		**Percentage of NPE in waste/ waste water**			

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Sewage treatment	Surface water (as NPE and NPEC) Degraded to NP in effluent Mineralised/highly degraded Sewage sludge as NP	33% 2.5% 45.5% 19%	2	According to the conclusions drawn in the RAR for NP, NPEs are degraded in the WWTP rather quickly particularly when treated with microorganisms during the biological step. Approximately 25 % leaves with the effluent as mono-, di-ethoxylates or NPECn and 8 % as longer chain ethoxylates (NPEn). The distribution is in the RAR indicated as based on realistic worst case assumptions – but it is not clear which of the parameters are "worst case"	ECB, 2002
	DK values: Surface water (as NPE and NPEC) Degraded to NP in effluent Mineralised/highly degraded Sewage sludge as NP	12% 2.5% 66.5% 19%		See section 2.3.2	
Municipal solid waste incineration	Air Landfill Degradation	0.01 0.1 99.98%	1.1 1.1 Remaining	It is assumed that the NP nearly 100% is degrade d by the municipal solid waste incineration	
Landfill	Surface water			No data on discharges of NP from landfills have been identified.	

*1 Total quantity of NP in products placed on the market the reference year

2.2.3 Overall flow and releases of NPE

The overall flow of NPE in the EU is shown in Figure 3 below. The longer chained NPEs are considered polymers and not registered and for this reason registration data cannot be used for estimating the actual consumption figures. The quantities used for the different applications are estimated on the basis of information from the RAR for NP for non-restricted applications and newer data on the total consumption of APEs.

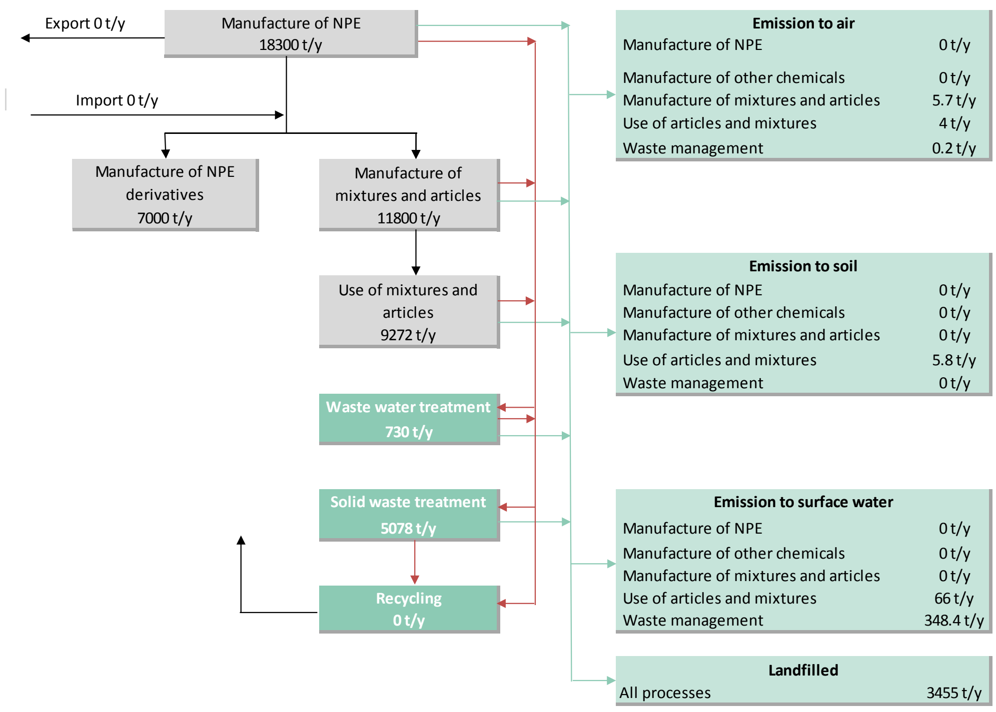


FIGURE 3

OVERALL FLOW OF NPE IN THE EU (MEAN VALUES).

Total releases of NPE to the three environmental compartments and landfill are shown in the Table 8. Please note that the total quantities released to solid waste and waste water are further terminated in the lower part of the table.

As mentioned in section 2.1.3 on NP releases, the major source of NP to surface water and soil when the mean values are considered is NP formed from NPE by waste water treatment. The quantities are shown in the two lower rows in Table 8.

Release to air – The releases to air are very small compared to the releases to waste water and surface water and not further discussed.

Releases to surface water and waste water – The sources to waste water are further summarised in Table 9.

The main source of NPE to waste water is imported textiles (major source, not included in the RAR for NP). The significance of this source is one of the main reasons for an Annex XV restriction proposal for NP and NPE in textiles in the EU (KemI, 2013). Estimation performed in the Annex XV dossier based on data from the Swedish Product Register reach the conclusion that the textiles (including technical textiles) likely account for about half of the emissions of NPE to waste water. The estimates performed in this survey indicate it may even be a higher percentage. .

Other potentially major sources are paints and varnishes, synthesis of NPE derivatives, degreasers, maintenance agents and technical textiles.

Considering the uncertainties, it seems to be very certain that textiles is the major source, whereas it is less certain which of the other sources are most significant. Sources such as degreasers, maintenance agents, synthesis of NPE and formulation of paints may also be among the major sources. It is quite certain that releases from use of end-products represent the major part of releases.

Leather articles have been excluded from the scope of the Annex XV restriction proposal (KemI, 2013), because the emission factors for emission to waste water are assumed to be very small, but the Annex XV restriction proposal does not include information on NPEs in leather. Based on information on NPE in leather manufactured in China and estimated emission factors, the releases to waste water are estimated in this survey. The estimate confirms that the releases from leather are small compared with the releases from textiles, even if the upper boundary of the estimated range is considered.

The registration of one of the NPE provides information on a significant tonnage used for formulation of flotation agents used in the mining industry. The application is not described in the EU RAR or any other assessment and no emission factors for the process are available

Contribution of NPE to the environmental load of NP - The contribution of the releases of NPE to the environmental load of NP is discussed in section 2.1.3.

TABLE 8 (ELLER 8?)
RELEASE OF NPE IN THE EU FROM ALL LIFE CYCLE STAGES

Life cycle stage	Total releases (average value and 90% confidence interval) (tonnes/year):						
	Air	Surface water	Landfill	Soil	Solid waste	Waste water	Degraded
Industry - Manufacture of chemical:							
Manufacture of NPE	0	0	0	0	0	6 (0.7-49.9)	0
Industry - Manufacture of other chemicals/resins (intermediate use):							
Synthesis of NPE derivatives	0	0	0	0	0	42 (8.7-200.7)	0
Industry - Formulation and processing:							
Formulation of flotation agents	1.7 (0.1-20.2)	0	0	0	0	2 (0.2-23.6)	0
Formulation of polymer dispersions	4 (0.8-20.2)	0	0	0	0	4.8 (0.5-42.3)	0
Formulation of paint and inks	0	0	0	0	0	5.6 (0.6-50.1)	0
Formulation of adhesives, sealants, etc.	0	0 (0-0.2)	0	0	0	0.4 (0.1-2.9)	0
Production of textile and leather in closed systems	0	0	0	0	0	0	0
End use of mixtures and articles:							
Use as flotation agent	0	66 (2.8-1,584.7)	0	0	0	0	0
Paints and inks	4 (1.8-8.7)	0	0	0	,3956 (1841-8510)	40 (18.6-86.7)	0
Adhesive, sealants and filling agents	0	0	0	0	297 (135-649)	2.7 (1.2-5.8)	0
Metal working fluids (in closed systems) and lubricating oils	0	0	0	0.1 (0-0.1)	0	0.1 (0-0.1)	0
Technical textiles	0	0	0	0	792 (100-6321)	8 (1-67)	0
Other textiles (imported)	0	0	0	0	32.5 (14.8-71)	618 (284-1335)	0
Degreasers	0	0	0	3 (0.6-14.5)	0	15 (3.1-70.6)	0
Maintenance agents	0	0	0	2.5 (0.5-12.4)	0	12.5 (2.6-60.7)	0
Leather products	0	0	0	0.2 (0-1.7)	0	1.2 (0.2-8.7)	0
Sum to wastewater and solid waste					5,078 (2,951-9,717)	730 (395-1456)	
Waste management:					,		
Recycling	0	0	0	0			0

Life cycle stage	Total releases (average value and 90% confidence interval) (tonnes/year):						
	Air	Surface water	Landfill	Soil	Solid waste	Waste water	Degraded
Solid waste management	0.2 (0.1-0.3)	0	3,455 (1,540-6,832)	0	0	0	1623 (722-3231)
Waste water treatment	0	348 (282-872)	0 (0-0)	0	0	0	381 (312-948)
Formation of NP from NPE in WWTP (to NP balance) In sludge	-	0 (0-0)	0 (0-0)	-	-	-	142 (158-260)
Formation of NP from NPE in WWTP (to NP balance) To surface water	-	0 (0-0)	0 (0-0)	-	-	-	18.2 (20.3-33.2)
Total	9.8 (5.7-34.9)	414 (323-2021)	3,455 (1,540-6,832)	5.8 (2.7-21)	as above	as above	2165 (1261-3874)

TABLE 9?
OVERVIEW OF SOURCES OF RELEASES OF NPE TO WASTE WATER IN THE EU

Application area	Releases, tonnes/year		Percentage of releases (mean values)
	Mean value	Range	
Synthesis of NPE derivatives	14	3-67	2%
Other manufacture and formulation processes	19	3-120	3%
End uses:			
Paints and inks	40	19-87	5%
Technical textiles	8	1-67	1%
Other textiles (imported)	618	284-1335	85%
Other uses	31	7-151	4%
Total	730		100%

2.3 Use and releases of NP and NPE in Denmark

2.3.1 Use of NP and NPE in Denmark

Use in mixtures

The applications of NP registered in the Danish Product Register are shown in the table below. The figures both covers NP used for formulation of mixtures and the application of the mixtures in Denmark. Due to confidentially the part of the consumption used for formulation processes cannot be specified, but this consumption is small compared with the consumption for application of the mixtures and consequently all consumption is in this study considered for application.

The application indicated as "Process regulators (hardeners)" seems predominantly to be the hardener part of two-component fillers and adhesives and will in this study be allocated to adhesives and sealants and fillers. The hardeners are not registered as used in the manufacture of plastics.

"Surface treatment" is not further indicated, but may likely be considered under paints, lacquers and varnishes and will in this study be included in this category.

Lubricants and additives are not included in the EU assessment but the total consumption is insignificant. Emission factors for other substances used in lubricants and additives will be applied.

TABLE 10
CONSUMPTION OF NP (*1) REGISTERED IN THE DANISH PRODUCT REGISTER, 2013

Application area (based on UC62)	Consumption (production + import – export) *1		
	n *2	t/y	%
Paints, lacquers and varnishes	40	6.3	30%
Adhesives	12	0.8	4%
Sealants and filling agents	10	5.1	24%
Surface treatment	6	0.1	0.3%
Lubricants and additives	7	0.004	0.02%
Process regulators (hardeners)	13	3.1	15%
Other (confidential or application area not indicated) *3	17	5.6	27%
Total (including confidential)	92	21.0	100%

*1 CAS Numbers 104-40-5, 25154-52-3, and 84852-15-3

*2 Number of mixtures.

*3 The total figures for application areas confidential or application area not indicated differs depending on the used codification systems and is e.g. higher for the dataset showing Ucn (Nordic use codes)

The registered consumption of NPE in mixtures in the Danish Product Register is shown in 10.

The consumption of 134 tonnes NPE for binders for paints and adhesives is unusual and much higher than the previous years.

TABLE 11
CONSUMPTION OF NPE (*1) REGISTERED IN THE DANISH PRODUCT REGISTER, 2013

Application area (based on UC62)	Consumption (production + import – export) *1		
	n *2	t/y	%
Binding agents for paints and adhesives	6	134.4	75%
Paints, lacquers and varnishes	156	2.7	2%
Adhesives	17	0.5	0%
Sealants and filling agents	10	0.5	0%
Lubricants and additives	23	1.3	1%
Biocidal products and pesticides	4	0.1	0%
Cleaning, washing, maintenance agents	53	4.1	2%
Degreasers	13	1.7	1%
Cutting fluids	3	0.4	0%
Surface treatment	10	0.4	0%
Process regulators	6	12	7%
Surface active agents	10	7.6	4%
Other (confidential or application area not indicated)	35	12.8	7%
Total		179	100%

*1 CAS Numbers 9016-45-9, 26027-38-3, 37205-87-3,68412-54-4, 127087-87-0

*2 Number of mixtures.

Leather and textiles – The survey of NP and NPE in textiles in Denmark indicates an import of textiles of 59.181 t/y (Rasmussen *et al.*, 2013) similar to 1% of the EU import reported by KemI (2013). It indicates that the Danish import of textiles on a per capita basis is quite similar to the EU average (Denmark represents approximately 1% of the EU population). Considering the small number of samples analysed, there is no basis for assuming that NPE and NP in textiles imported to Denmark should be different from the EU average. The same applies to leather for which no Danish analyses exist. For the estimates, it is consequently assumed that the NPE consumption in Denmark with textiles (all kinds) and leather account for 1% of the EU consumption.

2.3.2 Releases of NP and NPE in Denmark

The assessments of the releases at EU level clearly indicated that the main issues are related to releases to waste water (with subsequent releases to other compartments), surface water and soil, and the assessments of releases in Denmark will focus on these compartments. For the Danish data uncertainties have not been considered, but the uncertainties are most probably at the same size as for the EU data.

The emission factors for releases from applications are considered the same as for the releases at EU level, but specific Danish distribution factors for the management of waste water are applied. The Danish distribution factors for sewage and for disposal of sewage sludge is shown in Table 1 in section 1.5. The main difference, as compared to the EU average, is that the fraction of the sewage which is discharged to surface water without treatment is significantly lower.

The estimated releases of NP and NPE in Denmark are shown in the two tables below. The total estimated releases of NPE to surface water is 1.2 t/y; about 6 times the releases of NP. However, the major source of releases of NP to the surface water accounting for approximately 90% is formation of NP from NPE by treatment of NPE in WWTPs.

For both NP and NPE the main source of releases to waste water, when mean values are considered, is textiles. Formulation and use of paint and inks account for 17% of NP releases and 3.3% of the NPE releases.

TABLE 12
RELEASE OF NP TO SOIL, SURFACE WATER AND WASTE WATER IN DENMARK IN 2013 *1

Application area	Releases, tonnes/year			% of releases to waste water
	Surface water	Soil	Waste water	
End-uses of mixtures and articles:				
Paints, lacquers and varnishes (incl. surface treatment)	-	-	0.032	17%
Adhesives, sealants and filling agents (incl. hardeners)	-	-	0.059	32%
Articles of phenolic resins	-	-	0.013	7%
Textiles (incl. technical textiles)	-	-	0.080	43%
Other				
Total to waste water			0.184	100%
Waste water treatment *2	0.021	0.035		
Formation of NP from NPE in WWTP	0.194	0.332		
Total	0.219	0.392	As above	

*1 CAS Numbers 104-40-5, 25154-52-3, and 84852-15-3

*2 The difference between the total to waste water and the releases from waste water treatment is due to degradation by the management.

TABLE 13
RELEASE OF NPE TO SOIL, SURFACE WATER AND WASTE WATER IN DENMARK IN 2013*1

Application area	Releases, tonnes/year			% of releases to waste water
	Surface water	Soil	Waste water	
Formulation of paint, inks, adhesives, sealants, etc.	-	-	0.215	3%
End-uses:				
Paints and inks	-	-	0.027	0.3%
Adhesive, sealants and filling agents	-	-	0.009	0.1%
Metal working fluids (in closed systems)	-	-	-	0%
Lubricants	-	0.001	0.001	0.0%
Technical textiles	-	-	0.080	1%
Other textiles (imported)	-	-	6.175	77%
Degreasers	-	0.085	0.425	5%
Surface treatment	-	-	0.004	0.1%
Cleaning and maintenance agents	-	0.205	1.025	13%
Leather products	-	0.002	0.012	0.2%
Other mixtures (confidential or application area not indicated)	not indicated	not indicated	not indicated	not indicated
Total to waste water			**7.814**	**100%**
Waste water treatment *2	1.215	-		
Total	1.215	0.293	As above	

*1 CAS Numbers 104-40-5, 25154-52-3, and 84852-15-3

*2 The difference between the total to waste water and the releases from waste water treatment is due to degradation by the management.

Fate of NP and NPE in Danish WWTPs

Several studies have analysed the fate of NP and NPE in Danish WWTPs and the results indicate a broad variation among the plants.

Fauser *et al.* (2001) analysed the fate of NP and NP2EO in a Danish WWTP (Roskilde WWTP). Based on measurements of the substances in inlet, outlet and sewage sludge it was demonstrated that the quantities of each of the two substances in sludge and outlet constituted 20% of the inlet and it was concluded that about 80% was degraded. For both substances, the balance represents the sum of two opposite processes. The NP in the inlet is degraded in the WWTP and at the same time it is formed from the degradation of NPEs as discussed in section 2.1.2. The same is the situation for NP2EO which in the WWTP is formed from NPEs with longer ethoxylate chains. It is noteworthy that the high concentrations of NP2EO in the inlet as compared to the NP concentrations do not result in higher concentrations of NP in the outlet as consequence of the formation of NP from NP2EO (and other NPEs not measured).

TABLE 14
FATE OF NP AND NP2EO IN ROSKILDE WWTP (FAUSER *ET AL.*, 2001)

	Inlet concentration (µg/l)	% of inlet		
		Outlet	Sludge	Degraded
NP	7,15 ± 2,46	3.6%	15.7%	79.8%
NP2EO	118 ± 63.1	1.8%	18.5%	79.5%

The fate of NP and NPE in MWWTPs in Denmark was also analysed by Pedersen and Bøvadt (2002). The study analysed NP1EO, NP2EO and the long chained NPE, NPEOn in WWTPs in Herning and Hillerød. The study focused on fate of the substances by the treatment of the sludge and did not establish a full mass balance for the plants for each substance.

Inlet concentrations for the sum of NP, NP1EO and NP2EO were between 10 and 29 µg/l in Herning and between 25 and 24 µg/l in Hillerød. The concentration of NPEOn ranged from 25 to 35 µg/l in Herning and from 3.8 to 7.3 in Hillerød.

The molar distributions of the substances in the inlet and treated sludge in the two WWTPs are shown in Figure 4 (the principle is that one mole of NPE may be degraded to one mole NP).
In Henning, the total molar quantities of the substances in the treated sludge were similar to the amounts in the inlet whereas in Hillerød the total amount in the sludge was about 35%. The fraction ending up in the sludge is thus much higher than found by Fauser *et al.* 2001. Due to degradation of the NPEs, the total quantities of NP in the sludge is higher than the total in the inlet in Herning and in Hillerød they were at the same size. The concentrations in the outlets were not measured, but based on the balances it can be concluded that only a small part will be discharged though the outlet.

The NPEOn was degraded to short-chained substances and NP under both aerobic (with oxygen present) and anaerobic (without oxygen) conditions. In one plant, NPEOn accounted for 31% of the inflow, whereas in the other it accounted for 11%. In both plants the NPEOn was nearly 100% degraded and accounted for 0 and 2%, respectively, in the sludge from the two plants. The degradation was most pronounced under aerobic conditions. Under anaerobic conditions the substances were mainly degraded to NP1EO and NP.

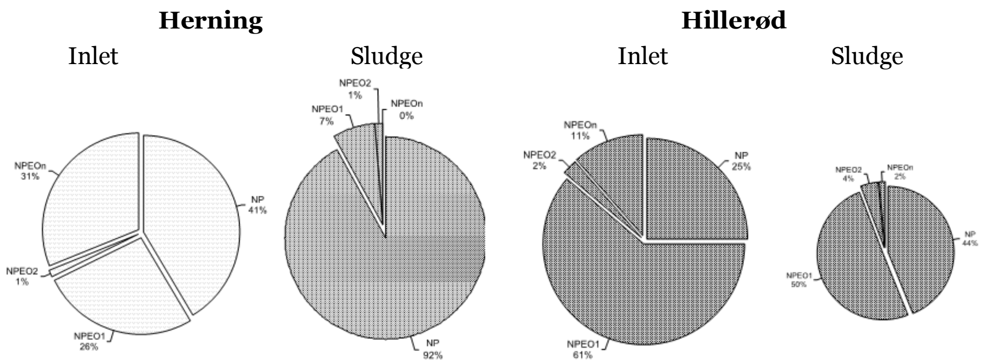


FIGURE 4
DISTIBUTION (MOLAR BASIS) OF NP, NP1EO, NP2EO AND NPEON IN TWO WWTPS IN DENMARK. THE SIZE OF THE CIRCLES ILLUSTRATED THE TOTAL QUANTITIES (PEDERSEN AND BØVADT (2002).

Based on about 327 samples for NPE and 62 samples for NP, collected during the time period 1998-2009 , "Nation Mean Concentrations" (Danish: "Nøgletal") for substance concentrations in inlets and outlets from WWTPs were derived by Kjølholt *et al.* (2011). The concentrations and calculated quantities are shown in Table 15. For NP and NP2EO the outlet concentrations were 12 and 8% of inlet concentrations, respectively. This is somewhat higher than found by Fauser *et al.*, 2001. From the available data in is not possible to determine to what extent the NP in the outlet originates from NP in the inlet, which is not degraded in the WWTP, or it originates from degradation of NPEs in the WWTP. But the fraction of the NP in the inlet discharged to surface water will be less than the 12% and similarly the fraction of NP1EO and NP2EO will be less than the indicated 2% and 8% respectively (as the substances are formed from longer-chained NPE).

On the basis of the mean concentrations, the total discharge in 2010 was estimated at 41 kg for nonylphenol monoethoxylates and 120 kg for nonylphenol, while the discharge of nonylphenol diethoxylates could not be estimated as the measured concentrations in outlets were below the detection level.

The study did not establish mean concentration of the substances in sludge from the waste water treatment. Furthermore, the study did not establish national mean concentrations of NPEO with longer chain lengths, NPEOn, which may account for a significant part of inflow as demonstrated by Pedersen and Bøvadt (2002).

TABLE 15
NP AND NPE IN IN AN OUTLET OF MUNICIPAL WWTPS IN DENMARK IN BASED ON NATION MEANS FROM 2011 (KJØLHOLT *ET AL.*, 2011) *1

	Inlet			Outlet			
	National mean concen-tration (µg/l)	Tonnes/year	Tonnes/ year NP_{eq}	National mean concentra-tion (µg/l)	Tonnes/ year	Tonnes/ year NP_{eq}	% of inlet
NP	1.4-2.5	2.0-3.5	2.0-3.5	0.15-0.33	0.21-0.46	0.21-0.46	12%
NP1EO	2.2-4.2	3.1-5.9	1.2-2.6	0-0.13	0.00-0.18	0.00-0.07	2%
NP2EO	0.31-0.98	0.4-1.4	0.2-0.6	0-0.10	0.00-0.14	0.00-0.06	8%
Total (NP_{eq})			1.4-2.0			0.00-0.13	3%

*1 Quantities based on a total waste water quantity of 716 million m^3.

The trends in discharges of NP and NPEO from MWWTP over the period 2000 to 2010 have been reported by Boutrup and Svendsen (2012) are shown in the table below. The mean concentration of NPs in outlets from MWWTP measured in 2010 was lower than previous years (0.06 µg/l) as compared to the period 2000-2002 which ranged from 0.24 to 0.43 µg/l. According to the authors, however, it is on basis of the data not possible to determine if the decrease is significant.

The studies did not analyse NPEC in the waste water and outlet from WWTPs and this makes a comparison with the EU data complicated, as the percentage in the outlets from WWTPs in the EU Risk Assessment is based on both NPE and NPEC in the effluents.

In summary, the percentage of the NP and NPE in the wastewater which is discharged to surface water seems to be significantly lower than the applied EU averages of 44% for NP and 33% for NPE (and NPEC).

For NP, the average value for releases to surface water is estimated in this study to be about 8% (assuming that a part of the 12% is due to formation from NPE) while it for NPE is roughly estimated to be 12% to take the NPEC into account. As concern the fraction ending up in sludge the data from Danish WWTPs are so variable that there is no basis for assuming that it should be different from the EU average. Similarly, the Danish data do not form any basis for assuming that the formation of NP from NPE in the plants differs from the EU average.

Comparison with measured releases
In order to compare the estimated releases to WWTP with actual measurements, the estimated quantities are compared to the quantities estimated by the use of the national means (Table 15).

The most pronounced difference is that the releases estimated in this study of NP to waste water is considerable lower than estimates based on inlet quantities (0.18 t/y as compared to 2.0-3.5 t/y). At the same time the estimated releases of NPE is slightly higher than the sum of NP1EO and NP2EO reaching the WWTPs (7.7 t/y as compared to 3.5-7.3 t/y), but this difference may be explained by the fact that the higher-ethoxylated NPEs are not covered by the national means. Furthermore, the differences are within the uncertainties of the results. The explanation for the relatively high concentrations of NP found in the inlet to the plants may partly be explained by a degradation of NPE already in the sewer system. Data are not available, but available experts estimates indicates that the formation of NP from NPE in the sewer system would be limited and most probably this cannot fully explain the differences. Another explanation could be that the releases of NP to waste water are underestimated.

The estimated total releases of NP from the WWTPs is of the same size as the total estimated releases based on the national means (0.2 t/y as compared to 0.21-0.46 t/y). The estimated releases of NPE (and NPEC) are much higher than the estimated releases based on the national means (1.2 t/y as compared to 0-0.13). The estimates are based on an assumption that 12% of the NPE in the inlet are discharged. As described in the previous section the 12% include releases of NPEC and longer-chained NPE which are not included in the national mean. Furthermore, it is estimated that 4% of the waste water is releases directly to surface water from overflow. For substances where the treatment efficiencies are high, the direct releases to surface water without treatment may contribute very significant to the total releases.

2.4 Releases of NP and NPE in Sweden

The releases of NP to the municipal waste water system in Sweden based on wide dispersive use of mixtures are shown below. The emissions are estimated on the basis of the quantities registered in the Swedish Product Register and emission factors derived from the default emission factors for the different ERC's in the ECHA (2012a) guidance document and some correction factors based on "expert estimates". As an example the default "worst case" emission factors were lowered by a factor of 200 if the mixture is solvent based as compared to water based

The major source categories were various applications of paint, cast compounds, stabilizers and adhesives. For some of the application it is difficult to interpret the results in terms of the main applications of NP as stated in the EU RAR (ECB, 2002). Contrary to the Danish Product Register the Swedish Product Register also included consumer products. Of 180 registered substances, only 9 were registered as consumer products.

Please note that table 15 and 16 do not include emissions from textiles and other articles. The tables show the releases to the waste water system and not the releases to the surface water.

TABLE 16
ESTIMATED RELEASES OF NP TO THE SWEDISH MUNICIPAL WASTE WATER SYSTEM BASED ON WIDE DISPERSIVE USE OF MIXTURES IN 2009 (KEMI, 2013)

Product Category	Sector of Use	Release to waste water system Tonnes/year
Paint, other solvent free for interior use	Construction industry	0.0297
Paint, solvent based anti-corrosive for industrial use	Surface treatment and coating of metals	0.0151
Paint, other curing paint for interior use	Construction industry	0.0134
Paint, curing paint with anti-corrosive effect for other use	Industry for fabricated metal products	0.0092
Paint, curing paint for other use	Construction industry	0.0022
Solvent	Paint industry	0.0030
Cast compounds	Industry for stone products	0.0196
Stabilizers	Industry for plastic products	0.0165
Adhesive, curing agent for industrial use	Construction industry	0.0120
Total		0.1200

The similar table for NPE is shown below. The total releases to NPE waste water are 27 times higher than the releases of NP; considering the uncertainties it is more or less the same as the similar ratio for the emissions of NP and NPE (excluding textiles) in the EU of 10 times (14 t/y NP vs. 142 t/y NPE). This indicates that also the emission of NPE from other sources than textiles may contribute significantly to the total releases of NP from the WWTP.

TABLE 17
ESTIMATED RELEASES OF NPE TO THE SWEDISH MUNICIPAL WASTE WATER SYSTEM BASED ON WIDE DISPERSIVE USE OF MIXTURES IN 2009 (KEMI, 2013)

Product Category	Sector of Use	Release(tpa)
Surface active agents, other	Industry for organic basic chemicals	1.687
Cleaner, other	Jeweller's shop	0.281
Car shampoo	Retail sale, except for such with motor vehicles	0.190
Printing ink remover	Publishers and printers other industry for reproduction	0.179
Degreasing agents	Wholesale of chemical products	0.166
Multi-purpose cleaners	Manufacture of food products	0.101
Cleaner, others	Services	0.093
Binders for paints, adhesives	Paint industry	0.092
Cutting oil	Sale, maintenance and repair of motor vehicles	0.089
Cleaner, others	Sale, maintenance and repair of motor vehicles	0.074
Paint, other water based for exterior use	Paint shop	0.061
Rolling oil	Industry for basic metals	0.036
Degreasing agents	Industry for fabricated metal products	0.035
Screw-cutting oils	Wholesale of chemical products	0.029
Rust preventive, other	Surface treatment and coating of metals	0.025

Product Category	Sector of Use	Release(tpa)
Paint, other water based for interior use	Paint shop	0.016
Adhesive, water based for consumer use	Construction industry	0.015
Sealant	Construction industry	0.014
Putty	Construction industry+ Retail sale, except for such with motor vehicles	0.012
Base oils	Tanneries industry for leather goods	0.010
Hardeners, other	Paint industry	0.010
Insulating materials, heat-cold	Construction industry	0.010
Pigments for paints and inks	Industry for dyes and pigments	0.009
Release agents, other	Industry for plastic and rubber products	0.009
Surface active agents, other	Paint industry	0.008
Paint, other water based for exterior use	Construction industry	0.008
Motor oil	Retail sale, except for such with motor vehicles	0.007
Friction reducing agents	Paint industry	0.007
Paint, water based with flame retardant effect for interior use	Paint shop	0.006
Binders for paints, adhesives	Industry for glues	0.005
Raw material for production of	plastics Construction industry	0.005
Adhesive, water based for industrial use	Industry for wood and products of wood	0.005
Pigment paste	Paint shop	0.004
Paint, other curing paint for interior use	Paint shop + Industry for fabricated metal products	0.004
Putty	Construction industry	0.004
Adhesive, water based for industrial use	Industry for pulp, paper and paper products	0.004
Total		3.310

3. Releases of octylphenols (OP) and octylphenol ethoxylates (OPE)

Octylphenol (NP) and octylphenol ethoxylates (OPE) are used for some of the same applications as NP and NPE.

The consumption of the two substances, releases and fate in the environment is interrelated as the OPE is manufactured from OP and to some extent is degraded to OP during product life, waste management and in the environment.

Substances identified in the LOUS survey (Lassen *et al.*, 2012) and included in the list of pre-registered substances under REACH are listed in Table 18.

The table further indicates tonnage bands for substances which have been registered under REACH and Tonnage registered in the Danish Product Register with a total of import and production.

TABLE 18
OCTYLPHENOL (OP) AND OCTYYLPHENOL ETHOXYLATES

CAS No	EC No	Substance name	Carbon atoms in alkyl chains	Registered, tonnage band , t/y *1	Danish Product Register, t/y *2
140-66-9	205-426-2	4-(1,1,3,3-tetramethylbutyl)phenol (4-*tert*-octylphenol)	8	10,000 - 100,000	confidential
949-13-3	213-437-9	o-octylphenol	8	n.r.	n.r.
1806-26-4	217-302-5	4-octylphenol	8	n.r.	n.r.
1818-08-2	217-332-9	4-(1-methylheptyl)phenol	8	n.r.	n.r.
3307-00-4	221-989-7	4-(1-ethylhexyl)phenol	8	n.r.	n.r.
3884-95-5	223-420-8	o-(1,1,3,3-tetramethylbutyl)phenol	8	n.r.	confidential
11081-15-5	234-304-1	isooctylphenol	8	n.r.	n.r.
17404-44-3	241-426-9	o-(1-ethylhexyl)phenol	8	n.r.	n.r.
18626-98-7	242-459-1	o-(1-methylheptyl)phenol	8	Intermediate Use Only	n.r.
26401-75-2	247-663-4	o-sec-octylphenol	8	n.r.	n.r.

CAS No	EC No	Substance name	Carbon atoms in alkyl chains	Registered, tonnage band , t/y *1	Danish Product Register, t/y *2
27193-28-8	248-310-7	(1,1,3,3-tetramethylbutyl)phenol	8	n.r.	n.r.
27214-47-7	248-330-6	4-sec-octylphenol	8	n.r.	n.r.
27985-70-2	248-759-9	(1-methylheptyl)phenol	8	n.r.	n.r.
67554-50-1	266-717-8	octylphenol	8	n.r.	n.r.
93891-78-2	299-461-0	sec-octylphenol	8	n.r.	n.r.
99561-03-2	308-979-9	Phenol, 4-octyl-, branched	8	n.r.	n.r.
37631-10-0	253-574-1	o-(1-propylpentyl)phenol	8	n.r.	n.r.
2497-59-8	219 -682-8	20-[4-(1,1,3,3-tetramethyl-butyl)phenoxy]-3,6,9,12,15,18-hexaoxaicosan-1-ol	C8-ethox-ylate	n.r.	n.r.
9002-93-1	618-344-0 *3	poly(oxy-1,2-ethanediyl), α-[4-(1,1,3,3-tetramethylbutyl)phenyl]-ω-hydroxy *5	C8-ethox	n.r.	12
9036-19-5	618-541-1 *3	poly(oxy-1,2-ethanediyl), α-[(1,1,3,3-tetramethylbutyl)phenyl]-ω-hydroxy	C8-ethox	n.r.	
68987-90-6	614-869-4*3	poly(oxy-1,2-ethanediyl), α-(octylphenyl)-ω-hydroxy-, branched	C8-ethox	n.r.	n.r.

*1 As indicated in the lists of pre-registered and registered substances at ECHA's website. For substances indicated as "Intermediate use only" no tonnage band is reported.

*2 Tonnage indicates the registered import + manufacturing in the Danish Product Register July 2012. n.r. = not registered.

*3 The substance has no EC number, but has been given a list number in the EC format through the preregistration. Chemical name from preregistration is indicated.

3.1 Use and releases of OP in the EU

3.1.1 Manufacture and overall use of OP in the EU

The octyl group is a chain of 8 carbon atoms, which may be branched or linear. Seventeen different CAS numbers of octylphenols are pre-registered. Only one of the substances is registered: 4-*tert*-octylphenol (4-*tert*-OP) (CAS No 140-66-9). 4-*tert*-OP is manufactured in the EU in the 10,000-100,000 t/y range according to the current registrations (ECHA, 2012e) and in the following description OP is in fact synonymous with 4-*tert*-OP.

The most comprehensive description of the use of 4-*tert*-OP in the EU is from a UK environmental risk evaluation report for 4-*tert*-OP (Environment Agency, 2005). The data concerns 2001. For the

LOUS survey, CEPAD has indicated these data as the most updated information on the use of OP in the EU. The same data are used for an Annex XV SVHC dosser for 4-*tert*-OP published in 2012 (ECHA, 2012c).

The use of OP and OPE is not restricted and it is expected that the consumption patterns today are more or less the same as in 2001.

TABLE 19
ACTIVITY DATA FOR THE USE OF OP IN THE EU IN 2011

Application	Activity t/y	Uncertainty factor	Remark
Manufacture of OP	23,000	1.3	According to the Environment Agency (2005), the production of OP in the EU (+ Switzerland + Norway) in 2001 was 22,633 tonnes.
Import/export of OP	375/150	2	With an overall net import, around 375 tonnes and an export of 150 tonnes it was estimated the 22,858 tonnes of OP were used in EU (+ Switzerland + Norway) in 2011. (Environment Agency, 2005)
Manufacture of other chemicals/resins:			In 2001, 4-*tert*-OP is mainly used as an intermediate in the production of phenolic resins (about 98 percent of the whole amount of 4-*tert*-OP) and an intermediate in the production of octylphenol ethoxylates (about 2%)
Manufacture of phenol/formaldehyde resins	22,600	2	In 2001 22,858 t were used for production processes in the EU (Environment Agency, 2005) “Resins” are polymeric materials of short chain length and used for rubbers, coating, adhesives, etc. Phenol formaldehyde resins (PF) are synthetic polymers obtained by the reaction of phenol or substituted phenol with formaldehyde. Of the 22.858 t, 20,060 were used at the same site as the production of OP (captive) use while the remaining was used off-site.
Manufacture of OPE	400	1.3	(Environment Agency, 2005)
Formulation and processing			The RAR for OP do not quantify any use of OP for formulation of other mixtures, but mention that OP may be used in some paint and adhesives, but do not include any estimates of releases from the formulation and application of the mixtures.
Use of OP-based resins for rubber compounding of tyres	550	1.5	According to Environment Agency (2005) 18,458 tonnes OP was used for production of tackifier resins used for tyres. The resins contained 3-4% of unreacted 4-*tert*-OP. The formaldehyde to phenol ratio used in the production of OP-based resins is not indicated. For NP-based resins, it is indicated that in a typical novolak process the formaldehyde to phenol ratio is 0.75:1 to 0.85:1 (ECB, 2002). Assuming the same ratio for the OP-bases resins, the18,458 tonnes OP corresponds to approximately 33,000 tonnes resin. With a content of 3% as best estimate the total OP content of the resins is approximately 550 tonnes.
Use of OP-based resins for formulation of insulating varnishes	60	3	The OP demand for formulation of insulating varnished was about 2,000 tonnes with a total content of unreacted OP of about 60 t/y (Environment Agency, 2005). The uncertainty both reflects the uncertainty on the consumption of resins and the residual OP content of the resins.
Use of OP-based resins for formulation of printing inks	60	3	The OP demand for formulation of printing inks was about 1,000 tonnes. (Environment Agency, 2005). On the basis of the information provided above, they are estimated to contain some 60 tonnes unreacted OP. The uncertainty both reflects the uncertainty on the consumption of resins and the residual OP content of the resins.

Application	Activity t/y	Uncertainty factor	Remark
Use of OP-based resins for formulation of marine paints	28	3	About 800 tonnes of resin (not OP) was used for the formulation of marine paints. Assuming a content of 3-4% unreacted OP, the total content can be estimated at some 28 tonnes unreacted OP. (Environment Agency, 2005). The uncertainty both reflects the uncertainty on the consumption of resins and the residual OP content of the resins. According to DEFRA (2008) the OP-based resins are used as binders in marine coatings with the resin content in the paints at around 25%. If 3-4% of the binder is unreacted OP, the OP content of the paint would be some 0.75-1%. Many of the safety data sheets for OP-containing paints indicate an OP-concentration of ≤2.5%, whereas others indicate lower content.
Ethoxylated resin production	200	3	These are used as emulsifiers to separate water from oil in oil recovery on offshore production platforms. The residual 4-*tert*-octylphenol present in the ethoxylated resins is <0.01% (Environment Agency, 2005) corresponding to a total content of <0.02 tonnes. Emissions from this application is not included in Environment Agency (2005) and not included in this study.
End-uses:			
Tyres	550	2	It is in this study assumed that the total content in the final mixtures correspond to the consumption for formulation processes in the EU (see above) In response to the Annex XV report for 4-*tert*-OP (ECHA, 2012c), the European Tyre & Rubber Manufacturers' Association (ETRMA, 2011) indicates that the resins used for tyres generally contain free 4-*tert*-OP monomer impurity of between 1 and 5%. Specifically, 4-*tert*-OP-based resins are sometimes used in tyre compounds, typically in the carcass plies or steel belts, in order to ensure adequate adhesion. According to company data on annual use of 4-*tert*-OP-based resins and tyre production, and assuming an average content of 3% free impurity 4-*tert*-OP in the resins (same as assumed by Environment Agency), it has been calculated that an average EU tyre contains between 0,007 % and 0,012 % of 4-*tert*-OP (ETRMA, 2011). As discussed in section 2.1.1, concentrations of 0.002 to 0.006% 4-*tert*-OP were demonstrated in actual analyses of 4-*tert*-OP in used tyres indication that the majority of the 4-*tert*-OP in the resin is still present in the final tyres.
Insulating varnishes	0	-	The use of resins in for the production of varnishes involves heat curing of the resin. This requires further cross-linking and reaction, and so can be considered as a polymer-processing step with the resin acting as a cross-linking agent. Hence there will be no significant releases from the use of insulating vanishes process
Printing inks	0	-	The ink production process actually involves some reaction between the components. There are no significant traces of 4-*tert*-ctylphenol left in the finished inks (Environment Agency, 2005). Hence there will be no significant releases from the printing process, or from the recycling of paper printed with these inks. These two steps are not considered further in this assessment.
Marine paints application	28	3	It is here assumed that the total content in the final mixtures correspond to the consumption for formulation processes in the EU (see above)
Other uses Chain terminating agent in the production of polycarbonate plastics	no data	-	According to a major manufacturer of 4-*tert*-OP, one of the main end-uses of 4-*tert*-OP is As a chain terminating agent in the production of polycarbonate plastics (SI Group, 2012)

3.1.2 Emission factors

Emission factors for use of OP in industrial processes, use of OP in articles and mixtures and by waste management are shown in Table 4 and the background for the emission factors are briefly described in the table.

TABLE 20
DERIVED EMISSION FACTORS FOR THE RELEASE ESTIMATIONS FOR OP

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Manufacture of OP and use of OP for the manufacture of other chemicals/resins					
Manufacture of OP	Air Surface water	0.00000002% 0.003%	3 3	Environment Agency (2005) applies the same emissions from as used for NP, noting that the emissions may likely be overestimated.	Environment Agency, 2005
Manufacture of OPE	Air Waste water	0.001% 0.12 %	3 3	Estimated from the indicated consumption of OP for manufacture of OPE and the estimated total releases from the plants	Environment Agency, 2005
Manufacture of phenol/formaldehyde resins	Air Waste water	0.01% 0.01%	3 3	Estimated from the indicated consumption of OP for manufacture of phenol/formaldehyde resins and the estimated total releases from the plants	Environment Agency, 2005
Formulation and processing					
Use of OP-based resins for rubber compounding of tyres	Air Waste water	0.05% 0.002%	3 3	Environment Agency applies default worst case emission factors from the TGD of 0.0015% to water and 0.05% to air. ETRMA SPERC emission factor for substances with a boiling point <300°C and vapour pressure <1 Pa is 0.05% to air (ETRMA SPERC 3/6d.x v.1, where x =1, 2 or 3 – all processes) Emission factors for emission to water depends on the processing facility and range from 0.02% for process with efficient raw material use (MSPERC ≤100 ton/year substance use) to 0.001% for processes with optimization for efficient raw material use (ETRMA SPERC 3/6d.3) include state of art, optimized and/or automated systems for the transport and handling of raw materials, that minimize overall exposure levels and incidental spills	ERTMA, 2010

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Use of OP-based resins for insulating varnishes	Air Surface water	2% 0.001%	3 3	The use of resins in this application involves heat curing of the resin. Environment Agency uses default worst case emission factors from the TGD of 7.5% to air and 0.005% to water. In this study used as the upper limit of the emission factor estimations.	
Use of OP-based resins for formulation of printing inks	Air Waste water	0.0097% 0.005%	3 3	The life-cycle step in which resins are used to produce inks can be considered as a formulation step, as the resin is mixed with a number of other components. Applied emission factors: CEPE SPERC 2.4c.v1, - formulation - liquid coatings and inks (where specific formulation not known) - solids Environment Agency applies default TGD (2003) emission factor for air of 0.2-0.5% and 0.3% for emission to water (Table A2.1).	CEPE, 2013
Use of OP-based resins for formulation of marine paints	Air Waste water Waste	0.0097% 0.005% 1.24%	3 3 3	The resins are used as binders in marine coatings. Applied emission factors: CEPE SPERC 2.4c.v1, - formulation - liquid coatings and inks (where specific formulation not known) - solids Environment Agency use emission factors of 0.004% to air and 0.002% to water and 1.24% to waste	CEPE, 2013
Ethoxylated resin production	Waste water	0.2%	3	Environment Agency applies default TGD (2003) emission factor for waste water of 0.7% and emission to water.	
End-uses:		**Percentage of quantity used in the product *1**			

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Tyres	Surface water Industrial soil Waste water	1.5% 1.5% 0.1%	5 5 5	Losses from tyres would be through abrasive wear of the material rather than through leaching or volatilisation. As the OP is not even distributed in the tyre, and it has been questioned to what extent the OP is actually released by abrasion of the tyre. According to comments from ETRMA to the EU Risk Reduction strategy, 4-*tert*-OP based resins are used as tackifiers for carcass compounds, where they are assuring the required short and long-term tack between green rubber components during tyre assembly. It derives that OP is not present in the tyre tread and, since leaching of substance occurs for whole tyres from the surface, it can be stated that OP is not released to the environment during tyre service life. This is valid also for eventual leaching from particles generated from rolling tyres because they are generated solely by abrasion of tread. (ETRMA, 2007) According to Environment Agency for England and Wales (Environment Agency, 2007), however, some evidence is available to suggest the presence of the substance in road runoff. Environment Agency (2005) assumes that as a worst case that 15% of the rubber of the tyre is lost during service life and that the OP content is similar to the average content of the tyre. They assume that the releases are evenly split between surface water and soil. They further note that even if the abraded material contained OP not all of it might be available to the environment. In fact some of the abraded materials might go to waste water in some towns without separate sewer systems for urban run of. The worst case assumption is in this study used as the upper limit of a rather uncertain emission factor estimate.	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Marine paints, application	Air Waste water Industrial soil Solid waste	2.2% 2% 1.5% 31.5%	3 3 3 1.3	Environment Agency (2005) states that for the application of the paints, use in an industrial situation is assumed, rather than use by the public. For marine paint use by professionals, the application method is likely spraying. Used by consumers, they are more likely applied by brush. CEPE SPERC 8f.3a.v1 - application - professional - spraying - outdoor use – solids : Air: 2.2% Waste water: 2% Soil: "to be advised" Environment Agency (2005) assumes on the basis of the ESD for the rubber industry a transfer efficiency of 65% for the application of paint (65% transferred to the painted surface); of the remaining 35%, 90% is captured for disposal and the remainder is lost to industrial soil and to waste water, with equal amounts assumed to each receiving compartment. The resulting emission factors to waste water and industrial soil are 1.5% to each pathway. The emission factor of 1.5% to industrial soil is used as a best estimate.	
Marine paints, service life	Surface water	1%	3	Losses can also occur during the service life of the paint. The ESD estimates this as 1% loss to water over the lifetime of the paint, which corresponds to 240 kg for the annual use. As marine paints, the losses are most likely to be to marine waters (in this study included in surface water). The actual emissions are probably higher if the OP-based resin is used below the waterline. The identified safety data sheets concerns marine paints applied both below and above the water line (section6.4.1). It is estimated that the releases during service life may likely be more than the 1 % assumed by Environment Agency.	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Marine paints, disposal	Waste water Soil Solid waste	3.2% 3.2% Remaining 58.5% (percentages of the quantities used for application – i.e. not % of quantities remaining on the boats)	3 3	The ESD also considers possible losses when the paint is removed at the end of its service life. Most of the coating removed is assumed to go to waste, but losses are considered possible to water and to industrial soil, and a factor of 3.2% is assumed for each of these. It is also assumed that the old paint is removed at a similar rate to the application of new paint.	
Varnishes, application	-	-	-	No emission factors derived as the residual content of OP is at trace level	
Inks, application	-	-	-	No emission factors derived as the residual content of OP is at trace level	
Waste management:		**Percentage of OP in waste/ waste water**			
Sewage treatment	Air Surface water Sewage sludge Degraded	8% 44% 36% 12%	1.3 1.3 1.3 1.3	Note this is the fate of the fraction of the sewage reaching the WWTP – the further fate of the OPs ending up in the sewage sludge is estimated using the general distribution factors listed in Table 1. Environment Agency does not provide information on the fate of OPs by sewage treatment. As a best estimate the same distribution as applied for NP will be applied. The following ranges indicate the differences in distribution factors from the RAR assuming that the OP is "not readily biodegradable" and "Inherently" degradable Air: 7-10% Surface water; 35-53% Sewage sludge: 34-38% Degraded: 0-24% A study of Danish national mean concentrations for NP estimates that the outlet concentrations of NP are approximately 11% of inlet concentrations. The remaining part ends up in the sewage sludge, is emitted to air or is degraded.	ECB, 2002 Kjølholt *et al.*, 2011

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
	DK values: Air Surface water Sewage sludge Degraded	 8% 8% 36% 48%		No data on the fate of OP/OPE in Danish WWTPs are available. The same factors as used for NP/NPE have been applied	
Municipal solid waste incineration	Degradation	99-100%		It is assumed that the OP nearly 100% is degrade d by the municipal solid waste incineration	
Landfill	Surface water			No data on discharges of OP from landfills have been identified.	
Releases from degradation of OPE		**Percentage of quantity of OPE used for the application/in the waste stream *1**			

Waste water treatment - anaerobic conditions	Surface water	(of OPE inflow to WWTP) 2.5%	The EU RAR for NP estimates as a worst case that 2.5% of the NPE directed to WWTPs is transformed in the plant and released to surface water as NP (= under anaerobic conditions). In the absence of specific data on OPE, Environment Agency (2005) uses the same distribution factors for OPE as for NPE.	ECB, 2002
	Sludge	19.5%	The RAR for NP estimates as a worst-case that 19.5% of the NPE in the waste water ends up as NP in de digested sludge. The further fate of the NEP in the sludge depends on the actual disposal of the sludge (soil, incineration, landfill)	

3.1.3 Overall flow and releases of OP

The overall flow of OP in the EU is shown in Figure 5 below. By the use of the OP in processes the majority of the OP is converted into other chemicals and polymers and consequently the total quantities decrease though the product chain. A major part of the OP content of articles and mixtures are due to residual OP in resins used for various applications.

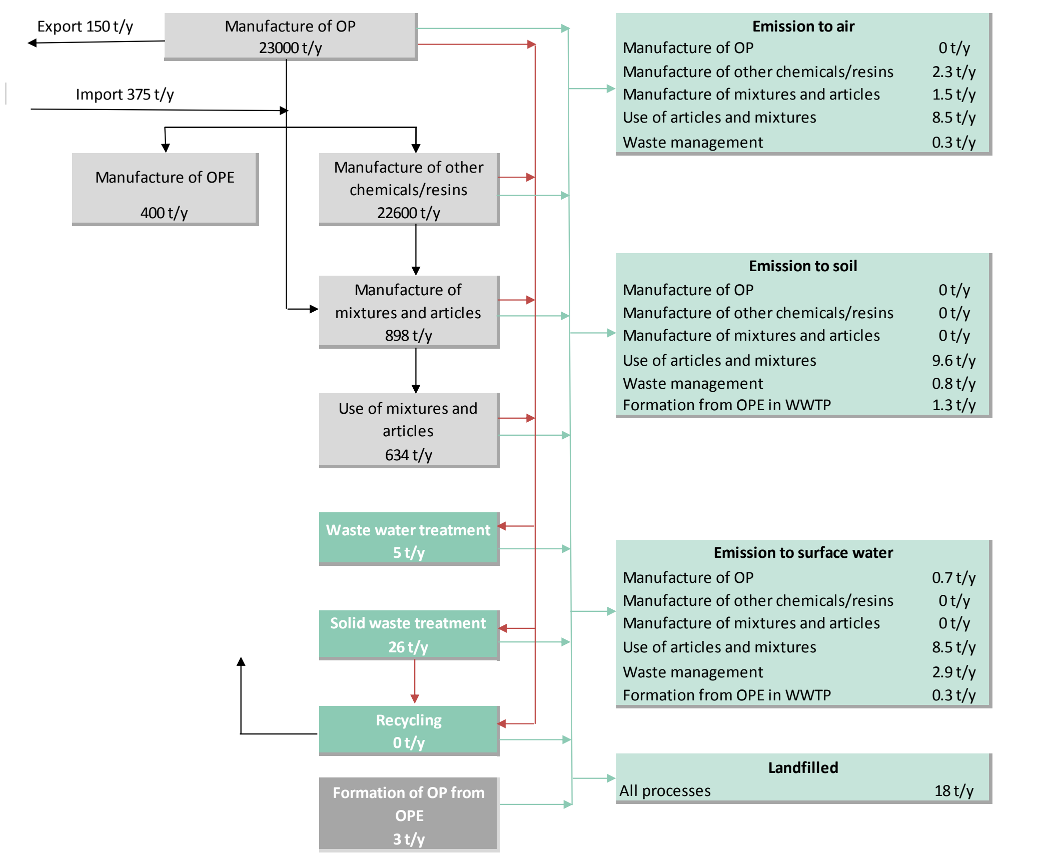


FIGURE 5
OVERALL FLOW OF OP IN THE EU (MEAN VALUES)

Total releases of OP to the different environmental compartments and landfill are shown in the Table 21 . Please note that the total quantities released to solid waste and waste water are further terminated in the lower part of the table.

Releases to air - Direct releases to the air are relatively small as compared to the releases to surface water. The major source is manufacture of phenol/formaldehyde resins.

Releases to waste water and surface water - The major source of OP to surface water, when the mean values are considered, is OP in tyres. However, the estimates are very uncertain. As discussed in section 3.2.2 OP is not present in the tyre tread and, since leaching of substance occurs for whole tyres from the surface, ETRMA (2007) notes that OP is not released to the environment during tyre service life. This is valid also for eventual leaching from particles generated from rolling tyres because they are generated solely by abrasion of tread. (ETRMA, 2007). According to Environment Agency (2005), however, some evidence is available to suggest the presence of the substance in road runoff. Environment Agency (2005) assumes that as a worst case that 15% of the rubber of the tyre is lost during service life and that the OP content is similar to the average content of the tyre. If the high value of the emission estimates are used, tyres account for more than 90% of the release to surface water and soil. If the lower values are applied tyres are still a significant source to both compartments, but not the dominating source.

The only other end-use with potential releases to waste water is the use of paint and varnishes, but this source is of less importance as compared to the potential releases from industrial processes.

Releases to surface water due to formation of OP from OPE in WWTP seems not be a significant source. This is different from the situation for NP/NPE because

OP releases to soil – The major source of OP to soil, when the mean values are considered, is OP in tyres. Other sources are sewage sludge from the treatment of OP i waste water and OP formed from OPE during waste water treatment.

The significance of degradation of OPE for the OP levels in the environment - OPE released to the environment may be degraded to OP. Environment Agency (2005) assumes that 2.5% of the OPE released to the environment will eventually end up as OP (same data as for NP/NPE).

The total OPE released to surface water is estimated at 20.3 (11.2-45.1) t/y (See section 3.2.3). If 2.5% is degraded to OP and the OP:OPE ratio is 2:5, approximately 0.2 (0.1-0.5) t/y, released as OPE to surface waste, may eventually be degraded to NP in the environment. Compared with the estimated releases of OP to surface water of 21.9 (5.3-229.4) t/y, the contribution from the degradation of OPE in the aquatic environment seems to be small. It should be noted that the bioavailability of OP in dust of tyres may be limited and the degradation of OPE may possibly contribute more significantly to the bioavailable OP in the environment.

The releases of OPE to soil are estimated at 134 (34-522) t/y. If 2.5% is degraded to OP it may contribute with an input of 1.3 (0.3-5.2) t/y. Compared to the estimated releases of OP of 21 (5-228) t/y, the contribution from formation of OP from OPE in the environment seems to the small. As discussed above, the bioavailability of OP formed from OPE may be higher than the bioavailability of

TABLE 21
RELEASE OF 4-*TERT*-OP IN THE EU FROM ALL LIFE CYCLE STAGES

Life cycle stage	Total releases (average value and 90% confidence interval) (tonnes/year):						
	Air	Surface water	Landfill	Soil	Solid waste	Waste water	Degraded
Industry - Manufacture of chemical:							
Manufacture of OP	0	0.7 (0.2-2.8)	0	0	0	0	
Industry - Manufacture of other chemicals/resins (intermediate use):							
Manufacture of OPE	0	0	0	0	0	0.5 (0.1-2)	
Manufacture of phenol/formaldehyde resins	2.3 (0.5-11.3)	0	0	0	0	2.3 (0.5-11.3)	
Industry - Formulation and processing:							
Use of resins for rubber compounding of tyres	0.3 (0.1-1.1)	0	0	0	0	0	
Use of resins for formulation of insulating varnishes	1.2 (0.2-8.4)	0	0	0	0	0	
Use of resins for formulation of printing inks	0	0	0	0	0	0	
Use of resins for formulation of marine paints	0	0	0	0	0.3 (0.1-2.5)	0	
Ethoxylated resin production	0	0	0	0	0	0.4 (0.1-2.8)	
End-use of mixtures and articles:							
Tyres	0 (0-0)	8.3 (0.9-77.4)	0 (0-0)	8.3 (0.9-77.4)	0 (0-0)	0.55 (0.06-4.8)	
Marine paints application	0.6 (0.1-4.4)	0 (0-0)	0 (0-0)	0.4 (0.1-2.8)	9 (2-36)	0.56 (0.08-3.78)	
Marine paints service life	0 (0-0)	0.3 (0-1.9)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	
Marine paints disposal	0 (0-0)	0 (0-0)	0 (0-0)	0.9 (0.1-6.1)	16 (2-115)	0.9 (0.13-6.06)	
Sum to waste water and solid waste					25.5 (10.2-127.7)	5.2 (3-16.9)	
Waste management:							
Recycling	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)			
Solid waste management	0 (0-0)	0 (0-0)	17.4 (2.3-138.4)	0 (0-0)			8.2 (1.1-66.2)

Life cycle stage	Total releases (average value and 90% confidence interval) (tonnes/year):						
	Air	Surface water	Landfill	Soil	Solid waste	Waste water	Degraded
Waste water treatment	0.3 (0.1-1.4)	2.9 (0.7-12.8)	0.3 (0.1-1.3)	0.8 (0.2-3.6)			0.8 (0.2-3.8)
Formation of OP from OPE in WWTP In sludge	0 (0-0)	0 (0-0)	0.5 (0.4-0.6)	1.3 (1.1-1.7)			0.6 (0.5-0.7)
Formation of OP from OPE in WWTP To surface water	0 (0-0)	0.3 (0.2-0.4)	0 (0-0)	0 (0-0)			
Total	4.7 (2.5-16.7)	12.5 (4.8-82.4)	18.1 (3-139.1)	11.7 (4.3-81.2)	as above	as above	9.6 (2.4-67.7)

3.2 Use and releases of OPE in the EU

At least four OPEs are pre-registered, but none of these are registered yet. They may, like the NPEs, be considered polymers by industry and for this reason not registered.

According to an Annex XV report for a group entry of 4-*tert*-octylphenol ethoxylates (ECHA, 2012d), the registration dossiers for 4-*tert*-octylphenol provide some information on the production of 4-*tert*-octylphenol ethoxylates without pointing out specific characteristics (ECHA, 2012e). The overall amount produced or imported per year may be in the range of 200 to 2.000 tonnes. According to CEPAD, there were only four to five manufacturers of octylphenol ethoxylates within the EU (as cited by ECHA, 2012d).

CEPAD (2012) has for the LOUS survey indicated that the flow chart from the Environment Agency (2005) report provides the best indication of the flow of octylphenol ethoxylates in the EU for the current study.

A significant part of the OPE used for textile and leather auxiliaries, paints and agriculture, as well as the octylphenol ether sulphates used for agriculture and paint may end up in the environment.

ECHA's background document for OPE assume that, based on the estimated fraction of 4-tOP used to manufacture its ethoxylates and the estimated average contribution to the molecular weight of its ethoxylates, the volume of ethoxylates produced is assumed to be in the range of 1,000 – 10,000 t/y (ECHA, 2012d)

In the comments on the Draft Recommendation of Substances for Inclusion in Annex XIV (ECHA, 2014a), CEPAD indicates that current understanding of volumes for OPEs in the EU based on published reports indicate their tonnage to be in the lower half of the tonnage range of 1.000-10.000 estimated in the Annex XIV Background Document for OPEs (with a decline in their use projected to be approximately 4.4% between 2009 and 2014

Three OPEs were in 2010 registered in the SPIN database of the Nordic Product Registers (total volume indicated in brackets) (Johansson *et al.*, 2012):

- CAS No 9036-19-5 (110 tonnes);[1]
- CAS No 37205-87-1 (15 tonnes, excluding conf. inf.);
- CAS No 68987-90-6 (conf. inf.);

3.2.1 Manufacture and overall use of OPE in the EU

Activity data for OPE in the EU are estimated in the table below.

TABLE 22
ACTIVITY DATA FOR THE USE OF OPE IN THE EU IN 2012

Application	Activity, t/y	Uncertainty, t/y	Remark
Manufacture of OPE	1,000	2	In 2001, the total manufacture of OPEs was 1,000 tonnes, corresponding to approximately 400 tonnes OP used for the manufacture of OPE (Environment Agency, 2005). Considering the information above the actual tonnage is rather higher than lower than 1000 t/y
Import/export of OPE	50/0		Data for 2001 used as best estimate (Environment Agency, 2005). No updated data on the import/export og OPE has been identified. The import/export is assumed to be relatively small compared with the high uncertainties on the total consumption of OPE in the EU

[1] CAS No 9036-19 -5: Poly(oxy-1,2-ethanediyl), .alpha.-[(1,1,3,3-tetramethylbutyl)phenyl]-.omega.-hydroxy-
CAS No 37205-87-1: Poly(oxy-1,2-ethanediyl), .alpha.-(isononylphenyl)-.omega.-hydroxy-
CAS No 68987-90-6: Poly(oxy-1,2-ethanediyl), .alpha.-(octylphenyl)-.omega.-hydroxy-, branched

Application	Activity, t/y	Uncertainty, t/y	Remark
Manufacture of other chemicals/resins:			
Synthesis of octylphenol ether sulphates	200	2	Octylphenol ether sulphates (OPE-Ss) are mainly used as emulsifiers in water-based paints. They can also be used as an emulsifier or dispersant in pesticide or herbicide formulations
Formulation and processing			
Formulation of polymer dispersions for emulsion polymerization	550	2	Octylphenol ethoxylates are used as processing aids in the formulation of a number of emulsion polymers including styrene–butadiene polymers or polytetrafluoroethylene (PTFE) polymers. The end applications for the polymer dispersions include paints, paper, inks, adhesives and carpet backings (Environment Agency, 2005). Environment Agency (2005) and DEFRA (2008) indicate that the major use is in paint and in the comment to the Anne XV report furthermore, CEPAD, indicates that OPEs are used predominantly in the formulation of paint and coating products. The quantities used for the formulation of polymer dispersions were consequently further used in the formulation of these end products.
Formulation of paints	760 (50 + 550 + 160)	2	In water-based paints, OPEs act as emulsifiers and dispersants, although the emulsifying properties are more dominant (Environment Agency, 2005). Environment Agency (2005) indicates that: • 50 t/y is used directly for paints • 550 t/y is used in polymer dispersions used for paints • 160 tonnes used for manufacture of octylphenol ether sulphates which is used for formulation of paints
Formulation of adhesives and sealants	10	2	The polymer dispersions may be used in the formulation of adhesives, but compared to the use in paint the consumption seems to be small and not reported in the available literature. The registration of OP indicate adhesives and sealants as consumer and professional end-use of products containing octylphenol ethoxylates

Application	Activity, t/y	Uncertainty, t/y	Remark
Formulation of textile auxiliaries	150	2	Environment Agency estimates that 150 t/y of OPE was used for textile processing and 50 t/y for leather processing in 2001. DEFRA (2008) indicates that the information received suggests instead that around 350 tonnes of OPEs were sold to the textile and leather auxiliaries sector in 2005, but also indicates that this was, however, at variance with information received from the textiles sector. The 150 t/y will consequently still be used as a best estimate for the textile auxiliaries OPEs act as emulsifiers in finishing agents (which are mainly styrene butadiene copolymers) which are used as textile (and leather) auxiliaries (e.g., hot melts, textile printing, leather finishing). (DEFRA, 2008). Finishing agents are used to cover textiles (and leather) with a thin polymer film to make the material more resistant to water, dust and light and provide a shiny appearance (for leather). According to Defra (2008), information received indicated that OPEs were normally used in the textile industry in specific emulsion processes (such as emulsion polymerisation, glues, emulsifiers for dyestuffs, etc.); however, they were unlikely to be used for washing purposes due to their rather high price.
Formulation of leather auxiliaries	50	2	Environment Agency estimates that 150 t/y of OPE was used for textile processing and 50 t/y for leather processing in 2001. DEFRA (2008) indicates that the information received suggests instead that around 350 tonnes of OPEs were sold to the textile and leather auxiliaries sector in 2005, but also indicates that this was, however, at variance with information received from the textiles sector. The 50 t/y will consequently still be used as a best estimate for the leather auxiliaries. The OPE was used mainly as emulsifiers of styrene-butadiene copolymers. The OPE is physically bound in the polymer matrix, which adheres to the substrate. Note, that this application is different from the described application of NPE which were formerly used for wet degreasing of hides in the leather industry (ECB, 2002).
Formulation of veterinary medicines and pesticides	100	3	The uses in agriculture include pesticide formulations and veterinary medicines. In pesticide formulations the OPEs act as emulsifiers and aid dispersion of the product over leaf surfaces. (Environment Agency, 2005) An estimated 3.4 tonnes of OPEs were sold in veterinary medicines per year in the UK in 2002 but according to DEPRA (2008) it was expected that many manufacturers throughout the EU are replacing OPEs in their products.
Other uses	No data		A number of uses of OPE is indicated in the literature including metal cleaning applications, lubricant additive, fragrances, floor finishes, latex, automotive care, household cleaning. No EU wide data on the consumption for these applications are provided, but the consumption is assumed to be small compared to the applications listed above.
End-uses:			

Application	Activity, t/y	Uncertainty, t/y	Remark
Paints	760	2	OPEs are used predominantly in the formulation of paint and coating products and are used at levels of generally 1% or less in those products. The OPEs are not use as reactant and are present in the cured paints. Due to their role in the emulsion polymerization process, OPEs are expected to be bound in the paint polymer and not widely dispersed to the environment.
Adhesives and sealants	10	2	See background for estimate above.
Textiles (polymer film covered)	150	2	The total used for manufacture of textile auxiliaries in 2001 was 150 tonnes as describe above. As described, OPEs act as emulsifiers in mainly styrene butadiene copolymer which are used are used to cover textiles (and leather) with a thin polymer film to make the material more resistant to water, dust and light.
Other textiles	10	3	A new Danish study of NP and NPEs in different types of imported textiles found a mean concentration of OPEs in textiles of less than 1.6 mg/kg (Rasmussen *et al.*, 2013); approximately 2% of the concentration of NPE in the textiles. In 8 of 15 tested textiles, the content was below the detection limit (0.2 mg OPE/kg textile) and no concentrations above 10 mg OPE/kg textile were measured. In the EU, the OPE are typical used for finishing agents used to cover textiles with a thin polymer film to make the material more resistant to water, dust and light. The textiles tested in the Danish study were not coated and consequently not of a type where OPEs would typically be found. It is not clear how the OPEs have been used in the manufacture of the textiles. The TRITON™ X-15 OPE-base surfactant is indicated by the manufacturer to be used as dye solubilize among other applications. According to KemI (2013) the import of textiles to the EU in 2010 was 6,037,526 tonnes with an average concentration of NPE in textile at 107 mg/kg. The dossier does not indicate the content of OPE i the textiles. Using 1.6 mg/kg as a best estimate, the content of imported textiles is 10 t/y.

Application	Activity, t/y	Uncertainty, t/y	Remark
Leather products	52	3	As indicated above 50 t/y was used in 2001 for leather auxiliaries in the EU. A significant part of leather products are today imported from countries outside the EU, and the application in the EU is probably smaller today, but may be counterbalances by import of OPE-containing leather. The OPEs are as surfactants in polymers used to provide a shiny appearance to the leather. As mentioned under NPE, Ma and Cheng (2010) measured OP and OPEOn in sheep-skin and goat skin leather for garment and cattle-hide for shoes and furniture. According to the authors, the leather may also be representative of the leather in the finished leather articles. A total of 90 different leathers were analysed in this study. The samples were obtained from sixteen tanneries in China for quality control. 18 of the 90 samples were found to contain $NPEO_n$ and three OPE_n, but no NP or OP was detected. The three samples with OPE_n were all goat-skin leather for garment. The detected concentrations in the three samples ranged from 21 to 1,100 mg/kg for OPE (normalised to OPE9 with 9 ethoxy units). The detection limits were 0.5 and 1.3 mg/kg for OP and OPE9, respectively. The total content of leather in articles placed on the market in the EU is not known, but is according to an Annex XV report on Cr (VI) in leather it is likely about 500,000 t/y (DEPA, 2012). Assuming an average concentration of 30-300 mg/kg in 3% of the leather, the total OPE content can be estimated to be 0.5-5 t/y. This is used as best estimated with additional uncertainties for the representative-ness of the available data.
Agriculture	100	3	Se background for the estimate above
Other uses	No data		One application has been mentioned as a minor essential applica-tion by the stakeholder consultation (ECHA, 2014a) • In vitro diagnostic applications in the medical device sector A number of uses of OPE is indicated in the literature, but has not been mentioned in the stakeholder consultation: • metal cleaning applications • lubricant additive • fragrances • floor finishes • latex • automotive care • household cleaning No EU wide data on the consumption for these applications are provided, but the consumption is assumed to be small compared to the applications listed above.

3.2.2 Emission factors

Emission factors for use of OPE in industrial processes, use of OPE in articles and mixtures and by waste management are shown in Table 23 and the background for the emission factors are briefly described in the table.

TABLE 23
DERIVED EMISSION FACTORS FOR THE RELEASE ESTIMATIONS OF OPE

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Manufacture of OPE and use of OPE for the manufacture of other chemicals:					
Manufacture of OPE	Waste water	0.036%	3	Environment Agency applies the emission factor releases to waste water derived for NPE production in the RAR for NP as the process is quite similar. The emission to air is indicated as 0.	Environment Agency, 2005
Synthesis of octylphenol ether sulphates	Waste water	0.2%	3	Default emission factors from the Technical Guidance Document of 0.7 % is applied by Environment Agency, 2005. The factor must be considered worst case and is in this study used as upper limit.	
Formulation and processing					
Formulation of polymer dispersions for emulsion polymerization	Surface water	0.01%	3	Emission factor applied by Environment Agency, 2005. Environment Agency (2005) notes that according to a survey of manufacturers, waste water is reported as typically being treated on-site or is totally enclosed (no liquid effluent stream) No SPERCs are public available from the European Polymer Dispersion & Latex Association (EPDLA)	Environment Agency, 2005

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Formulation of paints and inks	Waste water	0.14%	3	Environment Agency (2005) applies an emission factor for releases to waste water of 0.14%. This is considered to include emissions from emulsion polymer materials as well as ethoxylate used directly in the formulation process. The assessment estimated emissions to air to be negligible as the substance in not used in powder form. The OECD (2007) ESD for the Coating Industry indicates for aqueous dispersion coatings that the worst case fraction lost to waste water from equipment cleaning and liquid spills is 0.5%. With regard to emissions of substances charged in powder form, an additional 0.005% has to be added to the 0.5%. This factor will in this study be applied as the upper limit. Indicated as adopted from the OECD ESD, CEPE SPERC 2.2c.v1-formulation - water borne coatings and inks – solids applies an emission factor consisting of (CEPE, 2013): - indirect emissions via dust deposition and subsequent wet cleaning of surfaces: 0.005% - emissions via equipment cleaning and subsequent discharge to waste water : 0.005% No emission to air is expected. It is not indicated in the SPERC factsheet why an emission factor of 0.005% for equipment cleaning instead of the 0.5% from the OECD ESD is applied.	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Formulation and use of textile auxiliaries	Air Waste water	0.05% 1%	5 5	Environment Agency (2005) applies in the absence of data on specific emission from the use of textile auxiliaries, emission factors derived from print applications assuming that the application is quite similar to textile printing. The worst case factors are 14% to waste water and 0.25% to air. The emission from the formulation of the auxiliaries is considered small compared with the emissions from the use. Environment Agency (2005) indicates that the OPE is used in finishing agents which cover leather and textiles with a thin polymer film to make the material more resistant to water, dust and light. The OECD (2004a) ESD on textile finishing industry provides very different values for printing and coating of textiles. According to the ESD, coated fabric usually consists of a textile substrate, on which the polymer is applied directly as a viscous polymer liquid, a melt, or a coating powder. Printing is a process where the fabric is dyed by use of printing pastes where the dyes are dissolved in a limited amount of water. The description of the use OPE in textile finishing indicates that the process is rather a coating. For coating the ESD assumes a 99% of the coating liquors remains on the textile while the residual liquors account for 1% of the applied quantity (in the printing process the residual liquors is 25%). The ESD does not provide an emission factor for releases to waste water or air, but the residual liquors of 1% may be considered a worst case for the emission to water from coating. As some doubt exist of the actual process an emission factor of 1% to waste water and 0.05% to air is applied with a high uncertainty.	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Formulation and use of leather auxiliaries	Air Waste water	0.05% 1%	5 5	Environment Agency (2005) applies in the absence of specific emission factors for the use of leather auxiliaries, emission factors derived from print applications assuming that the application is quite similar to textile printing. The emission from the formulation of the auxiliaries are considered small compared with the emissions from the use and not included With the same considerations discussed above for textiles the process seems rather to be a coating than a printing process and the same emission factors as for textiles are applied in this study.	
Formulation of veterinary medicines and pesticides	Air Waste water	0.005% 0.1%	5 3	Environment Agency (2005) applies default worst case emission factors for all formulation processes of 0.025% to air and 0.3% to waste water.	
Other uses	No data	-	-	-	
End-uses:		**Percentage of quantity used in the product *1**			
Paints	Air Waste water	0.1% 1% Remaining part to solid waste (either by application or end of life)	5 3	Environment Agency (2005) assumes that all paints with OPE are used industrially and applies emission factors of 0.5% to waste water and 0% to air, figure considered realistic by industry. Different emissions factors for use by CEPE (2013) SPERCs covering consumer, professionals and industry: Consumer use, all applications and professional application by brush and roller: 1% to waste water and 0.5% to soil for applications outdoors. Professional application by spray: 2.2% to air, 2% to waste water. Soil indicated as "to be advised" for outdoor application. The SDS identified indicated that OPE may be present i both decorative paint (for buildings) use be consumers and professional and for industrial applications. The emission factors applied in this study assume that the paints are applied by various application methods – and for the releases to air it is assumed that only a minor part is applied by spray.	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Adhesives and seal-ants	Waste water	0.9% Remaining part to solid waste (either by application or end of life)	3	Environment Agency (2005) does not include any emission factors for application of adhesive, seal-ants and filling agents. Different emission factors for industrial use and wide dispersive use: FEICA (2013) SPERC 8c.3.v2-Wide dispersive Use of Substances other than Solvents in Adhesives and Sealants: 1.5% to waste water (same for solvent and water-based adhesives) FEICA SPERC 5.1c.v2 – Industrial Use of Substances other than Sol-vents in water borne adhesives: 0.3% to waste water An amalgamated emission factors of 0.9% is applied in this study as best estimate (same as indicated by FEICA with reference to OECD Emission Scenario Document	FEICA, 2013

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Textiles (polymer film covered)	Waste water	5% Remaining in solid waste	5	Environment Agency estimates that the emission of OPE from the polymer structure of the textiles are considered unlikely as the OPE is bound in the polymer matrix. The Emulsion Polymers Council (EPC, 2002) states that experimental data indicates that less than 1% of the NPE used in a textile coating can, under worst-case conditions, be released from the fabric. Releases were determined by washing a sample for 1 hour in a Launder-O-Meter at 72 °C (160°F) wash temperature using stainless steel balls and deionized water in the tumbling mode. By the test, 0.114% of the available NPE was extracted. The leaching of OPE may be quite similar to leaching of NPE. If the printed textiles are washed many times (e.g. a printed t-shirt), however, it must be expected that some OPE may be released from the textiles. Furthermore some of the print will be removed due to abrasion during wash. COHIBA (2011) estimated textile washing as the main source of OPE to the Baltic Sea Area, but do not provide any background information for the estimate. The report indicates that the OPE is used for textile printing. Besides the leaching, some losses may be due to abrasion and losses of material in the environment. The EU RAR for the phthalate DEHP, estimates a particulate emission from coated fabric applied outdoors of 4% over the service life of the products (ECB, 2008). The OPE is used as emulsifiers in finishing agents – mainly styrene butadiene copolymers. In a quite similar application, phthalates are used as plasticisers in PVC used for textile printing. Releases of phthalates from one washing cycle of textiles with PVC print was measured at 0.02%, 0.1%, 9%, 10% and 80% (Larsen *et al.*, 2000). The authors conclude that likely the phthalates was used as carriers in the textiles with high emission factors and used as softener in the PVC of textiles with low emission factors.	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Other textiles	Waste water	90% Remaining part in solid waste	1.1	The OPE present in these textiles are expected not to be bound in a polymer matrix in the textiles. The Annex XV restriction report (KemI, 2013) provides information suggesting that 100% of the NPE in textiles is releases to waste water by wash. However, some textiles are not washed or only washed a few times and the emission factor has been adjusted accordingly A recent Danish study found that removal of OPE by a single washing varied from 13% up to 89% (Rasmussen *et al.*, 2013). In the same test, the removal of NPE by washing was also measured. The removal varied between 35% and 99.9%, i.e. similar to that of OPE (the differences between the substances are not significant).	
Leather products	Waste water Soil	5% 1% Remaining part in solid waste	5 5	Environment Agency (2005) estimates that the emission of OPE from the polymer structure of the coating of the leather articles are considered unlikely as the OPE is bound in the polymer matrix. No emission factors for OPE in leather have been identified. According to the Annex XV report on Cr (VI) in leather, the main release route from the articles of leather to the environment is releases from shoes in wet weather and releases to waste water when articles of leather are washed off or wiped off (DEPA, 2012). Shoes is the major application of leather and represent nearly half of the leather in finished articles (DEPA; 2012). A part of the OPE contained finish may over time be release by abrasive wear of the surface layer. Furthermore a small part may leach from the surface as the OPE is water soluble. No data on the actual release of OPE from leather is available. The emission factor is roughly estimated with high uncertainty.	Environment Agency, 2005
Agriculture	Soil Surface water	96% 4%	1.01 4		Environment Agency, 2005
Other uses	No data	No activity data – emission factors not available	-	-	

Application	Derived emission factor			Emission factor indicated in data source	Source
	Pathway	Emission factor % of quantity used in the process	Uncertainty factor		
Waste management:		**Percentage of OPE in waste/ waste water**			
Sewage treatment	Surface water Released as OP in effluent Mineralised/highly degraded Sewage sludge as OP **DK values:** Surface water Soil (agricultural) Landfill Incineration	33% 2.5% 45.5% 19%	1.3 1.3 Remaining 1.3	Environment Agency (2005) applies the same reasonable worst-case assumptions for the fate of OPEs during anaerobic waste water treatment as applied for NPE.	ECB, 2002
	DK values: Surface water (as NPE and NPEC) Degraded to NP in effluent Mineralised/highly degraded Sewage sludge as NP	12% 2.5% 66.5% 19%		No data on the fate of OP/OPE in Danish WWTPs are available. The same factors as used for NP/NPE have been applied	
Municipal solid waste incineration	Degradation	99-100%		It is assumed that the OPE nearly 100% is degrade d by the municipal solid waste incineration	
Landfill	Surface water			No data on discharges of OPE from landfills have been identified.	

*1 Total quantity of OPE in products placed on the market the reference year

3.2.3 Overall flow and releases of OPE in the EU

The overall flow of OPE in the EU is shown in Figure 6.

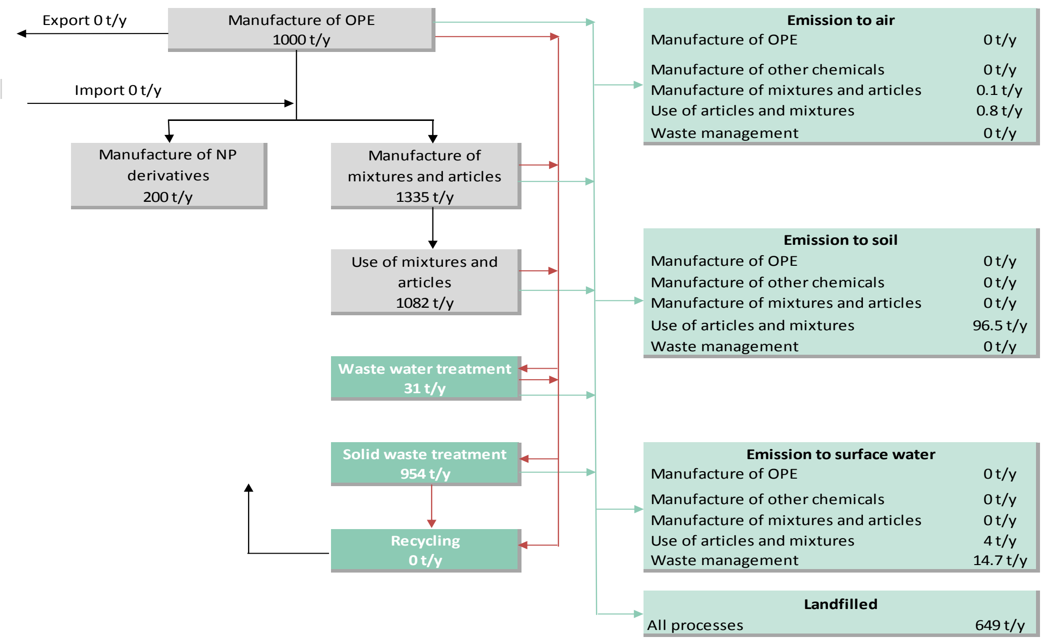


FIGURE 6
OVERALL FLOW OF OPE IN THE EU (MEAN VALUES)

Total releases of OPE to the three environmental compartments and landfill is shown in the table overleaf. Please note that the total quantities released to solid waste and waste water are further terminated in the lower part of the table.

Releases to air – The releases of OPE to air are small compared to other releases and originates from the use of paints applied by spray.

Releases to waste water and surface water – Releases from WWTPs and from the use of OPEs in pesticides account for the majority of the releases of OPE to surface water.

The main sources of releases to waste water (when considering mean values) are application of paints, polymer-coated textiles, other textiles, leather products and formulation of paints and textile auxiliaries, with no dominant single source. The data are summarised in Table 24.

Environment Agency (2005) also reach the conclusion that use and service life of formulations and products containing octylphenol ethoxylates such as use of paints and pesticides seem to be important sources on a regional and continental scale. On a local scale some of the formulation processes may be of higher significance.

At one point the current survey reach another conclusion than the Environment Agency (2005) report. Environment Agency (2005) estimates that 21 t/y is released to waste water from the textile finishing process accounting to approximately 74% of all losses to waste water. These releases were estimated with the assumption that the finishing process was a printing process and default emission factors for other printing processes were applied. The described process, however, seems rather to be a coating process than a printing process as defined in the OECD (2004a) ESD on the Textile Finishing Industry. Using the factors for textile coating, the total emissions are estimated to be significantly lower. Textiles, however still represent some 55% of all sources to the WWTPs.

On the other hand it is this survey estimated that the OPE may be released from the coated textiles and leather articles during use. Even the losses due to leaching of OPE from the textiles is small, it is estimated that some OPE may be released with abrasive losses of the coatings.

Releases to soil – The releases to soil are significantly higher than the releases to waste water, surface water or air, and originates from OPE in pesticides used in agriculture. The OPE released to soil may either be degraded within the soil or may end up in surface water by drainage.

TABLE 24
RELEASE OF OPE IN THE EU FROM ALL LIFE CYCLE STAGES

Life cycle stage	Total releases (average value and 90% confidence interval) (tonnes/year):						
	Air	Surface water	Landfill	Soil	Solid waste	Waste water	Degraded
Industry - Manufacture of chemical:							
Manufacture of OPE	0	0	0	0	0	0.4 (0.1-1.7)	0
Industry - Manufacture of other chemicals/resins (intermediate use):							
Synthesis of octylphenol ether sulphates	0	0	0	0	0	0.4 (0.1-1.9)	0
Industry - Formulation and processing:							
Formulation of polymer dispersions	0	0	0	0	0	0.1 (0-0.3)	0
Formulation of paints	0	0	0	0	0	1.1 (0.2-5.2)	0
Formulation of adhesives and sealants	0	0	0	0	0	0 (0-0.1)	0
Formulation and application of textile auxiliaries	0.1 (0-0.7)	0	0	0	0	1.5 (0.2-13.8)	0
Formulation and application of leather auxiliaries	0 (0-0.2)	0	0	0	0	0.5 (0.1-4.8)	0
Formulation of veterinary medicines and pesticides	0 (0-0.1)	0	0	0	0	0.1 (0-0.7)	0
End-use of mixtures and articles:							
Paints	0.8 (0.4-1.6)	0 (0-0)	0 (0-0)	0 (0-0)	752 (344-1615)	7.6 (3.5-16.4)	0
Adhesive, sealants and filling agents	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	9.9 (4.6-21.3)	0.1 (0-0.2)	0
Textiles (polymer film covered)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	142.5 (65.6-309)	7.5 (3.5-16.6)	0
Other textiles	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (0.2-3.8)	9 (2.3-35.7)	0
Leather products	0 (0-0)	0 (0-0)	0 (0-0)	0.5 (0.1-2.0)	48.9 (12.7-188.6)	2.6 (2.0-10.2)	0
Agriculture	0 (0-0)	4 (1.0-15.8)	0 (0-0)	96 (24.5-373.6)	0 (0-0)	0 (0-0)	0
Sum to waste water and solid waste					954 (539-1833)	31 (22-63)	
Waste management:							
Recycling	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)			0 (0-0)
Solid waste management	0 (0-0.1)	0 (0-0)	649 (318.9-1322.2)	0 (0-0)			304.9 (149.5-625.2)
Waste water treatment	0 (0-0)	14.7 (6.6-33.2)	0 (0-0)	0 (0-0)			16.1 (7.0-35.7)

Life cycle stage	Total releases (average value and 90% confidence interval) (tonnes/year):						
	Air	Surface water	Landfill	Soil	Solid waste	Waste water	Degraded
Formation of OP from OPE in WWTP (to OP balance) In sludge	-	-	-	-	-	-	6 (4.7-7.7)
Formation of OP from OPE in WWTP (to OP balance) To surface water	-	-	-	-	-	-	0.8 (0.6-1)
Total	0.9 (0-0)	18.7 (10.1-40.7)	649 (319-1322)	97 (25-374)	as above	as above	327.8 (172.1-648.6)

TABLE 25
OVERVIEW OF SOURCES OF RELEASES OF OPE TO WASTE WATER IN THE EU

Application area	Releases, tonnes/year		Percentage of releases (mean values)
	Mean value	Range	
Manufacture and formulation processes (all processes)	4.0	0.6-28.4	13%
End uses:			
Paints	7.6	3.5-16.4	25%
Adhesive, sealants and filling agents	0.1	0.0-0.2	0.3%
Textiles (polymer film covered)	7.5	3.5-16.6	24%
Other textiles	9.0	2.3-35.7	29%
Leather products	2.6	2.0-10.2	8%
Total	30.8	21.8-63.1	

3.3 Use and releases of OP and OPE in Denmark

3.3.1 Use of OP and OPE in Denmark

The total registered consumption of OP (CAS No 140-66-9) in mixtures in Denmark registered in the Danish Product Register is 0.01 t/y. The applications are confidential.

Applications of OPEs registered in the Danish Product Register are shown below.

TABLE 26
CONSUMPTION OF OPE (*1) REGISTERED IN THE DANISH PRODUCT REGISTER, 2013

Application area (based on UC62)	Consumption (production + import – export) *1		
	n *2	t/y	%
Binding agents for paints and adhesives	5	2.5	26%
Paints, lacquers and varnishes	68	1.1	11%
Sealants and filling agents	8	0.01	0.2%
Lubricants and additives	13	4.3	43%
Biocidal products	4	0.03	0.3%
Cleaning, washing, maintenance agents	13	0.04	0.4%
Other (confidential)	17	1.9	20%
Total		9.7	100%

*1 CAS Numbers 9016-45-9, 26027-38-3, 37205-87-3,68412-54-4, 127087-87-0

*2 Number of mixtures.

3.3.2 Releases of OP and OPE in Denmark

Apparently OP is not used in significant quantities for marine paints in Denmark. The total releases of OP from the applications of mixtures in Denmark are considered insignificant compared to the potential releases of OP from the use of tyres. The potential releases from tyres is expected to be at the same level (*per capita*) in Denmark as in other parts of the EU. Assuming the same *per capita* releases of OP from tyres in Denmark as the EU average would result in releases of 0.083 t/y to surface waste and soil respectively and 0.006 t/y to waste water. Please note that the uncertainty is very high with a factor of 100 between the lower and upper estimate. Assuming the formation of OP from OPE be the waste water treatment resemble the rates for NP/NPE, it can be estimated that the 0.218 t/y NPE in waste water (see below) result in a release of NP to surface water of 0.005 t/y and to soil (via sewage sludge) of 0.009 t/y.

Estimated releases of OPE in Denmark is summarised in the table below. The use of OPE for manufacture of chemicals and formulation processes is limited, and end-use of mixtures and articles represent nearly 100% of the releases.

OPE in surface coated textiles and other textiles account for the major releases to waste water while OPE in biocides/pesticides represent the major source of releases to soil.

TABLE 27
RELEASE OF OPE TO SOIL, SURFACE WATER AND WASTE WATER IN DENMARK IN 2013

Application area	Releases, tonnes/year			% of releases to waste water
	Surface water	Soil	Waste water	
Formulation of paint, inks, adhesives, sealants, etc.	0	0	0.004	2%
End-uses:				
Paints and inks	0	0	0.011	5.1%
Lubricants	0	0.002	0.002	1.0%
Surface coated textiles	0	0	0.075	34.4%
Other textiles	0	0	0.095	44%
Pesticides and biocides	0.001	0.029	0	0%
Cleaning and maintenance agents	0	0.001	0.005	2%
Leather products	0	0	0.026	11.9%
Total to waste water			**0.218**	**100%**
Waste water treatment *1	0.038	0		
Total	0.039	0.042	As above	

*1 The difference between the total to waste water and the releases from waste water treatment is due to degradation by the management.

4. Releases of 4-t-butylphenol (4-*tert*-BP)

4.1 Use and releases of 4-*tert*-BP in the EU

The butyl group is a chain of 4 carbon atoms, which may be branched or linear. At least 11 CAS numbers of butylphenols are included in the list of pre-registered substances. Two of these are registered in ECHA's database of registered substances: 4-*tert*-butylphenol (4-*tert*-BP) (CAS No 98-54-4) and 2-sec-butylphenol (CAS No 89-72-5).

With a consumption of approximately 27,000 t/y, the 4-*tert*-BP represents the major application.

2-sec-Butylphenol is registered with an imported and manufactured tonnage in the 1,000-10,000 tonnes range. The substance is indicated as raw material for the production of fungicides and other plant protection products (ECHA, 2012e) in the registration. The substance is not further assessed in this study.

o-*tert*-BP (CAS No 88-18-6) was produced in quantities of <1000 t/y in 2010 according to the European Council of Alkylphenols and Derivatives, CEPAD (2011). The substance is by August 2014 not registered under REACH indicating that the manufactured and imported volumes are <100 t/y. Together with other *ortho*-substituted alkylphenols, they are chemical intermediates for the production of herbicides, plastic additives, or – after hydrogenation – for the fragrance industry (Lassen *et al.*, 2012) and not further addressed in this study.

4.1.1 Manufacture and use of 4-*tert*-BP in the EU

The manufacture and use of 4-*tert*-BP in the EU is described in the EU Risk Assessment Report (RAR for BP) for 4-*tert*-BP from 2008 (ECB, 2008). The report presents production and consumption figures for 2001 (see Figure 7). CEPAD has indicated these data as the best indication of the flow of 4-*tert*-BP in the EU for the current study.

The RAR for BP does not provide a detailed breakdown of the consumption by application area but in a submission for the LOUS survey (Lassen *et al.*, 2012) CEPAD indicates that the consumption is >1,000 tonnes for three application areas: production of phenolic resins, production of polycarbonates and production of alcohols through hydrogenation.

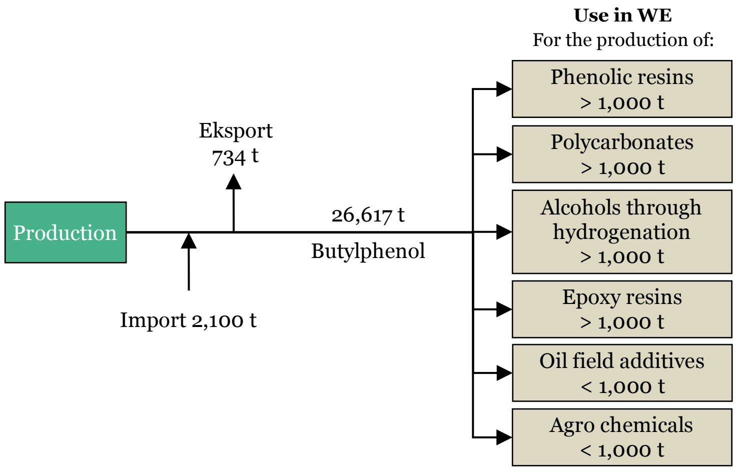


FIGURE 7
FLOW OF 4-*TERT*-BP IN WESTERN EUROPE (EU + SWITZERLAND + NORWAY) IN 2001 (LASSEN *ET AL.*, 2012 CORRECTED BASED ON ORIGINAL INFORMATION FROM CEPAD)

Phenolic and epoxy resins – 4-*tert*-BP is mainly used as a co-monomer in the polymer industry in the same way as 4-nonylphenyl, which means that 4-*tert*-BP is polymerized with other ingredients such as phenol and formic aldehyde (see description under NP). In the polymers, 4-*tert*-BP is chemically bound in the matrix (covalent binding) (ECB, 2008). The phenolic resins and epoxy resins are used for a range of applications. With respect to consumer exposure the use of 4-*tert*-BP in epoxy for canned food is considered to potentially be the major source (ECB, 2008).

The butylphenol/formaldehyde are used for two types of resins designated resoles and novolaks. Resoles are used as intermediates in contact and pressure sensitive adhesives, coatings, printing inks and electrical varnishes. Novolaks are used in rubber compounding (tyre manufacture) and are ethoxylated for use in oil recovery.

It is common for commercial 4-*tert*-BP/formaldehyde resins to contain up to 3% free 4-*tert*-BP. However, in all of the processes the resin is mixed with other resins/components and, with the exception of tyre tackifiers, further reaction takes place. This reaction will also occur with any free 4-*tert*-BP in the resin, and this dilution and reaction will reduce the free monomer to very low levels. Residual 4-*tert*-BP concentrations far below 0.1% have been measured in butylphenol/formaldehyde resins used to improve the tack of compounded rubber for tyres.

The RAR for BP does not provide any indication of the quantities used for the different applications. The data from the Danish Product Register shown in table 29Table 29 indicated that about 10 t/y are used for different applications registered in the product register. The main non-confidential applications are paint, lacquers and varnishes and hardeners (probably for epoxy adhesives or paints). The registered quantities would if they were extrapolated to the entire EU represent some 1,000 t/y at EU level, indicating that these applications represent a relatively small part of the total consumption in the EU of some 27,000 t/y.

Polycarbonate – 4-*tert*-BP is also used as a chain terminator in the synthesis of polycarbonate polymers. Polycarbonate resins produced with 4-*tert*-butylphenol contain 1-3 % (w/w) of 4-*tert*-BP, reacted and bound into the polymer chain. Since the polymers are further processed to finished products, the concentration of free residual monomers in the final products is much lower. The residual concentrations of non-reacted 4-*tert*-BP in polycarbonate are found to be non-detectable, at a limit of detection of 5 ppm (ECB, 2008). The main uses of polycarbonate are the following:

Compact discs, DVD, and CD Rom manufacture, solid and multi-wall sheet in glazing applications and films, as polycarbonate blends for diverse injection moulded functional parts used mainly in the electrical and electronics industry and the automotive industry, containers for storage of food and beverages, and tableware (ECB, 2008). Exposure to 4-*tert*-BP from polycarbonate used for food contact applications is estimated to be the second major source of consumer exposure to 4-*tert*-BP (ECB, 2008).

Oil field additives – Butylphenol/formaldehyde resins are ethoxylated to produce specialised surfactants for the separation of crude oil in aqueous refinery effluent from off-shore oil. Release of 4-*tert*-BP is restricted to the production process of the ethoxylated resins products and no additional environmental releases of 4-*tert*-BP therefore are expected during the production of oilfield chemicals (ECB, 2008).

Alcohols – 4-*tert*-BP is also hydrogenated to form the corresponding alcohol 4-*tert*-butylcyclohexanol.

Due to its low alkyl chain-length, 4-*tert*-BP is not suitable for the production of surfactants and butylphenol is not used to produce butylphenol ethoxylates (CEPAD, 2012).

4.1.2 Overall flow and releases of 4-*tert*-BP in the EU

Due to confidentiality reasons the RAR for 4-*tert*-BP (ECB 2008) does neither provide any data on the distribution of the consumption of the 4-*tert*-BP by application nor any specific emission factors. As such data are not available from other sources it has not been possible to apply the methodology for release estimations used for the other AP/APE in the previous chapters.

The RAR for BP provides data on actual releases from different processes and these are provided in the table below as the sum of the regional and continental releases. The releases concern the manufacture of the 4-*tert*-BP, the use of substance for manufacture of resins and other substances and apparently also some industrial uses of resins.

Releases to the environment during life-time are in the RAR for 4-*tert*-BP assumed to be negligible for 4-*tert*-BP and not included. Furthermore, releases from wide dispersive use (professional and consumer applications) of mixtures such as adhesives and paints containing resins with a residual content of 4-*tert*-BP are not included in the RAR for4-*tert*-BP.

The RAR for BP notes that data on release from ambient cured epoxy products (e.g. professional and consumer use) are available. As described in the RAR for BP, cured epoxy systems may still contain significant amounts of unreacted 4-*tert*-BP (up to 5-10 %). In general, high temperature cured epoxy formulations are not expected to release significant quantities because of low residual amounts of free 4-*tert*-BP. But ambient cured epoxies have significantly lower level of through-cure than epoxies cured at high temperatures. The RAR also indicates that more data are needed for phenolic resins.

In the absence of actual activity data, it has not been attempted to estimate the potential releases at EU level from the use of 4-*tert*-BP based resins for professional and consumer applications, but an estimate for Denmark based on the data from the Product Register is provided in the next section.

Releases of 4-*tert*-BP during the use of the finished products are according to the RAR for BP generally low or negligible (ECB, 2008) because the residual 4-*tert*-BP content of cured resins and polycarbonate is small.

According to the estimates (Table 28) manufacture and use of epoxy resins represent the major source of releases to the air while manufacture and use of phenolic resins and epoxy resins represent the major source of releases to WWTP. The releases to air are significantly higher than the direct releases to surface water and must be considered the major pathway for releases to the environment.

TABLE 28
ESTIMATED RELEASES OF 4-*TERT*-BP AT EU LEVEL (ECB, 2008)

Process	EU releases, t/y *1			
	Air	Surface water	Soil	WWTP
Production of 4-*tert*-BP	0.28	0.10	0	0.00
Manufacture and use of phenolic resins	0.15	0.00	0	14.98
Manufacture of polycarbonate	0.00	0.07	0	0.00
Manufacture and use of epoxy resins	59.90	0.00	0	9.57
Hydrogenation	0.00	0.00	0	0.00
Oil field chemicals	0.00	0.00	0	0.00
Total	60.33	0.17	0	24.55

*1 The data are in the RAR for BP (ECB, 2008) shown in kg/d divided on regional and continental releases. Total EU releases are calculated as the sum of the regional and the continental releases. It is indicated that the estimated releases are on an annual basis with 365 days per year.

4.2 Use and releases of 4-*tert*-BP in Denmark

4.2.1 Use of 4-*tert*-BP in Denmark

4-*tert*-butylphenol was in Denmark mainly used in paint, lacquers and varnishes and as hardeners i.e. as a constituent of the hardener component of two-component systems such as epoxy and phenolic adhesives, paints or plastics. As the substance is not classified as hazardous, mixtures with the substance will only be registered in the Product Register if the mixtures contain other substances which are classified as hazardous.

The consumption of other butylphenols by application area is confidential and only addressed in the confidential annex.

TABLE 29
CONSUMPTION OF 4-*TERT*-BP (*1) REGISTERED IN THE DANISH PRODUCT REGISTER, 2013

Application area (based on UC62)	Consumption (production + import – export) *1		
	n *2	t/y	%
Binding agents for paint and adhesives	17	0.9	8%
Paints, lacquers and varnishes	47	3.5	31%
Concrete flooring	6	0.9	8%
Sealants and filling agents	6	0.1	1%
Process regulators (hardeners)	14	2.4	21%
Other (incl. confidential)	9	3.5	31%
Total (including confidential)	97	11.2	100%

*1 CAS Number 98-54-4

*2 Number of mixtures.

*3 The total figures for application areas confidential or application area not indicated differs depending on the used codification systems and is e.g. higher for the dataset showing UCN codes (Nordic use codes).

4.2.2 Releases of 4-*tert*-BP in Denmark

As mentioned above, the EU Risk Assessment for 4-*tert*-BP does not include specific emission factors and does not include specific estimates for the releases from the end-uses of mixtures and articles with 4-*tert*-BP.

In the absence of specific emission factors, a first estimate for the releases of 4-*tert*-BP in Denmark is provided using the same emission factors as used for NP and activity data based on the data from the Product Register. As it appears from Table 12, the major sources of NP to waste water in Denmark is estimated to be paint, lacquers and varnishes, adhesives, sealants and filling agents and textiles (incl. technical textiles).

If the same emission factors as used for NP is used for the BP, total emissions to waste water can be estimated at 0.1 t/y. In the absence of emission factors for most of the specific uses, the NP emission factor for "Adhesive, sealants and filling agents" are used for all other applications than "Paints, lacquers and varnishes". The rationale is that "process regulators (hardeners)", "concrete flooring " and "other" most likely are two-component systems quite similar to sealants and filling agents. Under these assumptions the use of paints, lacquers and varnishes account for about 20% of the total releases to waste water. The majority of the 4-*tert*-BP in the inlet will like other APs end up in the sewage sludge while a small part is discharged from the WWTPs to surface water.

No data on BP in Danish WWTPs are available. Swedish investigations from 2005 found concentrations of 4-tert-BP in influents to WWTPs at the same levels as the concentration of OP and each of the two lower ethoxylated OPEs, and at levels of less than 1/20 the concentrations of NP and NPE (Remberger *et al.*, 2005).

The total releases of OPE to WWTPs in Denmark are here estimated at 0.2 t/y (section 3.2.3) and the differences between the estimated releases of OPE and 4-tert-BP to waste water are quite well in accordance with the Swedish investigations.

5. Releases of dodecylphenols (DP) and dodecylphenol ethoxylates (DPE)

5.1 Use and releases of DP in the EU

Use in the EU

The dodecyl group is a chain of 12 carbon atoms, which may be branched or linear. Four CAS No of dodecylphenol are included in the list of pre-registered substances.

Of these, branched dodecylphenol (CAS No 121158-58-5) is registered with a manufactured and imported tonnage in the 10,000-100,000 t/y range. The indicated uses are as chemical intermediate and monomer for synthesis of polymers. The CAS No in fact represents a large number of highly branched isomeric alkyl groups ranging from C10 to C15, in different positions (Brooke *et al.*, 2007).

The overall flow of dodecylphenol in Western Europe in 2010 as provided by CEPAD is shown in Figure 8.

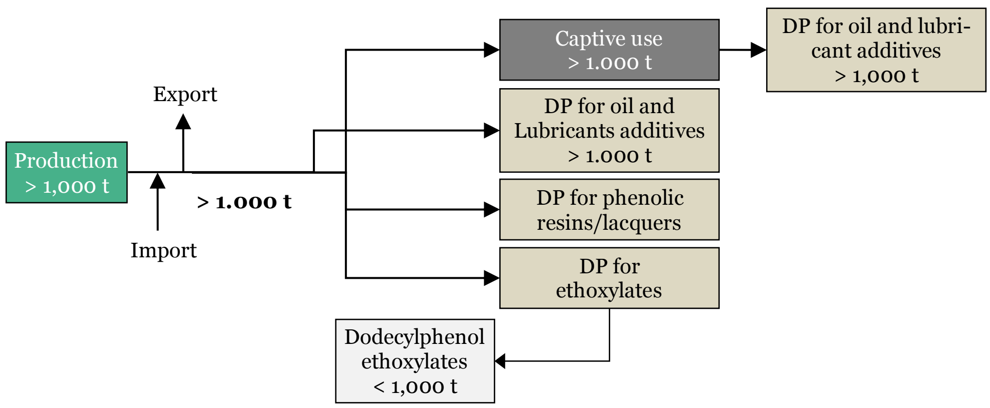


FIGURE 8
OVERALL FLOW OF DODECYLPHENOL IN WESTERN EUROPE (EU + SWITZERLAND + NORWAY) IN 2010 (LASSEN *ET AL.*, 2002 BASED ON DATA FROM CEPAD). CAPTIVE USE IS THE USE OF THE SUBSTANCE IN THE CHEMICAL INDUSTRY FOR SYNTHESIS OF OTHER CHEMICALS.

For an assessment of para-C12-alkylphenols (dodecylphenol and tetrapropenylphenol) prepared by the UK environmental risk evaluation report (Brooke *et al.*, 2007), members of CEPAD and RATG (Risk Assessment Task Group of the American Chemistry Council's Petroleum Additives Panel) have provided European production and import quantities for the period 1998–2002. The individual tonnages and capacities were confidential, but the total European consumption of the two substances was indicated to be approximately 50,000 t/y in 2004. It is indicated that the consumption was mostly as tetrapropenylphenol. "Tetrapropenylphenol" refers to the common name for the substance tetrapropenylphenol derivatives (CAS No 74499-35-7), which is also a dodecylphenol. This substance is not included in the database of registered substances (July 2014) indicating that the total production and import is less than 100 t/y. Branched dodecylphenol (CAS No 121158-58-5) is registered with a manufactured and imported tonnage in the 10,000-100,000 t/y range. Consequently, it does not seem that the tetrapropenylphenol derivative would take up the majority of the manufactured or imported totals today.

In the absence of updated data, the data from the UK environmental risk evaluation report will be used as a best estimate for the use in 2011.

At EU level, around 99% of the consumption volume of the two substances was used in the production of oil and lubricant additives (primarily calcium alkylphenate sulphides). Lubricant additives are complex mixtures of synthetic chemicals. They are combined with highly refined lubricant base oils to blend lubricants or are added to petroleum fuels to achieve a particular end-use or level of performance (e.g. two-cycle oils).

The dodecylphenol is present in the final lubricants at low levels. In Norway the average content of dodecylphenol in those lubricants indicated by the MSDS as containing dodecylphenol was 0.15% (Lambert, 2010). Import of dodecylphenol in oils was estimated to represent the major flow of dodecylphenols in Norway; consequently, improper disposal of used oil has been identified as the main source of environmental emission of dodecylphenols.

A relatively small amount was used to produce phenol/formaldehyde resins for printing inks and rubber tyre manufacturing (Brooke *et al.*, 2007)

A very small proportion (<1%) of the overall tonnage of tetrapropenylphenol was used to make ethoxylates. These are used as anti-rust agents in finished lubricants at levels of 0.05-0.30% w/w.

TABLE 30
ACTIVITY DATA FOR THE USE OF DP IN THE EU IN 2011

Application	Activity, t/y	Remark
Manufacture of DP	50.000	Of these, branched dodecylphenol (CAS No 121158-58-5) is registered with a manufactured and imported tonnage in the 10,000-100,000 t/y range. The total European consumption of para-DPs was around 50,000 t/y in 2004 (Brooke *et al.*, 2007). This figure is used as the most likely total manufactured volume.
Import/export of DP	No data	
Manufacture of other chemicals/resins:		

Application	Activity, t/y	Remark
Manufacture og and lubricant oil additives	49.500	Around 99% of the consumption volume is used in the production of oil and lubricant additives (primarily calcium alkylphenate sulphides) (Brooke *et al.*, 2007).
Manufacture of phenolic resins/lacquers	280	A small fraction of the para-C12-alkylphenols supplied in Europe was used to make phenolic resins. Printing inks account for the bulk of resins produced from paraC12-alkylphenols (Brooke *et al.*, 2007). A small quantity of DP was used for phenolic resins for tyres.
Manufacture of DP ethoxylates	<500	A very small proportion (<1%) of the overall tonnage of tetrapropenylphenol is used to make ethoxylates
Formulation and processing:		
Formulation of crankcase and marine lubricants based on DP derived phenates	6,950	The annual amount of DP consumption for manufacture of additives to crankcase lubricants was estimated at 49,500 tonnes. From this 59,400 t/y of phenates was manufactured with a mean content of 11.7% DP (the majority of the DP was converted to phenates). (Brooke *et al.*, 2007).
End-uses:		
Use of lubricants	6,950	See above
Use of phenolic resins for printing inks	~0	Printing inks account for the bulk of resins produced from paraC12-alkylphenols. The inks are manufactured in high-temperature processes in which the resins are reacted with other resins and oils leaving no significant trace of free alkylphenol. (Brooke *et al.*, 2007).
Use of phenolic resins for tyres	0.8	A small part of the resins was used for tyres. The maximum concentration of free DP in the resins used to make tyres is assumed to be 3%. This figure is in this study used as a best estimate.
Use of phenolic resins for printing inks	0.4	A small part of the resins was used for varnishes. The maximum concentration of free DP in the resins used to make tyres is assumed to be 3%.

Releases in the EU

The releases of DP in the EU in 2006 indicated that lubricant use and disposal accounted for nearly 100% of the total releases as shown in Table 31 based on the UK environmental risk evaluation report (Brooke *et al.*, 2007). The discussion will consequently focus on the releases from the use and disposal of lubricants.

If the DPs are added to fuels they would be combusted with the fuel. Used otherwise they would typically be disposed of with the waste oil, but spill may occur.

It is in the assessment assumed that spillage and leakages to soil and surface water correspond to about 1% of the total use of the substances for crankcase lubricants. The total amount of residual TP in crankcase lubricants were estimated at 3,370 tonnes per year. The UK risk evaluation report estimates the total releases from the use and disposal stage of the use of DP in crankcase lubricants at 23.4 t/y to waste water (0.69%) , 3.35 t/y to surface water (0.1%) and 22.6 t/y to soil (0.67%) for the EU as a whole. The emission factors are based on information from the OECD emission scenario document for lubricants and additives (OECD, 2004b) and may be considered worst case estimates. The releases are based on assumptions that 1% of the crankcase oils are leaked from the vehicles during use while 0.125% is spilled by charging or from oil left in containers. It is suggested that the leaked oil is assumed to be largely washed from the road surface by rainwater, and can be treated as a diffuse emission to surface water or soil. (OECD, 2004b)

By the marine application of the lubricants the majority of the lubricant is burned with the fuel and the remaining part is recycled.

TABLE 31
ESTIMATED RELEASES OFDP AT EU LEVEL IN 2006 (BROOKE AT AL., 2007)

Process	EU releases, t/y *1			
	Air	Surface water	Soil	WWTP
Manufacture and formulation processes:				
Manufacture of DP and lubricant additive manufacture		0.005		
Lubricant blending	0.007	0.003		
Phenol/formaldehyde resin production	0.003			0.003
Use of resins for ink formulation	0.016			0.019
Use of resin for tyre production	0.001			0.005
End-uses and disposal				
Lubricant use and disposal		3,340	22,300	23,300
Use of tyres with DP-based resins			0.008	0.008
Use of varnish with DP-based resins	0.080			<0.001
Total	0.107	3,340	22,300	23,300

5.2 Use and releases of DPE in the EU

At least two dodecylphenol ethoxylates are pre-registered but none are included in the database of registered substances or the list of 2013 intentions.

A very small proportion (<1% i.e. < 500 t/y) of the overall tonnage of tetrapropenylphenol was used to make dodecylphenol ethoxylates in 2004. These are used as anti-rust agents in finished lubricants at levels of 0.05-0.30% w/w. The number of ethoxy units is 10-15. Since the tetrapropenylphenol molecule has high oil solubility, its ethoxylate derivatives are never used in water-based applications. The volume of these materials used in lubricants has been dropping since the late 1980s, a continuing trend. According to Brooke *et al.* (2007), the industry believed the DPEs would eventually be totally phased out. The residual content of free dodecylphenol in the ethoxylates is unknown but most likely <1% (Brooke *et al.*, 2007).

No data on the releases of DPE at EU level is available. In the Nordic Countries according to data from the SPIN database the lubricants are mainly used for vehicles and identified safety data sheets (see section 6.8) also indicate that the DPE is mainly used for engine oils for vehicles. Most likely spillage and leakage of lubricants used for vehicles is the main source of releases. Under the assumption that the total consumption is <1000 t/y and the emission factors are similar to the emission factors used for DP, the total releases could be up to 6.9 t/y to waste water, 1.0 t/y to surface water and 6.7 t/y to soil .

5.3 Use and releases of DP and DPE in Denmark

Use of DP

The consumption of DPs as registered in the Product Register is shown in the table below. Contrary to the situation at EU level the main registered application is as fuel additive whereas the total content in lubricant additives account for 3% of the total. Brooke *et al.* (2007) notes that the use as a fuel additive as reported in the Danish and Swedish product register is presumably due to ethoxylate alternatives.

The registered content of DP in lubricants and fuel additives of 0.1% is very small compared to the content of DP i lubricants at EU level. If for a first estimate Denmark account for 1% of the total EU use, lubricants sold i Denmark should contain some 70 t/y of unreacted DP. This indicates that the low DP content of the lubricants is not reported to the Product Register.

TABLE 32
CONSUMPTION OF DPS (*1) REGISTERED IN THE DANISH PRODUCT REGISTER, 2013

Application area (based on UC62)	Consumption (production + import – export) *1		
	n *2	t/y	%
Fuels and fuel additives	14	3.2	97%
Lubricants and additives	17	0.1	3%
Hydraulic fluids and additives	11	0.01	0.2%
Total	42	3.2	100%

*1 CAS Numbers 104-43-8 and 27193-86-8. Both substances are not use for all of the applications.
*2 Number of mixtures.
*3 The total figures for application areas confidential or application area not indicated differs depending on the used codification systems and is e.g. higher for the dataset showing Ucn (Nordic use codes)

Releases of DP

DP used in fuels and fuel additive is assumed to be burned together with the fuel.

As mentioned above, lubricants sold in Denmark most likely contain DPs at the same level as lubricants sold elsewhere in the EU, and as a first estimated it may be assumed that the same emission factors apply. If the same emission factors are use the releases from the use of crankcase lubricants may be estimated at 33 kg to surface water, 223 kg to soil and 233 kg to waste water. The leakages from vehicles today is most likely significantly lower that from vehicles ten to twenty years ago, and the estimate may be considered worst case.

Compared to the total releases of NP to surface water of 215 kg/y and to soil of 367 kg/y, the potential releases of DP can be considered significant. No data on actual measurements of DP and DPE in waste water treatment plants in Denmark have been identified. A survey of AP/APEs in the Nordic environment found that DP levels may be in the same range as the concentration of NP in some environments e.g. close to towns and the DP was among the AP/APE found in the highest concentration in sewage sludge samples. (Hansen and Lassen, 2008).

Use of DPE

The registered tonnage of DPE in the Danish Product Register is shown in the table below. Lubricants and lubricant additives represent 99% of the registered volume in accordance with the consumption pattern at EU level.

No data on releases of DPE in Denmark exist but like the situation at EU level the main source of releases to the environment would be spillage and leakages of lubricating oils for vehicles.

TABLE 33
CONSUMPTION OF DPE (*1) REGISTERED IN THE DANISH PRODUCT REGISTER, 2013

Application area (based on UC62)	Consumption (production + import – export) *1		
	n *2	t/y	%
Lubricants and additives	41	9.2	99%
Confidential	4	0.1	1.1%
Total			

*1 CAS Numbers 9014-92-0 and 74499-35-7

*2 Number of mixtures.

*3 The total figures for application areas confidential or application area not indicated differs depending on the used codification systems and is e.g. higher for the dataset showing Ucn (Nordic use codes)

6. Akylphenols and alkylphenol ethoxylates in consumer products

6.1 Collection of data on use of AP/APE in consumer products

Information on the substances in consumer products has been collected from various sources.

Registrations – The registrations of the substances as reported at ECHAs website (ECHA, 2014) includes under "uses" some limited information on overall downstream uses by consumers e.g. "Consumer end-use of adhesives". The public parts of the registrations do not provide more specific information on the uses of the substances, and do not indicate how much of the total tonnage is used for consumer applications.

Product Registers – For this study detailed data from the Danish Product Register have been available. The notification requirements, however, concern mixtures for professional and industrial applications only. As many products used by professionals (e.g. paints, adhesives and sealants) also to some extent is used by consumers, the data from the Product Register would still indicate the presence of the substances in products used by consumers although the products may not be considered "consumer products". Furthermore, some of the use sector codes used in the Product Register such as "Paint shops" (as opposed to e.g. various industrial applications) may indicate the potential for consumer use of the mixtures. The detailed data on applications are to a large extent confidential and the published report is supplemented with a confidential report for the Danish EPA only.

The Swedish Product Register has a broader scope and requirements for notification of consumer products as well. For this study, detailed information on application areas from the Swedish Product Register has not been available, but total number of registered consumer products is for some of the substance groups indicated at the website of the Swedish Chemicals Agency (KemI, 2014).

Safety data sheets - Safety data sheets (SDSs) and material safety data sheets (MSDSs) have been identified using Google searches at the internet. Data from the sheets are listed in Appendix 1. The SDSs have preferably been collected from the websites of the manufacturers of the products. For regulated applications, outdated MSDSs are often present at the websites of some suppliers of the products. These data sheets have here been excluded from the Appendix. For applications at the borderline e.g. degreasers, only SDSs and MSDSs from manufacturer's websites are included. SDSs are in general not available for products for consumer use only. However, for many of the product groups with AP and APE (e.g. paints, adhesives and sealants), the same products are used by both professionals and consumers. For some product groups, e.g. degreasers and maintenance agents, some products are specifically marketed for consumer use, and for those products, most likely SDSs are not available.

Surveys of chemical substances in consumer products – The Danish EPA has over the years commissioned more than 100 surveys of chemicals in consumer products. The analysis results of the surveys are collected in a database searchable from the Danish EPA's website. The database has been searched using the gross lists of CAS numbers within each substances group.

Contact to market actors – By undertaking the LOUS survey, Danish trade organisations were contacted for more detailed information on the use of the substances in Denmark. In general very limited information was obtained because the manufacturers of paint, adhesives and other mixtures apparently did not possess detailed information on the AP and APE in the raw materials and thereby in the final products. Detailed information on the content of mixtures are often reported to the Product Register from manufacturers of the mixtures (e.g. raw materials) abroad and not necessarily known to the Danish users of the same materials. Contact has been established to Danish manufacturers of mixtures for which ESDs identified via the internet have indicated that AP/APEs were present in the products.

6.2 Nonylphenols (NP)

Registrations - The registration of phenol, 4-nonyl-, branched (CAS No 84852-15-3) lists the following consumer application of the substance: "Consumer end-use of adhesives", "Consumer use of coatings and paints" and "Consumer and professional end-use of adhesives, outdoor".

Surveys of chemical substances in consumer products - A search in the Danish EPA's database of chemicals in consumer products (DEPA, 2014) showed that NPE has mainly been included in the survey of NP and NPE in textiles described below (Rasmussen *et al.*, 2013). Furthermore the NP was detected in sex toys at levels of 0.3-2.5 mg/kg (Nilsson *et al.*, 2006), decorative paints used for windows at 51-95 mg/kg (Mikkelsen *et al.*, 2004), and in a sealant at 8 mg/kg (Nilsson *et al.*, 2004).

Safety data sheets: A search for SDSs has been performed for CAS No 84852-15-3 (phenol, 4-nonyl-, branched). The results are shown in Appendix 1; A.1 and further described in the sections below

Product Registers - The Swedish Product Register has registered 180 products with NP of which 9 are consumer products (Kemi, 2014). This indicates that about 5% of the products are consumer product and the percentage of the tonnage used by consumer may likely be smaller. The data clearly indicate that NP is mainly used for industrial and professional applications.

6.2.1 Paint and varnishes

For the RAR for NP (ECB, 2002) it was reported that nonylphenol was used in the hardener for two-component chemical- and abrasion-resistant protective coating for industrial applications. It was reported that the paints were used to protect structural steelwork in industrial applications where chemical or abrasion resistance is required.

The safety data sheets identified confirm that the NP is present at concentrations of typically 1- 5% in the hardener part of epoxy speciality paints for professional use. Some of the products can be purchased by consumers, e.g. via the Internet, and may to a limited extent be used by consumers e.g. for outdoor metal parts. By the use, the consumer has to blend the two components. After mixing, the blend hardens and all the nonylphenol is encapsulated in the water insoluble surface film. It is estimated that consumer applications account for a very small part of the total use.

6.2.2 Adhesives, sealants and filling material

Consumer end-use of adhesives is indicated as one of the downstream uses of NP. The number of products with NP registered in the Danish Products is 12 adhesives and 10 sealants and filling agents.

According to the safety data sheets identified, the NP is present at concentrations of up to 70% in the hardener part of many epoxy sealants, foams, adhesives, grouting material, etc. Furthermore, NP is present in some polyurethane two-component systems. The majority of the data sheets indicate that the products are used for industrial and professional applications

Some of the products may be purchased and used by consumers for DIY activities. Some of the products are available in common DIY stores and can be purchased via the internet. By the use, the consumer has to blend the two components. After mixing, the blend hardens and all the nonylphenol is encapsulated in the water insoluble matrix. It is estimated that consumer applications account for a very small part of the total use.

6.2.3 Lubricants

NP may be present in some lubricants at low level (7 products in the Danish Product Register). The identified SDS (Appendix 1; A.1.3) do not indicate consumer use. Compared to the use of NPE, DP and DPE in lubricants, the use of NP in lubricants is negligible.

6.2.4 Other applications with residual NP content

Nonylphenol/formaldehyde resins are according to the RAR for NP used as adhesives and tackifiers in the rubber industry (including tyres), paper coating resins and as intermediates for coating formulations, rosin modified resins for printing inks, electrical varnishes and as a modifier in several other applications.

The RAR for NP nor the Annex XV SVHC dossier for NP (ECHA, 2012b) do not indicate any consumer exposure apart from the consumer use of epoxy resins mentioned in the sections above. Residual content of NP in other consumer products is considered to be negligible.

6.3 Nonylphenol ethoxylates (NPE)

Registrations - The registration of NPE (CAS No 68412-54-4) do not indicated any consumer downstream used of the NPE. As mentioned elsewhere the longer-chained NPE are considered polymers and not registered. Some information is available on downstream applications of NPE from the registration of phenol, 4-nonyl-, branched (CAS No 84852-15-3). The list of applications of the NPE does not include any consumer applications.

Safety data sheets: A search for SDSs has been performed for the following NPE:

- CAS No 9016-45-9 (nonylphenol, ethoxylated)
- CAS No 68412-54-4 (2-{2-[4-(2,4,5-trimethylhexan-3-yl)phenoxy]polyethoxy}ethanol
- CAS No 127087-87-0 (4-nonylphenol, branched, ethoxylated)

The results are shown in Appendix 1; A.2 and further described in the sections below.

Surveys of chemical substances in consumer products - A search in the Danish EPA's database of chemicals in consumer products (DEPA, 2014) showed that NPE has mainly been included in the survey of NP and NPE in textiles described below (Rasmussen *et al.*, 2013). Furthermore the NPE was included in a survey of chemicals used in professional cleaning shops in which the products were in fact not consumer products (Glensvig and Mortensen, 2003).

Product Registers - The Swedish Product Register has registered 686 products with NPE of which 165 (24%) are consumer products (Kemi, 2014). Compared to the NP (5% consumer products), the consumer products account for a significantly higher percentage of all registered products. No specific data on consumer uses are available from the register, but the data indicate a widespread use of the NPE in consumer products.

6.3.1 Paint and varnishes

NPE is widely used as surfactant in paint and varnishes. The total number of products within this category registered in the Danish Product Register was 156. For 48 of these, the use sector was indicated as "paint shops" indicating that a large part of the paints may be used by professionals and consumers.

NPE are used in the preparation of paint resin based on polyvinyl acetates and also as a paint mixture stabilizer. Typical formulations contain 0.6-3% nonylphenol ethoxylates.
In decorative emulsions nonylphenol ethoxylates are used in the manufacture of the emulsion (for emulsion polymerization) and directly as emulsifiers and dispersants in water-based paints.

According to the identified SDS (appendix 1; A.2.1) CAS No 68412-54-4 is typically used for decorative building paints based on alkyd or acrylic binder at concentrations of 1-5%. CAS No 9016-45-9 is more commonly used for epoxy-based paints and wood preservatives, but also for paints based on acrylic binder.

The contacted manufacturers of paints all manufactured paints for industrial or professional applications. Paints based on acrylic and alkyd binders for consumers sold in Denmark do according to the contacted manufacturers usually not contain NPE or other AP/APE.

Many of the decorative building paints in appendix 1; A.2.1 can be purchased in Internet-based paint shops and are most probably also available from other paint shops and DIY stores. The products are to some extent used by consumers, but no data are available for estimate how much the consumer applications accounts for of the total consumption.

6.3.2 Adhesives, sealants and filling material

NPE is used in some types of adhesives (17 products in the Danish Product Register) and sealants and filling material (10 products in the Product Register). At EU level the total consumption for adhesives is likely less than 10% of the consumption for paints. According to a major manufacturer of adhesives, AP/APE have been phased out for most applications as alternatives are readily available.

Identified SDSs (Appendix 1; A.2.2) for products that may be used by consumers (but mainly used by professionals) are primers and bonding agents for floor and wall preparations, sealants for ceramic tiles and mosaics, and a wood adhesive.

6.3.3 Degreasers and maintenance agents

Degreasers and maintenance agents are on the borderline of the current restriction of NPE in cleaning agents.

Degreasers - NPE is used in some types of degreasers (23 products registered in the Product Register). The use of NPE in degreasers is not specifically mentioned in the EU RAR for NP. A large number of degreasers are marketed and the data indicates that NPE is present in only a few of the products.

SDSs for degreasers have been identified for both CAS Number 68412-54-4 (2-{2-[4-(2,4,5-trimethylhexan-3-yl)phenoxy]polyethoxy}ethanol) and 9016-45-9 (nonylphenol, ethoxylat-ed). The degreasers are used for various applications such as cleaning of engines, garbage disposals, walls, floors and kitchen surface. The products are indicated to be for industrial, agricultural, marine, automotive and domestic applications. Several of the SDSs indicates that the degreasers may be used for domestic (consumer) applications.

Maintenance agents - An update of the quantities registered the Danish Product revealed that the majority of the registered quantities of 53 t/y in 2012 were outdated. According to the update, still some 4 tonnes in various 53 cleaning and maintenance agents were registered. Some of the registered products are used for professional cleaning shops and probably beyond the scope of the current restriction. NPEs is restricted in cleaning agents so a part of the registered volume is probably still due to inadequate update. The NPE is present in various products groups and most the information on uses is confidential. Non-confidential uses are floor wax and floor polish, lime removers, plastic maintenance agents, and metal polishes. The products are registered for industrial and professional applications, but many of these products may as well be used for consumer applications.

6.3.4 Lubricants

NPE is used in some types of degreasers (23 products registered in the Product Register). SDSs have been identified for a few lubricants. Of these two of the products, motor oil, may be used by consumers.

6.3.5 Textiles

Non-technical textiles – The use of NPE in the manufacture of textiles in the EU is restricted but NPE has been demonstrated to be present in textiles imported from countries outside the EU. NPE is mainly used as a detergent or an emulsifying agent in the manufacturing of textiles. The Annex XV restriction report for NP and NPE has recently summarised the results of analyses of 253 samples. In 105 of these (41%), the concentration was below the detection level. For the remaining the concentration ranged from 1 to 27,000 mg/kg. The average concentration of all analysed samples was 107 mg/kg.

In a survey of 141 textiles samples from different countries NPE was measured in the area with plastisol print (PVC coating) in 31 of the articles (Greenpeace, 2012). The highest concentrations were found in the textiles with plastisol print (but not in all the textiles with plastisol prints) with the highest concentration at 45,000 mg/kg (4.5%).

A survey of NP and NPE in textiles undertaken for the Danish EPA (Rasmussen *et al.*, 2013) found similar results with a maximum NPE concentration of 310 mg/kg and an average of 96 mg/kg in the 15 analysed samples. NPEs were detected in all samples but in 6 samples the concentration was below 10 mg/kg.

Technical textiles - NPE is known to be used in some polymeric dispersions for coating technical textiles (for use in, for example, tents) (AMEC, 2013).

In a comment to Environment Canada's consideration in developing its Risk Management Strategy for the Wet Processing Textile Industry, the Global Emulsion Polymers Council (EPC, 2002) describes the use of NPE in emulsion polymers for textiles. According to the Council, textile coatings are typically based on emulsion polymers. Coating products based on emulsion polymers are generally applied to be permanently affixed to the textile in order to impart specific performance characteristics such as flame retardancy, back coatings to stabilize fabrics (upholstery, automotive), blackout drapery coatings and coated carpet. The emulsion polymer-based coating, including any surfactant present, attaches to the textile substrate during the coating process. Typical concentrations of NPE in an emulsion polymer range from 0.2 - 5%, and the level of NPE in the finished coating ranges from 0.05 to 1.5% (500-15,000 mg/kg) (ECP, 2002).

The Annex XV restriction report for NP and NPE describes the different types of technical textiles. The report does not include any information on to what extent NPE is actually used for the different types of technical textiles and the actual NPE concentration of the different types of technical textiles. Technical textiles used by consumers may include some functional parts of clothing and footwear e.g. sewing thread, interlinings and wadding, domestic textiles used in households such as curtain tapes, carpet backings and wadding for mattresses and furniture, sports textiles and tents.

6.3.6 Leather

The use of NPE in the manufacture of leather in the EU is restricted, but NPE has been demonstrated to be present in textiles produced in countries outside the EU. NPE is mainly used as a detergent or an emulsifying agent in the manufacturing of leather.

As described in section 2.2.1, 18 of 90 analysed samples (20%) of leather manufactured in China contained NPE. The detected concentrations ranged from 11 to 1,500 mg NPE/kg leather (normalised to NP9EO with 9 ethoxy units). The highest concentration of NPE (1500 mg/kg) was found in a cattle-hide leather designed for furniture. No European studies of NPE in imported leather have been identified.

No data on NPE in leather articles imported to the EU have been identified. As a significant part of the leather articles are imported from China and other countries outside the EU, it is likely that a significant part of the marketed leather articles used by consumers contain NPE.

6.3.7 Other

NPE is used for various other applications, but the available data (e.g. the SDS in Appendix 1; A.2.5) indicate that other applications is mainly industrial and professional applications.

6.4 Octylphenols (OP)

4-*tert*-OP account for nearly 100% of the use of OP and consequently the description of the use of OP in fact concerns 4-*tert*-OP.

Registrations - The registration of 4-*tert*-OP indicates "Consumer use of coatings and paints" and "Consumer use of adhesives" as two of the downstream uses of the substance (ECHA, 2014) (apart from down-steam uses of OPE described in section xx). The public part of the registrations does not include specific information on the consumer application or the quantities used for these applications.

Surveys of substances in consumer products - According to the Danish EPA's database on substances in consumer products, OP (CAS no. 140-66-9) was found in one of eight analysed samples of textile colours in a concentration of 24 mg/kg (DEPA, 2014). A recent survey (no data in the database) found, as further described in section 3.2.1, a mean concentration of OPEs in different types of imported textiles of less than 1.6 mg/kg (Rasmussen *et al.*, 2013).

Product Registers - The Swedish Product register has registered 31 products with OP. Of these, 5 (16%) are consumer products (Kemi, 2014). The percentage of the tonnage used may likely be smaller than the 16%. No specific data on consumer uses are available from the register. For each groups of end-use applications, the total consumption was <0.1 t/y (both professional and consumer use). The SPIN database of the Nordic product registers holds information on 4-*tert*-OP, but do not include any specific information on use in consumer products.

Residual content of 4-*tert*-OP in resins - Possible consumer applications of OP is reviewed in the environmental risk assessment report by the Environment Agency for England and Wales (2005). The major use of 4-*tert*-OP is the production of phenolic resins, which accounts for 98% of the use volume as reported by the manufacturers in 2001. Most of the OP in the phenolic resins is chemically bound and cannot be released even on subsequent chemical or biological degradation. However, the resins may as mentioned elsewhere contain approximately 3-4% of unreacted 4-*tert*-OP as further described below.

6.4.1 Residual OP in paint, varnishes and inks

One use of the OP-based resins is as binders in special paints used in marine applications, since they provide high resistance to saline waters (Environment Agency, 2005). The concentration of the resins might be around 25% in the paints (DEFRA, 2008). With a residual OP content of the resin of about 3%, the paints would contain about 1% OP. Such paints and varnishes are very likely also used by consumers for maintenance of pleasure boats.

According to Safety Data Sheets, 4-*tert*-OP is present in several types of paints and varnishes at concentrations of up to ≤ 2.5% (Appendix 1; A.3.1). The paints used for wooden boats and yachts are sold in small tins and can be purchased in conventional yacht shops. They are most probably applied by consumers (private owners of yachts) as well as by professional users.

The registration of 4-*tert*-OP indicates as mentioned above "Consumer use of coatings and paints" as one of the downstream uses of the substance (ECHA, 2014).

Phenolic resins are also essential components of modern printing inks. The phenolic resin typically makes up about 7-8% of the ink formulation. The ink production process actually involves some reaction between the components. There are no significant traces of 4-*tert*-OP left in the finished inks (Environment Agency, 2005) and no consumer exposure to 4-*tert*-OP in inks of e.g. inkjet printers or printed matter is expected. In accordance with this, no SDS of inks with 4-*tert*-OP has been identified.

One SDS was identified for an industry paint marker with 4-*tert*-OP, but it has not been possible to identify any paint markers with 4-*tert*-OP used by consumers.

6.4.2 Residual OP in adhesives, sealants and filling material

A few SDSs of OP in adhesives at concentrations up to 0.25% have been identified.

The registration of 4-*tert*-OP indicates "Consumer use of adhesives" as one of the downstream uses of the substance (ECHA, 2014) indicating that at least some adhesives with the substance is used by consumers. It has not been possible to identify any specific product likely to be used by consumers.

6.4.3 Residual OP in OP-based tyres

Phenolic resins are used in rubber compounding for production of tyres. The resins are usually added to rubber in amounts up to 1.5% of the rubber formulation. It has been calculated that an average EU tyre contains between 0.007 % and 0.012 % of 4-*tert*-OP. The tyres may be used by consumers. The direct exposure to 4-*tert*-OP in tyres is considered to be low because the substance is bound in the rubber matrix and furthermore, the 4-*tert*-OP is typically only present in the core parts of the tyre.

6.4.4 Other applications

The use of OP as additive in lubricants has been mentioned by the American Chemistry Council (DEFRA, 2008). DEFRA (2008) notes that this application could not be confirmed for Europe. However, it has also noted that the chemical composition of lubricant raw materials is usually considered to be proprietary or confidential (Environment Agency 2005, DEFRA, 2008).

6.5 Octylphenol ethoxylates (OPE)

Registrations - None of the preregistered OPE listed in Table 18 have been registered as of August 2014 (ECHA, 2014). Some limited information is available on downstream consumer applications of OPE from the registration of 4-*tert*-OP as described in the sections below.

Safety data sheets: A SDS search has been performed for the following OPE in order to see if they might be present in products potentially used by consumers:

- CAS No 2497-59-8 (20-[4-(1,1,3,3-tetramethyl-butyl)phenoxy]-3,6,9,12,15,18-hexaoxaicosan-1-ol)
- CAS No 9002-93-1 (poly(oxy-1,2-ethanediyl), α-[4-(1,1,3,3-tetramethyl-butyl)phenyl]-ω-hydroxy)
- CAS No 9036-19-5 (poly(oxy-1,2-ethanediyl), α-[(1,1,3,3-tetramethyl-butyl)phenyl]-ω-hydroxy)
- CAS No 68987-90-6 (poly(oxy-1,2-ethanediyl), α-(octylphenyl)-ω-hydroxy-, branched)

The results are shown in Appendix 1; A.4 and further described in the sections below.

Surveys of chemical substances in consumer products - A search in the Danish EPA's database of chemicals in consumer products (DEPA, 2014) showed that OPE has been included in one of the surveys with the following result: 0.1 % (w/w) in a spot remover, 0.89% in a cleaning intensifier and 0.86% in a pre-brushing fluid (Glensvig and Mortensen, 2003). The products were in fact not consumer products, but used in professional cleaning shops. Furthermore, the survey is more than 10 years old, and the data may be outdated.

Product Registers - The Swedish Product Register has registered 186 products with OPE. Of these, 25 (13%) may be used by consumers (KemI, 2014). No specific data on consumer uses are available from the register. For each group of end-use applications, the total consumption was <1 t/y (both professional and consumer use).

The SPIN database of the Nordic product registers holds information on three OPE, but does not include any specific information on use in consumer products.

The Annex XV dossier for 4-*tert*-OPE make reference to data from the Swiss Product Register with indication of the presence of OPE in several product types which may partly be used by consumers: Impregnating agents, car care products, limescale remover, adhesives and sealants, metal care products, air fresheners/air treatment, cleaning products, lubricants and additives, shoe and leather care products, household care products, detergents, auxiliaries, soaps. For many of the product categories only one product is registered (BAuA, 2012). The results indicated that the OPE is used in many different product groups, but they are not in widespread use in any of the product groups.

Emulsion polymerisation - The main use of OPE in the EU is as emulsifiers for emulsion polymerisation (e.g. for the production of styrene–butadiene polymers). The end applications for the polymer dispersions include paints, paper, inks, adhesives and carpet backings. The residual concentrations of OPE in the cured polymer have not been reported.

Concentration in products – A survey by the Norwegian Pollution Control Authority from 2001 on the use of alkylphenols and their ethoxylates in products in 1999 calculated the average concentrations of OPE in products at: Interior and exterior paint (0.1 %), other paint and/or varnish products (0.4%), degreasing products (2.3%), and other products (10%) (Environment Agency 2005).

6.5.1 Paint, varnishes and other coatings

In some water-based paints, OPE act as emulsifiers and as dispersants, although the emulsifying properties are more dominant (Environment Agency, 2005). The application area of such paints is not specified by Environment Agency.

In the comment to the background document for OPE (ECHA, 2014a) CEPAD indicate that "*OPEs are used predominantly in the formulation of paint and coating products and are used at levels of generally 1% or less in those products. Due to their role in the emulsion polymerization process, OPEs are expected to be bound in the paint polymer and not widely dispersed to the environment*". The OPEs are not used reactively in the process and must be expected to present in the final mixtures and articles.

The registration of 4-*tert*-OP indicates "Consumer and professional end-use of products (e.g. paints) containing octylphenol ethoxylates" as one of the downstream uses of 4-*tert*-OP (ECHA, 2014).

According to identified SDSs (Appendix 1; A.4.1), the OPE is present in acrylic paints for both indoor and outdoor applications at concentrations of <1% to 5%.

The total number of products within the product group paints, lacquers and varnishes in the Danish Product Register is 68 indicating that the OPE is common in paints, but not as common as NPE (the number of products with NPE is for comparison 156). Of the 68 products, 30 are indicated as sold to paint shops, which indicates that professional/consumer use may take up a significant part of the total use.

According to identified SDSs, OPE is also present in stone impregnation and floor finish at concentrations of 0.1-1% and in one of the components of a two-component paint for industrial applications.

The product safety assessment of octylphenol ethoxylate surfactants from the manufacturer Dow indicates that the substances are used as a component in paints, agricultural formulations and other products, so there is a potential for consumers to come into contact with products containing small amounts of these materials (DOW, 2010).

The acrylic paints used for building applications as well as the stone impregnation and floor finish may to some extent be sold from DIY shops and paint shops and used by consumers.

6.5.2 Adhesives, sealants and potting material

At EU level, the use of OPE for adhesives is small as compared to the use for paints (10 t/y as compared to 760 t/y for paints).

For the UK Risk Reduction Strategy, the use of OPEs as binders in adhesives was confirmed by one company (DEFRA, 2008). The main application was probably as a coating binder in epoxy resin for continuous filament glass fibre reinforcements, e.g. used in composite wind farm blades (DEFRA, 2008). Even though this will typically be an industrial application, it cannot be excluded that consumers might buy epoxy resins for private use

It has not been possible to identify any SDS for adhesives with OPE. In the Danish Product Register 2.5 t/y is registered for the application "binding agents for paints and adhesives", but the actual application may quite well be manufacture of paints. No adhesives with OPE are registered in the Product Register and the consumer use of adhesives with OPE is considered to be negligible.

OPE is present in concentrations of 0.1% to 5% in some jointing compounds and electrical potting and sealing compounds. The identified mixtures are most likely not used by consumers.

6.5.3 Textiles and leather

OPEs are used in textile and leather auxiliaries, e.g. hot melts (where the printing ink is heated), other textile printing, and leather finishing.

They generally act as emulsifiers in finishing agents, which are typically styrene-butadiene copolymers. Finishing agents cover leather and textiles with a thin polymer film to make the material more resistant to water, dust and light (Environment Agency 2005). They also provide leather with a shiny appearance. The OPE is physically bound in the polymer matrix, which adheres to the textile or leather. Thus, releases of OPE from this insoluble polymer structure are according to Environment Agency (2005) estimated to be unlikely. The concentration of OPE in the finishing agents has not been reported. The EU risk reduction strategy report further suggests that OPE have been largely replaced in textile formulation related to the high costs connected to this application (DEFRA, 2008).

In a Danish investigation of NP and NPE in textiles, OPE were part of the analysis packages although the project did not focus on OPE in textiles (Rasmussen *et al.*, 2012). In 8 of 15 textile samples, the concentration was below the detection limit of 0.2 mg OPE/kg textile and in none the samples the concentration was above 10 mg OPE/kg textile. The mean of all the measurements were below 1.6 mg OPE/kg textile, which is less than 2% of the mean value of the measured NPE concentrations.

In the EU, the OPE are typically used for finishing agents used to cover textiles with a thin polymer film to make the material more resistant to water, dust and light. The textiles tested in the Danish study were not coated and consequently not of a type where OPEs would typically be found.

In printed textile sections of children's clothing Greenpeace (2004) found OPE concentrations at levels ranging from 1.2-650 mg OPE/kg textile.

It has not been possible to identify newer studies of OPE in printed and coated textiles or leathe but OPE may likely still be present in some clothing or leather used by consumers.

6.5.4 Cleaning and maintenance agents

The data from the Danish Product register indicates a small consumption of OPE in cleaning, washing and maintenance agents of 0.04 t/y representing 0.4% of the total registered consumption of OPE. The total number of registered products was 14. For comparison 91 products with NPE with a total content of 53 t/y were registered in the Product Register in 2012 for this application area (Lassen *et al.*, 2012).

As mentioned above, the Annex XV dossier for 4-*tert*-OPE make reference to data from the Swiss Product Register with indication of the presence of OPE in several cleaning and maintenance agents: Impregnating agents, car care products, metal care products, cleaning products, lubricants and additives, shoe and leather care products, household care products, detergents and soap (BAuA, 2012). For many of the product categories only one product was registered.

The available data indicate that OPE may be used in a few products used by consumers within different products categories, but the use is not widespread.

It has not been possible to identify any specific cleaning and maintenance agents with OPE.

6.6 Butylphenols

According to the EU RAR for 4-*tert*-BP (ECB, 2008), consumer exposure to 4-*tert*-BP is possible via direct use of products with phenolic resins or epoxy resins containing residual 4-*tert*-BP monomers, or via use of the final articles containing residual concentrations of 4-*tert*-BP. Consumer exposure is furthermore possible via the use of products made of polycarbonates such as containers for storage of food and tableware.

According to the RAR for BP, data from the Norwegian Product Register consumer uses of 4-*tert*-BP have been identified for adhesives and paint and varnishes (ECB, 2008).

A search in the Danish EPA's database on substances identified in surveys of chemical substances in consumer products gave no results (DEPA, 2014).

6.6.1 Paint, varnishes and primers

According to the RAR for BP, the concentration of 4-*tert*-BP in paint and lacquer products for which consumer uses are indicated seems generally to be low (< 1 %).

Safety data sheets of paint, varnishes and primers with 4-*tert*-BP indicates that all products are epoxy-based systems. Some examples are shown in the table in Appendix 1; A.5.1, but many different products are marketed; in particular for industry flooring. The concentrations vary from 1% up to 50% in some hardener components of two-component systems. For many of the products it is indicated that they are for industrial or professional use only. Contacted manufactures of 4-*tert*-BP-containing coatings have indicated that the products are for industrial and professional use only.

The registration of 4-*tert*-BP indicates that the substance is also used for "Consumer application of coatings - indoor" ECHA (2014c).

Some of the epoxy-based coatings may, although often indicated as "for professional use only", be purchased in DIY shops and will to a limited extent be used by consumers. The concentration of the hardener part of the paints range from 1% to 50%.

In many of the mixtures, both in paints and in adhesives described in the next section, the 4-*tert*-BP is used together with NP.

6.6.2 Adhesives, sealants, fillers and flooring material

According to the RAR for BP (ECB, 2008), the concentration of 4-*tert*-BP in adhesives used by consumers are generally very low (from 0.1 to 1 %).

The registration of 4-*tert*-BP indicates that the substance is also used for "Consumer end-use of adhesives" (ECHA, 2014c).

Safety data sheets of paint, varnishes and primers with 4-*tert*-BP indicates that the products are mainly epoxy-based systems. Some examples are shown in Appendix 1; A.5.2, but many different products are marketed. The concentrations vary from <1% up to 50% in some hardener components of two-component systems and is thus significantly higher than the concentrations indicated in the RAR for BP. For some of the products it is indicated that they are for industrial or professional use only.

The epoxy-based adhesives are mainly used for industrial and professional applications, but some of the adhesives may be purchased in DIY shops and will to some extent be used by consumers.

6.6.3 Residual 4-*tert*-BP in BP-based plastics and rubber products

Polycarbonate – The residual concentrations of non-reacted 4-*tert*-BP in polycarbonate have been measured to be below a limit of detection of 5 ppm. According to the RAR for BP, potential consumer exposure to 4-*tert*-BP from polycarbonate uses may arise from these applications that involve direct contact with foodstuff i.e. containers for storage of food and beverages and tableware. The migration of 4-*tert*-BP from polycarbonate in food contact applications has been studied using food-simulating solvents. Migration was non-detectable applying a limit of detection ranging from 6 – 16 microgram/kg food for 4-*tert*-BP.

The RAR for BP includes consumer exposure estimates for exposure to residual 4-*tert*-BP in poly-carbonate used for food contact applications and epoxy resins used for canned food. The RAR for BP estimated the consumer exposure to 4-*tert*-BP in polycarbonate and epoxy resins to be approx. 100 times lower than the potential exposure to 4-*tert*-BP from consumer use of adhesives.

Epoxy resins used for canned food – The RAR for BP estimates the potential exposure to 4-*tert*-BP from epoxy resins used for canned food but also report that this application is historic.

6.7 Dodecylphenols

A search for docecylphenols in the database of substances analysed in the Danish EPA's surveys of chemicals in Consumer Products (DEPA, 2014) did not identify any analysis of DPs in the analysed consumer products.

6.7.1 Lubricants and engine oil additives

As described in section 5.1, the major application of DP is in lubricating oils. The identified safety data sheets indicate that the DP is used both is crankcase and engine oils (Appendix 1; A.6.1).

Whereas consumers would normally not change the crankcase oil of vehicles, it is common that consumers top-up engine oils and to some extent also change the engine oil of the cars. The type of oils used by professionals (auto repair shops) and consumers is deemed to be the same, and the safety data sheets of oils used for professional applications will also be representative for oils used by consumers. The concentration of free DP in the oils is usually below 1% but in one of the identi-fied oils the concentration was 1.5%.

6.7.2 Coatings and encapsulation

The use of DP in epoxy-based hardeners for paints and fillers is not described in section 5.1 and the application is not indicated in the SPIN database of the Nordic Product Registers. Several safety data sheets of epoxy hardeners with DP have been identified as shown in Appendix 1; A.6.2. The identified mixtures seem mainly to be used for industrial or professional applications, and the epoxy systems are most likely only used by consumers to a very limited extent.

6.8 Dodecylphenol ethoxylates

As described in section 5.1 the major application of DPE is in lubricating oils. The identified safety data sheets indicate that the DP is used both is engine oils. The oils may be used by consumers to top-up engine oils and to change the engine oil of the cars (Appendix 1; A.7.1). The type of oils used by professionals (auto repair shops) and consumers is deemed to be the same, and the safety data sheets of oils used for professional use will also be representative for oils used by consumers. The concentration is in the 0.01-0.5% range.

The Swedish Product Register include 3 products within the application area "Fuels and lubricants" of which 2 products are consumer products. This confirms that the DPE to some extend is used by consumers.

7. Abbreviations and acronyms

4-*tert*-BP	4-*tert*-butylphenol
4-*tert*-OP	4-*tert*-octylphenol
ACEA	European Automobile Manufacturers Association
AD	Activity data
AISE	International Association for Soaps, Detergents and Maintenance Products
AP	Alkylphenols
APE	Alkylphenol ethoxylates
Atiel	The Technical Association of the European Lubricants Industry
BP	Butylphenols
CEPAD	European Council for Alkylphenol and Derivatives
CEPE	European Council of the Paint, Printing Inks and Artists Colours Industry
DP	Dodecylphenols
DPE	Dodecylphenol ethoxylates
ECB	European Chemicals Bureau
ECHA	European Chemicals Agency
ECPA	European Crop Protection Association
EF	Emission factor
EPA	Environmental Protection Agency
EPDLA	European Polymer Dispersion & Latex Association
ERX	Environmental Release Category
ESD	Emission Scenario Document
ESIG	European Solvents Industry Group
ESVOC	European Solvents Industry Platform
ETRMA	European Tyre & Rubber Manufacturers' Association
EU	European Union
FEICA	Association of the European Adhesive & Sealant Industry
LOUS	List of Undesirable Substances (of the Danish EPA)
MSDS	Material Safety Data Sheet
MSW	Municipal solid waste
MSWI	Municipal solid waste incineration
NP	Nonylphenols
NP2EO	Nonylphenol ethoxylates with one ethoxylate group
NP2EO	Nonylphenol ethoxylates with two ethoxylate groups
NP9EO	Nonylphenol ethoxylates with nine ethoxylate groups
NPE	Nonylphenol ethoxylates
NPEC	Nonylphenol ethoxycarboxylates
NPEOn	Nonylphenol ethoxylates with various numbers of ethoxylate group
NPeq	Nonylphenol equivalents
NPnEC	Nonylphenol ethoxycarboxylates of various chainlength
OECD	Organisation for Economic Co-operation and Development
OP	Octylphenols

OPE	Octylphenol ethoxylates
OPE9	Octylphenol ethoxylates with nine ethoxylate groups
OPEOn	Octylphenol ethoxylates with various numbers of ethoxylate group
OPE-S	Octylphenol ether sulphate
PTFE	Polytetrafluoroethylene
RAR	Risk Assessment Report (different reports depending on context)
RATG	Risk Assessment Task Group of the American Chemistry Council's Petroleum Additives Panel
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals (Regulation)
RMM	Risk Management Measure
SDS	Safety Data Sheet
SPERC	Specific Environmental Release Category
SPIN	Substances in Products in Nordic Countries (Database of the Nordic Product Registers)
SVHC	Substances of Very High Concern
TGD	Technical Guidance Document
TNPP	Tri-(4-nonylphenyl) phosphite
UK	United Kingdom
VCI	Verband der Chemischen Industrie
WWTP	Waste water treatment plant

8. References

AMEC (2013). European Chemicals Agency. Abatement Costs of Certain Hazardous Chemicals. Lot 2 (Nonylphenol and nonylphenol ethoxylates in textiles). AMEC Environmental & Infrastructure UK Limited. for ECHA. Published in: Estimating the abatement costs of hazardous chemicals. A review of the results of six case studies. European Chemicals Agency, Helsinki.

BAuA (2012). 4-(1,1,3,3-tetramethylbutyl)phenol, ethoxylated - covering well-defined substances and UVCB substances, polymers and homologues. Annex XV Dossier.

Boutrup, S., Svendsen, L.M. (2012). Tilførsel af syntetiske stoffer samt ikke-syntetiske stoffer og forbindelser til de danske farvande [Releases of synthetic substances and non-synthetic substances to the Danish waters]. Notat 2.7 of August 2012. DCE, National Center for Environment and Energy.

BREF (2009). Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities, January 2009. The European Commission.

Brooke, Crookes M, Johnson I, Mitchell R, Watts C (2005). Prioritisation of alkylphenols for environmental Risk assessment. Environment Agency, Bristol.

Brooke, D., Mitchell, R., Watts, C., Dungey, S. and I. Indans (2007). Environmental risk evaluation report: para-C12-Alkylphenols (dodecylphenol and tetrapropenylphenol). Environment Agency, UK.

Byggforsk (2004). Potential health and environmental effects linked to artificial turf systems -final report. Norwegian Building Research Institute for Norwegian Football Association. http://www.isss-sportsurfacescience.org/downloads/documents/VSKYSLV2QQ_NBIEngelsk.pdf

CEFIC (2012). Cefic Guidance. Specific Environmental Release Categories (SPERCs). Chemical Safety Assessments, Supply Chain. Communication and Downstream User Compliance. Revision: 2.

CEPAD (2011). Markets and Uses in Western Europe Status 2010. Prepared by European Council for Alkylphenols and Derivatives. CEPAD

CEPE (2013). Specific environmental release categories (SpERCs) for the manufacture and application of coatings, inks and artists' colours, various data sheets. The European Council of Paint, Printing Ink and Artists 'Colours (CEPE).

COHIBA (2011). COHIBA Guidance Document No.7 for octylphenol (OP) and octylphenol ethoxylates (OPE). COHIBA (Control of Hazardous Substances in the Baltic Sea Region), report with Marscheider-Weidemann F, Fraunhofer Institute for Systems and Innovation Research ISI as lead author.

COHIBA (2012). WP4 background paper. Identification of sources and estimation of inputs to the Baltic Sea. Version 2.0 2012. COHIBA (Control of Hazardous Substances in the Baltic Sea Region), a project coordinated by Finnish Environment Institute SYKE.

DANVA. (2009a). Håndtering af spildevandslam. Katalog over metoder til behandling og deponering. [Handling of sewage sludge. Catalogue of methods for treatment and disposal]. Danish Water and Waste water Association (in Danish)

DEFRA (2008). 4-*tert*-Octylphenol – Risk Reduction Strategy and Analysis of Advantages and Drawbacks. Department for Environment, Food & Rural Affairs (DEFRA), London.

DEFRA (2008). 4-*tert*-Octylphenol Risk Reduction Strategy and Analysis of Advantages and Drawbacks. RPA for Department for Environment, Food and Rural Affairs (DEFRA), London.

DEPA (2009). Affaldsstatistik 2007 and 2008 [Waste Statistics] (in Danish). Danish Environmental Protection Agency.

DEPA (2012). ANNEX XV REPORT. PROPOSAL FOR A RESTRICTION. Chromium (VI) compounds. Submitted by the Danish Environmental Protection Agency.

DEPA (2014). Chemicals in consumer products – Database. http://eng.mst.dk/topics/chemicals/consumers-consumer-products/database-of-chemicals-in-consumer-products/

DOW (2010). Product Safety Assessment: DOW™ Octylphenol Ethoxylate Surfactants. Accessed August 2014 at: http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_07f3/0901b803807f3367.pdf?filepath=productsafety/pdfs/noreg/233-00258.pdf&fromPage=GetDoc

ECB (2002). European Union Risk Assessment Report. 4-Nonylphenol (branched) and nonylphenol. European Chemicals Bureau, European Communities.

ECB (2003). Technical Guidance Document on Risk Assessment in support of Commission Directive 93/67/EEC on Risk Assessment for new notified substances , Commission Regulation (EC) No 1488/94 on Risk Assessment for existing substances; Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market. European Chemicals Bureau, European Communities.

ECB (2008). European Union Risk Assessment Report. 4-*tert*-butylphenol. European Chemicals Bureau, European Communities.

ECB (2008). European Union Risk Assessment Report. Bis(2-ethylhexyl)phthalate (DEHP). European Chemicals Bureau, European Communities.

ECHA (2012a). Guidance on information requirements and chemical safety assessment. Chapter R.16: Environmental Exposure. Version 2.1, October 2012.

ECHA (2012b). Annex XV dossier. 4-Nonylphenol, branched and linear: substances with a linear and/or branched alkyl chain with a carbon number of 9 covalently bound in position 4 to phenol, covering also UVCB- and well-defined substances which include any of the individual isomers or a combination thereof. Submitted by Federal Institute for Occupational Safety and Health (BAuA), Germany. Available at: http://echa.europa.eu/documents/10162/59e6cb9d-f70b-4321-b7b6-557cbddca8da

ECHA (2012c). Annex XV report for 4-(1,1,3,3-tetramethylbutyl)phenol. Submitted by Federal Institute for Occupational Safety and Health (BAuA), Germany.

ECHA (2012d). Annex XV report for 4-(1,1,3,3-tetramethylbutyl)phenol, ethoxylated - covering well-defined substances and UVCB substances, polymers and homologues. Submitted by Federal

Institute for Occupational Safety and Health (BAuA), Germany. Available at: http://echa.europa.eu/documents/10162/c26cbb7e-91f9-4454-a054-c2a731029219

ECHA (2014a). Responses to Comments Document (RCOM) on ECHA's Draft 5th Recommendation for 4(1,1,3,3-tetramethylbutyl)phenol,ethoxylated (4-*tert*-OPnEO)) (EC number:). 6 February 2014. Public version.

ECHA (2014b). Background document for 4-(1,1,3,3tetramethylbutyl)phenol,ethoxylated (4-*tert*-Octylphenol ethoxylates) (4-*tert*-OPnEO). 6 February 2014

ECHA (2014c). ECHA database on registered substances. Available at: http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances

ECP (2002). Emulsion polymers council comments on the proposed risk management strategy for the wet processing textile industry addressing textile mill effluents and nonylphenol and its ethoxylates under CEPA 1999. Emulsion Polymers Council Inc.(EPC). Accessed August 2012 at http://www.emulsionpolymers.org/documents/finalepccomments.pdf.

EEA (2013b). Managing municipal solid waste — a review of achievements in 32 European countries. European Environment Agency.

EEA. (2013a). Municipal Waste Management in Denmark. European Environment Agency.

Environment Agency (2005). Environmental Risk Evaluation Report: 4-*tert*-Octylphenol. Environment Agency for England and Wales, Bristol.

ETRMA (2007). EU Risk Reduction Strategy proposed for octylphenol. European Tyre and Rubber Manufacturers Association, Brussels, 22nd October 2007.

ETRMA (2010). ETRMA SpERC Fact Sheet ERC 3 and ERC 6d [Includes Summary Tables from ETRMA Emission Factor Guidance]. ChemRisk LLC for European Tyre and Rubber Manufacturers Association.

ETRMA (2011). Comments for Annex XV - SVHC Dossiers. 4 (para)-*tert*-octylphenol (4-*tert*-OP). European Tyre and Rubber Manufacturers Association.

Fauser, P., Sørensen, P.B., Carlsen, L & Vikelsøe, J. (2001) Phthalates and Nonylphenols and LAS in Roskilde Waste water Treatment Plant. Fate Modelling Based on Measured Concentrations in Waste water and Sludge. National Environmental Research Institute, Roskilde. NERI Technical Report.

FEICA (2013). FEICA User Descriptors - various data sheets. Fédération Européenne des Industries de Colles et Adhésifs (FEICA).

Glensvig D, Mortensen P (2003). Mapping of chemicals in dry-cleaned textiles from Rynex and hydrocarbon dry-cleaning shops. Survey of chemicals in consumer products No 21. Danish EPA.

Greenpeace (2004). Toxic cildrenwear by Disney. Greenpeace, Brussels.

Greenpeace (2012). Hazardous chemicals in branded textile products on sale in 27 countries during 2012. Greenpeace Research Laboratories Technical Report 06-2012.

Hansen, A.B. and Lassen, P. (2008). Screening of phenolic substances in the Nordic environments. TemaNord 2008:530. Nordic Council of Ministers, Copenhagen.

Henrik Fred Larsen, Christian Helweg og Anne R. Pedersen, Helle Buchardt Boyd, Søren E. Lauresen og John Hansen. 2000. Kemikalier i tekstiler. Miljøprojekt Nr. 534, 2000.

Johansson O, Jansson E, Persson A (2012). Literature Survey of Surfactants in the Nordic Countries. Goodpoint AB for the Swedish Environmental Protection Agency.

KemI (2013). Annex xv restriction report. Proposal for a restriction. Nonylphenol and nonylphenolethoxylates in textiles. Submitted by Swedish Chemicals Agency (KemI).

KemI (2014). Kemikaliestatistik. Accessed August 2014 at: http://apps.kemi.se/flodessok/floden/flodessok.cfm

Kirkeby J, Gabriel S, Christensen TH. (2005). Miljøvurdering af genanvendelse og slutdisponering af spildevandsslam - en livscyklus screening af fire scenarier [Environmental assessment of recycling and disposal of sewage sludge - a lifecycle screening of four scenarios] (in Danish); Institute of Environment & Resources, DTU.

Kirtk Othmer (2003). Phenolic Resins. 19 Dec 2003 (most recent version). Kirk-Othmer Encyclopedia of Chemical Technology.

Kjølholt, J., Arnbjerg-Nielsen, K., Olsen, D. and Jørgensen, K.-R. (2011). Nøgletal for miljøfarlige stoffer i spildevand fra renseanlæg – på baggrund af data fra det nationale overvågningsprogram for punktkilder 1998-2009 [Key numbers of hazardous substances in waste water from waste water treatment plants - based on data from the national monitoring program for point sources 1998-2009]. Nature Agency Western Jutland, Danmark.

Lassen C, Jensen AA, Maag J, Christensen F, Kjølholt J, Jeppesen CN, Mikkelsen SH, Innanen S. (2013). Survey of alkylphenols and alkylphenol ethoxylates. Part of the LOUS-review. Environmental project No. 1470. Danish Environmental Protection Agency.

Ma H-W, Cheng Y (2010). Determination of free and ethoxylated alkylphenols in leather with gas chromatography–mass spectrometry. Journal of Chromatography A, 1217:7914–7920.

Mikkelsen SH, Havelund S, Skibsted A. (2004) Survey and assessment of chemical substances in window colours. Survey of chemical substances in consumer products, No. 48. Danish Environmental Protection Agency.

Nils H. Nilson, Søren Pedersen, Paul Lyck Hansen og Ivan Christensen (2004). Survey and liberation of chemical substances in joint sealants. Survey of chemical substances in consumer products, No. 38. Danish Environmental Protection Agency.

Nils H. Nilsson NH, Bjørn Malmgren-Hansen B, Nils Bernth N, Eva Pedersen E,Kirsten Pommer K. (2006). Survey and health assessment of chemicals substances in sex toys. Survey of chemical substances in consumer products, No. 77. Danish Environmental Protection Agency.

Nilsson NH, Bjørn Malmgren-Hansen B, Thomsen US. (2008). Mapping, emissions and environmental and health assessment of chemical substances in artificial turf. Survey of Chemical Substances in Consumer Products, No. 100. Danish Environmental Protection Agency.

NIWR (2005). Environmental risk assessment of artificial turf systems. Norwegian Institute for Water Research for Norwegian Pollution Control Authority. http://www.isss-sportsurfacescience.org/downloads/documents/5VEU2CZB25_NIVAEngelsk.pdf

OECD (2004a). OECD Series on Emission Scenario Documents. Number 12. Emission Scenario Documents on Textile Finishing Industry. Organisation for Economic Co-operation and Development, Paris.

OECD (2004b). OECD Series on Emission Scenario Documents. Number 22.Emission Scenario Documents on Coating Industry (Paints, Laquers and Varnishes). Organisation for Economic Co-operation and Development, Paris.

OECD (2009). OECD Series on Emission Scenario Documents. Number 10.Emission Scenario Documents on lubricants and lubricant additives. Organisation for Economic Co-operation and Development, Paris.

OECD (2011). Resource Compendium of PRTR Release Estimation Techniques, Part 4: Summary of Techniques for Releases from Products, Version 1.0. ENV/JM/MONO(2011)7/PART1. Organisation for Economic Co-operation and Development, Paris.

Rasmussen D, Slothuus T, Bjergstrøm M, Pedersen AR, Andersen DN, Larsen PB, Nielsen BS. (2013). Survey and environmental and health assessment of nonylphenol and nonylphenol ethoxylates in textiles. Survey on chemical substances in consumer products No. 120: Danish EPA.

Remberger, M., Lennart, K., Anna, P., Sternbech, J., Kjernes, E. and Brorström-Lundén, E. (2005). Screening tertiary butylphenols, methylphenols and long-chain alkylphenols in the Swedish environment. Report No. B1594. IVL Swedish Environmental Research Institute, Stockholm.

SII Group (2012). Product Safety Summary. 4-*tert*-Octylphenol. SII Group. http://www.siigroup.com/EHSPdf/PTOPGPS.pdf

Appendix 1: Safety data sheet data

A.1 Nonylphenol

A.1.1 Paint and varnishes

Type of paint	Application	Concentration	MSDS on Danish Web sites
84852-15-3			
Epoxy resin	Coating. For professional use only.	<1%	
Epoxy resin	Coating	2.5-5%	
Epoxy resin	Professional applications, used by spraying. Coating.	3-<5%	
Epoxy resin	Professional applications, used by spraying. Coating	3-<5%	

A.1.2 Adhesives, sealants and filling material

Type of product	Application	Concentration	MSDS on Danish Web sites
84852-15-3			
Epoxy hardener	Curing agent - High Impact Wearing Compound Hardener	1-3%	
Polyurethan-based grout	2 component elastic grout for concrete working for preparing matrices. Production of elastic negative forms for duplicates of concrete.	1-2.5%	
Epoxy adhesive	Component adhesive. Used for bonding all types of floor covering including vinyls and rubber to most common substrates including steel. It has excellent bond strength and can be used indoors and outdoors.	<1%	
Epoxy resin	Electrical insulation resin	35-40	
Epoxy hardener	Hardener for laminating resin system for gliders, motorgliders, boats automotive, sports equipment and other high performance products, low temperature moulds & tools.	1-2%	
Epoxy resin	For anchor/stud/tie setting and general purpose structural adhesive	<7%	
Epoxy resin	Three component high density grout with free flow characteristics. Suited to the setting of anchoring bolts, dowels and starter bars into horizontal plane concrete, rock and masonry.	<1	

Type of product	Application	Concentration	MSDS on Danish Web sites
Epoxy resin	Component of epoxy resin based adhesive for installing a wide range of sheet floorcoverings	1-5%	
Polyurethane based rigid foam	Two component, 1:1 ratio, rigid foam system which when processed through suitable spray machinery will produce a rigid foam. Uses are - Retrofit insulation / stabilisation for pitched / flat roofs - New build insulation - Loft conversions - Commercial buildings - Ocean going yachts / canal barges	<1%	
Polyurethane based epoxy system	For joints in polyurethane resin screeds for flooring used in the Food and Drink Industry.	1-10%	
Epoxy based system	A two-part thixotropic 1:1 ratio mix solvent free, epoxy based wood filler for large and extensive repairs to areas of damaged and rot affected timber in both horizontal and vertical applications. It will also directly treat the timber to prevent any further occurrences of decay.	<1%	
Epoxy adhesive	Two part clear adhesive which sets hard in just 4 minutes. Will bond metals, crockery, glass, wood, concrete, rubber, fabrics, crystal, jewellery and various hard plastics. Once cured may be drilled, sanded or painted. For industry and home.	50-70%	
Epoxy resin	Twin pack epoxy mortar for the repair, patching and bonding of concrete	> 25%	
Epoxy adhesive	Electrically conductive adhesive used in microscopy	30%	
Epoxy resin	Component of elastic repair compound. For the permanent repair of decayed and damaged wood. Can be used with a standard skeleton gun. Can be sanded and painted on the same day.	<0.8%	

A.1.3 Lubricants

Type of lubricant	Application	Concentration	MSDS on Danish Web sites
84852-15-3			
Gear Oil Different grades of same brand	General use of lubricants and greases in vehicles or machinery-Professional Lubricant for gears	<0.1	X

Type of lubricant	Application	Concentration	MSDS on Danish Web sites
Antioxidant for oils and lubricants.	Liquid antioxidant for oils, quenching oils, lubricants and greases. Thermal stabilizer for adhesives and polymers. Oilfield: Antioxidant	<= 0,1	

A.2 Nonylphenol ethoxylates

A.2.1 Paint and varnishes

Type of paint	Application	Concentration	MSDS on Danish Web sites
68412-54-4			
Oil-based, alkyd resin binder	Decoration of interior and exterior wood & metal	1-5%	
Water-borne, acrylic binder	Decoration of exterior masonry surfaces. Applied by brush roller and spray	1-5%	
Water-borne, acrylic binder	Decoration of interior walls and ceilings. Applied by brush roller & spray	1-5%	
Water-borne, acrylic binder	Used as aqueous topcoat in the industry. Recommended as a topcoat for steel structures, machinery and equipment, inside and out. Airless and conventional air spray and brush or dipping.	<1%	X
Water-borne, acrylic binder	A water-borne satin emulsion finish for interior walls and ceilings. Application by brush, roller or spray.	<2.5%	
Oil-based, alkyd resin binder	Undercoat for wood and metal. Applied by brush & roller.	1-5%	
Water-borne, acrylic binder	Decoration of interior walls and ceilings. Applied by brush roller & spray	1-5%	
Water-borne, acrylic binder	For the interior coating of walls and ceilings in low wear areas where controlled hygienic condition are of essential importance.	0-1%	
Oil-based, alkyd resin binder	Undercoat for wood and metal. Applied by brush & roller.	1-5%	
9016-45-9			
Water-borne, acrylic binder	Fire-resistant coat.	1-<5%	x

Type of paint	Application	Concentration	MSDS on Danish Web sites
Water-borne wood preserva-tiv	Wood preservation	<1%	x
Oil-based wood preservativ	Industrial coating for wooden surfaces	0.1-1%	
Water-borne, acrylic binder	Weathering protection paint	0-1%	
Silicone prepa-ration	For coatings and/or adhesives and sealants.	1-5%	
Epoxy resin	Waterborne 2K-sealing for coatings on concrete, asbestos cement, abrasion and masonry	0.5-1%	
Epoxy resin	Base for 2-component paint. Protective coatings for industrial buildings and castings	1-2.5%	
Water-based epoxy system	Base for 2-component paint.	0-1%	
Epoxy resin	Sealing varnish (e.g. for flooring)	0.5-1%	
Water-based epoxy system	Coating for use in critical hygiene areas. Protects brickwork, concrete, masonry, ceramic tiles, asbes-tos cement, plasterwork, blockwork, woodwork, primed metalwork and ceramic surfaces. May be applied over existing coatings, including bi-tumastic. Seals and protects floors, walls, ceilings, doors, window frames, structural steelwork and process equipment.	1-5%	
127087-87-0			
Acrylic polymer	Sealer finish for floors	0.1 – 1 %	
non-oil based product	Dressing & Sealer for teak wood, especially for pleasure boats	n.s.	

A.2.2 Adhesives, primers, sealants and filling material

Type of product	Application	Concentration	MSDS on Danish Web sites
68412-54-4			
Water-borne synthetic poly-mer	Bonding agent for floor and wall preparation, suitable for priming, sealing or dustproofing sur-faces prior to the application of ceramic tiles. May be applied directly with a brush as a primer, sealer or dust-proofer	1-5%	
Adhesive	Conduction flooring adhesive	0.1- <1%	
9016-45-9			

Type of product	Application	Concentration	MSDS on Danish Web sites
Water-borne acrylic disperi-on primer	Priming and preparation of floor and wall surfaces before plastering and painting.	0-<2%	x
Epoxy resin	Two-component system of an acid-resistant sealant for sealing of all kinds of ceramic surfaces, e.g. tiles and mosaic	1-5%	
Water-borne dispersion	Wood adhesive	<1%	
Polymer sealant	Cementitious, flexible, moisture tolerant sealant for construction joints in reinforced and precast concrete.	2-5%	
127087-87-0			
Cement with Butadiene-Styrene-Copolymer	Floor fill, quick-setting cement polymer-modified, Screed additive on polymer-based plasticizing, homogenizing and stabilizing effect	< 2 %	

A.2.3 Degreasers and maintenance agents

Type of product	Application	Concentration	MSDS on Danish Web sites
68412-54-4			
Degreaser	Cleaning materials to industrial and professional users	<10%	
Degreaser	Gunk Engine Degreaser Aerosol is specially formu-lated to remove oil, grease & grime from a wide range of engines & machinery.	1-5	
	Graffittti Remover Aerosol propelled by liquefied petroleum gas	1-5%	
Cleaner Water-borne spray	Works to dissolve dirt build up and old filter can be washed away with water.	1-5%	
Cleaner	Surface Plate Cleaner	≤ 2,5%	
9016-45-9			
Water-based dispersion Degreaser	Concentrated industrial cleaner Ideal for Industrial, Agricultural, Marine, Automotive and Domestic applications. Dilute with water. Apply with a spray, sponge, mop or soft brush. Wipe lean with a damp cloth or rinse with clean water	<5%	

Type of product	Application	Concentration	MSDS on Danish Web sites
Cleaner, de-greaser & deo-dorizer	Is a versatile cleaner-degreaser which is used to remove all of grease and oil, soot, carbon, printer's ink, crayon, lipstick, food spills, wax, floor finish, etc.	1-5%	
Degreaser foam	Cleaning of garbage disposal	n.a.	
Alkaline de-greasing and cleaning fluid with disinfect-ing effect	Used for all cleaning and cleaning most surfaces such as walls, floors, ceilings in all rooms, for ex-ample. production areas, storage, freezing and storage, waste and transport containers, stables, etc., and all machinery and equipment can be cleaned.	<3%	x
Cleaners and degreasers	A highly concentrated, water based solvent solution for use as domestic, janitorial and industrial clean-ers and degreasers. Use for general cleaning of walls, floors and kitchen surfaces Use for general and spot cleaning on all surfaces including hard surfaces, carpets, fabrics, wood-work.	3-5%	

A.2.4 Lubricants

Type of lubri-cant	Application	Concentration	MSDS on Danish Web sites
68412-54-4			
Oil-based	For lubricating tyre beads	1.4%	
9016-45-9			
Engine oil	Vehicles	< 0,15%	
Engine oil	Vehicles	<0.25%	
127087-87-0			
Oil-based	Metal pressing lubricants. Mainly for industrial use	2.5 – 10%	

A.2.5 Other

Type of product	Application	Concentration	MSDS on Danish Web sites
68412-54-4			
flux	Soldering flux for all types of printed circuit and solder mask. produce level, brilliant solder deposits with minimal flux residue	10-30%	
Epoxy resin	Jointless flooring	0-4%	

Type of product	Application	Concentration	MSDS on Danish Web sites
Epoxy resin	Epoxy coating for industrial floors	<2.5%	
Aqueous solution	Non metallic surface treatment used as a concrete retarder onto fresh concrete surfaces with a plastic sprayer	<1%	
127087-87-0			
Acrylic latex polymer	Wave solder process masking agent Cured mask can be for masking conformal coatings. May be used in applications such as robotic, pneumatic, hand applied or template screening (not recommended for silk screening).	< 3%	

A.3 Octylphenols

A.3.1 Paint, varnishes and inks

Type of product	Application	Concentration	MSDS on Danish Web sites
140-66-9			
Organic solvent-based varnish. Based on modified linseed oil, chinese tung oil and phenolic resins	Varnish for wooden boat parts above the water line for both inside and outside application	≤2.5%	x
Base:bitumen	Flexible black underwater coating for the (underwater) protection of steel and wood. Also suited for repair and/or maintenance of existing (coal-)tar layers. May also be used for application above the waterline. Apply first coat by stiff brush.	≤2.5%	
Dispersion in organic solvents	Provides the elastomer/metal bonding with excellent protection against water, corrosion and, generally, against hydrolytic effects. Can be applied by spraying, dipping or brush. For industrial/commercial use only. Must be applied by trained personnel only. Not to be used in household applications. Not for consumer use	<0.25%	x
Organic solvent-based varnish	Clear, high-gloss varnish. Seawater-proof, weather- and UV-resistant, high filling capacity, good scratch and wear resistance. Classic manufacture based on wood oil/phenol resin.	0.1 - 0.25%	
Marine paint	-	>=0.10 - <0.25%	x

Type of product	Application	Concentration	MSDS on Danish Web sites
High gloss varnish for wooden boat parts	-	≤ 2.5%	
Intermediate epoxy	Intermediate coat in long life systems for substrates subject to chemical aggressions in marine and industrial environments.	≤0.5%	
Ink	Ink for use in drawliners	<0.2%	

A.3.2 Adhesives, sealants and filling material

Type of product	Application	Concentration	MSDS on Danish Web sites
140-66-9			
Adhesive based on nitrile rubber	Especially suitable for bonding PVC materials in a variety of substrates. In particular, it is used for the inner lining of motor vehicles.	0.025 – 0.25%	
Metal primer	Bonding system for soft rubber linings	<0.1%	

A.4 Octylphenol ethoxylates

A.4.1 Paint, varnishes and other coatings

Type of product	Application	Concentration	MSDS on Danish Web sites
9002-93-1			
Acrylic	Shine Restorer for Floor Care, Floor Maintainer-Finish	1 -5 %	
9036-19-5			
Component A for painting system	Paint and industrial coating	0.1 – 0.2 %	
100 % Pure acrylic according to DIN 55945	Wall coating, solvent-free high-quality protective coating on dried chip coating to increase the durability and achieve a largely closed, well-cleanable surface	1 – 5%	
Acrylic paint	Facade paint, Coating of exterior and interior surfaces	1 -1.5 %	

Type of product	Application	Concentration	MSDS on Danish Web sites
Acrylic paint (Special synthetic resin dispersion according to DIN 55945))	Weatherproof colour, moisture-regulating, pigmented weather protection paint for wood, among others substrates	< 1 %	
Stone impregnation	Whole new environment and future technology with nano-technology, all at home use. Interior stone (kitchen countertops, bathrooms, walls, floors, chrome, window sills, tables) Outdoor stone, antifreeze, all absorbent floors (balconies + terraces, walls, facades of stone or plaster, fireplaces / chimneys, roof tiles, porphyry driveways) Outdoor wood (wood terraces, pine, Douglas fir, Bankirai, wooden benches, fences, chairs, tables)	< 1%	
Thermacrylic Floor Finish	Recommended for all resilient-type floors, as well as terrazzo and other hard surfaces such as polished concrete, terracotta, marble and other porous surfaces. Dazzler responds well to low or high maintenance schedules and is extremely cost effective.	0.1 – 1 %	
Polymer dispersion	For the effective and assured waterproofing in combination with tiled finishes when longer term or frequent impermeability to water is required e.g. in private bathrooms and kitchens, private and public sanitary areas as well as balconies and terraces, swimming pools and pool surrounds.	< 0.5 %	
68987-90-6			
Water-borne, acrylic binder	For the basic treatment and maintenance of outdoor furniture, fences, claddings, etc. of wood.	1 -5 %	x

A.4.2 Sealants and potting material

Type of product	Application	Concentration	MSDS on Danish Web sites
9002-93-1			
Polyurethane resin with methacrylat	Applications include retaining roller bearings or oil-impregnated bushings into housings	2 %	
9036-19-5			
Acrylat	Jointing compound. Primarily professional application.	1 – 5 %	
Solid elastomer	Electrical potting and sealing compound. Two-part manganese dioxide cured polysulfide compound. The uncured material is designed to flow around wires and connections in electrical-connectors to provide complete insulation. For industrial use only.	0.1 – 1 %	

A.5 4-*tert*-Butylphenol

A.5.1 Paint, varnishes and primers

Type of product	Application	Concentration	MSDS on Danish Web sites
98-54-4			
Lacquer	Marine applications	≤2.5%	x
Liquid epoxy resin, used as half of a two part system	Moisture tolerant, low viscosity, solvent free primer, designed specifically for concrete slabs exhibiting elevated moisture levels For professional use only.	2.5-10%	x
Coating material (paint)	Industry flooring For industrial and professional use only	Not indicated	x
Epoxy membrane	Fully covering membrane which is impermeable to water / liquid.	<2.5%	x
Epoxy paint	Especially used as a primer for steel surfaces difficult to clean in process and chemical industry and in water immersion. For industrial and professional use only	1-2.5%	x
Epoxy paint	Coatings for vehicles	2.5-<3%	x
Epoxy paint	Air-drying topcoat. Provides a smooth surface that is flexible, weatherproof and durable shine. Resistant to oil and water.	<0,25%	x
Hardener component of high build epoxy coating system	High building application Can be applied directly to mild steel and concrete	>25-<50%	
Epoxy coating	It can be roller or brush applied to concrete surfaces to act as a primer for subsequent coatings. It is ideal for priming in applications where a polyurethane elastomeric system will be installed over, such as car park decking or balcony/podium waterproofing systems.	25-50%	

A.5.2 Adhesives, sealants, fillers and flooring material

Type	Application	Concentration	MSDS on Danish Web sites
98-54-4			

Type	Application	Concentration	MSDS on Danish Web sites
Epoxy seal-ant/epoxy adhe-sive	Building applications	3-5%	x
Adhesive. Grout	Building applications	<1%	x
Hardener for epoxy adhesive	Repair of metal surfaces	1-5%	x
Epoxy flooring	Multi-component joint less flooring For professional use only.	5-10%	x
Adhesive	Various applications	<1%	x
Epoxyharz used as adhesive, primer and in some types of concrete	Building applications	25 - 50%	x
2-component epoxy potting compound	Encapsulation, sealing and impregnation of electrical and electronic components.	10-20%	
Adhesive	Multi-purpose contact adhesive based on poly-chloroprene, giving high heat resistance	<1%	
Cement/Epoxy Hybrid Grout and Adhesive	Building applications	1-5%	
Sprayable poly-chloroprene adhesive	Use in building industry and furniture industry	1-5 %	

A.6 Dodecylphenol

A.6.1 Lubricants and engine oil additives

Type of	Application	Concentration	MSDS on Danish Web sites
121158-58-5			
Crankcase oil	Recommended for the crankcase and cylinder lubrication of reciprocating air compressors. May also be used for the lubrication of drip feed rotary sliding vane compressors.	<1%	x
Engine oil	Lubricating oil for automotive engines	<0.5%	x
Crankcase oil	Manual transmission lubricant specially devel-oped for European heavy duty transmissions used in on-road commercial vehicles and passenger cars.	0,01 - 0,09 %	x

Type of	Application	Concentration	MSDS on Danish Web sites
Oil-based	Engine oil	0.18%	x
Crankcase oil	Multipurpose additive for crankcase oils combining advanced organo-metallic compounds in a high-purity paraffinic oil for • Motor bikes • Cars • Trucks • Busses • Boats • Farm and garden equipment • Stationary combustion engines	0-1%	x
Engine oil	Engine oil for vehicles	<0.12%	
Engine oil	Engine oil for vehicles	<0.12%	
Engine oil	Engine oil for vehicles	0,061%	x
Engine oil	Engine oil for vehicles	<1.5%	x
Engine oil	Engine oil for vehicles	0.05%	

A.6.2 Coatings and encapsulation

Type of	Application	Concentration	MSDS on Danish Web sites
CAS No 121158-58-5			
Epoxy hardener	2-Part epoxy textured roller and seal coat Coloured, textured and slip resistant coatings for production areas, storage and assembly halls or exhibition areas, seal coat for broadcast systems.	2.5-10%	
Epoxy hardener	Component of the multi-component protective coatings - Industrial Use	25-50%	
Epoxy hardener	For epoxy resin system recommended for encapsulating circuits or components where it is important that the level of ionic impurities is kept to a minimum.	5-10%	
Epoxy hardener	High build gloss epoxy floor line marking paint. Two part epoxy line marking paint system offering excellent chemical and abrasion resistance as well as high visibility where required. This epoxy line marking paint helps to clearly define walkways from working areas.	20-30%	

Type of	Application	Concentration	MSDS on Danish Web sites
Epoxy hardener	Multi-purpose epoxy resin, solvent free. Suitable for bonding, conserving, reinforcing and laminating various materials	2.5-10%	

A.7 Dodecylphenol ethoxylates

A.7.1 Various mixtures

Type of	Application	Concentration	MSDS on Danish Web sites
CAS No 74499-35-7			
Engine oil	Vehicles	0-0.5%	+
Gear oil	Industry	0.01-0.1%	
Engine oil	Vehicles	0.01-0.1%	
Engine oil	Vehicles	0.01-0.1%	
Engine oil	Vehicles	0.25-0.5%	

Releases of selected alkylphenols and alkylphenol ethox-ylates and use in consumer prod-ucts

Releases of selected alkylphenols and alkylphenol ethoxylates and use in consumer products, A LOUS follow-up project.

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