



Miljøministeriet
Miljøstyrelsen

Problematiske kemiske stoffer i plast

Kortlægning af kemiske stoffer i forbrugerpunkter nr. 132, 2014

Titel:
Problematiske kemiske stoffer i plast

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Forord

Baggrund og formål

Denne rapport er udarbejdet indenfor rammerne af Miljøstyrelsens program om kemikalier i forbrugerprodukter.

Rapporten tilstræber at være en oversigt over problematiske stoffer i plast og give information om funktionen og anvendelsen af disse stoffer i plast samt potentialet for migration og skæbne ved genanvendelse.

Projektet har omfattet følgende hovedaktiviteter:

- Identifikation af relevante problematiske stoffer til stede i plast.
- Vurdering af potentialet for migration for disse stoffer og potentialet for påvirkning af forbrugere.
- Vurdering af skæbnen for disse stoffer ved genanvendelse fokuseret på om stofferne kan forventes at blive omdannet eller nedbrudt ved genanvendelsesprocessen og om det er muligt at identificere og separere plast produkter som indeholder de enkelte stoffer.

Processen

Kortlægningen og vurderingen er gennemført af COWI A/S i samarbejde med Teknologisk Institut i perioden fra juli 2013 til november 2014. Arbejdet er overvåget af en følgegruppe bestående af følgende personer:

- Shima Dobel, Miljøstyrelsen (formand)
- Dorte Lerche, Miljøstyrelsen
- Nils Nilsson, TI
- Erik Hansen, COWI

Sammenfatning og konklusion

Denne rapport præsenterer information om problematiske stoffer i plast herunder information om funktion og anvendelser af stofferne i plast, potentiale for migration og skæbne ved genanvendelse.

Udvælgelse af stoffer – en screeningsproces

De kemiske stoffer, der er medtaget i dette projekt, omfatter stoffer, som er medtaget på de følgende lister over problematiske stoffer:

- Miljøstyrelsens liste over uønskede stoffer (LOUS)
- Kandidatlisten (SVHC-stoffer, Substances of Very High Concern) under REACH
- Den Norske liste over prioriterede kemiske stoffer
- ECHA's (det Europæiske Kemikalie Agentur) Registry of Intention
- CMR-stoffer (carcinogene, mutagene, reproduktionstoksiske) sandsynligvis til stede i plastlegetøj (en liste udarbejdet af Teknologisk Institut)
- Kendte alternativer til problematiske ftalater og bromerede flammehæmmere

De kemiske stoffer på disse lister er vurderet for at bestemme, hvilke af disse stoffer der anvendes i plast, eller af anden årsag må forventes at være til stede i væsentlige koncentrationer i plastprodukter. Stoffer der kun anvendes som monomerer ved produktionen af plast eller additiver til plast er også medtaget, da disse stoffer i mange tilfælde kan være til stede i de færdige produkter i lave koncentrationer. Denne vurdering er foretaget som en screeningsproces, der har udnyttet den tilgængelige information herunder EU Annex XV rapporter, litteratur om polymerer og additiver samt internettet.

Ved denne screeningsproces er der identificeret 132 kemiske stoffer eller stofgrupper. De resterende stoffer på de overfor angivne lister (ca. 330 stoffer), som vurderes ikke at blive anvendt i plast eller at være til stede i væsentlige koncentrationer i plast, er samlet i bilag 1 sammen med en kortfattet præsentation af deres anvendelser.

Indsamling af information for de udvalgte kemiske stoffer

For de udvalgte 132 problematiske stoffer eller stofgrupper er der indsamlet, vurderet og præsenteret data i det omfang disse data har været tilgængelige. De følgende emner er blevet belyst:

- Stoffernes tekniske funktion;
- De relevante plasttyper (som stofferne anvendes i);
- De vigtigste varegrupper (som plasten med de pågældende stoffer anvendes i);
- Potentiale for frigivelse fra plast (vil stoffet migrere?);
- Potentiale for at forbrugere udsættes for stoffet;
- Stoffets skæbne ved genanvendelse.

Den foreliggende viden er indsamlet fra videnskabelig litteratur herunder rapporter fra miljømyndigheder i de Nordiske lande samt information tilgængelig på internettet. Vigtige kilder til information har været Annex XV dossierer/rapporter tilgængelige fra ECHA for kemiske stoffer inkluderet på REACH kandidatlisten samt general litteratur om polymerer og additiver. Denne viden er suppleret bl.a. af ekspert vurderinger foretaget af de specialister, som har deltaget i arbejdet med denne undersøgelse.

Undersøgelsens resultater

Undersøgelsens detaljerede resultater er præsenteret i afsnit 3.1-3.11, organiseret primært baseret på funktionen af de udvalgte stoffer. I denne sammenhæng er betragtet følgende vigtige funktioner:

- Anti-mikrobielle stoffer (biocider)
- Opskumningsmidler
- Flammehæmmere
- Farvestoffer (organiske)
- Monomerer, hærdere, katalysatorer m.m.
- UV-stabilisatorer, antioxidanter og andre stabilisatorer
- Blødgørere
- Opløsningsmidler
- Andet (stoffer med forskellig funktion, som kun dårligt passer ind i andre kategorier)

Tungmetaller er beskrevet i et særligt afsnit, da problematiske stoffer som indeholder tungmetaller dækker flere funktioner herunder farvestoffer (uorganiske) og stabilisatorer (UV-stabilisatorer og varme stabilisatorer) samt katalysatorer.

At der også fokuseres på monomerer, katalysatorer og andre additiver anvendt ved fremstillingen af plast beror på, at rester af disse stoffer kan være til stede i færdigvarer. Disse rester beror på, at ikke alle stoffer har succes med at reagere fuldstændigt i polymerisationsprocessen. Koncentrationen af rester i færdigvarer vil typisk være på 0-2 %. Eksempler på sådanne stoffer omfatter bisphenol A i polycarbonat, og aromatiske aminer i polyamid.

De fleste problematiske stoffer, der anvendes som additiver i plast, er ikke kemisk bundet i plasten, men er i stand til at migrere. Migration sker, når kemiske stoffer i plast vandrer (migrerer) til overfladen af plasten eller over i et andet medie, som berører plasten. Ved overfladen vil det kemiske stof fordampe eller blive fjernet ved vask eller kontakt med et andet medie (f.eks. menneskers hud, vand eller fedt). Både blødgørere, f.eks. ftalater, og flammehæmmere, f.eks. bromerede flammehæmmere, er stoffer, som vides at migrere, men mange andre stoffer migrerer også. Evnen til at migrere er vurderet og angivet for alle de udvalgte stoffer.

Migrationen af kemiske stoffer afhænger af deres størrelse, kogepunkt, damptryk og deres opløsighed i plast såvel som i det miljø / materialer, som omgiver plasten. Migration afhænger derfor stærkt af det kemiske stofs fysisk-kemiske egenskaber. Små molekyler, typisk monomerer og opløsningsmidler, vil migrere hurtigt pga. det lave kogepunkt. Andre monomerer såsom formaldehyd, vinylchlorid og ætylen er alle gasser, som også migrerer hurtigt selv ved almindelige temperaturer. Store organiske molekyler migrerer langsommere, mens uorganiske uopløselige metalsalte, metalkomplekser og metaloxider ikke migrerer. I alle tilfælde vil migrationen aftage med tiden i takt med, at koncentrationen af det kemiske stof mindskes i plasten. Kemiske stoffer, der ikke migrerer, frigives kun ved slid og forvitring eller ved kemisk nedbrydning.

Der foreligger kun beskeden viden om migrationshastigheder. Migrationshastigheden for blødgøren DEHP er formodentlig i størrelsen 0,1-1 % årligt eller mindre. Den foreliggende viden om frigivelsen af cadmium fra plast pga. slid og forvitring peger på, at frigivelsen er meget lille. Det er dog ikke muligt at kvantificere denne frigivelse.

Evnens til at migrere bestemmer potentialet for frigivelse af kemiske stoffer fra plast og dermed potentialet for, i hvilket omfang forbrugerne udsættes for disse kemiske stoffer. For alle de udvalgte stoffer er det vurderet, om forbrugerne kan forventes at blive udsat for disse stoffer.

Generelt gælder, at for alle stoffer, der kan migrere, vil der være mulighed for, at forbrugerne kan blive udsat for disse. Den foreliggende viden om anvendelsen af de forskellige kemiske stoffer er dog

ikke detaljeret nok til, at det er muligt at vurdere, om der er forskel på, hvordan forskellige forbrugerggrupper, f.eks. voksne contra børn, udsættes for de enkelte stoffer.

Alle termoplastiske plasttyper som eksempelvis polyetylen kan genanvendes ved såkaldt mekanisk genanvendelse (omsmelting). For de fleste additiver er det vurderet, at stofferne (i hvert fald hovedparten) vil blive i de genanvendte materialer. Undtagelserne vil typisk være kemiske stoffer som fordamper let, monomerer som udsættes for fornyet reaktion i genanvendelsesprocessen samt stabilisatorer (især varme stabilisatorer), som tvinges til reaktion gennem genanvendelsesprocessen.

Hærdeplaster kan kun genavndes ved den såkaldte "feed-stock" genanvendelse, hvor plasten behandles ved processer, der kan nedbryde plasten til monomerer eller andre kemiske stoffer, som så kan anvendes til fremstilling af ny plast. Denne teknologi er under udvikling. Det er ikke muligt at forudsige skæbnen for additiver i plast ved feed-stock genanvendelse, udover at additiverne med stor sandsynlighed vil blive nedbrudt.

Både termoplast og hærdeplast kan udsættes for energi genvinding gennem forbrænding. Ved denne behandling vil alle organiske additiver samt de fleste uorganiske additiver med sikkerhed blive nedbrudt. Undtagelser kan være stoffer som antimontrioxid og molybdæntrioxid.

Det er ikke forsøgt at overveje mulighederne for separation af de kemiske stoffer, der her er udvalgt, da den foreliggende viden om anvendelsen af disse stoffer i de fleste tilfælde ikke er detaljeret nok til at tillade en pålidelig vurdering. Udviklingen mht. automatisk sortering, der udnytter NIR såvel som røntgenteknologi betyder, at det for adskillige stoffer vil det være muligt at udskille en væsentlig del af stoffet fra affaldsstrømme forudsat at den nødvendige indsats og omkostninger er investeret. Sortering ved kilden vil i en række tilfælde også være en mulighed, afhængig af de pågældende stoffer, deres anvendelser og omkostningerne knyttet til opgaven.

Conclusion and summary

This report presents information on hazardous substances in plastics including information on the function and application of the substances in plastics as well as on potential for migration and fate by recycling of plastics.

Selection of substances – a screening process

The substances considered in this project cover substances included on the following lists of hazardous substances:

- The Danish EPA's list of undesired substances (LOUS);
- The SVHC (substances of Very High Concern) Candidate List under REACH;
- The Norwegian list of priority substances;
- ECHA's Registry of Intentions;
- CMR-substances likely to be present in plastic toys (as assessed by the Danish Technological Institute);
- Recognized alternatives to problematic phthalates and brominated flame retardants.

The substances on these lists have been assessed in order to determine whether these substances are used in plastics or for other reasons likely to be present in significant concentration in plastic products. Substances used only as monomers in the production of plastics or in additives incorporated in final plastic products are also included in the assessment process, as these substances in many cases may be present in low concentrations in the final products. The assessment has been carried out as a screening process utilising available sources of information including e.g. EU Annex XV reports, polymer and additive literature and general search on the internet.

By this process a group of 132 chemical substances or substance groups has been identified. The remaining substances on the above-mentioned lists (approx. 330 substances), for which there is no indication of use or presence in significant concentrations in plastics, are listed in annex 1 together with keywords on their uses.

Survey of information for selected substances

For the selected 132 hazardous substances or substance groups information has been collected, assessed and presented to the extent, it has been available. The following issues have been addressed:

- Technical function (of the substance);
- Relevant types of plastics (where the substance is used);
- Main articles groups (for which the plastics with the substance are used);
- Potential for release from plastics (will it migrate?);
- Potential for exposure of consumers;
- Fate by recycling.

The information presented has been collected from scientific literature including study reports prepared for the Environmental Authorities in the Nordic Countries as well as information available on the internet. Important sources of information has been the Annex XV dossiers/reports available from the European Chemical Agency (ECHA) for substances included on the REACH Candidate list

as well as general literature on polymers and additives. This information has been supplemented e.g. by expert judgments by the consultants, who undertook this survey.

The study results

The detailed results of the study are presented in section 3.1-3.11 organised mainly by the function of the substances selected. In this context the following important functions are considered:

- Antimicrobial substances (biocides);
- Blowing agents;
- Flame retardants;
- Colorants (organic);
- Monomers, cross linkers, hardeners, chain modifiers and catalysts;
- UV stabilizers, antioxidants and other stabilizers;
- Plasticisers;
- Solvents;
- Others (substances with different function difficult to place in other categories).

Heavy metals are described in a separate section, as hazardous substances containing heavy metals cover several functions including colorants (inorganic), stabilisers (UV-stabilisers and heat stabilisers) and catalysts.

The focus on monomers, catalyst and other additives in polymer manufacturing processes is based on that residues of monomers and other reactive compounds may be present in the final products. These residues are a result of that not all monomers/compounds succeeds in reacting during the polymerisation process. Typical concentrations of residues left are 0-2 %. Examples of such substances include bisphenol A in polycarbonate, and aromatic amines in polyamide.

Most hazardous substances used as additives are not chemical bound in plastics, but are able to migrate. Migration is the phenomenon that takes place when chemical substances in the plastic move to the surface of the plastic item or to a medium in contact with the item. At the surface the substance may evaporate or be removed e.g. washing or contact with human skin. Both plasticisers, e.g. phthalates, and flame retardants, e.g. brominated flame retardants, are substances well-known to migrate, but many other substances migrate too. The ability to migrate has been assessed for all the substances selected.

The migration rate of chemical substances depends on their size, boiling point, vapour pressure and their solubility in the plastic as well as in the environment or material surrounding the plastic. Migration thus depends heavily on the physical-chemical characteristics of the substance. Small molecules, typically monomers and residual solvents, will migrate fast as they have a low boiling point. Some monomers such as formaldehyde, vinyl chloride and ethylene are all gases and have a high tendency to migrate quickly even at ambient temperatures. Larger organic molecules will migrate more slowly, while inorganic insoluble metal-salts, -complexes and- oxides will not migrate. In all cases migration will decrease with time as the concentration of the migrating substances get lower in the plastic. Substances that do not migrate will only be released by wear and tear including degradation by weathering or by chemical attack.

Only limited precise information is available regarding migration rates. E.g. the migration rate of the plasticiser DEHP is likely to be in the range of 0.1-1% per year or below, while the existing information on release of cadmium by wear and tear (e.g. abrasion) does not allow quantification, but is assessed as very small.

The ability to migrate significantly determines the potential for release of substances from plastics, and thereby the potential for exposure of consumers. For all the substances selected it has been assessed whether exposure of consumers could be expected. Generally for all substances able to

migrate, the possibility exists for exposure of consumers. The knowledge available regarding the applications of the individual substances is, however, not detailed enough to allow that the exposure assessment distinguishes between different consumer groups e.g. adults versus children.

All thermoplastic plastics such as e.g. polyethylene can be recycled by so-called mechanical recycling (remelting). For most additives it is judged that the substances (at least the dominant part) will remain in the materials recycled. The exemptions to this fate will typically be substances as solvents that evaporate easily, monomers etc. exposed to renewed reaction by the recycling process and stabilisers (in particular heat stabilisers) forced to react by the recycling process.

Thermosetting plastics can only be recycled by so-called feedstock recycling where the plastic is degraded into its basic monomers or other chemical substances which can then be used for manufacturing of new plastic polymers. This technology is under development. It is not possible to predict the fate of additives by feed stock recycling, apart from that the additives present in plastic materials treated most likely will be fully decomposed.

Both thermoplastic and thermosetting plastic can be subject to energy recovery by incineration. In this case all organic and most inorganic additives will also be decomposed. Exemptions may be substances as antimony trioxide and molybdenum trioxide.

It has not been tried to assess the opportunities for separation of the specific substances presented here from the waste, as the knowledge available regarding the applications of the substances for most substances is not detailed enough to allow a reliable assessment to be undertaken. The development regarding automatic sorting utilizing NIR as well as X-ray technology indicates that for several substances it will be possible to separate a significant part of the substance out of waste streams assuming that the necessary efforts and costs are invested. Also sorting at the source may in a number of cases be an option depending on the substance in question, its applications and the amount of substance to be separated as well as the costs related to the operation.

1. Indledning

Kemiske stoffer anvendt i plast i forbrugerprodukter kan migrere fra plasten og derved være en eksponeringskilde for mennesker og miljøet. Disse stoffer vil i et vist omfang også være til stede i plast som genanvendes. De igangværende bestræbelser for at øge genanvendelsen af plast kan derfor medføre at også fremtidige generationer af plastprodukter indeholder de pågældende kemiske stoffer og muliggør vedblivende eksponering.

Projektet bygger på et projekt, "Prioritized hazardous substances in plastic materials" (se [Hansen et al 2013]), som er publiceret af Miljødirektoratet i Norge (tidligere KLIF) i 2012.

Det norske projekt omhandlede kemiske stoffer omfattet af den Norske Prioritetsliste (se [Norwegian EPA 2013]) samt stoffer på kandidatlisten under REACH (per august 2012) og til stede i forskellige plastmaterialer. Det norske projekt indsamlede oplysninger on:

- Egenskaber og anvendelse for de mest anvendte plastmaterialer.
- Potentialet for genanvendelse for disse plastmaterialer.
- De stoffer på den Norske Prioritetsliste og REACH kandidatlisten, der vil være til stede i forskellige plastmaterialer.
- Funktionen og indholdet af disse stoffer i plastmaterialer.
- Potentialet for udvaskning/fordampning af disse stoffer fra plastmaterialer.
- EU restriktioner og Norsk regulering af brugen af disse stoffer i plastmaterialer.
- Alternativer
- Hvilke stoffer i hvilke produkter kan forventes at være til stede i affald.

Dette danske projekt har indsamlet information om de stoffer, der er listet i det norske projekt tillige med stoffer indeholdt i:

- Miljøstyrelsens liste over uønskede stoffer (LOUS).
- Den opdaterede kandidatliste (fra juni 2013).
- ECHAs Registry of Intentions (fra november 2013).
- CMR (carcinogene, mutagene eller giftige for reproduktion) -stoffer vurderet at kunne være til stede i legetøj.
- Lister over anerkendte alternativer til problematiske ftalater og bromerede flammehæmmere.

For de stoffer, som vurderes at være til stede i plastprodukter i signifikante koncentrationer er indsamlet information om

- Funktionen af disse stoffer i plastmaterialer
- Potentialet for migration af disse stoffer fra plastmaterialer
- Stoffernes skæbne ved genanvendelse.

Rapporten indledes med en beskrivelse af processen med at identificere de stoffer, der er til stede i plast i signifikante koncentrationer (kapitel 2). De identificerede stoffer er præsenteret i kapitel 3, mens de stoffer, som er vurderet ikke at være til stede i signifikante koncentrationer er angivet i bilag 1.

Denne danske rapport over projektet er en delvis oversættelse af den engelske version "Hazardous substances in plastics". En væsentlig del af informationen i rapporten er præsenteret i skemaer for

de enkelte stoffer og det er grundet rapportens omfang valgt ikke at oversætte indholdet af disse skemaer.

2. Identifikation af relevante stoffer

Problematiske kemiske stoffer anvendt i plast omfatter additiver som antimikrobielle stoffer, op-skumningsmidler, farvestoffer, flammehæmmere, blødgørere og stabilisatorer. Til disse stoffer kan tilføjes rester af monomerer, katalysatorer og andre additiver anvendt i fremstillingsprocesser for polymerer foruden nedbrydningsprodukter til stede i færdigvarer.

I dette projekt er overvejet stoffer omfattet af følgende stoflister:

- **Miljøstyrelsens liste over uønskede stoffer (LOUS) [Danish EPA 2011]**

Denne liste er en vejledning for virksomheder. Den angiver kemiske stoffer, som giver be-kymring og hvis brug bør ophøre eller begrænses. Kemiske stoffer medtages i LOUS, hvis de har en række uønskede effekter og bruges i Danmark i væsentlige mængder. Miljøsty-relsen har opstillet følgende kriterier for, at stoffer er optaget i LOUS 2009:

- Problematiske egenskaber på "EU's liste over farlige stoffer", f.eks. CMR katego-ri 1, 2 or 3.
- Problematiske egenskaber identificeret ved computerbaserede modelberegninger præsenteret i "Miljøstyrelsens vejledende liste til selvklassificering af farlige stof-fer" (selvklassificeringslisten).
- PBT/vPvB stoffer identificeret af EU.
- Stoffer medtaget på "EU's prioriteringsliste over stoffer, der skal yderligere un-dersøges for hormonforstyrrende egenskaber"
- Stoffer, der er genstand for særligt fokus i Danmark f.eks. fluorholdige drivhus-gasser.
- Som hovedregel er kun stoffer, som anvendes i en mængde på 100 tons årligt eller mere, medtaget i LOUS 2009. Der kan dog anvendes andre mængde grænser for stoffer, som er genstand for særligt fokus i Danmark.

- **Kandidat listen under REACH (SVHC, Substances of Very High Concern) [ECHA 2013b]**

Denne liste omfatter stoffer identificeret særligt problematiske. Stofferne på kandidatlisten er stoffer foreslægt af EU's medlemmede eller af ECHA (efter ønske fra EU Kommissionen). Ifølge REACH forordningen omfatter SVHC – stoffer kemiske stoffer med følgende egen-skaber:

- Carcinogene, mutagene eller reproduktions skadelige (CMR), der opfylder krite-rierne for at være klassificeret i kategori 1 eller 2 som angivet i EU forordning (EC) 1272/2008 om klassifikation, mærkning og emballering af kemiske stoffer og blandinger, den såkaldte CLP forordning. I henhold til den nye CLP forordning skal disse stoffes klassificeres som 1a eller 1b.
- Persistente, bioakkumulerende og toksiske (PBT) eller meget persistente og me-get bioakkumulerende (vPvB) i henhold til kriterierne i REACH forordningen Annex XIII.
- Identificeret, baseret på videnskabelig dokumentation, som forårsagende sand-synlig alvorlig påvirkning af menneskelig sundhed eller miljøet på et niveau, der

giver tilsvarende grund til betænkelighed som de egenskaber, der er angivet ovenfor (f.eks. stoffer med hormonforstyrrende egenskaber).

- **Den Norske Prioritetsliste [Norwegian EPA 2013]**

Denne prioritetsliste omfatter en række stoffer og stofgrupper, som er omfattet af den norske nationale målsætning om, at brug og udslip skal ophøre eller væsentligt reduceres. Listen omfatter ca. 30 navngivne stoffer og stofgrupper og inkluderer stoffer, som er persistente og bioakkumulerende, som har alvorlige sundhedseffekter på længere sigt eller er meget økotokiske.

- **ECHA's Registry of Intentions [ECHA 2013c]**

ECHA's Registry of Intentions omfatter officielle meddelelser fra EU Medlemslande eller ECHA om, at disse lande eller ECHA har til hensigt at fremsende et Annex XV dossier for identifikation af SVHC-stoffer, eller for at foreslå harmoniseret klassifikation og mærkning eller restriktioner. Dette register kan således betragtes som en liste over stoffer, der af forskellige årsager kan betragtes som problematiske i forhold til menneskets sundhed eller miljøet og som i fremtiden kan blive genstand for restriktioner, klassifikation eller blive omfattet af listen over SVHC stoffer.

- **CMR-stoffer muligvis til stede i plast legetøj [DTI 2009]**

Teknologisk Institut udarbejdede for Miljøstyrelsen i 2009 en liste over stoffer klassificeret i henhold til CLP-forordningen som CMR-stoffer (carcinogene, mutagene eller toksiske i forhold til reproduktion) og vurderet som muligvis til stede i plast legetøj. Denne liste er anvendt i denne rapport som et kvalificeret estimat for CMR-stoffers tilstedeværelse i plast og gummi materialer.

- **Anerkendte alternativer til problematiske ftalater og bromerede flammehæmmere**

Nylige rapporter om bromerede flammehæmmere og udvalgte problematiske ftalater udarbejdet på vegne af Miljøstyrelsen [Mikkelsen et al 2013; Lassen et al 2013b] angiver alternativer til disse stoffer anvendt i plast. Disse alternativer påregnes at være både teknisk og økonomisk realistiske samt mindre problematiske end de stoffer, de forventes at erstatte. Disse lister over alternativer må således betragtes som lister over stoffer, der allerede erstatter problematiske ftalater eller bromerede flammehæmmere i plast eller sandsynligvis vil gøre dette i fremtiden. Alternativerne er medtaget i denne rapport for at tillade sammenligning med de stoffer, de forventes at erstatte, selvom de fleste af alternativerne ikke umiddelbart vurderes at være problematiske stoffer.

De kemiske stoffer på disse lister er vurderet for at bedømme om disse stoffer anvendes i plast eller af andre årsager kan være til stede i væsentlige koncentrationer i plast produkter. I denne forbindelse er der taget hensyn til, at rester af stoffer anvendt som monomerer eller mellemprodukter i produktionen af plast eller i additiver indeholdt i færdige plast produkter i mange tilfælde kan være til stede i lave koncentrationer i færdigvarer.

Denne vurdering er foretaget som en screeningsproces baseret på følgende informationskilder:

- EU Annex XV og CLH rapporter.
- EU risiko vurderings rapporter, og SIDS/SIAR – rapporter fra OECD.
- Vare guide (Varuguiden) fra Kemikalieinspektionen i Sverige om sammensætningen af plast og produkter.
- Litteratur om polymerer og additiver.
- Internetsøgninger baseret på nøgleord (f.eks. CAS numre).

- Generelle internet kilder f.eks. Chemicaland and "compendium of Pesticide Common Names [Pesticides 2013]".
- Information fra kemikalie leverandører til stede på internettet herunder sikkerhedsdatablade (SDS og MSDS).
- Rapporter fra Miljøstyrelsen.
- Ekspert vurdering foretaget af Teknologisk Institut.

De kemiske stoffer, der er vurderet at være til stede i plast i væsentlige koncentrationer, er præsenteret i det efterfølgende kapitel 3. For hvert stof eller stofgruppe vurderet som til stede i plast og relevant at overveje er udarbejdet et særligt skema/afsnit. For stofgrupper (f.eks. arsen og arsenforbindelser) gælder, at gruppen er medtaget, hvis blot et stof i gruppen er vurderet som relevant.

Da antallet af relevante stoffer er relativt stort er det vurderet hensigtsmæssigt at organisere stofferne baseret på deres funktion.

De stoffer, som vurderes ikke at blive anvendt eller at være til stede i plast i væsentligt omfang er præsenteret i bilag 1 sammen med en kortfattet præsentation af deres anvendelser.

Som angivet ovenfor er kun medtaget stoffer, som kan være til stede i plast produkter i væsentlige koncentrationer. Denne begrænsning er indført, da produktionen af plastprodukter herunder af additiver kan omfatte mange trin, hvori særlige stoffer anvendes som mellemprodukter i produktionsprocesserne.

Kemiske reaktioner vil afhængig af reaktionskinetikken kunne medføre, at det producerede produkt indeholder 0,1 – 2 % rester af de stoffer (monomerer etc.) der indgik i reaktionen. Af dette følger, at det ikke er sandsynligt, at rester af mellemprodukter anvendt i reaktionskæden 2-3 trin tilbage i denne, vil være til stede i færdigvarer i væsentlige koncentrationer, dvs. koncentrationer over sporstof niveau. Det er derfor antaget, at det generelt ikke er relevant at medtage mellemprodukter, der anvendes mere end 1-2 trin tilbage i reaktionskæden.

Gummi og elastomerer betragtes ikke som plastmaterialer, og stoffer, der kun anvendes i gummi og elastomerer er ikke medtaget i rapportens kapitel 3. Hvad angår tekstil materialer er kun medtaget stoffer som er integreret i plast matricen, mens stoffer, der kun anvendes til behandling af tekstilfibre eller tekstiler (f.eks. farvestoffer) ikke er medtaget.

En gruppe problematiske stoffer, som kun delvist er præsenteret i dette projekt, er nedbrydningsprodukter til stede i plast. Som eksempel på sådanne stoffer kan peges på aromatiske aminer i polyamid (nylon). Sådanne stoffer er kun medtaget såfremt de indgår i en af de lister over problematiske stoffer som er præsenteret ovenfor. Aromatiske aminer er repræsenteret af stoffet 4,4'- Diaminodiphenylmetan (MDA) (se afsnit 3.6.10). Det må erkendes, at det ofte er vanskeligt at identificere kilderne til aromatiske aminer i plast. Aromatiske aminer i polyamid kan f.eks. stamme fra hydrolyse af aromatisk diisocyanat, aromatisk amid anvendt som stabilisator eller fra et sort farvestof anvendt i polyamid.

3. Problematiske stoffer i plast

I dette kapitel er nævnt og beskrevet de kemiske stoffer, som vurderes at blive anvendt eller at være til stede i plast i væsentlige koncentrationer. Beskrivelsen er rettet mod at præsentere en række centrale data for alle stoffer, der har relation til deres brug i plast.

Centrale data er i denne forbindelse afgrænset til følgende data:

- CAS nummer.
- Begrundelse (i hvilken stofliste er stoffet angivet?).
- Stoffets funktion.
- Plasttyper, hvor stoffet anvendes.
- De vigtigste varegrupper, hvor de nævnte plasttyper indeholdende stoffet anvendes.
- Potentiale for frigivelse af stoffet fra plast herunder udvaskning og fordampning.
- Potentiale for påvirkning af forbrugere.
- Stoffernes skæbne ved genanvendelse.
- Referencer.

Disse data er, i det omfang de er tilgængelige, præsenteret i de følgende afsnit 3.2- 3.11, som omfatter i alt 132 stoffer eller stofgrupper. For hvert stof er oprettet et særligt skema, som indeholder de relevante oplysninger.

Den viden der er tilgængelig for de angivne stoffer varierer imidlertid betydeligt. For visse stoffer, som i mange år har givet anledning til bekymring og intensive undersøgelser, f.eks. tungmetaller, bromerede flammehæmmere og ftalater, er der en betydelig information tilstede og vurderingen af påvirkning ved migration og af skæbnen ved genanvendelse hviler generelt på et solidt grundlag. For andre stoffer er den tilgængelige information spinkel, da der kun er foretaget begrænsede undersøgelser og vurderinger for disse stoffer. Det følger naturligt heraf, at vurderingerne for disse stoffer er mere usikre og mindre pålidelige.

Det skal understreges, at for mange af de angivne stoffer må de vurderinger, der er foretaget mht. migration og skæbne ved genanvendelse betragtes som ekspert vurderinger foretaget af de konsulenter, der er ansvarlige for denne rapport. Vurderingerne er foretaget på baggrund af mere end 30 års erfaring udviklet gennem deltagelse i plast udviklings projekter, forbruger beskyttelses projekter samt forsøg og vurderinger foretaget for mange private kunder med henblik på at opnå godkendelse f.eks. for anvendelse af plast i forbindelse med drikkevand og fødevarer.

3.1 Introduktion til de angivne data

Hvad angår de data, der angivet for de enkelte stoffer i de følgende afsnit 3.2- 3.11, skal opmærksomheden henledes på følgende overvejelser:

CAS nummer

CAS numre er anvendt som en klar og præcis identifikation af de pågældende kemiske stoffer. For en stofgruppe (f.eks. arsen og arsenforbindelser), kan de angivne CAS numre dække alle eller mange af de stoffer, som tilhører gruppen, selvom det reelt kun er et eller få stoffer der er relevante i denne sammenhæng.

Begrundelse

Begrundelsen angiver i hvilken liste af problematiske stoffer det kemiske stof eller stofgruppen er medtaget, og hvilke af de udvælgelseskriterier, som er præsenteret i kapitel 2, der dermed er benyttet. Alle lister, som indeholder stoffet, er angivet. For stofgrupper gælder, at en liste er angivet, såfremt blot et stof i gruppen er medtaget på listen.

For alle stoffer, med undtagelse af de stoffer som er medtaget på listen over CMR stoffer i legetøj, er tillige angivet om stoffet er harmoniseret klassificeret som CMR stof. Dette er angivet med forkortelsen CMR. For stofgrupper gælder, at CMR er angivet, såfremt blot et stof i gruppen er klassificeret som CMR.

For stoffer medtaget i ECHAs Registry of Intentions er det angivet, om stoffet eller stofgruppen er medtaget baseret på hensigt om harmoniseret klassifikation og mærkning (angivet ved forkortelsen "CLP"), eller baseret på hensigt om at blive identificeret som SVHC (angivet ved forkortelsen "SVHC"), eller baseret på hensigt om at indføre restriktion (angivet med ordet "restriktion").

Funktion (af stoffet)

De relevante funktioner for stoffet i plast er angivet. Typiske additiver i plast omfatter antioxidanter og andre stabilisatorer, flammehæmmere, blødgørere, opskumningsmidler, antimikrobielle stoffer (biocider), pigmenter (farvestoffer) og opløsningsmidler. Hertil kan tilføjes funktionerne for monomerer, mellemprodukter, katalysatorer, initiatorer og acceleratorer (hærdemidler) etc. i produktion af plast, som alle kan medføre forekomst af rester i færdigvarer.

Skemaerne for stofferne er generelt grupperet efter stoffernes funktion med en kort indledning om den pågældende funktion og det typiske indhold i plast. Stoffer, der anvendes som monomerer eller mellemprodukter etc. i produktionen af plast er dog samlet i en særlig gruppe. Endelig er oprettet en ekstra gruppe benævnt "andre" for stoffer, som af forskellige årsager ikke passer ind i andre grupper.

Relevante plasttyper (hvor stoffet anvendes)

De vigtigste plasttyper er angivet for pågældende kemiske stoffer. Som bemærket i kapitel 2 er medtaget både termoplaster og hærdeplaster, mens elastomerer (gummi) normalt ikke er angivet.

Vigtigste varegrupper (hvor de nævnte plasttyper indeholdende stoffet anvendes)

De vigtigste varegrupper er angivet i det omfang, de er kendte.

Potentiale for frigivelse

Migration er det fænomen, som finder sted, når et kemisk stof flytter sig (vandrer) i plast til overfladen af plasten eller til et andet medie (f.eks. sved eller vand) i kontakt med plasten.

Det er et relativt kompliceret fænomen, som er beskrevet mere detaljeret i det følgende.

Migration kan være en ønsket egenskab, men er i de fleste tilfælde ikke ønsket. Som eksempel på migration som en ønsket egenskab kan peges på migration af slipmidler til overfladen af plast for at fremme frigivelsen fra støbeforme eller for at opnå antistatiske egenskaber. Kontrolleret frigivelse af medicin fra en plast matrice for præcis dosering til patienter er et andet eksempel på ønsket eller kontrolleret migration.

Et eksempel på uønsket migration er migrationen af blødgørere til overfladen af en plast genstand fra hvilken de kan friges ved fordampning, eller afvaskning eller ved at blive fjernet som støv.

Migration af kemiske stoffer i plast emballage for fødevarer eller medicin er andre eksempler på uønsket migration, idet visse af de stoffer, som migrerer, kan være giftige, eller give en ubehagelig smag til maden, forstærke nedbrydningen af de aktive stoffer i medicin eller til slut i værste fald ødelægge medicinen.

Migrationshastigheden for organiske stoffer afhænger af deres størrelse og kemiske struktur. Små molekyler, typisk monomerer og rester af opløsningsmidler, vil migrere hurtigt, da de har et lavt kogepunkt. Monomerer såsom formaldehyd, vinylchlorid, aetylen og butadien er alle gasser og har en stærk tendens til at migrere hurtigt selv ved sædvanlige omgivelsestemperaturer og med sikkerhed ved 100 °C.

Molekylvægten af stoffer anvendt som additiver i plast vil typisk være af størrelsen 200 – 2000 g/mol. En høj molekylvægt svarer til et stort molekyle og en lav migrationshastighed og omvendt. Denne tommelfinger regel anvendes til at designe additiver med lav tendens til migration ved at designe dem med stor molekylvægt. Denne metode anvendes for antioxidanter, flammehæmmere og blødgørere. Blødgørere og flammehæmmere baseret på dette princip anvendes dog kun i mindre omfang, pga. af de højere omkostninger, der er knyttet til fremstillingen af store molekyler.

Endvidere gælder reglen, at opløseligheden af stoffet i plast skal være høj og modsat lav i en væske eller materiale i kontakt med plasten. Dette kan bedømmes ved parameteren $\log P_{ow}$ (log K_{ow}) eller opløselighedsparameteren. Begge parametre udtrykker balancen mellem lipophile (fedt-elskende) og hydrofile (vand-elskende) egenskaber for stoffet (tendens til at være opløselig i fedt/olie og vand). Et lavt $\log P_{ow}$ betyder typisk, at opløseligheden i vand er høj, mens et højt $\log P_{ow}$ betyder, at opløseligheden i fedt/olie er høj.

Migrationshastigheden påvirkes tillige på en kompleks måde af forhold som start koncentrationen af det kemiske stof i plasten, tykkelsen af plastemnet og overfladestrukturen af plastemnet. Migrationen vil primært finde sted via de amorfde dele af plasten.

Fluxen J af stoffet (additiver og andre små molekyler som monomerer) fra plast og andre materialer er udtrykt ved

Fick's lov $J = -D \times \frac{dc}{dx}$, hvor

- D er diffusionskoeficienten for stoffet,
- J er fluksen (mængde stof pr. tidsenhed), og
- $\frac{dc}{dx}$ er koncentrations forskellen for stoffet over diffusionsafstanden.

Fluxen J vil formindskes over tid i takt med at koncentrationen af stoffet i produktet mindskes, og diffusionskoeficienten D vil afhænge af temperaturen i overensstemmelse med Arrhenius ligningen

$$D = K \exp^{(-E/RT)}$$

Fluxen kan integreres over tid til en total migration M. For et givet tidsrum og temperature kan den samlede migration modelleres som følger:

$$M = C_0 \times t^{0.5} \times K \times \text{EXP}(-E/RT)$$

- Hvor M: Migration
C₀: Koncentration af stoffet i materialet (plasten)
t: Tidsrum
K: Konstant
T: Temperatur
E: Aktiverings energi
R: Gas konstant

I praksis måles migrationen af stoffer fra plast ved kontakt eksperimenter svarende til de værst tænkelige scenarier (worst case). I nogle tilfælde kan bruges standardiserede metoder til bestemmelse af migration fra materialer i kontakt med fødevarer og for farmaceutiske produkter. I andre tilfælde er det nødvendigt at opstille særlige migrationsexperimente baseret på eksponeringsscenarioer afhængig af materialets (plastens) anvendelse. Særlige undersøgelser af migration foretages eksempelvis i projekter, som er rettet mod at beskytte forbrugere mod påvirkning fra giftige stoffer i produkter.

Sundheds vurderinger foretages baseret på resultaterne fra sådanne migration studier.

Matematisk modellering er også mulig, hvis tilstrækkelige migrations data er til rådighed. I Simoneau [2010] er givet eksempler på sådanne beregninger for plast i kontakt med fødevarer.

Det er dog altid påkrævet at gennemføre praktiske migrations undersøgelser, hvis modellering giver resultater, der er højere end tilladt.

I [KL, 2012] er det angivet, at kun additiver med molekyle vægt lavere end 1000 g/mol betragtes som toksikologisk væsentlige, da det er meget usandsynligt, at molekyler større end 1000 g/mol vil blive optaget af mave-tarm systemet. Molekyler større end 1000 g/mol vurderes derfor ikke at udgøre en toksikologisk risiko. For molekyler med en størrelse under 600 g/mol gælder, at de fleste stoffer optages, og at optagelsen er bestemt af andre faktorer end størrelsen og formen af molekylerne.

Hvad angår farvestoffer anvendt i plast er der taget udgangspunkt i følgende overvejelser. Der findes 4 grupper af farvestoffer:

- Opløselige farvestoffer
- Organiske pigmenter
- Uorganiske pigmenter
- Særlige farvestoffer

De opløselige farvestoffer er dyre og har begrænset modstandsdygtighed overfor lys og varme og en lille tendens til migration. De anvendes i PS, PMMA og cellulose plast for at opnå en klar gennemsigtig kulør. De bruges i koncentrations på 0,25–5 % w/w. De er rene organiske stoffer som f.eks. azofarvestoffer.

Organiske pigmenter er uopløselige og migrerer ubetydeligt. De omfatter alizarin derivater, phthalocyaniner, benzidiner, kønrog (carbon black), og metal-azo komplekser. De bruges som additiver i mængder på 0,001-2,5 %.

Uorganiske pigmenter har ingen tendens til migration og har stor modstandsdygtighed overfor høje temperaturer og UV/VIS – lys. De omfatter zinksulfid, jernoxid, cadmiumsalte, chromsalte, bly- og molybdænsalte, ultramarin and titan dioxid.

Betegnelsen “solid bound” (fast forankret) er anvendt i denne rapport og betyder, at selvom stoffet ikke er bundet kemisk i plasten, er det vurderet, at den kemiske struktur forhindrer migration medmindre plasten udsættes for kemikalier, som ikke er tilsigtede (f.eks. syrer/baser eller stærke oxidationsmidler).

For nogle flammehæmmere med høj molekylevægt er det vurderet, at de ikke vil migrere, men der kan være anvendelser, hvor temperaturen under brug er så høj (f.eks. i “hot spots” i elektronik), at en vis begrænset migration er mulig.

Tommelfingerregler for migration – en opsummering

Med hensyntagen til den kompleksitet, der er forbundet med migration, er der nedenfor formuleret en række tommelfingerregler for migration:

- Additiver er ikke kemisk bundet i plast, med undtagelse af de temmelig få reaktive stoffer, som er indbygget i plast molekylerne ved co-polymerisation (gælder visse flammehæmmere).
- Små organiske molekyler som gasser og opløsningsmidler med lavt kogepunkt og højt damp tryk vil migrere hurtigt (typiske eksempler er monomerer og opløsningsmidler f.eks. reaktive opløsningsmidler anvendt i polymeriseringsreaktioner for plast).
- Stoffer, som er dårligt opløselige i plast vil migrere hurtigere end stoffer, der er letopløselige i plast.
- Visse organometalliske stoffer vil migrere pga. lave kogepunkter (f.eks. organotin forbindelser).
- Kemiske stoffer med molekyle vægt højere end 600 g/mol vil have en svag tendens for migration.
- Uorganiske pigmenter, kønrøg (carbon black), fyldmaterialer og armerings fibre vil ikke migrere med mindre plast materialet er nedbrudt af vejrliget eller som følge af kemiske påvirkninger.
- Migrationshastigheden vil stige med øget temperatur.
- Migration sker hurtigere i de amorfde dele af semi krystallisk plast pga. af bedre plads mellem plastmolekylerne i de amorfde dele.
- Migration i amorft plast sker langsommere når plastens glasovergangstemperatur (den temperatur, hvor plasten bliver stiv og glasagtig) øges, fordi mobiliteten af plast polymer kæderne mindskes;
- Migrationen til et andet medie/materiale i kontakt med plasten (kontakt medie) øges, hvis opløseligheden af det migrerende stof er høj i kontakt mediet (f.eks. migration af ftalat blødgørere til vegetabilsk olie).
- Migrationen vil mindskes med tiden i takt med, at koncentration af det migrerende stof mindskes i plasten.

Potentiale for påvirkning af forbrugere

Vurderingen af forbrugernes eksponering for problematiske stoffer, som kan være til stede i plastmaterialer er generelt baseret på vurderingen af migrationspotentialet for de pågældende stoffer. Der er dog også benyttet erfaring fra en række Miljøstyrelsес projekter om forbruger beskyttelse i forhold til problematiske stoffer i forskellige forbrugerprodukter. I adskillige kortlægninger af forbrugerprodukter er der foretaget undersøgelser af frigivelsen af kemiske stoffer fra plastprodukter, og der er sket en vurdering af mulige sundhedsmæssige risici for udvalgte stoffer. Studier og kortlægninger omhandlende eksponering af forbrugere for giftige kemikalier frigivet fra plastmaterialer er også udført af miljømyndigheder i andre lande f.eks. i USA. Konklusionerne fra disse undersøgelser er også udnyttet som grundlag for vurderingen af påvirkningen af forbrugere foretaget i denne rapport.

Vurderingen er fokuseret på, om væsentlig eksponering af forbrugerne kan forventes og forsøger ikke at vurdere risikoen af de pågældende stoffer. Generelt gælder, at den viden, der er til stede om anvendelsen af de enkelte stoffer, ikke er tilstrækkeligt detaljeret til at tillade, at der i vurderingen skelnes mellem forskellige forbrugergrupper såsom eksponering af voksne versus børn.

Forbud og andre begrænsninger i anvendelsen af udvalgte stoffer er angivet og taget i betragtning i vurderingsprocessen, når dette har været hensigtsmæssigt. Det er dog ikke formålet med denne rapport at give et dækkende overblik over alle forbud og anvendelsesbegrænsninger, der gælder for de stoffer, der er omfattet af rapporten. Den information, der er givet i denne sammenhæng må derfor betragtes som ufuldstændig.

Hvad angår arbejdsmiljø er det relevant særligt at fokusere på stoffer, som sandsynligvis fordamper let pga. højt damptryk og lave smelte- og kogepunkter. Disse egenskaber vil forårsage en væsentlig fordampning allerede i produktionsfasen. De stoffer, der skal fokuseres på, omfatter primært opløsningsmidler. Andre stoffer såsom visse isocyanater og styren er dog også relevant i denne sammenhæng.

Adskillige af de kemiske stoffer, der er kortlagt i denne rapport er indtil videre ikke undersøgt detaljeret og de foreliggende data om stoffet og dets anvendelse er begrænset. Dette er især tilfældet for nye stoffer, som påregnes at erstatte forbudte plastadditiver f.eks. de forbudte bromerede flammehæmmere.

I de tilfælde, hvor der mangler basale data, er de angivne konklusioner naturligvis begrænsede. Det er f.eks. vanskeligt at angive, i hvilket omfang alternativer til forbudte additiver finder anvendelse i plastprodukter.

Stoffernes skæbne ved genanvendelse

Hvad angår skæbnen for stofferne ved genanvendelse er skelnet mellem skæbnen ved mekanisk genanvendelse, ved feed-stock genanvendelse og ved energivinding.

I henhold til "End of Life plastics 2013" [S. Hawyward-Higham, 2013] er det årlige forbrug af plast i Europa på 50 millioner tons årligt. Af denne mængde ender 10 millioner tons på lossepladser, mens 9 millioner tons udnyttes efter brug (en fjerdedel heraf genanvendes, mens 3 fjerdele forbrændes i forbindelse med produktion af elektricitet). Termoplast udgør ca. 80 % af affaldet, og hærdeplast udgør de resterende ca. 20 %. Termoplasten kan omsmeltes, mens hærdeplast såsom epoxy, polyuretan og phenoplast ikke kan omsmeltes og kun kan genvendes ved feed-stock genanvendelse.

Ifølge Klean Industries svarer det årlige forbrug af plast på verdensplan til 8-10 % af den årlige globale olieforsyning. Klean Industries vurderer, at globalt ender 80 % af alt plast affald på lossepladser, 8 % forbrændes, mens kun 7 % genanvendes. [J.Klinkhamer, 2013].

Som angivet i det følgende er vurderingen af stoffernes skæbne ved genanvendelse fokuseret på skæbnen ved mekanisk genanvendelse, da både feed-stock genanvendelse og energi genvinding generelt vil resultere i nedbrydning af stofferne, idet de kemiske bindinger brydes i organiske forbindelser og organometalliske komplekser, f.eks. ved pyrolyse i fravær af ilt eller ved oxidation i forbindelse med forbrænding og energi genvinding. For både feed-stock genanvendelse og energi genvinding gælder, at de aktuelle processer er meget komplekse og skæbnen for stoffernes bestanddele kun er sparsom kendt og vanskelig at forudsige.

Stoffernes skæbne ved mekanisk genanvendelse

Mekanisk genanvendelse dækker den proces, hvor plasten blot vaskes, skæres eller neddeles mekanisk på anden vis til små stykker i form af granulater og anvendes som råmaterialer for nye produkter (omsmelting), der er tilpasset de plasttyper og additiver, det handler om. Mekanisk genanven-

delse anvendes hovedsageligt for de mest almindelige termoplaster anvendt til emballage og forbrugerprodukter, f.eks. PE (HDPE, LDPE), PP, PET og PVC, men også for plasttyper som PS, ABS, PA and TPU. Termoplastisk PU (TPU) er en særlig type PU, som i modsætning til almindeligt tværbundet PU kan omsmeltes. TPU dækker dog kun en lille del af det samlede marked for PU.

De anvendte temperaturer ved genanvendelses processer varierer fra plasttype til plasttype og sværer til de temperaturer, der anvendes ved fremstilling af produkter baseret på jomfruelige råvarer. De temperaturer, der f.eks. anvendes ved sprøjtestøbnings processer varierer fra 150-170°C for blødt PVC til 220-290 °C for PP og 260-280 °C for PET. Generelt vil sprøjtestøbnings temperaturer for typiske termoplastiske materialer som PE, PP, PS, ABS, PVC, PA og PET være af størrelsesordenen 150-290 °C. Andre fremstillings processer såsom extrudering, termoformning etc. vil finde sted ved tilsvarende temperaturer.

Skæbnen af stoffer ved mekanisk genanvendelse er vurderet ved at sammenligne de fysisk-kemiske egenskaber for stofferne med den viden om proces temperature, der er nævnt ovenfor.

For de fleste stoffer er det vurderet, at stoffet (i det mindste hovedparten) vil forblive i de materialer som genanvendes. Selv stoffer, som migrerer, vil i mange tilfælde have lave migrationshastighed, der bevirker, at hovedparten af stoffet stadig er til stede i plastproduktet ved slutningen af dets brug (end of life) såvel som i materialer, der er blevet genanvendt. Undtagelser herfra vil typisk være stoffer såsom opløsningsmidler, der let fordamper, monomerer etc., som aktiveres på ny i genanvendelsesprocessen samt stabilisatorer (i særdeleshed varmestabilisatorer), som tvinges til reaktion af genanvendelsesprocessen.

Genanvendelsespotalet for plast er ikke diskuteret i den information, som er præsenteret for stofferne. En optimal genanvendelsesrate på 90-93 % kan påregnes ved mekanisk genanvendelse af termoplast i alle tilfælde, hvor mere præcis viden ikke er til rådighed. Denne udnyttelsesgrad repræsenterer genanvendelse af gode kvalitets materialer leveret til genanvendelsesanlægget. Med gode kvalitets materialer skal forstås relativt rene materialer godt separeret i forskellige plasttyper med et rimeligt ens indhold af additiver. Disse udnyttelsesgrader tager ikke hensyn til vanskeligheder ved at indsamle og separere plast, da sådanne forhindringer afhænger stærkt af, hvorledes affaldsindsamlingen er organiseret i samfundet.

Separation af plast materialer og udvalgte additiver

Succesfuld mekanisk genanvendelse forudsætter effektiv separation af plast materialer efter plasttyper og om muligt også de dominerende additiver. Separation kan i princippet udføres som separation ved kilden såvel som ved automatisk affalds sortering.

Separation ved kilden er relevant for produkter der anvendes i lukkede (eller næsten lukkede) kredsløb (f.eks. ølkasser, PET flasker etc.) eller for produkter, der er lette at identificere og til rådighed i væsentlige mængder, således at separat håndtering er lønsom. Selvom genanvendelses systemer eksisterer for adskillige produkter, er disse produkter normalt ikke forbundet med tilsætning af særlige additiver. Separation af produkter som en metode til at udseparere særlige additiver er i princippet muligt, men vil generelt kun gøre det muligt at udseparere en del af stoffet i omløb, foruden at det vil være vanskeligt at foretage en præcis afgrænsning af de produkter der skal indsamles.

De følgende eksempler illustrerer kompleksiteten af de problemer, der skal overvejes:

- Cadmium var den dominerende UV-stabilisator i PVC-vinduer og døre op til slutningen af 1980'erne. Efter dette tidspunkt blev cadmium i Danmark erstattet af bly-stabilisatorer (igen erstattet af andre stabilisatorer omkring år 2000), foruden at plastdøre fremstillet af andre materialer (PP, HDPE) blev markedsført i løbet af 1990'erne.

- Flammehæmmere bruges sandsynligvis i alle elektroniske produkter. Før indførelsen af EUs RoHS direktiv var disse flammehæmmere hovedsageligt bromerede flammehæmmere. Efter indførelsen af RoHS direktivet er bromerede flammehæmmere i vid udstrækning erstattet af andre flammehæmmere herunder reaktive bromerede flammehæmmere.
- Ftalater anvendes hovedsageligt i blødt PVC. Andre bløde plastfolier omfatter LDPE, polyester etc. Opskummet blødt plast vil hovedsageligt være PVC eller polyuretan.

Automatisk affaldssortering af blandet plast vil typisk omfatte procestrin som for-sortering, mekanisk neddeling, sigtning og separation efter plasttype ved hjælp af NIR identifikation eller røntgen identifikation, masseylde, og efter farve. Ved neddelingen bliver plasten typisk reduceret til flager i størrelsen 10 mm x 10 mm.

"Near-infrared spectroscopy" (NIR) gør det muligt at foretage automatisk identifikation og separation af forskellige plasttyper. Med denne teknologi kan opnås omkring 90 % sorterings effektivitet ved et gennemløb for plasten. Teknologien kan dog ikke adskille sort indfarvet eller plast med særlige overfladebelægninger. [Jakobsen et al, 2014].

Røntgen identifikation kan anvendes til at identificere særlige grundstoffer i plasten som f.eks. klor, brom og tungmetaller. Særlige grundstoffer kan derfor anvendes som indikatorer for problematiske stoffer, f.eks. kan brom anvendes som indikator for bromerede flammehæmmere.

Massefyld kan også anvendes til at separere en række plast typer. Blandt de mest anvendte plast typer skiller især PVC sig ud med massefylder af størrelsесordenen $1,38 - 1,53 \text{ g/cm}^3$, hvilket er signifikant højere end massefylden for PE, PP og PS ($0,9 - 1,07 \text{ g/cm}^3$). En række tekniske plast typer vil dog have massefylder tæt på eller højere end for PVC, bl.a. som følge af uorganiske fyldstoffer.

Sortering efter farve kan anvendes i særlige situationer, f.eks.:

- Cadmium og bly har historisk været vigtige stoffer i gule og røde farver. Brugen af cadmium stoppede omkring 1990 og brugen af bly omkring 2000. Mange andre gule og røde farver er dog tilgængelige på markedet. På grund af dette er røntgen baseret sortering at foretrække.
- Kobolt acetat anvendes for at opnå den gennemsigtige blå tone, som ofte findes i PET flasker. Denne farve er dog ved at blive udfaset. Også i denne sammenhæng vil røntgenbaseret sortering baseret på detektion af kobolt være at foretrække.

Farvesortering anvendes derfor hovedsagelig for at sikre en bestemt farvekvalitet (eksempelvis hvid plast eller grøn plast) og bruges især ved udsortering af PET flasker, idet farvekvaliteten har betydning for afsætningsprisen.

De forskellige separations teknikker for plast, som i dag er tilgængelige på markedet, er kortlagt i et nyligt projekt for Miljøstyrelsen [Jakobsen et al, 2014].

Der er ikke udviklet idiotsikre sorterings teknologier og det er vedblivende en udfordring at sikre, at kemiske stoffer, som er uønskede af sundheds- og miljømæssige årsager ikke kontaminerer de forskellige plastmaterialer, som genanvendes. Dette uløste spørgsmål er emnet for et igangværende projekt INNOSORT ved Teknologisk Institut. I dette projekt anvendes spektroskopiske metoder med brug af avancerede hyperspektrale billedgenkendelsesteknikker og andre genkendelsesteknikker med anvendelse af avanceret matematisk signalbehandling (sensor fusion) med henblik på at forbedre mulighederne for at frasortere emner og materialer, der vil forringe genanvendelsesmulighederne for plasten.

Det er ikke forsøgt at vurdere mulighederne for separation af de særlige stoffer, som præsenteres i denne rapport, da den information, som er tilgængelig om stoffernes anvendelse, for de fleste stoffer ikke er detaljeret nok til at muliggøre en pålidelig vurdering. Udviklingen med hensyn til automatisk sortering, der udnytter NIR og røntgen teknologi indikerer, at for adskillige stoffer vil det være muligt at separere en væsentlig af stofmængden ud af affaldsstrømmene forudsat, at de nødvendige ressourcer er investeret. Kildesortering kan også i en række tilfælde være en mulighed afhængig af det pågældende stof, dets anvendelser, mængden af stof, der skal separeres, samt omkostningerne ved sorteringen og processen.

Stoffernes skæbne ved feed-stock genanvendelse

Hærdeplaster såsom epoxytyper og almindeligt tværbundet PU kan ikke genanvendes med mekaniske metoder, men feed-stock genanvendelse er muligt. Der er dog kun enkelte feed-stock anlæg i drift i Europa og teknologien er stadig under udvikling. I mange lande er energi genvinding ved forbrænding blevet prioriteret fremfor materiale genanvendelse og i særdeleshed i stedet for feed-stock genanvendelse.

Ved feed-stock genanvendelse (eller kemisk genanvendelse) er principippet at genvinde plast monomerer ved kemisk nedbrydning ved så høje temperaturer, at de kemiske bindinger mellem monomererne brydes ved "cracking" eller ved hydrolyse. Hydrolyse er relevant for plast polymerer med bindinger, der kan hydrolyseres (med vand eller glykoler) f.eks. polyamider, polyuretaner og polyester. De anvendte processer er meget komplekse, og det er ikke muligt at forudsige stoffernes skæbne ved feed-stock genanvendelse bortset fra, at de additiver, der er til stede i plasten, med stor sandsynlighed vil blive nedbrudt.

For at være lønsom kræves, at der er store plastmængder til rådighed for processen. Dette kan være forklaringen på, at feed-stock genanvendelse ikke anvendes i Danmark. Hertil kommer, at i Danmark er energi genvinding ved forbrænding indtil fornylig blevet prioriteret fremfor materiale genanvendelse og i særdeleshed i stedet for feed-stock genanvendelse.

I følge [Jensen et al 2000] findes der feed-stock genanvendelses anlæg i Tyskland, Frankrig og USA. Disse anlæg omdanner polyamider, polyuretan og PET til f.eks. monomerer. I Tyskland findes et anlæg, der nedbryder PVC til petrokemiske produkter.

Klean Industries Inc. [Klinkhamer 2013] angiver, at et anlæg i Japan for feed-stock genanvendelse af mobil telefoner har en kapacitet på 20 tons pr. dag (installeret i 2012), mens et andet anlæg i Japan for genanvendelse af kommunalt og industrielt blandet affald med stort indhold af PVC og PET har en kapacitet på 50 tons pr. dag (installeret 2000-2011).

Stofferne skæbne ved forbrænding

For Europæiske forbrændingsanlæg er fastsat i EU direktiv 2000/76/EC at temperaturen ved forbrænding af kommunalt og industrielt affald skal være på mindst 850 °C og for farligt affald på mindst 1100 °C i minimum 2 sekunder. Så vidt vides vil disse drifts betingelser sikre tilstrækkelig nedbrydning af brændbare materialer inklusive komplekse molekyler. Det kan derfor påregnes, at problematiske stoffer med undtagelse af selve grundstofferne generelt vil blive nedbrudt ved kontrolleret forbrænding. Grundstoffer eksempelvis metaller vil typisk blive omdannet til oxider.

Dannelsen af problematiske stoffer såsom dioxiner og PCB'er samt syrer såsom saltsyre (HCl) og flussyre (HF) kan dog finde sted på ny efter forbrændningsprocessen i skorstenssystemet ved "de novo synthesis" og tilsvarende processer. Disse emissioner begrænses typisk ved brug af aktivt kul i røggasrensningssystemet. Hvad angår andre stoffer end halogerede forbindelser og syrer, er der kun begrænset viden om de processer, der finder sted og de nye stoffer, der dannes. Dette emne er derfor ikke yderligere diskuteret.

Referencer

For alle stoffer og stofgrupper, hvor der i de følgende sektioner 3.2-3.11 er præsenteret data, er relevante referencer angivet i bunden af skemaerne. Referencerne er tillige blevet indarbejdet i den generelle referenceliste i slutningen af rapporten.

For alle stoffer har REACH Annex XV rapporter været en vigtig kilde til information. Disse rapporter er kun anført i skemaerne for de enkelte stoffer og er ikke medtaget i den generelle referenceliste. Disse rapporter er alle tilgængelige fra ECHA på internettet.

3.2 Antimikrobielle stoffer

Antimikrobielle stoffer (også kaldet biocider) bruges i plast for at beskytte disse materialer mod angreb og nedbrydning fra mikroorganismer.

Naturlige eller bioplastiske materialer kan angribes af mikroorganismer, mens syntetiske plasttyper fremstillet af syntetiske monomerer ofte er meget modstandsdygtige. Nogle mikroorganismer er dog i stand til at udnytte additiver såsom blødgørere som en energi kilde, når der er vand til stede. For at undgå dette kan der tilsættes antimicrobielle stoffer til plasten [Subramanian 2013].

Det typiske indhold af antimikrobielle stoffer i plastprodukter er 0,001-1 % (w/w) [Hansen et al, 2013]. De vigtigste anvendelser skønnes at være blødgjort PVC, herefter polyuretan, polyethylen og polyester.

Evn'en til migration er forskellig fra stof til stof. Triclosan og tin forbindelser vil migrere, mens den vigtigste arsen forbindelse (10,10'-oxybisphenoxarsin (OBPA)) er fast forankret og ikke vil migrere væsentligt. Potentialet for påvirkning af forbrugerne er generelt vurderet som lavt, men tributyltin forbindelser vil have stor tendens til migration til fedtholdige materialer.

Hvad angår genanvendelse er skæbnen også forskellig fra stof til stof. Tin forbindelser som biocider bruges kun i polyuretan (PU), som ikke kan genanvendes mekanisk, men som skal behandles ved feed-stock genanvendelse eller forbrænding. I Danmark anvendes kun forbrænding, hvilket medfører nedbrydning af tin forbindelserne og opsamling af tin med slagter og røggasrensningsprodukter fra forbrænding.

For triclosan og arsen forbindelser vil mekanisk genanvendelse være muligt og stofferne vil ikke blive nedbrudt eller tvunget til at fordampe ved genanvendelsesprocessen. Stofferne kan således hovedsageligt genfindes i de genanvendte materialer.

3.2.1 Arsen og arsenforbindelser

Substance	Arsenic and arsenic compounds
CAS Number	7440-38-2; 7778-39-4; 58-36-6; 1303-28-2; 1327-53-3; 7784-40-9; 7784-42-1; 15606-95-8; etc.
Justification	Norwegian priority list; Candidate list; Registry of intentions (CLP, SVHC); CMR.
Function	10,10'-oxybisphenoxarsine (OBPA) is an antimicrobial (accounting for 70 % of the demand for antimicrobials in plastics) [Zweifel et al, 2009]. Other substances included in the substance group may be used for manufacturing of OBPA.
Relevant types of plastics	Plasticised PVC (have a particular susceptibility to microbial attack and is by far the main plastic in which antimicrobials are incorporated), followed by polyurethane, and then LDPE and polyesters [Zweifel, 2001].
Main article groups	Examples include: shower curtains, floor coverings, wall coverings, coated fabrics, marine upholstery, automotive vinyl trim, vinyl moulding, tarpaulins, awnings, gaskets, weather stripping, caulking, ditch liners and swimming pool liners, and textiles [US EPA, 2009b].
Potential for release from plastics	OBPA will likely remain bound without significant migration in the plastics (molecular weight: 502; very low vapour pressure) [US EPA 1993]. Release by wear and tear mainly.
Potential for exposure of consumers	It is judged that arsenic and arsenic compounds used for the production of OBPA will not be present in concentrations which will be of concern for the consumers. As the migration tendency of OBPA is low due to the high molecular weight it is judged that the risk for consumer exposure is very low.

Substance	Arsenic and arsenic compounds
Fate of the substance by recycling	OBPA is judged mainly to remain in the plastic by mechanical recycling processes.
References	<p>US EPA (1993). 10,10'-Oxybisphenoxarsine (OBPA) Reregistration Eligibility Document. National Service Center for Environmental Publications (NSCEP).</p> <p>US EPA (2009b). 10,10'-Oxybisphenoxarsine (OBPA) Summary Document: Registration Review. Document ID: EPA-HQ-OPP-2009-0618-0004.</p> <p>Zweifel, H. (2001). Plastics additives handbook. 5th edition. Carl Hanser Verlag, Munich.</p> <p>Zweifel, H., Maier, R.D., Schiller, M. (2009). Plastics additives handbook. Carl Hanser Verlag, Munich.</p>

3.2.2 Bis(tributyltin)oxid (TBTO)

Substance	Bis(tributyltin)oxide (TBTO) - see also section 3.35.
CAS Number	56-35-9
Justification	Norwegian priority list; Candidate list; Registry of intentions (SVHC).
Function	Antimicrobial agent, intermediate.
Relevant types of plastics	Polyurethane (foam) and other polymers (unspecified), impurities in mono- and dibutyltin stabilisers for plastic. [Annex XV dossier].
Main article groups	Polyurethane foam; polymers used in products such as flooring, tiles and carpeting [Annex XV dossier]. Are today according to [ECHA 2009b] only used as intermediate.
Potential for release from plastics	Molecular weight: 596.12 g/mol, melting point: < - 45 °C, boiling point: 220-230 °C at 13 hPa, vapour pressure: 0.00000085 – 0.00016 hPa at 20 °C, water solubility: 4.0 mg/l (at pH 7.0; 20 °C; distilled water), log K _{ow} : 3.2 – 4.05 [Annex XV dossier]. Assessed as a volatile compound. Not solid bound and will migrate. [Nilsson, 2012]. By migration and by wear and tear. Given sufficient time, a significant part of the substance will probably be released. [Nilsson, 2012].
Potential for exposure of consumers	The substance is banned in EU and will not be present in new products. Exposure to consumers is on this background judged to be only on subtrace level in plastics as it is only present as an impurity in other tin based antimicrobial agents. For PUR only exposure from products marketed before the EU ban was implemented might happen, but the risk for exposure is judged low.
Fate of the substance by recycling	PUR can only be recycled by incineration or feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised. The tin will be distributed between the slag and the gas cleaning products.

Substance	Bis(tributyltin)oxide (TBTO) - see also section 3.35.
References	<p>Annex XV dossier Report. http://echa.europa.eu/documents/10162/13640/svhc_axrep_norway_pbt_tbto_20083006_en.pdf</p> <p>ECHA (2009b). Background document for bis(tributyltin) oxide (TBTO). Document developed in the context of ECHA's first Recommendation for the inclusion of substances in Annex XIV. ECHA 1. June 2009.</p> <p>Nilsson N. (2014). Expert assessment by Nils Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>RPA (2007). Impact Assessment of Potential Restrictions on the Marketing and Use of Certain Organotin Compounds. European Commission, Directorate-General Enterprise and Industry. Brussel.</p> <p>http://ec.europa.eu/enterprise/sectors/chemicals/files/studies/organotins_en.pdf</p>

3.2.3 Organiske tin forbindelser (tributyltin, triphenyltin)

Substance	Organic tin compounds (tributyltin, triphenyltin) - see also section 3.8.6
CAS Number	76-63-1, 76-87-9, 379-52-2, 639-58-7, 76-87-9, 900-95-8, 56-35-9, 1461-22-9, 2155-70-6, 26354-18-7, 688-73-3
Justification	Norwegian priority list; CMR.
Function	Biocide (trisubstituted tin compounds - tributyltin, triphenyltin). Impurity in e.g. disubstituted tin compounds used as stabilizers in PVC and catalyst in production of polyurethane foams.
Relevant types of plastics	Polyurethane foam and PVC.
Main article groups	Dibutyltin compounds are used preferably as stabilizers in colourless and/or transparent PVC plastic articles [KEMI 2012]. Examples on transparent PVC products include roof panels/windows, transparent partitions for clean rooms, packaging (blisters), containers, bottles and films (wrapping). Tributyltin: Polyurethane foam used in furniture; fibrefill polymers used in products such as flooring, carpeting; back-coating of textiles used in upholstery and fabrics treated with a coating (e.g. PVC) containing tributyl tin [Annex XV dossier; US EPA, 2008].
Potential for release from plastics	Assessed as a volatile compound. Not solid bound and will migrate. Release will take place by migration and by wear and tear. Given sufficient time, a significant part of the substance will probably be released. [Nilsson, 2012].
Potential for exposure of consumers	The MW is 290.05 g/mol for tributyltin and 385.5 g/mol for triphenyltin. The consumer may be exposed to the substances by inhalation, dermal exposure or orally due to the low molecular weight. The log P _{ow} especially for the triphenyltin is higher than 3, which means that the substance will have a high tendency to migrate to fatty substances.

Substance	Organic tin compounds (tributyltin, trifenyltin) - see also section 3.8.6
Fate of the substance by recycling	<p>PUR can only be recycled by incineration or feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised. The tin will be distributed between the slag and the gas cleaning products.</p> <p>PVC may be mechanical recycled. The organic tin compounds added as biocide to PVC will mainly remain in the PVC by the recycling process. If PVC is energy recycled by incineration the fate of tin will be the same as for PUR.</p>
References	<p>Annex XV dossier. http://echa.europa.eu/documents/10162/13640/svhc_axrep_norway_pbt_tbto_20083006_en.pdf</p> <p>ECHA (2009b). Background document for bis(tributyltin) oxide (TBTO). Document developed in the context of ECHA's first Recommendation for the inclusion of substances in Annex XIV. ECHA 1. June 2009.</p> <p>KEMI (2012). Dibutyltin compounds. http://apps.kemi.se/fodessok/floden/kemamne_eng/dibutyltennforeningar_eng.htm (Nov.2012).</p> <p>Nilsson N. (2014). Expert assessment by Nils Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>US EPA (2008a). Reregistration Eligibility Decision for the Tributyltin Compounds: Bis(tributyltin) oxide, Tributyltin benzoate, and Tributyltin maleate (Case 2620). http://www.epa.gov/opprrd1/REDs/tbt-compounds-red.pdf</p>

3.2.4 Triclosan

Substance	Triclosan $C_{12}H_7Cl_3O_2$
CAS Number	3380-34-5
Justification	Norwegian priority list.
Function	Biocide [NICNAS, 2009].
Relevant types of plastics	Polyethylene, polypropylene and PVC, polyester and polyamide fibres [NICNAS, 2009].
Main article groups	<p>Polyethylene and polypropylene: injection moulded and blow moulded plastic products PVC: calendered film and cast PVC plastisol [NICNAS, 2009]. Polyester and polyamide fabrics [NICNAS, 2009].</p> <p>Plastic end products using triclosan additives include various household moulded plastic products including:</p> <ul style="list-style-type: none"> • Food storage containers; • Wheelee bins; • Toilet seats; • Toilet tidy sets; • PVC carpet backing; • Swimming pool liners; • Toothbrushes; and • Pet accessories such as litter trays, food bowls, and Frisbees. [NINCAS, 2009].

Substance	Triclosan C₁₂H₇Cl₃O₂
Potential for release from plastics	The substance is not chemically bound, but is assessed as semivolatile (Molecular weight: 290 g/mol; vapour pressure: 4×10^{-6} mm Hg (4×10^{-4} Pa) at 20 °C, melting point: 56 – 58 °C, boiling point: 374 °C, log K _{oc} : 3.34 – 4.67) and should be assumed to migrate but fairly slow due to the high boiling point and probably not from a wet surface unless the water is basic (due to the phenolic hydroxyl group present).
Potential for exposure of consumers	As the triclosan might be added to a diverse number of consumer products like toys and toothbrushes, floor wax emulsions, polyethylene, polyurethane, polypropylene and other materials e.g. textiles there will be a risk for consumers to be exposed to the substance alone because it is used in many applications. However according to the Danish EPA [Danish EPA 2006] 99 % of the consumption in Denmark in the period 2000-2004 (3.9 – 1.8 t/year) is in cosmetic products including pasta for tooth brushing and deodorants, so the exposure from plastics is assumed negligible.
Fate of the substance by recycling	The substance is judged to stay in the plastic by mechanical recycling due to the high boiling point. To the extent products containing the substance are directed to incineration the content of chlorine may add to formation of dioxins and HCl in the chimney system.
References	<p>NICNAS (2009). Triclosan. Priority existing chemical, Assessment report no. 30. National industrial chemicals notification and assessment scheme. Australian Government. http://www.nicnas.gov.au/publications/car/pec/pec30/pec_30_full_report_pdf.pdf</p> <p>Danish EPA (2006). Kortlægning af kemiske stoffer i forbrugerprodukter, 73, 2006. Danish Environmental Protection Agency.</p>

3.3 Opskumningsmidler

Opskumningsmidler skaber celle strukturen i plastsrum og kan opdeles i fysiske og kemiske opskumningsmidler. Fysiske opskumningsmidler virker ved fordampning fra væsketilstanden eller ved ekspansion af en gas under tryk. CFC-gasser og HCFC-gasser, samt hydrocarboner som propan, butan og pentan er eksempler på fysisk virkende drivmidler og anvendes eller har typisk været anvendt til isolerende plastprodukter som PU isolerings skum, EPS og XPS. Kuldioxid anvendes også i kombination med de øvrige gasser/væsker.

De kemisk virkende opskumningsmidler er skræddersyede, så de frigiver gassen til celledannelsen tæt ved forarbejdningstemperaturen. Det er vigtigt, at gassen frigives langsomt og helst under energiforbrug (endotermt). Typiske repræsentanter er azocarbonamider og andre hydrazinderivater eller kvælstofholdige organiske stoffer, der ved opvarmning frigiver kvælstof som drivgas for opskumningen [Plastteknologi 2000].

Mængden af opskumningsmidler, der anvendes, afhænger af den massefylde, der ønskes for det færdige plastsrum og den potentielle gas produktion af opskumningsmidlet. Der kan ikke angives generelle regler for forbruget. Den mængde der er til sted i slut produktet bør optimalt være nul, men i praksis kan der være små rester af opskumningsmidlet til stede.

Klormetan og fluorholdige drivhusgasser (fysiske opskumningsmidler) må anses for at migrere let fra skum med åbne celler. Men for lukkede celler og skum indesluttet mellem metalplader o.lign. er diffusionen begrænset, i det er faringer viser, at selv f.eks. gamle CFC holdige fjernvarmerør, hvor medierøret er ca. 90 °C, stadig indeholder et højt indhold af CFC.

C,C'-azodi(formamid) (ADCA) spaltes under frigivelse af kvælstof under opskumningen, men rester af uomsat ADCA kan være til stede i slut produkterne.

Stoffernes skæbne ved genanvendelse afhænger stærkt af de pågældende plastmaterialer. I materialer, som kan genanvendes mekanisk (neddeling/omsmeltnings – f.eks. PVC, PE, PP og PS) vil ADCA forblive i materialet, mens de øvrige opskumningsmidler sandsynligvis vil fordampe fuldstændigt. Materialer som PU, phenol skum og epoxy kan kun genanvendes ved forbrænding eller ved feedstock genanvendelse. I begge tilfælde vil alle rester af opskumningsmidlerne blive nedbrudt.

3.3.1 C,C'-azodi(formamid) (ADCA)

Substance	C,C'-azodi(formamide) (ADCA C ₂ H ₄ N ₂ O ₂) ; Diazene-1,2-dicarboxamide
CAS Number	123-77-3; 97707-96-5
Justification	Candidate list, Registry of intentions (SVHC).
Function	Foaming agent.
Relevant types of plastics	PVC, polyethylene and epoxy resins.
Main article groups	Foamed/cell products inclusive of plastisols, carpets and epoxy structural foam.
Potential for release from plastics	Molecular weight: 116.1g/mol, no melting point, but decomposition at >200 °C, vapour pressure: 2 x 10 ⁻⁸ Pa, water solubility: 33 mg/l at 20°C, log ₁₀ P _{ow} < 1.0 [Annex XV dossier]. Only present in plastic if the substance is not 100% converted to the blowing gases nitrogen, carbon monoxide, carbon dioxide and ammonia. As the gasses are formed at 200 °C, residues of the substance may be present if the decomposition temperature is not reached during processing throughout the plastic product.

Substance	C,C'-azodi(formamide) (ADCA C ₂ H ₄ N ₂ O ₂) ; Diazene-1,2-dicarboxamide
Potential for exposure of consumers	The substance has been banned in materials in contact with food in EU since august 2005. Based on this ban it is judged that there might be left residues in other consumer products. Due to its very polar structure it is judged to be very water-soluble and might migrate easily to water, water solutions or by skin contact.
Fate of the substance by recycling	For plastics which are recycled at temperatures below 200°C (e.g. flexible PVC) the substance may be present in the recycled materials. In other cases it will decompose. Epoxy can only be recycled by incineration or by feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised.
References	Annex XV – ADCA. C,C'-azodi(formamide). http://echa.europa.eu/documents/10162/d9e11c88-481a-47a9-8fff-915b48086ddb

3.3.2 Chlormetan, methyl chlorid

Substance	Chloromethane, methyl chloride CH ₃ Cl
CAS Number	74-87-3
Justification	List of CMR-substances in toy.
Function	Blowing/foaming agent.
Relevant types of plastics	PS-, PE-,PP-,PUR-,Phenol resin-, acetylcellulose- foams.
Main article groups	Foamed, cell plastics.
Potential for release from plastics	Molecular weight: 50.49 g/mol, melting point: - 97.4°C, boiling point: -23.8°C, vapour pressure: 506 hPa at 20°C, water solubility: 5.325 mg/l [Wikipedia 2014]. Low boiling gas (boiling point at minus 23.8°C) assumed to evaporate during production and use of the products. It is not known whether methyl chloride is still used as blowing agent on the European marked, but it is judged that the risk is low.
Potential for exposure of consumers	The low boiling point of the substance means that it will evaporate rapidly from the blown products. Only shortly after production there is judged to be a risk for exposure. The substance will probably be converted to hydrochloric acid and methanol in presence of water.
Fate of the substance by recycling	For plastics which can be subject to mechanical recycling (e.g. PS, PE, and PP) residues of the blowing agent will likely evaporate completely during the recycling process. Polyurethane and phenolic foam can only be recycled by incineration or by feedstock recycling. In both cases chloromethane will be decomposed. In Denmark only incineration is practised. The content of chlorine may add to the formation of dioxins and HCl in the chimney system.
References	Wikipedia (2014). Chloromethane. http://en.wikipedia.org/wiki/Chloromethane (April 2014)

3.3.3 Fluorholdige drivhusgasser (HFC'er, PFC'er og SF6)

Substance	HFCs, PFCs and SF6
CAS Number	811-97-2 (HFC 134a); 354-33-6 (HFC 125); 420-46-2 (HFC 143a); 75-37-6 (HFC 152a); 460-73-1 (HFC 245fa); 406-58-6 (HFC 365mfc); 75-73-0 (CF4); 76-16-4 (C ₂ F ₆); 76-19-7 (C ₃ F ₈); 2551-62-4 (SF6) etc.
Justification	Danish list of undesired substances.

Substance	HFCs, PFCs and SF6
Function	Blowing agent.
Relevant types of plastics	Polyurethane foam (HFC 134a, HFC 245fa, and HFC 365mfc), polystyrene foam (HFC 134a, HFC 152a) and phenolic foam (HFC-365mfc).
Main article groups	In Denmark today fluorinated greenhouse gasses are banned as blowing agent but until about 2002 they were used for rigid polyurethane foam for insulation purposes (refrigerators, freezers, insulation panels, district heating pipes). Still used outside Denmark as blowing agent in polyurethane foam, polystyrene foam and phenolic foam (the precise applications are not known) [Hansen et al 2014].
Potential for release from plastics	Data for HFC 134a (serves as example): Molecular weight: 102.03 g/mol, melting point: -101°C, boiling point: -26°C, vapour pressure: 630 kPa at 25°C, water solubility: none, log P _{ow} : 1.06 [Barker et al, 1998]. The substances are not chemical bound and will diffuse more or less fast depending on the temperature for use and the product. In many cases the product will be a sandwich construction, e.g. freezers or insulating panels, in which the foam is placed between sheets of metal or plastic that significantly reduces the rate of diffusion.
Potential for exposure of consumers	Exposure depends on the products in question. Generally the low boiling point of the substance means that it will evaporate rapidly from the blown products. Only shortly after production there is judged to be a risk for exposure. For products in which the foam is placed between sheets of metal or plastics (e.g. most or all refrigerators and freezers manufactured up till about 2002 and still in use) consumers will be exposed to HFCs slowly evaporating. The toxicity of these substances are however very low [Hansen et al 2014]. New products manufactured outside Denmark and imported to Denmark may result in higher exposure.
Fate of the substance by recycling	Polyurethane and phenolic foam can only be recycled by incineration or by feedstock recycling. In both cases HFCs will be decomposed. In Denmark only incineration is practised. By incineration fluor acid will be generated. The acid is generally neutralised in the filter unit of the plant. Polystyrene foam can be subject to mechanical recycling (fragmentation/remelting). In this case residues of the blowing agent will likely evaporate completely during the recycling process.
References	Barker P, Cary R and Dobson S (1998): Concise International Chemical Assessment Document 11: 1,1,1,2-Tetrafluoroethane. http://apps.who.int/iris/bitstream/10665/42125/1/9241530111.pdf Hansen E., Pedersen P.H., Christensen F.M., Feilberg K.L. (2014). Review and survey of selected Fluorinated greenhouse gases. A report under the LOUS review project. Danish Environmental Protection Agency. 2. Draft version.

3.4 Tungmetal baserede farvestoffer, stabilisatorer og katalysatorer

Visse tungmetaller danner komplekser med stærke farver, som er blevet anvendt til farvning af polymerer. Tungmetaller såsom bly, tin, cadmium og zink er også anvendt som stabilisatorer i PVC [Subramanian 2013].

Det typiske indhold af tungmetal baserede farvestoffer i plast er 0.01-10 % (w/w) [Hansen et al, 2013].

Generelt er stofferne solidt bundet i plastmaterialeerne og vil ikke migrere. Påvirkningen af forbrugerne må derfor anses for lav. Ved mekanisk genanvendelse vil stoffer til stede i plasten blive genanvendt og derfor integreret i de nye produkter.

Kviksølv er dog undtagelsen til dette, da kviksølv vil migrere og fordampe. Kviksølv anvendes tillige kun i polyuretan, som kun kan genvendes ved feed-stock genanvendelse eller ved energi genvinding (forbrænding). Kviksølvs skæbne ved feed-stock genanvendelse er ikke kendt.

3.4.1 Cadmium og cadmiumforbindelser

Substance	Cadmium and cadmium compounds
CAS Number	7440-43-9, 10108-64-2, 542-83-6, 7790-79-6, 4464-23-7, 7790-80-9, 17010-21-8, 1306-19-0, 10124-36-4, 1306-23-6 etc.
Justification	Danish list of undesired substances; Norwegian priority list: Candidate list; Registry of intentions (CLP, restriction); List of CMR-substances in toy.
Function	<p>Pigment - colours include yellow, orange, red and in principle all others colours as green, brown, beige etc. that may be based on yellow and red. Cadmium sulphide and cadmium selenide are the main substances used as pigments. [MST 1980].</p> <p>Heat and UV stabilizer in PVC and similar materials [MST 1980].</p> <p>The starting material is cadmium oxide for pigments and PVC stabilisers, but also the cadmium metal can be used for making the stabiliser [EU, 2007].</p>
Relevant types of plastics	Cadmium pigments may be used in all types of plastics being coloured. Cadmium stabilizers are used mainly in PVC.
Main article groups	Cadmium pigments are/were used mainly in quality products with a long lifetime. Cadmium pigments are/were used anywhere the colours in question are needed, and in particular for safety purposes. [Hansen et al 2005]. Cadmium stabilizers were used mainly for outdoor purposes (doors, windows, crystal clear roof windows) [Hansen et al 2005].
Potential for release from plastics	Cadmium and cadmium compounds will be solid bound in plastics. Release is related to wear and tear of products (e.g. if a plastic window is grinded before painting). Existing information does not allow quantification. However, the quantity released can be assessed as small compared to the quantity present in the product.
Potential for exposure of consumers	Cadmium pigments and stabilisers are today banned in EU. So exposure will only happen from products produced before the ban or illegal products sold on the market. Many items containing cadmium are, however, still in use (e.g. old plastic building toy bricks, windows frames etc.). Exposure to the substance from cadmium pigments and stabilizers is considered unlikely due to the low concentration of the pigments in the plastic. However it is possible that the consumers can be exposed to cadmium from plastic items (e.g. old kitchen items or windows) exposed to acidic liquids (acetic acid, HCl).

Substance	Cadmium and cadmium compounds
Fate of the substance by recycling	Cadmium pigments and stabilisers will remain in the plastic by mechanical recycling as they are solid bound.
References	<p>EU (2007). European Union Risk Assessment Report. Cadmium metal. http://esis.jrc.ec.europa.eu/doc/risk_assessment/REPORT/cdmetalreport303.pdf</p> <p>Hansen, E.; Lassen, C.; Stuer-Lauridsen, F.; Kjølholt, J. (2002). Heavy metals in waste. EU Commission, DG Environment, Brussels 2002.</p> <p>Hansen, E.; Lassen, C.; Maxson, P. (2005). RoHS substances (Hg, Pb, Cr(VI), Cd, PBB and PBDE) in electronic equipment in Belgium. Directorate-General Environment. Federal Public Service Health, Food Chain Safety and Environment. Belgium.</p> <p>MST (1980). Cadmiumforurening. En redegørelse om anvendelse, forekomst og skadenvirkninger af cadmium i Danmark. Miljøstyrelsen, København.</p> <p>ATSDR 2012d. Toxicological Profile for Cadmium. Agency for Toxic Substances and Disease Registry. U.S. Dept. of Health and Human Services, Public Health Service: www.atsdr.cdc.gov/toxprofiles/index.asp</p>

3.4.2 Chrom og chromforbindelser

Substance	Chromium and chromium compounds - see also section 3.4.3, 3.4.6-3.4.8 and 3.11.6
CAS Number	1333-82-0, 7778-50-9, 7789-09-5, 10588-01-9, 7789-00-6, 13765-19-0, 7789-06-2, 24613-89-6, 12656-85-8, 1344-37-2, 1308-38-9, 7738-94-5, 7758-97-6, 7775-11-3, 7789-12-0, 7789-09-5, 10294-40-3, 13530-68-2, 13530-65-9, 14977-61-8, 37300-23-5, 11103-86-9, 18540-29-7 etc.
Justification	Norwegian priority list; Candidate list; List of CMR substances in toy; Registry of intentions (SVHC, restriction).
Function	Catalyst for production of plastics (chromium trioxide - see section 3.16), component in pigments (yellow, red and green colours - see section 3.25-3.28) [Annex XV report; Hoffmann et al 2002].
Relevant types of plastics	PVC, polyethylene, polypropylene and other non-specified plastics [Annex XV report; Hoffmann et al 2002].
Main article groups	All articles, where a need for yellow, red and green colours exist.
Potential for release from plastics	Chromium and chromium compounds is solid bound in plastics. Release is related to wear and tear of products (e.g. if a plastic window is grinded before painting). Existing information does not allow quantification. However, the quantity released can be assessed as small compared to the quantity present in the product.
Potential for exposure of consumers	Chromium can be found in many consumer products such as: wood treated with copper dichromate, leather tanned with chromium sulphate and stainless steel cookware. The exposure to the consumers from plastic coloured with chromium based pigments is judged insignificant. The same is the case for the chromium used as catalyst as catalysts are used in very low concentrations.
Fate of the substance by recycling	Chromium pigments will stay in the plastic by mechanical recycling as they are solid bound.

Substance	Chromium and chromium compounds - see also section 3.4.3, 3.4.6-3.4.8 and 3.11.6
References	<p>Annex XV report. Proposal for a restriction. http://echa.europa.eu/documents/10162/4d88d444-4b8b-48ab-9c11-6e74819e047c</p> <p>Hoffmann L., Grinderslev M., Helweg C., Rasmussen J.O. (2002). Massestrømsanalyse af chrom og chromforbindelser. Miljøprojekt Nr. 738. Miljøstyrelsen.</p> <p>Swedish Chemicals Agency. (2007). Varuguiden. (Guide for articles) Database. https://webapps.kemi.se/varuguiden/VarugrupperAmne.aspx.</p> <p>ATSDR 2012e. Toxicological Profile for chromium. Agency for Toxic Substances and Disease Registr. U.S. Dept. of Health and Human Services, Public Health Service. www.atsdr.cdc.gov/toxprofiles/index.asp</p>

3.4.3 Chromtrioxid

Substance	Chromium trioxide - see also section 3.4.2
CAS Number	1333-82-0
Justification	Norwegian priority list; Candidate list; Registry of intentions (SVHC); List of CMR-substances in toy.
Function	Catalyst for production of plastics. Intermediate for pigment manufacture [Annex XV report].
Relevant types of plastics	Polyethylene and other plastics [Annex XV report].
Main article groups	Not specified - probably many different products.
Potential for release from plastics	Probably solid bound and may only be released by wear and tear.
Potential for exposure of consumers	No potential risk for exposure as chromium trioxide only is used as catalyst in low amount for the polymerisation of plastics and as intermediate for pigments which is solid bound in the plastic.
Fate of the substance by recycling	Chromium compounds will stay in the plastic by mechanical recycling as they are solid bound.
References	Annex XV report. http://echa.europa.eu/documents/10162/13640/svhc_axrep_germany_cmr_chromium-trioxide_en.pdf

3.4.4 Kobolt(II) diacetat

Substance	Cobalt(II) diacetate
CAS Number	71-48-7
Justification	Candidate list; Registry of intentions (SVHC); CMR.

Substance	Cobalt(II) diacetate
Function	<p>Pigment for tinting PET a light blue colour [Annex XV report].</p> <p>Note: This use is being phased out according to information from the Committee of PET manufacturers in Europe [ECHA, 2011].</p> <p><i>Other plastic related function:</i> Catalyst e.g. in the production of Purified Terephthalate Acid (an intermediate for the manufacture of polyester fibre) – by far the main use [Annex XV report].</p>
Relevant types of plastics	Polyester (PET).
Main article groups	PET bottles.
Potential for release from plastics	<p>Molecular weight: 177.02g/mol, melting/freezing point: No data for anhydrous form (loses 4 H₂O at 140 °C for tetrahydrate form), water solubility: Readily soluble [Annex XV report 2010].</p> <p>Probably solid binding in plastics. The pigment should not be assumed to migrate. Release only by wear and tear of plastic materials. The potential for release from plastics is likely to be insignificant.</p>
Potential for exposure of consumers	The substance is easily soluble in water and might migrate from blue PET bottles into the liquid (e.g. mineral water) contained in the bottles, but no data is available in the Annex XV report to support this judgement. The reason might be that the salt is solid bound in the PET. Anyhow the manufacturers of PET bottles will out phase the substance from use in PET bottles.
Fate of the substance by recycling	It is judged that by mechanical recycling the substance (and colour) will remain in the plastic, but a small amount might be removed in the washing step due to the high solubility in water.
References	<p>Annex XV report. http://echa.europa.eu/documents/10162/13640/svhc_axrep_netherlands_cmr_codiacetate_en.pdf</p> <p>ECHA (2011). Background document for cobalt (II) diacetate. http://echa.europa.eu/documents/10162/e8682070-93db-40d4-846b-214daf89719e</p> <p>Nilsson N. (2014). Expert assessment by Nils Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.4.5 Bly og blyforbindelser

Substance	Lead and lead compounds - see also section 3.4.6-3.4.8.
CAS Number	75-74-1, 78-00-2, 301-04-2, 1072-35-1, 1314-41-6, 1317-36-8, 1319-46-6, 1335-32-6, 1344-37-2, 6838-85-3, 7428-48-0, 7439-92-1, 7446-14-2, 7446-27-7, 7758-95-4, 7758-97-6, 12141-20-7, 12656-85-8, 13424-46-9, 13453-65-1, 15245-44-0, 16038-76-9, 16183-12-3, 17570-76-2, 24824-71-3, 25808-74-6, 53807-64-0, 61790-14-5, etc.
Justification	Danish list of undesired substances; Candidate list; Norwegian priority list; List of CMR-substances in toy; Registry of intentions (SVHC, restriction).
Function	Heat and UV stabiliser for PVC (50% of all stabilisers used for PVC), pigments [Hansen et al, 2005; PVC, 2012].
Relevant types of plastics	Lead pigments may be used in all types of plastics being coloured. Lead stabilizers are used in PVC.

Substance	Lead and lead compounds - see also section 3.4.6-3.4.8.
Main article groups	<p>Lead pigments may be used in all products where the colours provided are required. The colours available include yellow (lead chromates), orange, and red (mixtures of lead chromates/molybdates) and in fact all other colours like green, brown, beige, etc. that may be based on yellow or red. [Hansen et al 2005].</p> <p>Lead stabilisers are dominantly used for pipes, gutters, outdoor products inclusive of roofs, windows and doors besides electrical cables and wires [Hansen et al 2005]. Regulated in plastic since 2001 in Denmark and implemented in 2003. The limit value is 100 mg/kg. EU also has set limits in ELV and RoHS directives and PVC producers in EU expect total substitution in 2015. Based on a restriction proposal a limit for lead in articles that can be mouthed by children is expected [WTO 2014].</p>
Potential for release from plastics	The substance is solid bound. Release is related to wear and tear of products (e.g. if a plastic window is grinded before painting). Existing information does not allow quantification. However, the quantity released can be assessed as small compared to the quantity present in the product.
Potential for exposure of consumers	The most likely source of exposure is ingestion of contaminated food and drinking water. Exposure from lead in plastics either as a stabilizer or as a colour pigment is low. Release might happen in acidic environment and analysis standards exist which can be used for assessing the risk under these environmental conditions. Due to the ban in Denmark the risk for exposure is judged to be insignificant.
Fate of the substance by recycling	Lead substances will remain in the plastic during mechanical recycling as it is solid bound.
References	<p>ATSDR 2012f. Toxicological Profile for lead. Agency for Toxic Substances and Disease Registry. U.S. Dept. of Health and Human Services, Public Health Service: www.atsdr.cdc.gov/toxprofiles/index.asp</p> <p>Hansen, E.; Lassen, C.; Stuer-Lauridsen, F.; Kjølholt, J. (2002). Heavy metals in waste. EU Commission, DG Environment, Brussels 2002.</p> <p>Hansen, E.; Lassen, C.; Maxson, P. (2005). RoHS substances (Hg, Pb, Cr(VI), Cd, PBB and PBDE) in electronic equipment in Belgium. Directorate-General Environment. Federal Public Service Health, Food Chain Safety and Environment. Belgium.</p> <p>PVC (2012). Lead stabilisers. webpage: http://www.pvc.org/en/p/lead-stabilisers</p> <p>Swedish Chemicals Agency. (2007). Varuguiden. (Guide for articles) Database. https://webapps.kemi.se/varuguiden/VarugrupperAmne.aspx</p> <p>WTO [2014]. https://members.wto.org/crnattachments/2014/tbt/eec/14_4233_01_e.pdf</p>

3.4.6 Blychromat

Substance	Lead chromate - see also section 3.4.5
CAS Number	7758-97-6
Justification	Norwegian priority list; Candidate list; Registry of intentions (SVHC); List of CMR substances in toy.
Function	Pigment/used in manufacturing of other lead chromate pigments [Annex XV report; Zweifel, 2001]. Provides green-yellow to red-yellow colours [Annex XV report].

Substance	Lead chromate - see also section 3.4.5
Relevant types of plastics	Used in plastic in all kinds of application [Zweifel, 2001].
Main article groups	Used in plastic in all kinds of application [Zweifel, 2001].
Potential for release from plastics	Molecular weight: 323.18 g/mol, melting/freezing point: 844 °C, water solubility (two values found): 0.0000058 g/100 ml at 25°C and 0.2 mg/l [Annex XV report 2009]. The substance is solid bound. Release is related to wear and tear of products (e.g. if a plastic window is grinded before painting). Existing information does not allow quantification. However, the quantity released can be assessed as small compared to the quantity present in the product.
Potential for exposure of consumers	Exposure from lead in plastics is low. Release might happen in acidic environment and analysis standards exist which can be used for assessing the risk under these environmental conditions. Due to the ban in Denmark the risk for exposure is judged to be insignificant.
Fate of the substance by recycling	Lead chromate will remain in the plastic during mechanical recycling.
References	Annex XV report. http://echa.europa.eu/documents/10162/13640/svhc_axvrep_france_cmr_lead_chromate_20090831_en.pdf Zweifel, H. (2001). Plastics additives handbook. 5th edition. Carl Hanser Verlag, Munich.

3.4.7 Blychromatmolybdænsulfat (C.I. Pigment Red 104)

Substance	Lead chromate molybdate sulphate red (C.I. Pigment Red 104) - see also section 3.4.5
CAS Number	12656-85-8
Justification	Norwegian priority list; Candidate list; Registry of intentions (SVHC); List of CMR substances in toy.
Function	Pigment (red). The plastic industry is the largest consumer of C.I. Pigment Red 104 [Annex XV dossier].
Relevant types of plastics	All types of plastics, where red pigments are used.
Main article groups	All types of plastic products, where red pigments are used.
Potential for release from plastics	The substance is solid bound. Release is related to wear and tear of products (e.g. if a plastic window is grinded before painting). Existing information does not allow quantification. However, the quantity released can be assessed as small compared to the quantity present in the product.
Potential for exposure of consumers	The substance is composed by 69-80% lead chromate (323.2 g/mol), 9-15 % lead sulphate (303.4 g/mol) and 3-7 % lead molybdate (367.1 g/mol). Melting/freezing point: > 800 °C, vapour pressure: insignificant, water solubility: < 0.01 mg/l at 20°C [Annex XV dossier 2009]. Exposure from lead in plastics is low. Release might happen in acidic environment and analysis standards exist which can be used for assessing the risk under these environmental conditions. Due to the ban in Denmark the risk for exposure is judged to be insignificant.
Fate of the substance by recycling	The lead substance will remain in the plastic during mechanical recycling.

Substance	Lead chromate molybdate sulphate red (C.I. Pigment Red 104) - see also section 3.4.5
References	<p>Annex XV dossier http://echa.europa.eu/documents/10162/13640/svhc_axvrep_france_cmr_lead_chromate_sulfate_red_20090831_en.pdf</p> <p>Swedish Chemicals Agency (2007). Varuguiden.(Article guide) Database. https://webapps.kemi.se/varuguiden/VarugrupperAmne.aspx.</p>

3.4.8 Blysulfochromat (C.I. Pigment Yellow 34)

Substance	Lead sulfochromate yellow (C.I. Pigment Yellow 34) - see also section 3.4.5
CAS Number	1344-37-2
Justification	Danish list of undesired substances; Norwegian priority list; Candidate list; Registry of intentions (SVHC); List of CMR substances in toy.
Function	Pigment (yellow).
Relevant types of plastics	Mainly HDPE, LDPE, PVC [Zweifel, 2001], cellulose acetate [Annex XV] and polypropylene [Swedish Chemicals Agency, 2007]. In reality all types of plastics, where yellow pigments are used.
Main article groups	In reality all types of plastics, where yellow pigments are used.
Potential for release from plastics	The substance is solid bound. Release is related to wear and tear of products (e.g. if a plastic window is grinded before painting). Existing information does not allow quantification. However, the quantity released can be assessed as small compared to the quantity present in the product.
Potential for exposure of consumers	<p>The substance is composed by 40-90% lead chromate (323.2 g/mol) and 20-50 % lead sulphate (303.4 g/mol). Melting/freezing point: 840 °C, vapour pressure: insignificant, water solubility: < 0.01 mg/l at 20°C [Annex XV dossier 2009].</p> <p>Exposure from lead in plastics is low. Release might happen in acidic environment and analysis standards exist which can be used for assessing the risk under these environmental conditions. Due to the ban in Denmark the risk for exposure is judged to be insignificant.</p>
Fate of the substance by recycling	The lead substance will remain in the plastic during material recycling.
References	<p>Annex XV dossier http://echa.europa.eu/documents/10162/13640/svhc_axvrep_france_cmr_lead_sulfochromate_yellow_20090831_en.pdf</p> <p>Swedish Chemicals Agency (2007). Varuguiden. (Article guide) Database. https://webapps.kemi.se/varuguiden/VarugrupperAmne.aspx.</p> <p>Zweifel, H. (2001). Plastics additives handbook. 5th edition. Carl Hanser Verlag, Munich.</p>

3.4.9 Kviksølv og kviksølvforbindelser

Substance	Mercury and mercury compounds
CAS Number	55-68-5, 62-38-4, 100-57-2, 123-88-6, 593-74-8, 627-44-1, 628-86-4, 1335-31-5, 1344-48-5, 7439-97-6, 7487-94-7, 7546-30-7, 7783-35-9, 8003-05-2, 10112-91-1, 62-38-4, 103-27-5, 13302-00-6, 13864-38-5, 26545-49-3
Justification	Danish list of undesired substances; Norwegian priority list; Registry of intentions (CLP, restriction); CMR.
Function	Catalyst [UNEP, 2011].
Relevant types of plastics	Polyurethane [UNEP, 2011].
Main article groups	Examples of mercury catalyst based polyurethanes in use today, for example in gaskets and seals, as encapsulant for electronic assemblies, in film and television props, in vibration dampers, for clear polyurethane on labels, water resistant coatings and concrete sealants, for boat repair and repair on conveyor belts, in rollers on swivel chairs and roller skates and in shoe soles. It has also been used in flooring [UNEP, 2011].
Potential for release from plastics	The substances are not chemically bound and will migrate. Elemental mercury will vaporise from the plastic material, e.g. flooring [Lassen et all, 2008]. The use of mercury in products on the Danish market has in principle been banned in plastics since 1994. At that time the allowed limit was 50 ppm. In 2003 it was changed to 100 ppm. The use of mercury as a catalyst in PU was first generally recognized in 2005. This use is banned in Denmark but not in other EU countries and globally.
Potential for exposure of consumers	Mercury present in polyurethane products should be expected slowly to evaporate. Consumers may be exposed by inhalation and skin contact but actual risk is likely small. However, measurements confirming this assessment are not available.
Fate of the substance by recycling	Polyurethane can only be recycled by feed stock recycling or energy recovering as practised in Denmark. Most mercury has likely evaporated by then. The fate of mercury by feed stock recycling is not known. Polyurethane products containing mercury will in Denmark dominantly be directed to incineration.
References	<p>Annex XV restriction report – phenylmercury. Phenylmercury acetate, phenylmercury propionate, phenylmercury 2-ethylhexanoate, phenylmercuric octanoate, phenylmercury neodecanoate.</p> <p>http://enfo.agt.bme.hu/drupal/sites/default/files/annex%20XV%2ophenylmercury.pdf</p> <p>Lassen C., Andersen B.H., Maag J., Maxson P. (2008). Options for reducing mercury use in products and applications, and the fate of mercury already circulating in society. European Commission Directorate-General Environment, Brussel.</p> <p>UNEP. 2011. Intergovernmental negotiating committee to prepare a global legally binding instrument on mercury. Third session Nairobi, 31 October–4 November 2011. Submission by the Government of Norway on processes using mercury, particularly catalysts in the production of polymers and chemicals.</p> <p>http://www.zeromercury.org/phocadownload/Developments_at_UNEP_level/INC3/CRP8_Norway_processes.pdf</p> <p>Weinberg, J. (2010). An NGO introduction to mercury pollution. International POPs Elimination Network (IPEN).</p> <p>http://www.ipen.org/penweb/documents/book/pen%20mercury%20booklet_s.pdf</p>

3.5 Flammehæmmere

Plast er relativt let brændbart og kan udvikle korrosiv eller giftig røg ved forbrænding. For at øge modstandsdygtigheden overfor brand tilsættes ofte flammehæmmere til polymeren.

Flammehæmmerne har forskellig måde at fungere på [Subramaniam 2013]:

- Nedbrydning uden dannelse af flygtige gasser.
- Fjerne kritiske radikaler, så flammer kan forebygges eller fjernes.
- Fjerne varme ved endothermiske reaktioner;
- Danne et varmeisoleringe kokslag på overfladen af polymeren.

Det typiske indhold af bromerede flammehæmmere i plast er 12-18 % (w/w) [Hansen et all, 2013].

I følge [US EPA, 2014] det typiske indhold af forskellige flammehæmmere er som angivet i følgende skema:

Type flammehæmmer	Indhold (vægt %)
Brom -baseret	2-25 %
Aluminium hydroxid	13-60 %
Magnesium hydroxid	53-60 %
Chlorofosfater	9-10 %
Organofosfor	5-30 %

Evnen til at migrere varierer kraftigt mellem stofferne. Visse stoffer og i særdeleshed bromerede flammehæmmere migrerer relativt let ved driftstemperaturer for elektriske og elektroniske produkter (EEE), som er et af hovedanvendelses områderne for flammehæmmere og kan derfor medføre væsentlig påvirkning af forbrugere.

Andre stoffer såsom de reaktive bromerede flammehæmmere er dog stærkt bundet i plastmaterialet og vil ikke migrere i væsentligt omfang. De vil derfor ikke medføre væsentlig påvirkning af forbrugere.

Alternativer til eksisterende flammehæmmere udgør en relativ stor del af denne stofgruppe. Alternativerne er generelt mindre godt undersøgt og karakteriseres derfor af mangel på viden mht. både anvendelser og skæbne i produkterne, samt hvad angår efterfølgende genanvendelsespotentiale.

Stoffernes skæbne ved genanvendelse afhænger stærkt af de pågældende plastmaterialer. For materialer, som kan genanvendes mekanisk (neddeling/omsmelting – f.eks. PVC, PE, PP og PS) vil flammehæmmerne forblive i den plast som genanvendes. Materialer som PU og epoxy kan kun genanvendes ved forbrænding eller ved feed-stock genanvendelse. I begge tilfælde vil alle rester af flammehæmmere blive nedbrudt med dannelse af nedbrydningsprodukter.

Det bør bemærkes, at chlorparaffiner (SCCP and MCCP – se afsnit 3.9.3 og 3.9.4) også vil fungere som flammehæmmere foruden at fungere som blødgørere.

3.5.1 Bor syre

Substance	Boric acid (H_3BO_3)
CAS Number	10043-35-3, 11113-50-1
Justification	Danish list of undesired substances; Candidate list; Registry of intentions (CLP, SVHC); CMR.
Function	Boric acid can be used as flame retardant for polystyrene beads [Weil and Litchi, 2009]. Component (39-48 %) in zinc borate flame retardant [Murphy, 2001]. Component (not further defined) in silly putty toys [Annex XV dossier].

Substance	Boric acid (H_3BO_3)
Relevant types of plastics	Polystyrene beads [Weil and Litchi, 2009], PVC [Murphy, 2001], Silly putty (synthetic rubber) [Silly putty 2012].
Main article groups	Polystyrene foam [Weil and Litchi, 2009]; PVC leather cloth, foil, calendering film and cable [Murphy, 2001], and Silly putty toy [Annex XV dossier].
Potential for release from plastics	Molecular weight: 61.83 g/mol, melting point: No melting point can be defined in the range 25- 1000°C due to the decomposition of the substance, water solubility : 47.2 g/l at 20°C, log K_{ow} : -1.09 ± 0.16 (22± 1°C) [Annex XV dossier 2010]. Zinc borates will be solid bound, while boric acid may migrate. Not solid bound in silly putty, will migrate at least partly. [Nilsson, 2012].
Potential for exposure of consumers	If used in polystyrene as flame-retardant it is judged that the consumer will not be exposed as the substance will be present in polystyrene used for insulation purposes and the substance will not evaporate. Exposure might happen to workers (professionals). Uses as PVC leather cloth, foil, calendering film and silly putty toy may lead to exposure of children and adults.
Fate of the substance by recycling	By mechanical recycling the substance will remain in the plastic as it will not evaporate. However if the temperature rise to more than 100° C, water (H_2O) will be split off and HBO_2 formed. By energy recovery in incineration plants the substance will be converted to B_2O_3 and caught by the filters.
References	<p>Annex XV dossier 2010. http://echa.europa.eu/documents/10162/13640/svhc_axrep_germany_cmr_boric_acid_en.pdf</p> <p>Murphy, J. (2001). Additives for plastics handbook. Elsevier Science Ltd. Oxford, New York, Tokyo.</p> <p>Nilsson N. (2014). Expert assessment by Nils Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Silly putty (2012). http://www.chem.umn.edu/outreach/Sillyputty.html (Dec 2012).</p> <p>Wiel, E.D., Levchik, S.V. (2009). Flame retardants for plastics and textiles. Practical applications. Carl Hanser Verlag, Munich.</p>

3.5.2 Bromerede flammehæmmere

Substance	Brominated flame retardants - see also section 3.5.3
CAS Number	32534-81-9 (PeBDE), 32536-52-0 (OBDE), 1163-19-5 (DBDE), 25637-99-4 (HBCDD; 79-94-7(TBBPA), 3194-55-6, 134-51-7, 134237-52-8, etc. Some of the brominated flame retardants are covered by specific sections.
Justification	Danish list of undesired substances; Norwegian priority list; Candidate list; Registry of intentions (CLP, SVHC); CMR.
Function	Flame retardant [Zweifel, 2001].
Relevant types of plastics	ABS, EPS, HIPS, polyamides, PBT, polyethylene, polypropylene, epoxy, unsaturated polyester, polyurethane [Zweifel, 2001].
Main article groups	Brominated flame retardants are frequently used in: <ul style="list-style-type: none"> • ‘Brown’ goods such as television sets, computer hardware housings and monitors, etc.;

	<ul style="list-style-type: none"> in polystyrene foams (e.g. see also hexabromocyclododecane(HBCDD)); EPS and XPS: Insulation boards in buildings, against frost heaves of road and railway embankments, in transport vehicles; <p>EPS: Packaging material (minor use and not in food packaging).</p> <p>HIPS: Electric housings for VCR; Electrical and electronic equipment e.g. distribution boxes for electrical lines; Video cassette housing.</p> <ul style="list-style-type: none"> Polymer dispersions in textile coating: Upholstery fabric; Bed mattress ticking; Flat and pile upholstered furniture (residential and commercial furniture); Upholstery seatings in transportation, draperies, and wall coverings; Interior textiles e.g. roller blinds; Automobile interior textiles [Annex XV].
Potential for release from plastics	<p>Flame retardants can be either reactive (chemically bound in the material) or additive (not chemically bound in the material) [Zweifel, 2001]. While TBBPA generally are used as a reactive flame retardant, the other brominated flame retardants focused on here are additive flame retardants [Lassen et al., 1999]. Additive flame retardants will migrate.</p> <p>For thermoplastics non-reactive flame retardants (additive) are usually used, while reactive flame retardants are normally used for thermosetting plastics (epoxy, unsaturated polyester and polyurethane) [Frisk et al, 2003; Zweifel, 2001].</p> <p>Additive flame retardants can be released from the plastic material since they are not chemically bound. For the reactive flame retardant release is limited since they are chemically bound within the polymer. [Frisk et al, 2003].</p>
Potential for exposure of consumers	<p>Polybrominated biphenyls and diphenylethers have been banned or restricted to <0.1% in new electrical and electronic products according to EU ROHS directive since 2006, but they may still be present in a number of products still in service for a considerable time. Consumers can thus be exposed to the banned substances from inhalation of either emitted particles with the condensed flame retardants or the flame-retardant themselves for a considerable time. Marketing and use of HBCDD requires special authorisation according to the REACH-regulation from 21 August 2015.</p> <p>For reactive flame retardants potential for exposure of consumers is limited as they are chemically bound within the polymer.</p>
Fate of the substance by recycling	Brominated flame retardants will probably remain in the recycled materials by mechanical recycling. By energy recovery in incineration plants the substance will be decomposed.
References	<p>Frisk, P.R., Girling, A.E., Widely, R.J. (2003). Prioritisation of flame retardants for environmental risk assessment. UK EPA. http://ec.europa.eu/environment/waste/stakeholders/industry_assoc/ebfrip/annex2.pdf</p> <p>Lassen C., Løkke S., Andersen L.I. (1999). Brominated Flame Retardants - Substance Flow Analysis and Assessment of Alternatives Environmental Project Nr. 494/1999. The Danish Environmental Protection Agency</p> <p>Zweifel, H. (2001). Plastics additives handbook. 5th edition. Carl Hanser Verlag, Munich.</p>

3.5.3 Hexabromcyclododecan (HBCDD) og alle hoved diastereoisomerer

Substance	Hexabromocyclododecane (HBCDD) and all major diastereoisomers identified - Alpha-hexabromocyclododecane, Beta-hexabromocyclododecane, Gamma-hexabromocyclododecane - see also section 3.5.2)
CAS Number	25637-99-4; 3194-55-6; 134237-50-6; 134237-51-7; 134237-52-8 (included in the group of brominated flame retardants)
Justification	Danish list of undesired substances; Norwegian priority list; Candidate list; Registry of intentions (SVHC); CMR.
Function	Flame retardant
Relevant types of plastics	Expandable polystyrene (EPS), extruded polystyrene (XPS), High impact polystyrene (HIPS), polymer dispersions on cotton or cotton/synthetic blends [Annex XV dossier].
Main article groups	<p>EPS and XPS:</p> <ul style="list-style-type: none"> • Insulation boards in building constructions e.g. houses' walls, cellars and indoor ceilings and "inverted roofs" (outdoor) – main use; • Insulation boards against frost heaves of road and railway embankments – main use; • Insulation boards (against cold or warm) of transport vehicles e.g. lorries and caravans. <p>EPS: Packaging material (minor use and not in food packaging).</p> <p>HIPS:</p> <ul style="list-style-type: none"> • Electric housings for VCR; • Electrical and electronic equipment e.g. distribution boxes for electrical lines; • Video cassette housing. <p>Polymer dispersions in textile coating:</p> <ul style="list-style-type: none"> • Upholstery fabric; • Bed mattress ticking; • Flat and pile upholstered furniture (residential and commercial furniture); • Upholstery seatings in transportation, draperies, and wall coverings; • Interior textiles e.g. roller blinds; • Automobile interior textiles [Annex XV dossier].
Potential for release from plastics	The substance is not chemically bound and will migrate. Solid substance. Approximate boiling point: 172 – 205 °C (in average 190 °C), log P _{o/w} : 5.1 -5.6. Given sufficient time, a significant part of the substance will probably be released by migration to the surface followed by evaporation or removal by washing. Tear and wear will also take place.

Substance	Hexabromocyclododecane (HBCDD) and all major diastereoisomers identified - Alpha-hexabromocyclododecane, Beta-hexabromocyclododecane, Gamma-hexabromocyclododecane - see also section 3.5.2)
Potential for exposure of consumers	<p>The main part (90 %) of HBCDD is used as flame retardant in polystyrene (PS). PS-containing HBCDD, in the form of Expanded PS (EPS) or Extruded PS (XPS), is mainly used as rigid thermal insulation panels/boards for buildings and for road and railway constructions to prevent frost heaves and provide a lightweight load-spreading construction material. HBCDD is also used to flameretarded textiles (for furniture, automobile interiors etc.) and in smaller quantities in High Impact PS (HIPS). (Annex XV dossier). Marketing and use of HBCDD requires special authorisation according to the REACH- regulation from 21 August 2015.</p> <p>Exposure to the consumers from electric and electronic equipment is possible because the flame retardants are used in places which get hot during service. Consumers can be exposed to the substances from inhalation of either emitted particles with the condensed flame retardants or the flame-retardant themselves by touching surfaces of relevant products.</p>
Fate of the substance by recycling	By recycling some evaporation of HBCDD will likely take place but a significant part will remain in the recycled materials. By energy recovery in incineration plants the substance will be decomposed.
References	Annex XV dossier http://echa.europa.eu/documents/10162/3f5de199-8732-4881-aec6-730bf9499a36

3.5.4 Molybdæn trioxid

Substance	Molybdenum trioxide
CAS Number	1313-27-5
Justification	Danish list of undesired substances; CMR.
Function	Flame retardant.
Relevant types of plastics	Polyester, PVC [Canada 2009].
Main article groups	No information.
Potential for release from plastics	Solid bound. Melting point: 795 °C, boiling point: 1155 °C, solubility in water: 0.5 g /l. Water absorption in both polyester and PVC is low so it is judged that molybdenum trioxide will not migrate even if in contact with water.
Potential for exposure of consumers	It is judged that there is no risk for exposure.
Fate of the substance by recycling	The molybdenum will remain in the material by mechanical recycling and end in the slag by energy recovery by incineration
References	<p>Canada (2009). Molybdenum trioxide. Office of Environmental Health Hazard Assessment. http://www.oehha.ca.gov/prop65/CRNR_notices/state_listing/prioritization_notices/pdf/Molybdenumtrioxide.pdf</p> <p>ChemBlink.com; Online database of Chemicals. http://www.chemblink.com/products/1313-27-5.htm</p>

3.5.5 Tris(2-chlorethyl)fosfat

Substance	Tris(2-chloroethyl)phosphate (TCEP)
CAS Number	115-96-8
Justification	Candidate list; Registry of intentions (SVHC); List of CMR substances;
Function	Plasticiser and viscosity regulator with flame retardant properties (for polyurethane, polyesters, polyvinyl chloride and other polymers), secondary plasticiser (for PVC), flame retardant (for paint and varnishes containing e.g. polyvinyl acetate) [Annex XV report].
Relevant types of plastics	<p>Polyurethane, polyester, PVC, polyvinyl acetate [Annex XV], polymethylacrylate (PMMA), epoxy, polyamide, polycarbonate, polyurethane, thermoplastic polyester and unsaturated polyester [Swedish Chemicals Agency, 2007].</p> <p>The main use of today is in the production of unsaturated polyester resins (80 %). Other fields of application are acrylic resins, adhesives and coatings. [EU, 2008].</p>
Main article groups	Main industrial branches include furniture, the textile and the building industry (roof insulation); it is also used in the manufacture of cars, railways and aircrafts, and in paint and varnishes [Annex XV report; EU, 2008].
Potential for release from plastics	<p>The compound is not chemically bound and may be regarded as semi-volatile (Molecular weight: 285.49 g/mol, no boiling point but decomposition at 320°C , vapour pressure: 43 Pa at 136.9 °C and 0.00114 Pa at 20°C (extrapolated)).</p> <p>Given sufficient time, the major part of the substance will probably be released by leaching to the surface followed by evaporation or removal by washing. Tear and wear will also take place but be of minor importance.</p>
Potential for exposure of consumers	<p>According to [ATSDR 2012a] routes of exposure for the consumers are oral - as the predominant route of exposure is through ingestion of contaminated food or water.</p> <p>Contaminated food is a result of the extensive use of phosphate esters in plastic. Exposure might also happen by inhalation of contaminated indoor air from fumes of plastic, adhesives, foams or electronics.</p>
Fate of the substance by recycling	The TCEP will mainly remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed. The content of chlorine may add to dioxin and HCl formation in the chimney system.
References	<p>Annex XV report. http://echa.europa.eu/documents/10162/13640/svhc_axrep_austria_cmr_tcep_2009083_1_en.pdf</p> <p>EU (2008). EU Risk Assessment Report. Tris(2-chloroethyl) phosphate, TCEP. CAS-No.: 115-96-8. http://esis.jrc.ec.europa.eu/doc/risk_assessment/REPORT/tcepreport068.pdf</p> <p>Swedish Chemicals Agency (2007). Varuguiden.(Article guide) Database. https://webapps.kemi.se/varuguiden/VarugrupperAmne.aspx.</p> <p>ATSDR (2012a). Toxicological Profile for Phosphate Ester Flame Retardants. Agency for Toxic Substances and Disease Registry, U.S. Dept. of Health and Human Services, Public Health Service: www.atsdr.cdc.gov/toxprofiles/index.asp</p>

3.5.6 Tris(2-chlor-1-methylethyl)fosfat (TCEP)

Substance	Tris(2-chlor-1-methylethyl)phosphate (TCEP)
CAS Number	13674-84-5
Justification	Danish list of undesired substances.
Function	Flame retardant.
Relevant types of plastics	PUR. No certain information on other plastics, but the substance may be used in the same articles as TCEP (see section 3.5.5), as TCEP is regarded as an alternative for TCEP [EU 2014].
Main article groups	Toys. No certain information on other articles, but the substance may be used in the same articles as TCEP (see section 3.5.5), as TCEP is regarded as an alternative for TCEP [EU 2014].
Potential for release from plastics	The compound is not chemically bound and may be regarded as semi-volatile. Given sufficient time, the major part of the substance will probably be released by leaching to the surface followed by evaporation or removal by washing. Tear and wear will also take place but be of minor importance.
Potential for exposure of consumers	Probably most exposure by inhalation indoor from foamed PUR products. No data found to support this.
Fate of the substance by recycling	Polyurethane can only be recycled by incineration or by feedstock recycling. In both cases the substance. In Denmark only incineration is practised. The content of chlorine may add to formation of dioxins and HCl in the chimney system.
References	Larsen P.B., Andersen D. N., Lam H.R., Slothuus T. (2013). Survey of Tris(2-chloro-1-methylethyl)-phosphate. A LOUS review project. Danish Environmental Protection Agency. ATSDR (2012b). Toxicological Profile for Phosphate Ester Flame Retardants. Agency for Toxic Substances and Disease Registry, U.S. Dept. of Health and Human Services, Public Health Service: www.atsdr.cdc.gov/toxprofiles/index.asp . EU (2014). COMMISSION DIRECTIVE 2014/79/EU of 20 June 2014 amending Appendix C of Annex II to Directive 2009/48/EC of the European Parliament and of the Council on the safety of toys, as regards TCEP, TCEP and TDCP.

3.5.7 Bis(hexachlorocyclopentadieno) cyclooctan

Substance	Bis(hexachlorocyclopentadieno) cyclooctane
CAS Number	13560-89-9
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	CPE, engineering thermoplastics, HIPS, PE, PP, thermosets.
Main article groups	Electronics, wire cable, construction materials, waterborne emulsions & coatings.
Potential for release from plastics	The substance has a molecular weight of 654 g/mol and a melting point of 350 °C with decomposition and a vapour pressure of 0.006 mmHg at 200 °C. Log P _{o/w} : 9.3. Insoluble in water [EHSI 2004]. Due to the high molecular weight and melting point, significant migration is deemed unlikely. Migration is likely only relevant in contact with fatty products/oils.

Substance	Bis(hexachlorocyclopentadieno) cyclooctane
Potential for exposure of consumers	If used in plastic exposure is judged to be very low. Only in contact with fatty products/oils migration might take place.
Fate of the substance by recycling	Will stay in the plastic by mechanical recycling. By energy recovery the substance will be decomposed. The content of chlorine may add to formation of dioxins and HCl in the chimney system.
References	<p>EHSI (2004). Dechlorane Plus, High Production Volume (HPV) chemical Challenge Program Test plan, prepared by The ENVIRON Health Sciences Institute (EHSI) August 2004 (physical /chemical data).</p> <p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>US EPA (2014). An Alternatives Assessment for the Flame Retardant Decabromo-diphenyl Ether (DecaBDE). http://www.epa.gov/oppt/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.8 Decabromodiphenylætan (DBDPE)

Substance	Decabromodiphenyl ethane (DBDPE)
CAS Number	84852-53-9
Justification	List of alternative flame retardants
Function	Flame retardant
Relevant types of plastics	CPE, Engineering thermoplastics, HIPS, PE, PP, thermosets
Main article groups	Electronics, wire cable, construction materials, waterborne emulsions and coatings
Potential for release from plastics	Molecular weight: 971, melting point: 345 °C, boiling point: 676 °C, vapour pressure: 0 at 25° C. Predicted log P _{o/w} = 7.8 – 14. Due to the high molecular weight and boiling point, significant migration is deemed unlikely.
Potential for exposure of consumers	Judged to be low to negligible due to the high boiling point.
Fate of the substance by recycling	Will mainly remain in the recycled materials by mechanical recycling.

Substance	Decabromodiphenyl ethane (DBDPE)
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>CAS Chemnet.com, Online database of Chemicals. http://www.chemnet.com/cas/en/84852-53-9/1,2-Bis(pentabromophenyl)-ethane.html</p> <p>UK Environment Agency May (2007), Environmental risk evaluation report: 1,1'-(Ethane-1,2-diyl)bis (penta-bromobenzene). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/290840/choo507bmor-e-e.pdf</p> <p>US EPA (2014). An Alternatives Assessment for the Flame Retardant Decabromo-diphenyl Ether (DecaBDE). http://www.epa.gov/oppt/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.9 Åtylen (bistetrabromfthalimid) (EBTEBPI)

Substance	Ethylene (bistetrabromophthalimide) (EBTEBPI)
CAS Number	32588-76-4
Justification	List of alternative flame retardants
Function	Flame retardant
Relevant types of plastics	HIPS, PP, PP, PBT, OPET, PC and engineering thermoplastics in general
Main article groups	Electrical and electronic components, wire and cable insulation, switches and connectors, construction materials
Potential for release from plastics	<p>Molecular weight: 951.5, melting point: 446 °C. Solubility in water less than 0.1 g/100 ml at 21 °C. Vapour pressure at 25 °C is 2.5×10^{-22} mm Hg</p> <p>Due to the high molecular weight and melting point together with the low vapour pressure, migration is deemed unlikely.</p>
Potential for exposure of consumers	Deemed negligible as migration is unlikely.
Fate of the substance by recycling	Will mainly remain in the recycled materials by mechanical recycling.

Substance	Ethylene (bistetrabromophthalimide) (EBTEBPI)
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>ChemBlink.com, online database of chemicals. http://www.chemblink.com/products/32588-76-4.htm</p> <p>Albemarle Corporation (2004). HPV Data summary and test plan for 1H-Isoindole-1,3(2H)-dione, 2,2'-(1,2-ethanediyl)bis(4,5,6,7-tetrabromo-). http://www.epa.gov/hpv/pubs/summaries/thisoind/c15090.pdf</p> <p>US EPA (2014). An Alternatives Assessment for the Flame Retardant Decabromo-diphenyl Ether (DecaBDE). http://www.epa.gov/oppt/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.10 Tetrabrombisphenol A bis (2,3-dibrompropyl) æter (TBBPA-BDBPE)

Substance	Tetrabromobisphenol A bis (2,3-dibromopropyl) ether (TBBPA-BDBPE)
CAS Number	21850-44-2
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	ABS, HIPS, Phenolic resins, epoxy-laminates (based on similarity to TBBP-A).
Main article groups	Electric and electronic equipment.
Potential for release from plastics	Judged similar to 2,2',6,6'-tetrabromo-4,4'-isopropylidenediphenol (TBBPA - CAS no 79-94-7). TBBPA is a reactive flame retardant (see section 3.5.2). For reactive flame retardants release are limited as they are chemically bound within the polymer.
Potential for exposure of consumers	For reactive flame retardants potential for exposure of consumers is limited as they are chemically bound within the polymer.
Fate of the substance by recycling	Similar to TBBP-A (see section 3.5.2).
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.

3.5.11 Tris(tribromneopenty) fosfat (TTBNPP)

Substance	Tris(tribromneopentyl) phosphate (TTBNPP)
CAS Number	19186-97-1
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	PP.
Main article groups	Electronics, construction materials, cars.

Substance	Tris(tribromoneopentyl) phosphate (TTBNPP)
Potential for release from plastics	Molecular weight: 1018.46 g/mol, melting point: >180°C (decomposition: 309°C), boiling point: 719 °C, vapour pressure: 7x10 ⁻¹⁶ mmHg (20°C), water solubility: 0.0156mg/l at 20°C, log P _{ow} : - 4.87 [ResNovae technologies 2011]. Due to the high molecular weight the substance should be assumed not to migrate and be released from plastics.
Potential for exposure of consumers	Low to a negligible potential for exposure of consumers as the substance is assumed not to migrate.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. ResNovae technologies (2011). Material Safety Data Sheet: http://resnovatech.com/images/safety_sheets/PyroVex++B-115.pdf US EPA (2014). An Alternatives Assessment for the Flame Retardant Decabromo-diphenyl Ether (DecaBDE). http://www.epa.gov/oppt/dfe/pubs/projects/decaBDE/deca-report-complete.pdf

3.5.12 Tris(tribromophenoxy) triazin (TTBPTAZ)

Substance	Tris(tribromophenoxy) triazine (TTBPTAZ)
CAS Number	25713-60-4
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	ABS, HIPS.
Main article groups	Electronics.
Potential for release from plastics	The substance has a molecular weight of 10167g/mol, a melting point of 230°C and a boiling point of 812 °C. Due to the high molecular weight and boiling point the substance should be assumed not to migrate and be released from plastics.
Potential for exposure of consumers	Low to a negligible potential for exposure of consumers as the substance is assumed not to migrate.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. US EPA (2014). An Alternatives Assessment for the Flame Retardant Decabromo-diphenyl Ether (DecaBDE). http://www.epa.gov/oppt/dfe/pubs/projects/decaBDE/deca-report-complete.pdf

3.5.13 Triphenylfosfat

Substance	Triphenyl phosphate
CAS Number	115-86-6
Justification	List of alternative flame retardants
Function	Flame retardant and plasticiser
Relevant types of plastics	PPE-HIPS, PC-ABS and Cellulose Acetate
Main article groups	Electronics
Potential for release from plastics	The substance has a molecular weight of 3267 g/mol a melting point of 50.5°C. Boiling point is 245 °C at 11 mmHg. Log K_{ow} : 4.6. Migration is unclear. The high molecular weight indicates no migration. The melting point is, however, low.
Potential for exposure of consumers	Exposure is uncertain. There may be an exposure due to the low melting point.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. US EPA (2014). An Alternatives Assessment for the Flame Retardant Decabromo-diphenyl Ether (DecaBDE). http://www.epa.gov/oppt/dfe/pubs/projects/decaBDE/deca-report-complete.pdf

3.5.14 Bisphenol A bis-(diphenylfosfat) (BAPP)

Substance	Bisphenol A bis-(diphenyl phosphate) (BAPP)
CAS Number	181028-79-5
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	PPE (high impact) and HIPS.
Main article groups	Electronics.
Potential for release from plastics	Molecular weight: 692.65 g/mol, melting point: 90 °C, boiling point: >400 °C, vapour pressure: <10 ⁻⁶ mmHg, water solubility: <10 ⁻⁶ g/l, log K_{ow} : 10.0 [Syracuse 2006]. Due to the high molecular weight and boiling point significant migration of the substance is deemed unlikely. The substance is insoluble in water due to the high K_{ow} .
Potential for exposure of consumers	The potential for exposure of consumers is deemed low due to the little migration expected.
Fate of the substance by recycling	Will mainly remain in the plastic by mechanical recycling. By energy recovery the substance will be decomposed.

Substance	Bisphenol A bis-(diphenyl phosphate) (BAPP)
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>Syracuse (2006). Flame retardant Alternatives. Syracuse Research Corporation. http://www.ecy.wa.gov/programs/swfa/pbt/docs/flameretard.pdf</p> <p>US EPA (2014). An Alternatives Assessment for the Flame Retardant Decabromo-diphenyl Ether (DecaBDE). http://www.epa.gov/oppt/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.15 Melamin cyanurat

Substance	Melamine cyanurate
CAS Number	37640-57-6
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	PA, PBT, TPU, UP.
Main article groups	Electronics, construction materials, cars, textiles, waterborne emulsions & coatings.
Potential for release from plastics	<p>Molecular weight: 255.2 g/mol, thermally stable up to 440°C, water solubility: 0.01g/l, volatility: 1 % weight loss at 305 °C, 5% loss at 340°C, log K_{ow}: -1.14, -1.34 [BASF 2010a; Metall-Chemie 2014].</p> <p>The low molecular weight indicates that migration is possible. Other data are, however, scarce. The data available do not allow a solid judgment of, whether migration will take place.</p>
Potential for exposure of consumers	Unknown.
Fate of the substance by recycling	Unknown.
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>BASF (2010a). Melapur MC, Technical information. BASF. http://www.telko.com/files/images/telko/ru/bASF/drugie/melapur_mc_tds.pdf</p> <p>Metall-Chemie (2014). Molymet M product description. Metall-Chemie. http://www.mc-chemie.com/fileadmin/user_upload/mc-chemie/pdf/Molymet-M-TDS.pdf</p> <p>US EPA (2014). An Alternatives Assessment for the Flame Retardant Decabromo-diphenyl Ether (DecaBDE). http://www.epa.gov/oppt/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.16 Melamin polyfosfat

Substance	Melamine polyphosphate
CAS Number	15541-60-3
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	Epoxy resins, phenolic based composites, PA, PBT, PE, PP, TPU, UP.
Main article groups	Electronics, construction materials, cars, waterborne emulsions & coatings.
Potential for release from plastics	Molecular weight: 430.23 g/mol, melting/boiling points: Starts to decompose ~350 °C, water solubility: ~0.08g/100ml at ambient temperature [Hummel Croton 2009]. The low molecular weight indicates that migration is possible. Other data are, however, scarce. The data available do not allow a solid judgment of, whether migration will take place.
Potential for exposure of consumers	Unknown
Fate of the substance by recycling	Unknown. Probably remains in the plastic by mechanical recycling.
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. Hummel Croton (2009). Material safety data sheet. Hummel Croton. http://www.hummelcroton.com/msdspdf/mpp_m.pdf US EPA (2014). An Alternatives Assessment for the Flame Retardant Decabromo-diphenyl Ether (DecaBDE). http://www.epa.gov/oppt/dfe/pubs/projects/decaBDE/deca-report-complete.pdf

3.5.17 N-alkoxy "hindered amine" reaktionsprodukter

Substance	N-alkoxy hindered amine reaction products
CAS Number	191680-81-6
Justification	List of alternative flame retardants.
Function	Flame retardant, UV-stabilizer.
Relevant types of plastics	Polyolefins (PE, PP) [BASF 2010b; US EPA 2014].
Main article groups	Polyolefin fibres, nonwovens and films, construction materials and textiles [BASF 2010b; US EPA 2014].
Potential for release from plastics	Molecular weight: 2261 g/mol, melting point: 108 – 123 °C, boiling point: >400 °C , vapour pressure: < 1.10-4 Pa, water solubility: <40 ppb, volatility: 1 % weight loss at 260 °C, 10 % at 285 °C (recommended for use at temperatures below 250 °C only)[BASF 2010b]. Due to the high molecular weight and boiling point the substance should be assumed not to migrate and be released from plastics
Potential for exposure of consumers	Low to a negligible potential for exposure of consumers.
Fate of the substance by recycling	The substance should be assumed to remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.

Substance	N-alkoxy hindered amine reaction products
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>BASF (2010b). Technical Information on Flamestab® NOR 116. BASF. http://www.telko.com/files/images/telko/ru/bASF/drugie/flamestab_nor_116_tds.pdf</p> <p>US EPA (2014). An Alternatives Assessment for the Flame Retardant Decabromo-diphenyl Ether (DecaBDE). http://www.epa.gov/oppt/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.18 Fosfonat oligomerer, polyfosfonater

Substance	Phosphonate oligomer
CAS Number	68664-06-2
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	Thermosets.
Main article groups	Electronics, construction materials.
Potential for release from plastics	<p>Molecular weight: 1,000-5,000 g/mol, softing point: 60 °C, melting point: 180-220 °C, boiling point: >300 °C; vapour pressure: 10⁻⁸ mmHg (estimated), water solubility: <10⁻³ mg/l [US EPA 2014; FRX 2010].</p> <p>Due to the high molecular weight and low vapour pressure the substance should be assumed not to migrate and be released from plastics.</p>
Potential for exposure of consumers	Very low.
Fate of the substance by recycling	The substance should be assumed to remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.
References	<p>FRX (2010). Material Safety Data Sheet. http://www.frxpolymers.com/frx3100.pdf</p> <p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>US EPA (2014). An alternatives Assessment for the flame retardant decabromodiphenyl ether http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.19 Poly(fosfonat-cocarbonat)

Substance	Poly(phosphonate-co-carbonate)
CAS Number	77226-90-5
Justification	List of alternative flame retardants.

Substance	Poly(phosphonate-co-carbonate)
Function	Flame retardant.
Relevant types of plastics	Engineering plastics (and elastomers).
Main article groups	Electronics, construction materials, cars, aviation applications. Elastomers also for cables.
Potential for release from plastics	Molecular weight: >1,000 g/mol, melting point: 220-250 °C, boiling point: >300 °C (estimated), vapour pressure: <10 ⁻⁸ mmHg (estimated), water solubility: <<10 ⁻³ g/l, log K _{ow} : No data [US EPA 2014]. Due to the high molecular weight, high boiling point and low vapour pressure the substance should be assumed not to migrate and be released from plastics.
Potential for exposure of consumers	Very low.
Fate of the substance by recycling	The substance should be assumed to remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. US EPA (2014). An alternatives Assessment for the flame retardant decabromodiphenyl ether. http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf

3.5.20 Resorcinol bis-diphenylfosfat

Substance	Resorcinol bis-diphenylphosphate
CAS Number	125997-21-9
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	PPE-HIPS, PC-ABS.
Main article groups	Electronics.
Potential for release from plastics	Molecular weight: minimum 574.46 g/mol (if only 1 diphenylphosphate group, can contain 1-7), melting point: -16,7 - -12 °C, boiling point: >300 °C (estimated, decomposition may occur before the boiling point is reached), vapour pressure: 1.9x10 ⁻⁵ mmHg at 20°C (measured), water solubility: 1.05 mg/l at 20°C (measured), log K _{ow} : 4.93 (measured) [US EPA 2014]. Migration may take place (low melting point), but the high boiling point and low vapour pressure as well as low water solubility indicates that migration will be weak.
Potential for exposure of consumers	Low.
Fate of the substance by recycling	The substance should be assumed to remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.

Substance	Resorcinol bis-diphenylphosphate
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>US EPA (2014). An alternatives Assessment for the flame retardant decabromodiphenyl ether. http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.21 Aluminium diethylfosfinat

Substance	Aluminium diethylphosphinate
CAS Number	225789-38-8
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	Epoxy, polyamide, PBT, PET, TPU.
Main article groups	No information.
Potential for release from plastics	<p>Molecular weight: minimum 390.27 g/mol, melting point: decomposes at 300-330 °C (measured), vapour pressure: 10^{-8} mmHg (estimated), water solubility: 2.5×10^{-3} mg/l (measured), $\log K_{ow}$: -0.44 (measured) [US EPA 2014].</p> <p>Migration may take place, but the high melting point, low vapour pressure and low water solubility indicates that migration will be very low and the substance will most likely not be released from plastics.</p>
Potential for exposure of consumers	Very low.
Fate of the substance by recycling	The substance should be assumed to remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>US EPA (2014). An alternatives Assessment for the flame retardant decabromodiphenyl ether. http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.22 Aluminium hydroxid

Substance	Aluminium hydroxide
CAS Number	21645-51-2
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	EVA, PE, thermosets.
Main article groups	No information.

Substance	Aluminium hydroxide
Potential for release from plastics	Molecular weight: minimum 78.01 g/mol, melting point: decomposes at 150-300 °C (measured), vapour pressure: 10^{-8} mmHg (estimated), water solubility: ≤ 0.09 mg/l (measured) [US EPA (2014)]. The substance is an inorganic compound and therefore solid bound and will not migrate.
Potential for exposure of consumers	No risk.
Fate of the substance by recycling	Depending on the plastic and recycling process in question the substance will either remain in the plastic by mechanical recycling or be decomposed. By energy recycling (normal incineration) the substance will be decomposed.
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. US EPA (2014). An alternatives Assessment for the flame retardant decabromodiphenyl ether. http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf

3.5.23 Ammonium polyfosfat ($\text{NH}_4 \text{PO}_3)_n$

Substance	Ammonium polyphosphate
CAS Number	68333-79-9
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	PE, PP.
Main article groups	No information.
Potential for release from plastics	Molecular weight: ~100,000 g/mol, melting point: decomposes at 150-300 °C, vapour pressure: $< 10^{-8}$ mmHg at 25 °C (estimated), water solubility: 0.5% (w/w) at 25°C in 10% suspension (measured) [US EPA, 2014]. Migration ability is unknown, but judged to be very low due to high molecular weight, high melting/deposition point and low vapour pressure.
Potential for exposure of consumers	Unknown – likely very low.
Fate of the substance by recycling	Depending on the plastic and recycling process in question the substance will either remain in the plastic by mechanical recycling or be decomposed. By energy recovery of the plastic by incineration the substance will be decomposed.
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. US EPA (2014). An alternatives Assessment for the flame retardant decabromodiphenyl ether. http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf

3.5.24 Magnesium hydroxid

Substance	Magnesium hydroxide
CAS Number	1309-42-8
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	EVA, polyamide, PE, PP.
Main article groups	Electronics (PA). For other plastics: Wire/cables, construction materials, cars, aviation applications. For PE and PP: Storage and distribution products and for PP waterborne emulsions & coatings.
Potential for release from plastics	Molecular weight: ~ 58.32 g/mol, melting point: decomposes at 350-380 °C, vapour pressure: $<10^{-8}$ mm Hg (estimated), water solubility: 1.78 at 20°C, pH 8.3 (measured) [US EPA (2014)]. The substance is an inorganic compound and therefore solid bound and will not migrate.
Potential for exposure of consumers	No risk.
Fate of the substance by recycling	The substance will likely remain in the plastic by mechanical recycling. By energy recycling (normal incineration) the substance will be transformed to magnesium oxide.
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. US EPA (2014). An alternatives Assessment for the flame retardant decabromodiphenyl ether. http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf

3.5.25 Rødt fosfor

Substance	Red phosphorus
CAS Number	7723-14-0
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	Epoxy resins, PA, PA66, PP.
Main article groups	Electronics. Epoxy also in cars and in aviation applications as well as in waterborne emulsions and coatings. PA also in aviation applications.
Potential for release from plastics	Molecular weight : >1.000 g/mol (estimated), melting point: sublimes at 416-436 °C, vapour pressure: 0.03-0.05 mmHg at 21-25 °C (measured), water solubility: not soluble (measured). Migration ability is unknown, but judged to be very low due to high molecular weight, high sublimation temperature, low vapour pressure and lack of water solubility.
Potential for exposure of consumers	Unknown, but likely very low.

Substance	Red phosphorus
Fate of the substance by recycling	The substance should be assumed to remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be transformed to phosphorus oxides or similar compounds.
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>US EPA (2014). An alternatives Assessment for the flame retardant decabromodiphenyl ether. http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.26 Zink borat

Substance	Zinc borate
CAS Number	1332-07-06, 138265-88-0
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	PUR, PVC, EVA, PE, PP.
Main article groups	PUR foam, soft PVC products, electronics, wire and cables, construction materials, cars, aviation applications, storage and distribution products. For EVA also waterborne emulsions & coatings.
Potential for release from plastics	Molecular weight minimum: not well defined, melting point: > 650 °C (not well defined), water solubility: 0.28 % at 25 °C [Chemphys, 2008]. Migration ability is unknown, but judged to be low due to high melting point. May, however, migrate to water due to significant water solubility.
Potential for exposure of consumers	Unknown, but likely low.
Fate of the substance by recycling	The substance will remain in the plastic by mechanical recycling. By energy recycling (normal incineration) the substance will be decomposed and transformed to oxides of zinc and boric.
References	<p>Chemphys (2008). Material Safety Data Sheet. http://www.chemphys.com/en/YKTGuanLi/System/UpFile/200881817524346.pdf</p> <p>Gächter R., and Müller H. (1990). Taschenbuch der Kunststoff-Additive, Hansa, ISBN: 3-446-15627-5</p> <p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>US EPA (2014). An alternatives Assessment for the flame retardant decabromodiphenyl ether. http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.27 Tetrabrombisphenol A bis (allyl æter)

Substance	Tetrabromobisphenol A bis (allyl ether)
CAS Number	25327- 89-3
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	EPS.
Main article groups	No information.
Potential for release from plastics	As for other tetrabromobisphenol A based flameretardants (see section 3.5.2 and 3.5.10).
Potential for exposure of consumers	As for other tetrabromobisphenol A based flameretardants (see section 3.5.2 and 3.5.10).
Fate of the substance by recycling	As for other tetrabromobisphenol A based flame retardants (see section 3.5.2 and 3.5.10).
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.

3.5.28 1,2,5,6-tetrabromcy-clo-octan (TBCO)

Substance	1,2,5,6-tetrabromocy-clo-octane (TBCO)
CAS Number	3194- 57-8
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	EPS (This flame retardant is not functional in current EPS and XPS manufacturing processes. Its thermal stability does not meet operating temperature requirements for the manufacture of XPS foam [US EPA 2013]).
Main article groups	No information.
Potential for release from plastics	Molecular weight: 427.80 g/mol, vapour pressure: 3.59×10^{-5} at 25 °C, log K _{ow} : 4.42 [de Wit et al. 2011]. Migration ability is uncertain. The data available are too scarce for solid judgments.
Potential for exposure of consumers	Unknown
Fate of the substance by recycling	The substance is assumed mainly to remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.
References	de Wit, CA; Kierkegaard, A; Ricklund, N; Sellstrom, U (2011)."Emerging Brominated Flame Retardants in the Environment" in the book "Brominated flame retardants", Springer. Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. US EPA (2013). Flame retardant alternatives for hexabromocyclododecane (HBCD).

3.5.29 2,4,6- tribromphenyl allyl æter

Substance	2,4,6- tribromphenyl allyl ether
CAS Number	3278-89-5
Justification	List of alternative flame retardants
Function	Flame retardant
Relevant types of plastics	<p>EPS</p> <p>(This flame retardant is recommended in patents as a potential alternative. It is not a potential alternative for the use of HBCD in XPS foam because of its poor thermal stability at operating temperatures. It is not a cost-effective alternative in EPS because it is only viable in the less-economic two-step manufacturing process. This flame retardant may also interfere with the styrene polymerization process, resulting in a product with a lower average MW and more residual unreacted styrene in the product, resulting in foam that will lack the strength to meet building code requirements. [US EPA (2013)].)</p>
Main article groups	No information.
Potential for release from plastics	Molecular weight: 370.86 g/mol, boiling point: 339.5 ± 37.0 °C, vapour pressure: 4.9×10^{-2} Pa at 25 °C, water solubility: 2.0×10^{-2} g/l at 25 °C, $\log P_{ow}: 4.974 \pm 0.564$ [Harju et al. 2009]. Migration ability is uncertain. Migration will likely be low due to relatively high boiling point and low vapour pressure.
Potential for exposure of consumers	Unknown, but likely low.
Fate of the substance by recycling	The substance is assumed mainly to remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.
References	<p>US EPA (2013). Flame retardant alternatives for hexabromocyclododecane (HBCD).</p> <p>Harju M, Heimstad ES, Herzke D, Sandanger T, Posner S and Wania F (2009). "Emerging "new" Brominated flame retardants in flame retarded products and the environment" for Norwegian Pollution Control Authority.</p> <p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p>

3.5.30 Tetrabrombisphenol A bis(2,3- di-bromopropyl æter) (TBBPA- DBPE), med dicumene for XPS og dicumyl peroxid for EPS, som sædvanlige synergister

Substance	Tetrabrombisphenol A bis(2,3- di-bromopropyl ether) (TBBPA- DBPE), with dicumene for XPS and dicumyl peroxide for EPS, as usual synergists
CAS Number	21850-44-2
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	EPS, XPS.
Main article groups	No information.

Substance	Tetrabromobisphenol A bis(2,3- di-bromopropyl ether) (TBBPA- DBPE), with dicumene for XPS and dicumyl peroxide for EPS, as usual synergists
Potential for release from plastics	<p>Molecular weight: 943.61 g/mol, melting point: 90–105 °C, boiling point: 676.5±55.0 °C, vapour pressure: 1.60×10^{-7} Pa at 25 °C, water solubility: 1.60×10^{-7} g/l at 25 °C, log P_{ow}: 10.422±0.696 [[Harju et al. 2009]].</p> <p>Potential for release corresponds to other tetrabromobisphenol A based flame retardants (see section 3.5.2 and 3.5.10).</p>
Potential for exposure of consumers	As for other tetrabromobisphenol A based flame retardants (see section 3.5.2 and 3.5.10).
Fate of the substance by recycling	As for other tetrabromobisphenol A based flame retardants (see section 3.5.2 and 3.5.10).
References	<p>Harju M, Heimstad ES, Herzke D, Sandanger T, Posner S and Wania F (2009). "Emerging "new" Brominated flame retardants in flame retarded products and the environment" for Norwegian Pollution Control Authority.</p> <p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p>

3.5.31 Ätylen bis(tetrabro-mofthalimid) (EBTPI)

Substance	Ethylenebis (tetrabro-mophthalimide) (EBTPI)
CAS Number	32588-76-4
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	HIPS, polyethylene, polypropylene, thermoplastic polyesters, polyamide, polycarbonate, ethylene co- polymers.
Main article groups	Electronics for HIPS and engineering thermoplastics. For PP and PE also wire/cables, construction materials, cars and storage and distribution products.
Potential for release from plastics	<p>Molecular weight: 951.5 g/mol (measured), boiling point: 886.97 °C (estimated), vapour pressure: $2.54 \cdot 10^{-22}$ mmHg at 25°C, partition coefficient (log value) log P_{ow}: 9.80 [Stuer-Lauridsen et al., 2007].</p> <p>Migration is judged to be very low or negligible due to high molecular weight, high boiling points and low vapour pressure.</p>
Potential for exposure of consumers	Very low.
Fate of the substance by recycling	The substance will remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.

Substance	Ethylenebis (tetrabro-mophthalimide) (EBTPI)
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>Stuer-Lauridsen F., Cohr K.-H. & Andersen T.T. (2007) Health and Environmental Assessment of Alternatives to Deca-BDE in Electrical and Electronic Equipment. Danish Environmental Protection Agency, Environmental Project No. 1142/2007. http://www2.mst.dk/Udgiv/publications/2007/978-87-7052-351-6/pdf/978-87-7052-352-3.pdf</p>

3.5.32 Decabromodiphenyl ætan (DBDPE)

Substance	Decabromodiphenyl ethane (DBDPE)
CAS Number	84852-53-9
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	HIPS, PE, PP, thermosets and CPE.
Main article groups	Electronics, wire and cables, construction materials, cars. For PP and PE also storage and distribution products and for PP waterborne emulsions and coatings.
Potential for release from plastics	<p>Molecular weight: 971.23 g/mol (measured), melting point: 345 °C at 5.00 hPa, vapour pressure: ~1 x 10⁻⁶ Pa at 25 °C, partition coefficient (log value) log P_{ow}: in the region of 7 – 8 or more [UK Environment Agency 2007].</p> <p>Migration is judged to be very low or negligible due to high molecular weight, high boiling points and low vapour pressure.</p>
Potential for exposure of consumers	Very low.
Fate of the substance by recycling	The substance will remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>UK Environment Agency (2007). Environmental risk evaluation report: 1,1'-(Ethane-1,2-diyl)bis[penta-bromobenzene]. http://a0768b4a8a31e106d8bo-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/schoo507bmor-e-e.pdf</p> <p>US EPA (2014). An alternatives Assessment for the flame retardant decabromodiphenyl ether. http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf</p>

3.5.33 Diphenyl cresylfosfat

Substance	Diphenyl cresyl phosphate
CAS Number	26444-49-5
Justification	List of alternative flame retardants.
Function	Flame retardant, plasticiser.
Relevant types of plastics	HIPS (flame retardant), PVC (plasticiser). Mostly used as plasticiser for PVC. Is not used as DecaBDE replacement.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 340.31 g/mol (measured), boiling point: 235 - 255 °C at 5.00 hPa, vapour pressure: < 0.001 hPa at 25 °C, partition coefficient (log value) log K _{ow} : 3.7 at 25 °C [Sigma-Aldrich, 2014a]. Migration unknown, but possible due to low molecular weight and low boiling point.
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will be decomposed.
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. Sigma-Aldrich (2014a). Material Safety Data Sheet. http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=DK&language=da&productNumber=32957&brand=FLUKA&PageToGoToURL=http%3A%2F%2Fwww.sigmaaldrich.com%2Fcatalog%2Fsearch%3Finterface%3DCAS%2520No.%26term%3D26444-49-5%26N%3Do%26mode%3Dpartialmax%26focus%3Dproduct%26lang%3Den%26region%3DDK

3.5.34 6H-Dibenz[c,e][1,2]oxafosforin, 6-oxid (DOPO)

Substance	6H-Dibenz[c,e][1,2]oxaphosphorin, 6-oxide (DOPO)
CAS Number	35948-25-5
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	Epoxyes.
Main article groups	Printed circuit boards.
Potential for release from plastics	Molecular weight: 216.18 g/mol (measured), boiling point: 359 °C at 760 mm Hg (extrapolated), vapour pressure: 2.2 x 10 ⁻⁵ mm Hg at 25 °C (extrapolated), water solubility: 0.51 g/l (estimated), partition coefficient (log value) log P _{ow} : 1.87 (Estimated) [US EPA, 2008b] Migration possible due to low molecular weight, low boiling point and notable water solubility. Vapour pressure, on the other hand, is low.

Substance	6H-Dibenz[c,e][1,2]oxaphosphorin, 6-oxide (DOPO)
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The material can only be recycled by feed stock recycling or energy recovery. By energy recovery of the plastic by incineration the substance will be decomposed.
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>U.S. EPA (2008b). FLAME RETARDANTS IN PRINTED CIRCUIT BOARDS - Revised review draft. http://www.epa.gov/dfe/pubs/projects/pcb/full_report_pcb_flame_retardants_report_draft_11_10_08_to_e.pdf</p>

3.5.35 Poly-(m-phenylen methylfosfonat)(Fyrol PMP)

Substance	Poly-(m-phenylene methylphosphonate)
CAS Number	63747-58-0
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	Epoxyes.
Main article groups	Printed circuit boards.
Potential for release from plastics	<p>Molecular weight: >1.000 (measured) g/mol, boiling point: >400 (estimated) °C, vapour pressure: <10⁻⁶ mm Hg (estimated), partition coefficient (log value) log P_{ow}: data not available [US EPA, 2008b].</p> <p>Migration is judged to be very low or negligible due to high molecular weight, high boiling points and low vapour pressure.</p>
Potential for exposure of consumers	Low to negligible.
Fate of the substance by recycling	The material can only be recycled by feed stock recycling or energy recovery. By energy recovery of the plastic by incineration the substance will be decomposed.
References	<p>Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>U.S. EPA (2008b). FLAME RETARDANTS IN PRINTED CIRCUIT BOARDS - Revised review draft http://www.epa.gov/dfe/pubs/projects/pcb/full_report_pcb_flame_retardants_report_draft_11_10_08_to_e.pdf</p>

3.5.36 Fosfor syre, diethyl-, aluminium salt

Substance	Phosphoric acid, diethyl-, aluminium salt
CAS Number	225789-38-8
Justification	List of alternative flame retardants.
Function	Flame retardant.
Relevant types of plastics	Epoxyes.
Main article groups	Printed circuit boards.
Potential for release from plastics	Molecular weight: no data, water solubility: 2.5 g/l, partition coefficient (log value) log P _{ow} : log K _{ow} : -0.44 [Stuer-Lauridsen et al. 2007]. The substance is solid bond as a salt. Will only be released to a minor degree by wear and tear.
Potential for exposure of consumers	No risk.
Fate of the substance by recycling	The material can only be recycled by feed stock recycling or energy recovery. By energy recovery of the plastic by incineration the substance will be decomposed.
References	Lassen C., Jensen A.A., Crookes M., Christensen F., Jeppesen C.N., Clausen A.J., Mikkelsen S.H. (2013). Brominated flame retardants - Part of the LOUS-review. Danish Environmental Protection Agency. Stuer-Lauridsen F., Cohr K.-H. & Andersen T.T. (2007). Health and Environmental Assessment of Alternatives to Deca-BDE in Electrical and Electronic Equipment. Danish Environmental Protection Agency, Environmental Project No. 1142/2007. http://www2.mst.dk/Udgiv/publications/2007/978-87-7052-351-6/pdf/978-87-7052-352-3.pdf

3.5.37 1,3,4-Metheno-1*H*-cyclobuta[cd]pentalen (MIREX)

Substance	1,3,4-Metheno-1 <i>H</i> -cyclobuta[cd]pentalene
CAS Number	2385-85-5
Justification	List of CMR-substances in toy.
Function	Flame retardant (plastics) – also known as pesticide – included on the list of banned substances under the Stockholm Convention.
Relevant types of plastics	No information – highly unlikely that it is actually used.
Main article groups	No information - highly unlikely that it is actually used.
Potential for release from plastics	Molecular weight: 545.59 g/mol, melting point: 483–487 °C, vapour pressure: 3 x 10 ⁻⁷ mm Hg at 25 °C, partition coefficient (log value) log P _{ow} : 5.28 [US EPA, 2003a].
Potential for exposure of consumers	No information - highly unlikely that it is actually used.
Fate of the substance by recycling	No information - highly unlikely that it is actually used.

Substance	1,3,4-Metheno-1H-cyclobuta[cd]pentalene
References	<p>U.S. EPA (2003a). "Toxicological review of Mirex – review draft".</p> <p>ChemCAS (2008). Material Safety Data Sheet for Mirex, CAS 2385-85-5. http://www.chemcas.org/msds114/supplier/cas/729/2385-85.asp</p> <p>Stockholm Convention (2014). The 12 initial POPs under the Stockholm Convention. http://chm.pops.int/TheConvention/ThePOPs/The12InitialPOPs/tabid/296/Default.aspx</p>

3.5.38 Antimon trioxid

Substance	Antimony trioxide
CAS Number	1309-64-4
Justification	Registry of intentions (CLP); List of CMR-substances in toy; List of flame retardants.
Function	Flame retardant, stabiliser.
Relevant types of plastics	Various plastics.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 291.5, melting point: 655–656 °C, boiling point: 1425 °C. Slightly soluble in hot water. Log P _{ow} unknown. The substance is an inorganic compound and therefore solid bound and will not migrate. Judged to be only liberated by tear and wear.
Potential for exposure of consumers	No risk. Will not migrate.
Fate of the substance by recycling	Remain in the plastic by mechanical recycling. By energy recovery of the plastic by incineration the substance will decompose.
References	Integrated Lab. (2005). Antimony Trioxide, Brief Review of Toxicological Literature, Integrated Laboratory systems, July 2005.

3.5.39 Trixylylfosfat

Substance	Trixylyl phosphate
CAS Number	25155-23-1
Justification	Registry of intentions (CLP, SVHC); CMR.
Function	Intermediate used for manufacturing and use of plastic products [ECHA 2013]. Aryl phosphates are generally used as flame-retardant additives in polymer systems [UK Environment Agency 2009].
Relevant types of plastics	No information.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 410.45 g/mol, melting point: -20 °C, boiling point: >300 °C at atm.pressure, vapour pressure: 8.7 x 10 ⁻⁶ Pa at 20°C, water solubility: 0.89 mg/l (room temperature), log P _{ow} : 5.63 [UK Environment Agency 2009]. Migration is deemed possible due to the low melting point.

Substance	Trixyl phosphate
Potential for exposure of consumers	Unknown but possible.
Fate of the substance by recycling	If used in thermoplastics judged mainly to remain in the plastic by mechanical recycling. Thermosetting plastics can only be recycled by incineration or by feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised.
References	<p>ATSDR (2012c). Toxicological Profile for Phosphate Ester Flame Retardants. Agency for Toxic Substances and Disease Registry, U.S. Dept. of Health and Human Services, Public Health Service: www.atsdr.cdc.gov/toxprofiles/index.asp</p> <p>ECHA (2013). Information on chemicals. http://www.echa.europa.eu/da/information-on-chemicals/registered-substances</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>UK Environment Agency (2009). An overview of the environmental risk evaluation reports for aryl phosphate esters. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/290484/choo809bqtz-e-e.pdf</p>

3.5.40 TDCP (Tris[2-chloro-1-(chloromethyl)ethyl] fosfat)

Substance	TDCP (Tris[2-chloro-1-(chloromethyl)ethyl] phosphate)
CAS Number	13674-87-8
Justification	Registry of intentions (CLP); CMR.
Function	Flame retardant additive for polyurethane at typical loadings of ~ 3% w/w. [RAR-TDCP 2008].
Relevant types of plastics	Polyurethane.
Main article groups	Flexible foams for the automotive industry and furniture [RAR-TDCP 2008].
Potential for release from plastics	Molecular weight: 430.91, melting point: below -20 °C, boiling point: 326 °C (decomposition occurs), vapour pressure: 5.6×10^{-6} Pa at 25 °C, water solubility: 18.1 mg/l at 20 °C, log K _{ow} : 3.69 at 20 °C. Might migrate due to the low molecular weight, low melting point and the low log K _{ow} .
Potential for exposure of consumers	Unknown.
Fate of the substance by recycling	The substance is assumed mainly to remain in the plastic by mechanical recycling. By feed stock recycling or energy recovery of the plastic by incineration the substance will be decomposed. The content of chlorine may by incineration add to formation of dioxins and HCl in the chimney system.
References	EURAR-TDCP 2008. Tris[2-chloro-1-(chloromethyl)ethyl]phosphate (TDCP). Summary. http://echa.europa.eu/documents/10162/e3e784ff-48fa-4fbc-8972-b7fe70cb38bf

3.5.41 Tetrakis(2,6-dimethylphenyl)-m-phenylen bifosfat

Substance	Tetrakis(2,6-dimethylphenyl)-m-phenylene biphenylphosphate
CAS Number	139189-30-3
Justification	Registry of intentions (CLP).
Function	Used as a fire-preventing agent in electronic circuit boards for products such as mobile phones, personal computers, televisions and video recorders. Added in amounts 10-20 % weight.
Relevant types of plastics	Styrene based plastics.
Main article groups	Electrical and electronic products without halogenated flame retardants [Daring & Dietrich's, 2009].
Potential for release from plastics	Molecular weight: 686.67, boiling point: 632 °C at 760 mm Hg [Guidechem 2014a]. Migration possible as not solid bound.
Potential for exposure of consumers	Possible, but unknown.
Fate of the substance by recycling	The substance will remain in the plastic during mechanical recycling. By feed stock recycling and energy recovery the substance will be decomposed.
References	Guidechem (2014a). CAS No. 139189-30-3 (Phosphoric acid,P,P'-1,3-phenylene P,P,P',P'-tetrakis(2,6-dimethylphenyl) ester). http://www.guidechem.com/cas-139/139189-30-3.html Döring M., Diederichs J., (2009). Innovative Flame Retardants in E &E Applications - Non-Halogenated phosphorous, inorganic and nitrogen flame retardants. Pinfa, Cefic, Brussels.

3.6 Monomerer, hærdemidler, kæderegulatorer og katalysatorer

Denne stofgruppe er meget bred og med en meget varieret kemisk struktur. Monomerer er byggestenene for plast polymerer og omfatter lavt kogende gasser (f.eks. ætylen, propylen, butadien, og formaldehyd), reaktive oplosningsmidler (f.eks. styren) og faste stoffer (MDA, MOCA). Hærdemidler (initiatorer og acceleratorer) og katalysatorer er alle stoffer, som anvendes til at enten igangsættet eller accelerere kemiske reaktioner i polymeriseringen af plast typisk for hærdeplaster (epoxy, PU, UP). Kæderegulatorer anvendes til at modificere plast polymerernes egenskaber (f.eks. butanediol, som er en kædeforlænger).

Selvom disse stoffer generelt vil reagere i dannelsesprocessen for polymererne, kan rester af monomerer og reaktive forbindelser være til stede i de færdige produkter. Disse rester beror på, at ikke alle monomerer/forbindelser har succes med at reagere i polymeriseringsprocessen. Typiske koncentrationer af rester er på 0-2 %. Hærdemidler herunder peroxider og andre tverbindingsmidler og katalysatorer bruges typisk i koncentrationer på 0,1-2 %.

Evnen til at migrere, muligheden for at påvirke forbrugerne ved eksponering for stofferne og skæbnen ved genanvendelse er forskellig fra stof til stof, og der kan ikke præsenteres generelle regler.

Det bør bemærkes, at tin stabilisatorer (se afsnit 3.8.5 og 3.8.6) også vil fungere som katalysatorer ved produktionen af PU ud over deres funktion som stabilisator i PVC.

3.6.1 Acrylamid

Substance	Acrylamide
CAS Number	79-06-1
Justification	Candidate list; Registry of intentions (SVHC); CMR.
Function	Intermediate – Co-monomer [Kostikov, 1995; ECHA 2009a].
Relevant types of plastics	Polyacrylamide [ECHA 2009a]. Polyacrylonitrile copolymer [Kostikov, 1995].
Main article groups	Acrylamide is almost exclusively (France 2005: 99,54%) used for the synthesis of polyacrylamides, which are used as flocculating agent, in particular in waste water treatment and paper processing. Minor uses include soft contact lenses, cosmetics and comonomer for acrylic fibres [ECHA 2009a; NICNAS 2002; Kostikov, 1995]. Other uses of acrylamide includes the preparation of polyacrylamide gels for research purposes, grouting agent in civil engineering and the production of acrylic/acrylamide resins used in household appliances and in automotive engineering (for covering and coating of automotive parts).
Potential for release from plastics	Molecular weight: 71,09 g/mol, melting/freezing point: 84,5 °C, boiling point: 125 °C at 25 mm Hg or 3,3 kPa, vapour pressure: 0,9 Pa at 25°C, water solubility: 2,155 g/l at 30°C, partition coefficient (log value): -1,0 [Annex XV dossier 2009]. Residual monomer is not chemically bound to the polymer and will migrate. Besides residual monomer from production, monomers may be released by weathering processes (hydrolysis). All monomers present may migrate. [Nilsson, 2008].

Substance	Acrylamide
Potential for exposure of consumers	<p>Primary exposure to acrylamide is by ingestion of contaminated food. The acrylamide in food is formed by grilling or baking starch rich food (e.g. French fries). Tobacco smoke is another risk for exposure to acrylamide. In areas near plastic and dye manufacturing plants, drinking water might contain acrylamide.</p> <p>Exposure from the use as soft contact lenses might be very limited, based on expert judgement as the residual amount of monomer is considered very low. Exposure may occur in laboratories using polyacrylamide gels (professionals).</p>
Fate of the substance by recycling	Due to the low boiling point the substance will likely evaporate at least partly by mechanical recycling. Residues of the substances may, however, be present in recycled materials.
References	<p>Annex XV dossier. http://echa.europa.eu/documents/10162/13640/svhc_axrep_netherlands_cmr_acrylamide_20090831_en.pdf</p> <p>ATSDR 2012a. Toxicological Profile for Acrylamide. Agency for Toxic Substances and Disease Registry, U.S. Dept. of Health and Human Services, Public Health Service: www.atsdr.cdc.gov/toxprofiles/index.asp</p> <p>ECHA (2009a). COMMENTS AND RESPONSE TO COMMENTS ON ANNEX XV SVHC for Acrylamide - CAS number: 79-06-1 http://echa.europa.eu/documents/10162/13638/rcom_final_cc009698-48_acrylamide_nonconf_12112009_en.pdf (Nov. 2012).</p> <p>Kostikov, V.I. (ed.) (1995). Fibre science and technology. Chapman and Hall, London.</p> <p>NICNAS (2002). Acrylamide. Priority Existing Chemical Assessment Report No. 23. National Industrial Chemicals Notification and Assessment Scheme. Australia 2002.</p> <p>Nilsson N. (2014). Expert assessment by Nils Nilsson, Danish Technological Institute, Århus, Dec. 2012.</p>

3.6.2 4-(1,1,3,3-tetramethylbutyl)phenol, (4-tert-Octylphenol)

Substance	4-(1,1,3,3-tetramethylbutyl)phenol, (4-tert-Octylphenol) - see also section 3.34.
CAS Number	140-66-9
Justification	Candidate list; Norwegian priority list; Registry of intentions (SVHC).
Function	<p>As a monomer for polymer preparations.</p> <p>As an intermediate for manufacture of ethoxylates.</p> <p>As a component in phenolic resins used in the formulation of adhesives.</p> <p>As a component in coatings, incl. insulation of electric windings (e.g. in motors and transformers) to improve insulation and to bond windings together. [Annex XV dossier; DEFRA 2008].</p>
Relevant types of plastics	Phenol resins [UK Environment Agency, 2005].
Main article groups	98% used as an intermediate for the production of phenolic resins (mainly for rubber) and 2% used for octylphenol ethoxylates [Annex XV dossier]. No other information is available

Substance	4-(1,1,3,3-tetramethylbutyl)phenol, (4-tert-Octylphenol) - see also section 3.34.
Potential for release from plastics	<p>Molecular weight: 206.32 g/mol, melting/freezing point: 79 – 82 °C, boiling point: 280 – 283°C, vapour pressure: 0.001 kPa at 20 °C, water solubility: 19 mg/l at 22 °C, log P_{ow}: 3.7.</p> <p>Most of the 4-tert-octylphenol 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 (~3-4%) of unreacted substance that may migrate out of the resin.</p>
Potential for exposure of consumers	Residual 4-tert-Octylphenol in the resins might migrate as the molecular weight is low and the boiling point also fairly low. The log K _{ow} is 5.5 and the solubility in water is 3.1 mg/l at 25 °C (estimated). Migration to fat or oils will thus be the most likely pathway for exposure. It is judged that the risk for exposure is very low, if the manufacturing processes have been in control.
Fate of the substance by recycling	If present unreacted substance will likely react or evaporate by mechanical recycling.
References	<p>Annex XV dossier.</p> <p>http://echa.europa.eu/documents/10162/13640/svhc_axrep_germany_equivalent_concern_4-tert-octylphenol_20110829_en.pdf</p> <p>DEFRA (2008). 4-tert-Octylphenol Risk Reduction Strategy and Analysis of Advantages and Drawbacks. Department for Environment, Food and Rural Affairs. UK. http://archive.defra.gov.uk/environment/quality/chemicals/documents/op-rrs-aad-report.pdf</p> <p>UK Environment Agency (2005). Environmental Risk Evaluation Report: 4-tert-Octylphenol. http://cdn.environment-agency.gov.uk/scho0405biyz-e-e.pdf</p> <p>US EPA (2009c). Screening-level hazard characterization Alkylphenols Category, September 2009.</p>

3.6.3 Bisphenol A (BPA)

Substance	Bisphenol A (BPA)
CAS Number	80-05-7
Justification	Danish list of undesired substances; Norwegian priority list; Registry of intentions (CLP, restriction); List of CMR substances in toy.
Function	<p>Monomer (polycarbonate, epoxy resin, unsaturated polyester resin), used in processing (not further specified, of phenoplast cast resin), antioxidant (in PVC processing and in production of plasticisers for PVC), ingredient in PVC additive package, crosslinking agent (rigid polyurethane foam), unspecified function (modified polyamide) [EU, 2010]</p> <p>Note: The use in PVC manufacture is being phased out [EU, 2010].</p>
Relevant types of plastics	Polycarbonate, epoxy resins, phenoplast cast resin, PVC, rigid polyurethane foam, modified polyamide, unsaturated polyester resin.
Main article groups	All polycarbonate plastics, and many epoxy resins, some phenoplast e.g. phenoplast high pressure laminate compact panels, and PVC articles (groups not specified).

Substance	Bisphenol A (BPA)
Potential for release from plastics	Based on the chemical properties of bisphenol A (molecular weight: 228 g/mol, boiling point: 288 °C, water solubility: 300 mg/l, log K _{ow} : 3.4 [EU, 2010]) it should be regarded as a semi-volatile compound able to migrate out of plastics. Given sufficient time, the major part of the substance will probably be released by leaching to the surface followed by evaporation or removal by washing. Tear and wear will also take place but be of minor importance.
Potential for exposure of consumers	Studies of baby dummies with shield, ie.the hard part, made of polycarbonate, which consists of bisphenol A, available on the Danish marked, have been conducted. Very low migration of bisphenol A was observed.
Fate of the substance by recycling	By mechanical recycling it is judged that free bisphenol A, if present, mainly will remain in the plastic by recycling of polycarbonate and PVC and modified polyamide.
References	<p>ATSDR 2012b. Toxicological Profile for bisphenol A. Agency for Toxic Substances and Disease Registry, U.S. Dept. of Health and Human Services, Public Health Service: www.atsdr.cdc.gov/toxprofiles/index.asp</p> <p>Biles, J.E., McNeal, T.P., Begley, T.H., Hollifield, H.C. (1997). Determination of bisphenol A in reusable polycarbonate food-contact plastics and migration to food-simulating liquids. Journal of Agricultural and Food Chemistry 45:3541–3544.</p> <p>EU (2010). European Union Risk Assessment report 4,4'- Isopropylidenediphenol (Bisphenol-A) CAS No: 80-05-7. EINECS No: 201-245-8. RISK ASSESSMENT. http://esis.jrc.ec.europa.eu/doc/risk_assessment/REPORT/bisphenolareport325.pdf</p> <p>Lassen C., Mikkelsen S.H., Brandt U.K. (2011). Migration of bisphenol A from cash register receipts and baby dummies. Survey of Chemical Substances in Consumer Products 110. Danish Environmental Protection Agency.</p> <p>Wong, K.O., Leo L.W., Seah, H.L. (2005). Dietary exposure assessment of infants to bisphenol A from the use of polycarbonate baby milk bottles. Food Additives and Contaminants 22:280–288.</p>

3.6.4 Formaldehyd

Substance	Formaldehyde
CAS Number	50-00-0
Justification	Danish list of undesired substances; Registry of intentions (CLP); List of CMR-substances in toy.
Function	Monomer.
Relevant types of plastics	Melamine, phenolic resins, acetal resins, POM.
Main article groups	Kitchen equipment, electric and electronic equipment and insulation products. POM is also used in armatures for drinking water.
Potential for release from plastics	<p>Molecular weight: 30 g/mol, melting point: -92 °C, boiling point: -19.5 °C, water solubility: 400 g/l (25 °C), vapour pressure: 3,890 mm Hg (25 °C), log K_{ow}: 0.35 [NTP 2011].</p> <p>The physical properties of formaldehyde mean that unreacted formaldehyde should be expected to migrate strongly. The strong evaporation of the substance means that occupational exposure may be given special attention.</p>

Substance	Formaldehyde
Potential for exposure of consumers	There is a potential risk for exposure caused by unreacted monomer or depolymerisation caused by acidic hydrolysis (POM, melamine, phenolic resins) and alkaline hydrolysis (phenolic resins).
Fate of the substance by recycling	By mechanical recycling unreacted formaldehyde may likely evaporate due to the low boiling point and the very high vapour pressure. The substance will most likely not be present in recycled materials. Melamine and phenolic resins can only be recycled by feedstock recycling or by energy recovering. In both cases unreacted formaldehyde will likely evaporate and be decomposed.
References	<p>Nilsson N. (2014). Expert assessment by Nils Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>NTP 2011. Formaldehyde CAS No. 50-00-0. Report on Carcinogens, Twelfth Edition (2011). National Toxicology Program, Department of Health and Human Services. http://ntp.niehs.nih.govntp/roc/twelfth/profiles/formaldehyde.pdf</p>

3.6.5 Formaldehyd, oligomerisk reaktionsprodukt med anilin

Substance	Formaldehyde, oligomeric reaction products with aniline
CAS Number	25214-70-4
Justification	Candidate list; Registry of intentions (SVHC).
Function	Intermediate for selected high performance polymers, hardener for epoxy resins. Dominant application is intermediate for methylene diphenyldiisocyanate (MDI). [Annex XV dossier].
Relevant types of plastics	Epoxy resins, high performance polymers (not specified) [Annex XV dossier].
Main article groups	Epoxy: rolls with composite cover, chemically resistant pipes, moulds [Annex XV dossier].
Potential for release from plastics	Molecular weight: > 168 g/mol, melting/freezing point: 30 – 70 °C, boiling point: 410.6 °C at 1013.25 hPa, vapour pressure: < 0.000001 hPa; 20 °C, water solubility: 1.22 g/l, temp. 20 °C; pH 7.5 – 7.6, log K _{ow} : 2.5 at 23 °C [Annex XV dossier]. Hardeners in epoxy will react with other substances and create chemical bindings. No data on reaction residues in other polymers are available. Migration of reaction residues is possible, but likely low due to the physical properties.
Potential for exposure of consumers	Unknown, but deemed possible depending on the amount of reaction residues actually present.
Fate of the substance by recycling	By mechanical recycling (if relevant) unreacted formaldehyde may mainly remain in the plastics due to the high boiling point and low vapour pressure. Epoxy can only be recycled by feedstock recycling or by energy recovering. In both cases unreacted formaldehyde will likely be decomposed.
References	<p>Annex XV dossier.</p> <p>http://echa.europa.eu/documents/10162/13640/svhc_axvrep_germany_cmr_techmda_201_10829_en.pdf</p>

3.6.6 Phenol

Substance	Phenol
CAS Number	108-95-2
Justification	Danish list of undesired substances; CMR.
Function	Monomer in the production of phenol-aldehyde plastics.
Relevant types of plastics	Bakelite (phenol-formaldehyde).
Main article groups	Mineral wool and plywood glued with phenol-formaldehyde adhesive.
Potential for release from plastics	Molecular weight: 94 g/mol, melting point: 41 °C, boiling point: 182 °C, water solubility: 41%, log P _{ow} : 1.46. The physical properties of phenol mean that unreacted phenol should be expected to migrate strongly.
Potential for exposure of consumers	There is a potential risk for exposure caused by unreacted monomer or depolymerisation caused by acidic hydrolysis and alkaline (phenolic resins). The strong evaporation of the substance means that occupational exposure may be given special attention.
Fate of the substance by recycling	Bakelite can only be recycled by feedstock recycling or by energy recovering. In both cases unreacted phenol will likely be decomposed.
References	Lise M. Moller L.M., Larsen P.B., Fotel F.L., Slothuus T., Boyd H.B., Hjelmar O., Lam H.R. 2013. Survey of phenol. Part the LOUS review. Danish Environmental Protection Agency. ATSDR 2012c. Toxicological Profile for Phenol, Agency for Toxic Substances and Disease Registry, U.S. Dept. of Health and Human Services, Public Health Service. www.atsdr.cdc.gov/toxprofiles/index.asp

3.6.7 Hexahydromethylphthalic anhydrid og lignende forbindelser

Substance	Hexahydromethylphthalic anhydride , Hexahydro-4-methylphthalic anhydride, Hexahydro-1-methylphthalic anhydride, Hexahydro-3-methylphthalic anhydride
CAS Number	25550-51-0, 19438-60-9, 48122-14-1, 57110-29-9
Justification	Candidate list; Registry of intentions (SVHC).
Function	Intermediates for manufacture of polyester and alkyd resins and plasticisers for thermoplastic polymers. Hardeners for epoxy resins. Chain cross-linkers for thermoplastic polymers. [Annex XV dossier – MHPA].
Relevant types of plastics	Polyesters, plasticisers manufactured from the substance, epoxies.
Main article groups	No knowledge.
Potential for release from plastics	Molecular weight is 168 g/mol. The substance is a liquid, which might migrate.
Potential for exposure of consumers	It is judged that there is a potential risk for exposure caused by unreacted substance.
Fate of the substance by recycling	It is not possible to predict the fate of the unreacted substance by mechanical recycling due to lack of data. Epoxy can only be recycled by feedstock recycling or by energy recovering. In both cases the unreacted intermediate will likely be decomposed.

Substance	Hexahydromethylphthalic anhydride , Hexahydro-4-methylphthalic anhydride, Hexahydro-1-methylphthalic anhydride, Hexahydro-3-methylphthalic anhydride
References	Annex XV dossier – MHHPA. Hexahydromethylphthalic anhydride, Hexahydro-4-methylphthalic anhydride, Hexahydro-1-methylphthalic anhydride, Hexahydro-3-methylphthalic anhydride. http://echa.europa.eu/documents/10162/96184coe-245a-49a2-8a69-691e156dbaf7

3.6.8 Hexahydro-2-benzofuran-1,3-dion og lignende forbindelser

Substance	Hexahydro-2-benzofuran-1,3-dione, cis-cyclohexane-1,2-dicarboxylic anhydride, trans-cyclohexane-1,2-dicarboxylic anhydride, Cyclohexane-1,2-dicarboxylic anhydride
CAS Number	85-42-7, 13149-00-3, 14166-21-3
Justification	Candidate list; Registry of intentions (SVHC).
Function	Intermediate/monomer (resins, plasticisers), hardener (epoxy resins). [Annex XV dossier – HHHPA].
Relevant types of plastics	Epoxy resins.
Main article groups	Thermoset epoxy croslinked by dicarboxylic acid anhydrides.
Potential for release from plastics	Molecular weight: 154.2 g/mol, melting/freezing point: 31.9 °C, boiling point: 290.6 °C at 1013 hPa, vapour pressure: 77 Pa at 20°C and 93 Pa at 25°C, water solubility: 4.2 g/l at 20°C and pH 2.9, log K _{ow} : 1.59 at 40 °C [Annex XV dossier]. Migration is possible for unreacted substances due to the low molecular weight and low melting and boiling points.
Potential for exposure of consumers	Possible if unreacted residues are present in the epoxy resins after cure.
Fate of the substance by recycling	Epoxyes can only be recycled by incineration or by feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised.
References	Annex XV dossier – HHHPA. Hexahydro-2-benzofuran-1, 3-dione, cis-cyclohexane-1, 2-dicarboxylic anhydride, trans-cyclohexane-1, 2-dicarboxylic anhydride. http://echa.europa.eu/documents/10162/6a9bf645-3e36-4540-b9b8-48da3afb8245 Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.6.9 Hydrazin

Substance	Hydrazine
CAS Number	302-01-2; 7803-57-8
Justification	Candidate list; Registry of intentions (SVHC); CMR.
Function	Cross linker, chain extender in polyurethane. Intermediate in production of blowing agents in thermoplastics, polymerization initiators for acrylic and vinyl, flame retardants for nylon and smoke suppressant additives for polyurethane foam [Annex XV report].
Relevant types of plastics	Polyurethane [Annex XV report].

Substance	Hydrazine
Main article groups	Polyurethane coatings. End-applications for blowing agents include wind turbine blades, isolation panels, flotation devices, boat structures and seat foams, etc. [Annex XV report].
Potential for release from plastics	Molecular weight: 50.0 g/mol, boiling point: 113.5 °C, log P _{o/w} : -1.37. Totally miscible with water. Solid bound due to reactive behaviour in PU. Very reactive substance. Therefore most likely no intermediate residues in the end products. Residues will migrate. [Nilsson, 2012].
Potential for exposure of consumers	Unlikely due to the high reactivity of hydrazine and its difunctionality (at least one group is expected to react in the polymerisation and is thus fixed to the polymer network).
Fate of the substance by recycling	Judged not to be present in recycled plastics due to the difunctionality and high reactivity.
References	Annex XV report. http://echa.europa.eu/documents/10162/13640/svhc_axrep_echa_cmr_hydrazine_en.pdf Nilsson N. (2014). Expert assessment by Nils Nilsson, Danish Technological Institute, Århus, April 2014. Environment Canada 2011. Screening Assessment for the Challenge Hydrazine, January 2011.

3.6.10 4,4'-Diaminodiphenylmethan (MDA)

Substance	4,4'-Diaminodiphenylmethane (MDA)
CAS Number	101-77-9
Justification	Candidate list; Registry of intentions (SVHC); CMR.
Function	Hardener for epoxy resins, intermediate in the manufacture of high-performance polymers [Annex XV dossier] e.g. building block for polyether ether ketone (PEEK) [BASF, 2012].
Relevant types of plastics	Epoxy coatings and composites, and the high-performance polymer polyether ether ketone (PEEK) [BASF, 2012].
Main article groups	Mainly used in epoxy coatings and composites and PEEK [BASF, 2012]. The uses are described as "open use in the skilled trade".
Potential for release from plastics	Molecular weight: 198.3 g/mol, melting/freezing point: 89 °C, boiling point: 398-399 °C at 1013 hPa, vapour pressure: 2.87 x 10 ⁻⁸ hPa at 20 °C, water solubility: 1.25 g/l at 20 °C, log K _{ow} (Partition coefficient octanol/water (log value)): 1.59 [Annex XV dossier 2008]. Depends on the application - will e.g. be solid bound in epoxy due to crosslinking (reactive) behaviour. If present as unreacted residues or due to degradation of colorants or polymers migration should be expected to take place. [Nilsson, 2012].
Potential for exposure of consumers	Consumers might be exposed to the substance from not properly hardened epoxies but no data has been identified which support this judgement. The substance might be formed if methylene diphenyl diisocyanate (MDI – see section 3.6.13) is hydrolysed. It is known that MDA has been found in kitchen wares made of nylon. MDI might be used for crosslinking nylon although it is not known by the public. Thus it cannot be excluded that a major source of exposure to the consumer might be MDI based polyurethane products.

Substance	4,4'- Diaminodiphenylmethane (MDA)
Fate of the substance by recycling	Epoxyes can only be recycled by feedstock recycling or by energy recovering. In both cases unreacted MDA will likely be decomposed. MDA present in thermoplastic materials as nylon (PA) may likely remain in the recycled materials due to the high boiling point.
References	<p>Annex XV dossier. http://echa.europa.eu/documents/10162/13640/svhc_axrep_germany_cmr_mda_public_20083006_en.pdf</p> <p>BASF (2012). Webpage: http://www.bASF.com/group/corporate/en/brand/4_4_DIAMINODIPHENYLMETHANE_MOL</p> <p>Nilsson N. (2014). Expert assessment by Nils Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.6.11 2,2'-dichlor-4,4'-methylenedianilin (MOCA)

Substance	2,2'-dichloro-4,4'-methylenedianiline (MOCA)
CAS Number	101-14-4
Justification	Candidate list; Registry of intentions (SVHC); CMR.
Function	Curing agent (for polyurethane resins, epoxy resins and epoxy urethane resins, polystyrene and poly(methylmethacrylate) (PMMA), cross-linker (for polyurethane), chain extender (for polyurethane) or prepolymer [Annex XV dossier].
Relevant types of plastics	Mainly polyurethane (PU) [Annex XV dossier].
Main article groups	PU used in construction, for wheels, cars, electric wire coating, safety belts and recently also in biomaterials such as pace makers and implants, polyurethane coatings, castable urethane (curing agent). Polyurethanes with crosslinking agent can be used in the production of machines, buildings, automobiles, airplanes, mining and sport equipment. [Annex XV dossier].
Potential for release from plastics	<p>Molecular weight: 267.2 g/mol, melting point: 110 °C, boiling point: Decomposing prior boiling at 370 °C, vapour pressure: 0.0017 hPa at 60 °C, water solubility: 13.8 mg/l at 20 °C; pH: 7.6, partition coefficient octanol/water (log value) log K_{ow}: 2.5 at 25 °C and pH ca. 7 [Annex XV dossier].</p> <p>Solid bound due to reactive behaviour. Unreacted MOCA will, however, migrate due to the low molecular weight. Degradation of some azocolorants used in plastics might result in the liberation of MOCA.</p>
Potential for exposure of consumers	Exposure might happen for all types of the thermosetting plastics where the substance is used if the plastics are not properly cured.
Fate of the substance by recycling	Epoxyes and ordinary PU can only be recycled by feedstock recycling or by energy recovering. In both cases unreacted MOCA will likely be decomposed. Unreacted MDA present in thermoplastic materials as polystyrene may likely remain in the recycled materials due to the high boiling point if not bound by chemical reaction. To the extent products containing the substance are directed to incineration the content of chlorine may add to formation of dioxins and HCl in the chimney system.

Substance	2,2'-dichloro-4,4'-methylenedianiline (MOCA)
References	<p>Annex XV dossier.</p> <p>http://echa.europa.eu/documents/10162/13640/svhc_axrep_echa_cmr_moca_20110829_en.pdf</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.6.12 Andre alkylphenoler og ethoxilater

Substance	4-tert-Butylphenol, 2,6-Di-tert-butylphenol
CAS Number	98-54-4, 128-39-2
Justification	Danish list of undesired substances; Registry of intentions (CLP).
Function	Intermediate, co-polymer, chain terminator.
Relevant types of plastics	Phenolic resins, polycarbonate.
Main article groups	No information.
Potential for release from plastics	<p>Data for 2,6-Di-tert-butylphenol:</p> <p>Molecular weight: 206 g/mole, melting point: 37 °C, boiling point: 253 °C, log P_{ow}: 4.92.</p> <p>Migration of the unreacted substance may take place due to the low melting and boiling point.</p>
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The fate by recycling of thermoplastics is unclear. Some evaporation as well as renewed chemical reaction of the unreacted substance may be envisaged. Residues of the substances may, however, be present in recycled materials. Phenolic resins can only be recycled by feedstock recycling or by energy recovering. In both cases unreacted substance will likely be decomposed.
References	Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.6.13 Visse isocyanater

Substance	Methylene diphenyl diisocyanate (MDI), Toluene-diisocyanate, TDI
CAS Number	26447-40-5, 5873-54-1, 101-68-8, 26471-62-5, 584-84-9, 91-08-7
Justification	Danish list of undesired substances; List of CMR substances in toy.
Function	Intermediate – manufacturing of PUR.
Relevant types of plastics	PUR.
Main article groups	All products made of PUR except the PUR based on aliphatic diisocyanates (rubber, sealants and lacquers).

Substance	Methylene diphenyl diisocyanate (MDI), Toluene-diisocyanate, TDI
Potential for release from plastics	MDI has a very low vapour pressure at room temperature and will not evaporate and the migration to water containing liquids will result in hydrolysis to the similar diamine. TDI has a higher vapour pressure at room temperature and might migrate if left as residual monomer in the plastic. By hydrolysis TDI might also be hydrolysed to the similar diamine.
Potential for exposure of consumers	Studies from the Danish EPA indicate that exposure might take place from some PUR products, also products intended for babies. The strong evaporation of TDI means that it is relevant to give special attention to occupational exposure.
Fate of the substance by recycling	Polyurethane can only be recycled by incineration or by feedstock recycling. In both cases isocyanates will be decomposed. In Denmark only incineration is practised.
References	Christensen F., Nilsson N.H., Jeppesen C.N., Clausen A.J. (2013). Survey of certain isocyanates (MDI and TDI) - Part of the LOUS-review. Danish Environmental Protection Agency.

3.6.14 Styren

Substance	Styrene
CAS Number	100-42-5
Justification	Danish list of undesired substances; Registry of intentions (CLP).
Function	Intermediate
Relevant types of plastics	PS, ABS, SAN, EPS ,Glassfiber reinforced products (styrinated polyesters)
Main article groups	All article groups based on the relevant types of plastics
Potential for release from plastics	Molecular weight: 104.1 g/mol, melting point: -30.6 °C, boiling point: 145 °C, water solubility: 310 mg/l at 25°C, log P _{ow} : 2.95 Migration of the unreacted substance may take place due to the low melting and boiling point.
Potential for exposure of consumers	There is a potential risk for exposure caused by unreacted substance. The strong evaporation of the substance means that it is relevant to give special attention to occupational exposure.
Fate of the substance by recycling	Due to the low boiling point the unreacted substance will likely evaporate at least partly by mechanical recycling. Residues of the substances may, however, be present in recycled materials. Glasfiber reinforced products can only be recycled by incineration or by feedstock recycling. In both cases unreacted styrene will be decomposed. In Denmark only incineration is practised.
References	ATSDR 2012d. Toxicological Profile for Styrene. Agency for Toxic Substances and Disease Registry, U.S. Dept. of Health and Human Services, Public Health Service: www.atsdr.cdc.gov/toxprofiles/index.asp US EPA 1994. OPPT Chemical fact sheets styrene, Dec. 1994. http://www.epa.gov/chemfact/styre-sd.pdf

3.6.15 1,1-dichlorethylen, vinyliden chlorid

Substance	1,1-dichloroethylene, vinylidene chloride
CAS Number	75-35-4
Justification	List of CMR-substances in toy.
Function	Monomer.
Relevant types of plastics	Saran (thermoplastic copolymers of vinylidene chloride with monomers of vinyl chloride, acrylonitrile, acrylic esters or unsaturated carboxyl groups) – Saran packaging is due to environmental concerns today manufactured from chlorine-free plastics [DOW 2006; Bellis 2014; Johnson 2014; Dictionary.com 2014].
Main article groups	Fibres, packaging, acid-resistant pipes.
Potential for release from plastics	Molecular weight: 96.9 g/mol, melting point: -123° C, boiling point: 31.6° C, vapour pressure: 600 mm Hg (25° C), moderate water solubility: 2.4 g/l (25° C) [Toxnet 2014]. Migration of the monomer is possible due to low molecular weight and low melting and boiling points.
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	By mechanical recycling unreacted substance may likely evaporate due to the low boiling point and the very high vapour pressure. To the extent products containing the substance are directed to incineration the content of chlorine may add to formation of dioxins and HCl in the chimney system.
References	<p>Bellis M. (2014). Saran Wrap ®. http://inventors.about.com/library/inventors/blsarawrap.htm</p> <p>Dictionary.com (2014). Saran. http://dictionary.reference.com/browse/saran</p> <p>DOW (2006). Product Safety Assessment (PSA): SARAN™ PVDC Resins and Films http://www.dow.com/productsafety/finder/saran.htm</p> <p>Johnsson (2014). Saran – frequently asked questions. http://www.saranbrands.com/faq.asp#3</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Toxnet (2014). Vinylidene chloride http://toxnet.nlm.nih.gov</p>

3.6.16 p-dichlorbenzen, 1,4-dichlorbenzen

Substance	p-dichlorobenzene, 1,4-dichlorobenzene
CAS Number	106-46-7
Justification	List of CMR-substances in toy.
Function	Monomer.
Relevant types of plastics	PPS (polyphenylene sulphide).
Main article groups	Surface coatings.

Substance	p-dichlorobenzene, 1,4-dichlorobenzene
Potential for release from plastics	Molecular weight: 147 g/mol, melting point: -53° C, boiling point: 174° C, log P _{ow} : 3.44 [Toxnet 2014]. Migration of the monomer is possible due to low molecular weight and low melting and boiling points.
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	Due to the low boiling point the substance will likely evaporate at least partly by mechanical recycling. Residues of the substances may, however, be present in recycled materials. To the extent products containing the substance are directed to incineration the content of chlorine may add to formation of dioxins and HCl in the chimney system.
References	Toxnet (2014). Vinylidene chloride http://toxnet.nlm.nih.gov Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.6.17 Acrylonitril

Substance	Acrylonitril
CAS Number	107-13-1
Justification	List of CMR-substances in toy.
Function	Monomer.
Relevant types of plastics	ABS, SAN, ASA.
Main article groups	All products based on ABS, SAN, ASA including toys, packaging , drinking water contact products and many technical products including electronic and electrical products.
Potential for release from plastics	Molecular weight: 53 g/mol, melting point: -83° C, boiling point: 77° C, vapour pressure: 86 mm Hg (20 °C), log P _{ow} : 0.25. Acrylonitrile might be left as monomer in the final plastic product in low concentrations. As it is very polar, it has a high solubility in water. Migration of acrylonitrile is possible due to low molecular weight and low melting and boiling points.
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	Due to the low boiling point and high water solubility the substance will likely evaporate or be removed by washing in recycling process. The substance will most likely not be present in recycled materials.
References	Chemicalbook (2008). Acrylonitrile (107-13-1). http://www.chemicalbook.com/ProductChemicalPropertiesCB8764818_EN.htm Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.6.18 1,3-butadien

Substance	1,3-butadiene
CAS Number	106-99-0
Justification	List of CMR-substances in toy.
Function	Monomer.
Relevant types of plastics	HIPS (high impact polystyrene).
Main article groups	All products made from HIPS.
Potential for release from plastics	Molecular weight: 54.092 g/mol, melting point: < -108.9 °C, boiling point: -4.4 and -4.9°C at 101.325 kPa, vapour pressure: 244.7 kPa at 21°C, water solubility: 0.735 g/l at 20°C, log K _{ow} : 1.85 – 2.22 [ECB 2002a]. 1,3-butadiene is a low boiling gas and is judged to evaporate during moulding of the HIPS consumer goods. 1, 3 – butadiene is, furthermore, used for the production of the polybutadiene rubber, which is added to the polystyrene for improving resistance to impact. For this reason the presence of 1, 3- butadiene in the HIPS is considered to be very low if it is present at all.
Potential for exposure of consumers	Exposure to the consumers is not likely to happen as 1,3-butadiene most likely has evaporated during manufacturing of HIPS.
Fate of the substance by recycling	Is not likely to be present in end products and therefore not in materials being recycled.
References	ECB (2002a). European Union Risk Assessment Report – 1,3 butadiene. http://echa.europa.eu/documents/10162/1f512549-5bf8-49a8-ba51-1cf67dc07b72 Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.6.19 Allyl 2,3-epoxypropyl æter, allyl glycidyl æter, prop-2-en-1-yl 2,3-epoxypropyl æter

Substance	Allyl 2,3-epoxypropyl ether, allyl glycidyl ether, prop-2-en-1-yl 2,3-epoxypropyl ether
CAS Number	106-92-3
Justification	List of CMR-substances in toy.
Function	Intermediate for epoxies and some synthetic rubbers.
Relevant types of plastics	Epoxyes.
Main article groups	Unknown.
Potential for release from plastics	Molecular weight: 114.1, boiling point: 134 °C, water solubility: 172 g/l. Migration is possible for unreacted substances due to the low molecular weight and boiling point and high solubility in water.
Potential for exposure of consumers	Unknown, but possible if unreacted residues is present in the epoxy resins after cure.
Fate of the substance by recycling	Epoxyes can only be recycled by incineration or by feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised.

Substance	Allyl 2,3-epoxypropyl ether, allyl glycidyl ether, prop-2-en-1-yl 2,3-epoxypropyl ether
References	<p>Sheftel V.O. (1990). Toxic properties of polymers and additives. Rapra technologies.</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.6.20 Butyl 2,3-epoxypropyl æter, butyl glycidyl æter

Substance	Butyl 2,3-epoxypropyl ether, butyl glycidyl ether
CAS Number	2426-08-6
Justification	List of CMR-substances in toy.
Function	Intermediate as reactive solvent as epoxy resin additive.
Relevant types of plastics	Epoxyes.
Main article groups	Coatings, electronics, structural composites, adhesives.
Potential for release from plastics	The molecular weight is 130 g/mol and the boiling point 152- 164 C. The substance is very reactive due to the oxirane ring structure. Migration is possible for unreacted substances due to the low molecular weight and boiling point.
Potential for exposure of consumers	Unknown, but possible if unreacted residues is present in the epoxy resins after cure.
Fate of the substance by recycling	Epoxyes can only be recycled by incineration or by feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised.
References	<p>ERSTG (2001). High Production Volume Challenge Program For n-butyl Glycidyl Ether Submitted to the US EPA. The Epoxy Resin Systems Task Group, Dec. 2001.</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.6.21 1,3-bis(2,3-epoxypropoxi)benzen, resorcinol diglycidyl æter

Substance	1,3-bis(2,3-epoxypropoxy)benzene, resorcinol diglycidyl ether
CAS Number	101-90-6
Justification	List of CMR-substances in toy.
Function	Intermediate/monomer.
Relevant types of plastics	Epoxyes.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 240.3, boiling point: 451.2 C. The substance is reactive diglycidyl ether like the Bisphenol A types. Migration may take place for unreacted substances due to the low molecular weight and fairly low boiling point.
Potential for exposure of consumers	Some risk for exposure by unreacted substance if present in the cured epoxy resin.

Substance	1,3-bis(2,3-epoxypropoxy)benzene, resorcinol diglycidyl ether
Fate of the substance by recycling	Epoxyes can only be recycled by incineration or by feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised.
References	Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.6.22 1,2-epoxy-4-epoxyethylcyclohexan, vinylcyclohexan diepoxid

Substance	1,2-epoxy-4-epoxyethylcyclohexane, vinylcyclohexane diepoxide
CAS Number	106-87-6
Justification	List of CMR-substances in toy.
Function	Monomer, reactive dilutant.
Relevant types of plastics	Epoxyes.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 140.2 g/mol, melting/freezing point: -108.9 °C, boiling point: 142.2 °C, vapour pressure: 0.1 torr at 20°C, water solubility: water-soluble [Chhabra 1989]. Migration is possible for unreacted substances due to the low molecular weight and low melting and boiling points and water solubility.
Potential for exposure of consumers	Possible if unreacted residues are present in the epoxy resins after cure.
Fate of the substance by recycling	Epoxyes can only be recycled by incineration or by feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised.
References	Chhabra R. (1989). Toxicology and carcinogenesis studies of 4-vinyl-1-cyclohexene diepoxide (CAS NO. 106-87-6) in F344/N RATS AND B6C3F1 mice (dermal studies). NTP Technical report. http://ntp.niehs.nih.gov/ntp/htdocs/LT_rpts/tr362.pdf

3.6.23 1,5-naphthylenediamin

Substance	1,5-naphthylenediamine
CAS Number	2243-62-1
Justification	List of CMR-substances in toy.
Function	Intermediate.
Relevant types of plastics	PUR.
Main article groups	No information.
Potential for release from plastics	The substance has a molecular weight of 158.2 g/mol and a boiling point of 200-210 °C at 5 mm Hg. Water solubility is less than 0.1 g /100 ml. Migration may take place for unreacted substances due to the low molecular weight and fairly low boiling point.
Potential for exposure of consumers	Unknown, but judged possible if present due to the low molecular weight.
Fate of the substance by recycling	Polyurethane can only be recycled by incineration or by feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised.

Substance	1,5-naphthylenediamine
References	<p>Chemical Book. CAS DataBase List. http://www.chemicalbook.com/CASEN_2243-62-1.htm</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.6.24 1,2-epoxybutan

Substance	1,2-epoxybutane
CAS Number	106-88-7
Justification	List of CMR-substances in toy; Registry of intentions (CLP).
Function	Intermediate.
Relevant types of plastics	Epoxyes.
Main article groups	No information.
Potential for release from plastics	1,2- epoxybutane has a molecular weight of 72.1 g/mol and is a low boiling liquid (b.p.63°C) and very reactive. The risk for unreacted 1,2- ethoxybutane in the plastic is considered very low as it is used as an intermediate in initial reactions. Low monomer residual is expected to react with water in humid conditions.
Potential for exposure of consumers	The potential is considered negligible as it is judged that 1,2-epoxybutane will not be present in high enough concentrations to be a risk.
Fate of the substance by recycling	It is judged that 1,2-epoxybutane will not be present in the end of life plastic as it is judged to have reacted with a nucleophile by ring opening of the oxirane ring.
References	<p>ALS Environmental 2014a. http://www.caslab.com/1-2-epoxybutane_CAS_106-88-7/</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.6.25 Methylloxiran (Propylenoxid)

Substance	Methylloxirane (Propylene oxide)
CAS Number	75-56-9
Justification	Candidate list; Registry of intentions (CLP, SVHC); CMR.
Function	Intermediate/monomer (polyether polyol, thermoplastics) [ECHA 2013; Wikipedia – propylene oxide]. Most common use is the manufacturing of polyols for PUR.
Relevant types of plastics	PUR, thermoplastics.
Main article groups	No information.
Potential for release from plastics	Propylene oxide has a molecular weight of 58.1 g/mol and is a low boiling liquid (b.p. 34°C) and very reactive. The risk for unreacted propylene oxide in the plastic is considered very low as it is used as an intermediate in initial reactions. Low monomer residual is expected to react with water in humid conditions.
Potential for exposure of consumers	The potential is considered negligible as it is judged that propylene oxide will not be present in high enough concentrations to be a risk.

Substance	Methyloxirane (Propylene oxide)
Fate of the substance by recycling	Judged not to be present in the end of life plastic as it is judged to have reacted with a nucleophile by ring opening of the oxirane ring.
References	<p>ECHA (2013). Information on chemicals. http://www.echa.europa.eu/da/information-on-chemicals/registered-substances</p> <p>Wikipedia – propylene Oxide (2013). Propylene Oxide. http://en.wikipedia.org/wiki/Propylene_oxide (Nov. 2013)</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.6.26 1,3,5-Tris(oxiran-2-ylmethyl)-1,3,5-triazinan-2,4,6-trion (TGIC) & 1,3,5-tris[(2S and 2R)-2,3-epoxypropyl]-1,3,5-triazin-2,4,6-(1H,3H,5H)-trion (β -TGIC)

Substance	1,3,5-Tris(oxiran-2-ylmethyl)-1,3,5-triazinan-2,4,6-trion (TGIC)¹⁾ 1,3,5-tris[(2S and 2R)-2,3-epoxypropyl]-1,3,5-triazin-2,4,6-(1H,3H,5H)-trion (β-TGIC)²⁾ <p>¹⁾ Contains a combination of isomers 90% α and 10% β isomer. ²⁾ Exist and is used only as a part of TGIC (mixture of isomers, 90% α and 10% β isomer) [Annex XV dossier]</p>
CAS Number	2451-62-9; 59653-74-6
Justification	Candidate list; Registry of intentions (SVHC); CMR.
Function	Main function is as a three-dimensional cross-linking or curing agent (in polyester powder coatings). Also used as stabiliser in plastics [Annex XV dossier].
Relevant types of plastics	Polyester. TGIC is an epoxy compound [Annex XV dossier].
Main article groups	The main use is in polyester powder coatings for metal finishing for coated articles (in particular articles for exterior use) such as steel garden furniture, car parts, metal fencing, window and door frames, electrical equipment, refrigerators, washing machines and ovens [Annex XV dossier].
Potential for release from plastics	CAS no. 2451-62-9: Molecular weight: 297.3 g/mol, boiling point: > 240°C (not determined, as decomposition started at 240 °C), vapour pressure: 0.0072 Pa at 20°C, partition coefficient (log value) log P _{ow} : -0.8, at 20°C (measured). Solid bound due to crosslinking (reactive) behaviour. Release only by wear and tear.
Potential for exposure of consumers	Low risk if totally cross-linked.
Fate of the substance by recycling	The substance will remain in the plastic by mechanical recycling, but partly be decomposed.
References	Annex XV dossier. http://echa.europa.eu/documents/10162/13638/svhc_axrep_tgic_combinationisomers_en.pdf Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.6.27 Imidazole

Substance	Imidazole
CAS Number	288-32-4
Justification	Registry of intentions (CLP).
Function	Intermediate - monomers for manufacture of thermoplastics - amine component in PU, Epoxy, etc. [ECHA 2013].
Relevant types of plastics	PU and epoxy.
Main article groups	Unknown.
Potential for release from plastics	Molecular weight: 68.08, melting point: 88-91 °C, boiling point: 256° C [Sigma-Aldrich, 2014j]. Water-soluble strong base. If left in the plastic high risk for migration due to the low molecular weight, low boiling point and high water solubility.
Potential for exposure of consumers	Possible, but unknown.
Fate of the substance by recycling	The substance is judged to be partly removed in the washing step during mechanical recycling. By feedstock recycling or energy recovery the substance will be decomposed.
References	ECHA (2013). Information on chemicals. http://www.echa.europa.eu/da/information-on-chemicals/registered-substances Sigma-Aldrich (2014j). Imidazole www.sigmaplitech.com/catalog/product/fluka/1336500?lang=en&region=DK

3.6.28 1,4-Diaminobutan (Putrescine)

Substance	1,4-Diaminobutane (Putrescine)
CAS Number	110-60-1
Justification	Registry of intentions (CLP).
Function	Intermediate – production of polyamide (Nylon-4,6), by reaction with adipic acid.
Relevant types of plastics	Nylon-4,6.
Main article groups	Technical PA based products.
Potential for release from plastics	Molecular weight: 88.15, melting point: 27 °C, boiling point: 158-160°C [ALS Environmental 2014b]. If left unreacted the substance might migrate due to the low molecular weight and boiling point. Judged to be very soluble in water.
Potential for exposure of consumers	Unknown.
Fate of the substance by recycling	If left as monomer in the plastic the substance might remain in the plastic by mechanical recycling, but the risk is considered low because of the solubility in water which means that the substance will be removed in the washing process. By feed stock recycling and energy recovery the substance will be decomposed.
References	ALS Environmental 2014b. 1,4-diaminobutane - CAS 110-60-1. http://www.caslab.com/1-4-diaminobutane_CAS_110-60-1/

3.6.29 Vinyl acetat

Substance	Vinyl acetate
CAS Number	108-05-4
Justification	Registry of intentions (CLP).
Function	Monomer used for PVA, EVA etc.
Relevant types of plastics	PVA, VA/AA, PVCA.
Main article groups	Unknown.
Potential for release from plastics	Molecular weight: 86.09, melting point: -100 °C, boiling point: 72° C, vapour pressure: 100 mm Hg at 22 °C, water solubility: slightly [ALS Environmental 2014c]. Possible if left unreacted due to the low molecular weight and low boiling point.
Potential for exposure of consumers	Unknown.
Fate of the substance by recycling	Judged to evaporate or to be oxidised by mechanical recycling. Decomposed by feed stock recovery or energy recovery.
References	ALS Environmental 2014c. Vinyl acetate - CAS 108-05-4. http://www.caslab.com/Vinyl_acetate_CAS_108-05-4/

3.7 Organiske farvestoffer

Farver (opløselige) og pigmenter (uopløselige) er bredt anvendt ved produktion af plast. Mens pigmenter kan være uorganiske eller organiske, er farver (dyes) altid organiske forbindelser. Både organiske pigmenter og farver er til rådighed i et bredt udvalg af kulører og skal opfylde følgende krav [Subramanian 2013]:

- Stabile over for vejrførandringer.
- Varmefaste ved produktionsprocesser.
- Spredes frit i plast.
- Kompatible med plast materialet.

Det typiske indhold af organiske farver i plastprodukter er 0,25-5 % (w/w) og for organiske pigmenter på 0,001-2,5 % (w/w) [Hansen et al, 2013].

Alle organiske farvestoffer præsenteret i dette afsnit er karakteriseret af begrænsede data, hvilket medfører, at migration kun kan vurderes med væsentlig usikkerhed og at påvirkningen af forbrugerne reelt er ukendt. Det vurderes dog som sandsynligt, at ved mekanisk genanvendelse vil farvestofferne forblive i plast materialerne.

Et organisk farvestof, der ikke er medtaget her, er kønror (carbon black), som produceres ved ufuldstændig forbrænding af olie og tjære produkter. Kønror er relevant at overveje pga. det potentielle indhold af polyaromatiske hydrocarboner (PAHer - se afsnit 3.11.5).

3.7.1 Malachite grøn hydrochlorid, malachite grøn oxalat

Substance	Malachite green hydrochloride, malachite green oxalate
CAS Number	569-64-2, 18015-76-4
Justification	List of CMR-substances in toy.
Function	Colorant.
Relevant types of plastics	Green coloured plastics.
Main article groups	No information.
Potential for release from plastics	Malachite green hydrochloride: Molecular weight: 364.91 g/mol, boiling point: data not available, vapour pressure: 111 Pa at 50°C, Log P _{ow} : 0.062. Very soluble in organic solvents. [ECHA 2010; Sigma-Aldrich 2014b]. Malachite green oxalate: Molecular weight: 926 g/mol g/mol, melting point: 164 °C, boiling point: 172-175 °C, decomposition: 210 °C, vapour pressure: 111 Pa (50 °C) [ECHA 2010]. Migration is uncertain, but may take place due to the low boiling point.
Potential for exposure of consumers	Unknown.
Fate of the substance by recycling	The fate by recycling of thermoplastics is unclear. Some evaporation as well as decomposition may take place depending on the plastic type in question. Part of the substance may, however, also be present in recycled materials. Thermosetting plastics can only be recycled by feedstock recycling or by energy recovering. In both cases unreacted substance will likely be decomposed. To the extent products containing the substance are directed to incineration the content of chlorine may add to formation of dioxins and HCl in the chimney system.

Substance	Malachite green hydrochloride, malachite green oxalate
References	<p>ECHA (2010). Background document to the Opinion proposing harmonised classification and labelling at Community level of leucomalachite green ECHA/RAC/CLH-O-oooooooo1309-75-03/A1. http://echa.europa.eu/documents/10162/13641/leucomalachite_green_annex_1_en.pdf</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Sigma-Aldrich (2014b). Malachite Green chloride - Material Safety Data Sheet http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=DK&language=da&productNumber=38800&brand=FLUKA&PageToGoToURL=http%3A%2F%2Fwww.sigmaaldrich.com%2Fcatalog%2Fsearch%3Finterface%3DCAS%2520No.%26term%3D569-64-2%26lang%3Den%26region%3DDK%26focus%3Dproduct%26N%3D220003048%2B219853103%2B219853286%26mode%3Dpartialmax</p>

3.7.2 **N-[4-[(2-hydroxy-5-methylphenyl)azo]phenyl]acetamid, C.I. Disperse Yellow 3**

Substance	N-[4-[(2-hydroxy-5-methylphenyl)azo]phenyl]acetamide, C.I. Disperse Yellow 3
CAS Number	2832-40-8
Justification	List of CMR-substances in toy.
Function	Colorant.
Relevant types of plastics	Yellow coloured plastics.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 269.3 g/mol, melting point: 268 - 270 °C, vapour pressure: data not available, log P _{ow} : 3.6 [Sigma-Aldrich 2014c]. Migration is uncertain, but may take place due to the low molecular weight. Melting point is, however, relative high.
Potential for exposure of consumers	Unknown.
Fate of the substance by recycling	Judged to mainly remain in the plastic by mechanical recycling due to the high melting point.
References	<p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Sigma-Aldrich (2014c). Disperse Yellow 3- Material Safety Data Sheet. http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=DK&language=da&productNumber=215686&brand=ALDRICH&PageToGoToURL=http%3A%2F%2Fwww.sigmaaldrich.com%2Fcatalog%2Fproduct%2Faldrich%2F215686%3Flang%3Den</p>

3.7.3 1-phenylazo-2-naphthol, C.I. Solvent Yellow 14

Substance	1-phenylazo-2-naphthol, C.I. Solvent Yellow 14
CAS Number	842-07-9
Justification	List of CMR-substances in toy.
Function	Colorant.
Relevant types of plastics	Yellow coloured plastics.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 248.3g/mol, melting point: 144.4 °C, vapour pressure: 1.27×10^{-5} Pa, log Pow: 5.51 [Environment Canada 2013]. Migration is uncertain, but may take place due to the low molecular weight. Melting point is, however, relative high and the vapour pressure low.
Potential for exposure of consumers	Unknown.
Fate of the substance by recycling	The fate by recycling of thermoplastics is unclear due to lack of data. Some evaporation may take place, but the main part of the substance may well remain in the plastic by mechanical recycling due to the high melting temperature. Thermosetting plastics can only be recycled by feedstock recycling or by energy recovering. In both cases unreacted substance will likely be decomposed.
References	Environment Canada (2013). Aromatic Azo and Benzidine-based Substance Grouping. Certain Azo Solvent Dyes. Appendix of Draft Screening Assessment http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=oC7DoBE6-1842 Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.8 UV stabilisatorer, antioxidanter og andre stabilisatorer

Generelt tilføres stabilisatorer for at forebygge nedbrydning af plasten (f.eks. fra varme, lys, UV lys, ilt og andre former for miljøpåvirkninger) og dermed forlænge levetiden af produkterne.

Varmestabilisatorer beskytter polymerer ved produktionsprocesser, hvor der sker opvarmning, for at undgå nedbrydning af produkterne samt overfor varme ved brug i lang tid ved høje temperaturer.

UV stabilisatorer benyttes til at forebygge og beskytte mod nedbrydning af plast mod ultraviolette stråler for at forlænge levetiden af færdigvarer, mens antioxidanter anvendes til at begrænse den oxidationsmæssige nedbrydning af produkter [Subramanian 2013].

Indholdet af varmestabilisatorer er typisk 0,5-3 % (w/w), mens det typiske indhold af antioxidanter og and UV stabilisatorer i plast produkter er 0,05-3 % (w/w) [Hansen et al 2013].

Stoffernes adfærd er forskellig fra stof til stof. De fleste stoffer kan antages at migrere, men raten vil være så beskeden, at hovedparten af stoffet vil forblive i materialerne, indtil disse bortskaffes som affald, forudsat at migration er den eneste mekanisme for at mindske indholdet i plast.

Antioxidanter og mange UV stabilisatorer vil dog blive kemisk ændret ved produktionen af plast og ved brugen af produkterne, da stabilisatorerne fungerer på den måde, at de nedbrydes i stedet for plastpolymererne. Dette betyder, at ved mekanisk genanvendelse er det nødvendigt at tilføre flere stabilisatorer til materialet for at beskytte den genanvendte plast (de nye produkter) mod nedbrydning.

Det skal bemærkes, at følgende stoffer også vil fungere som stabilisatorer eller antioxidanter i plast:

- 1,6-hexanediol diglycidyl æter (afsnit 3.10.5).
- Nonylphenol og dets ethoxylater (afsnit 3.11.1).
- Oktylphenol og dets ethoxylater (afsnit 3.11.2).
- 1,3,5-Tris(oxiran-2-ylmethyl)-1,3,5-triazinan-2,4,6-trion (TGIC) 1) 1,3,5-tris[(2S and 2R)-2,3-epoxypropyl]-1,3,5-triazin-2,4,6-(1H,3H,5H)-trion (β -TGIC) 2) (afsnit 3.6.26).
- Bly og blyforbindelser (afsnit 3.4.5).
- Cadmium og cadmiumforbindelser (afsnit 3.4.1).
- Antimon trioxid (afsnit 3.5.38).

3.8.1 1,4-benzenediol, 2,5-bis(1,1-dimethylethyl)-

Substance	1,4-benzenediol, 2,5-bis(1,1-dimethylethyl)-
CAS Number	88-58-4
Justification	Danish list of undesired substances.
Function	Antioxidant in plastics.
Relevant types of plastics	No information.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 222.33 g/mol, boiling point: 321-324.52 °C, vapour pressure: 0.0000009 hPa at 25 °C, partition coefficient (log value) log P _{ow} : 4.85. Not solid bound and will migrate due to low molecular weight and medium high boiling point.
Potential for exposure of consumers	Exposure is deemed possible. But because the substance typically is added in low concentration in the plastic products (0.1-1%) the risk is considered low.

Substance	1,4-benzenediol, 2,5-bis(1,1-dimethylethyl)-
Fate of the substance by recycling	The substance will partly be decomposed by mechanical recycling. Residues may be present in recycled materials, but no practical experience is available.
References	Hansen E., Christensen F.M., Kjølholt J., Jeppesen C.N., Lassen C. (2012b). Survey of 1,4-benzenediol, 2,5-bis(1,1-dimethyl ethyl)- (2,5-di-tert-butylhydroquinone). Danish Environmental Protection Agency. Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.8.2 Phenol benzotriazoler

Substance	Phenolic benzotriazols (2-benzotriazol-2-yl-4,6-di-tert-butylphenol (UV-320), 2,4-di-tert-butyl-6-(5-chlorobenzotriazol-2-yl)phenol (UV-327), 2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol (UV-328), 2-(2H-benzotriazol-2-yl)-4-(tert-butyl)-6-(sec-butyl)phenol (UV-350)
CAS Number	3846-71-7, 3864-99-1, 25973-55-1, 36437-37-3
Justification	Registry of intentions (SVHC).
Function	UV-stabilizer.
Relevant types of plastics	UV320: Polyurethane and other plastics. UV327: Polyurethane and other plastics. UV328: ABS, Epoxy, unsaturated polyester, polypropylene, PVC, polycarbonate, polyacrylate and polyurethane. UV350: Polyurethane and other plastics.
Main article groups	E.g. coated textiles and coating of surfaces on cars and wood etc. – relevant for all surfaces seriously exposed to sunlight.
Potential for release from plastics	CAS no.: 3846-71-7: Molecular weight: 323.4 g/mol, boiling point: 444.0 ± 55.0°C, vapour pressure: 1.70×10^{-8} torr at 25 °C, log P _{ow} : 6.853 ± 1.254 at 25 °C (calculated properties). The other substances have similar values. Not solid bound and will migrate due to low molecular weight and medium high boiling point.
Potential for exposure of consumers	Exposure is deemed possible. But because the substance typically is added in low concentration in the plastic products (0.1-1%) the risk is considered low.
Fate of the substance by recycling	The substance will partly be decomposed by mechanical recycling. Residues may be present in recycled materials. Substances used in thermosetting materials as polyurethane and epoxies will be decomposed by feedstock recycling as well as energy recovery.

Substance	Phenolic benzotriazols (2-benzotriazol-2-yl-4,6-di-tert-butylphenol (UV-320), 2,4-di-tert-butyl-6-(5-chlorobenzotriazol-2-yl)phenol (UV-327), 2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol (UV-328), 2-(2H-benzotriazol-2-yl)-4-(tert-butyl)-6-(sec-butyl)phenol (UV-350)
References	<p>Annex XV dossier – UV320. http://echa.europa.eu/documents/10162/13638/annex_xv_svhc_ec_223-346-6_uv320_en.pdf</p> <p>Annex XV dossier – UV327. http://echa.europa.eu/documents/10162/06a69fa4-beod-441e-9a65-471d1ddaa9e3</p> <p>Annex XV dossier – UV328. http://echa.europa.eu/documents/10162/13641/rac_opinion_annex_UV-328_en.pdf</p> <p>Annex XV dossier – UV350. http://echa.europa.eu/documents/10162/a4fd8518-5e1c-40b7-a8c0-320b9f71f676</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.8.3 N-2-naphthylanilin, N-phenyl-2-naphthylamin

Substance	N-2-naphthylaniline, N-phenyl-2-naphthylamine
CAS Number	135-88-6
Justification	List of CMR-substances in toy.
Function	Thermo stabilizer, antioxidant.
Relevant types of plastics	PE, EVA, PIB.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 219.28 g/mol, boiling point: 395 – 395.5 °C, vapour pressure: no data available, partition coefficient (log value) log P _{ow} : 5 [Sigma-Aldrich 2014h]. Not solid bound and will migrate due to low molecular weight and medium high boiling point.
Potential for exposure of consumers	Exposure is deemed possible. But because the substance typically is added in low concentration in the plastic products (0.1-1%) the risk is considered low.
Fate of the substance by recycling	The substance will partly be decomposed by mechanical recycling. Residues may be present in recycled materials.
References	<p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Sigma –Aldrich (2014h). N-Phenyl-2-naphthylamine - Material Safety Data Sheet http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=DK&language=da&productNumber=178055&brand=ALDRICH&PageToGoToURL=http%3A%2F%2Fwww.sigmaplitech.com%2Fcatalog%2Fsearch%3Finterface%3DCAS%2520No.%26term%3D135-88-6%26lang%3Den%26region%3DDK%26focus%3Dproduct%26N%3Do%2B220003048%2B219853103%2B219853286%26mode%3Dmatch%2520partialmax</p>

3.8.4 2-ethylhexan syre

Substance	2-ethylhexanoic acid
CAS Number	149-57-5
Justification	List of CMR-substances in toy.
Function	Stabilizer (thermo) as a salt.
Relevant types of plastics	PVC and as residue in PUR products.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 144.21 g/mol, boiling point: 227.6 °C, vapour pressure: 1.33×10^{-3} kPa at 20°C, log P _{ow} : 3 at 25°C [US EPA 2001]. Not solid bound and will migrate due to low molecular weight and medium high boiling point.
Potential for exposure of consumers	Exposure is possible. But due to typically low concentrations present in products (500 ppm) [Tønning et al 2008] the risk is considered as low.
Fate of the substance by recycling	The substance will partly be decomposed by mechanical recycling. Residues may be present in recycled materials. Substances used in thermosetting materials as polyurethane will be decomposed by feedstock recycling as well as energy recovery.
References	<p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Tønning K., Pedersen E., Lomholt A.D., Malmgren-Hansen B., Woin P., Møller L., Bernth N. (2008). Kortlægning og afgivelse samt sundhedsmæssig vurdering af kemiske stoffer i babyprodukter. Kortlægning af kemiske stoffer i forbrugerprodukter, Nr. 90/2008. Danish Environmental Protection Agency.</p> <p>US EPA (2001). Robust Summaries and SIDS dossier for 2-Ethylhexanoic Acid. http://www.epa.gov/hpv/pubs/summaries/metalcarb/c14172rr12.pdf</p>

3.8.5 Dibutyltin dichlorid

Substance	Dibutyltin dichloride
CAS Number	683-18-1
Justification	Candidate list, Registry of intentions (SVHC); CMR.
Function	Stabiliser in PVC. Catalyser in the production of polyurethanes.
Relevant types of plastics	PVC, polyurethane (PUR).
Main article groups	PVC: food wraps and food packaging, T-shirts, polyurethane gloves, sanitary napkins, medical equipment, cellophane wrap and soft toys, water pipes, packing materials, textile products. Polyurethanes: Foam plastics, glue/sealants, insulators in electronics and cables, transparent plastic.
Potential for release from plastics	Molecular weight: 304 g/mol, melting point: 43 °C, boiling point: 135 °C (10 mm Hg), solubility water: 80 mg/l at 25 °C. Migration is possible due to low molecular weight and low melting and boiling points.

Substance	Dibutyltin dichloride
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	By recycling of thermoplastics some evaporation as well as oxidation must be expected. Residues of the substances may, however, be present in recycled materials. Polyurethane can only be recycled by incineration or by feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised. The content of chlorine may add to formation of dioxins and HCl in the chimney system.
References	<p>Annex XV dossier. Dibutyltin dichloride. http://echa.europa.eu/documents/10162/8a520ac1-f460-447f-9ac4-388768fe0784</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Sheftel V.O. (1990). Toxic properties of polymers and additives. Rapra technologies</p>

3.8.6 Andre tin stabilisatorer

Substance	Dimethyltin bis(2-ethylhexylmercaptoacetate) (DMT EHMA); Diocyltin bis(2-ethylhexyl mercaptoacetate); Dibutyltin dilaurate; Dimethyltin dichloride (DMTC)
CAS Number	57583-35-4, 15571-58-1, 77-58-7, 753-73-1
Justification	Registry of intensions (CLP).
Function	Heat stabilizer in PVC - the substances are added to PVC in amounts of 0.3 – 12 phr (parts per hundred parts PVC). Catalyst in production of PU (dibutyltin laurate) [KEMI – Dibutyltenndilaurate 2013].
Relevant types of plastics	PVC
Main article groups	Plastic doors, windows, pipes for water transport, decorative PVC items etc.
Potential for release from plastics	The substances are liquids or solids with melting points in the range 22° C to 106 °C and molecular weight in the range 219.69 to 752. Boiling point is from 188 °C and higher. The substances are all strong reducing agents which prevent oxidation of the PVC by being oxidised themselves. The substances are not solid bound and might migrate.
Potential for exposure of consumers	Possible as not solid bound.
Fate of the substance by recycling	It is judged that the substances will remain in the plastic during mechanical recycling but oxidation might take place during the recycling due to the strong reducing properties of the substances. By feed stock recycling and energy recovery the substances are decomposed. To the extent products containing the substance are directed to incineration content of chlorine may add to formation of dioxins and HCl in the chimney system.

Substance	Dimethyltin bis(2-ethylhexylmercaptoacetate) (DMT EHMA); Diocytin bis(2-ethylhexyl mercaptoacetate); Dibutyltin dilaurate; Dimethyltin dichloride (DMTC)
References	<p>Chemicalbook (2010a). Dimethyl dichloride (753-73-1). http://www.chemicalbook.com/ChemicalProductProperty_EN_CB1729317.htm</p> <p>Chemicalbook (2010b). Dibutyltin dilaurate (77-58-7). http://www.chemicalbook.com/ChemicalProductProperty_EN_CB7416378.htm</p> <p>Chemnet (2014). 57583-35-4 Methyl Tin Mercaptide. http://www.chemnet.com/cas/en/57583-35-4/Methyl-Tin-Mercaptide.html</p> <p>Health Canada 2013. Priority Substances List Assessment Report for Non-pesticidal organotin compounds. http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1_lsp1/non_pest_org_comp/index-eng.php</p> <p>KEMI (2012). Dibutyltin compounds. http://apps.kemi.se/floressok/floden/kemamne_eng/dibutyltenforeningar_eng.htm (Nov.2012)</p> <p>KEMI – Dibutyltenndilaurate 2013. http://apps.kemi.se/floressok/floden/kemamne_eng/dibutyltennd_eng.htm</p> <p>Sigma-Aldrich (2014j). Dibutyltindilaurat CAS no. 77-58-7 – Material safety data sheet. http://www.sigmaproducts.com%2Fcatalog%2Fsearch%3Finterface%3DAll%26term%3D77-58-7%26N%3D0%26mode%3Dpartialmax%26focus%3Dproduct%26lang%3Den%26region%3DDK</p> <p>Vetamo 2014. Methyl Tin Mercaptide. http://www.vetamo.com/181.htm</p>

3.8.7 TNPP (tris(nonylphenyl)fosfit)

Substance	TNPP (tris(nonylphenyl)phosphite)
CAS Number	26523-78-4
Justification	Registry of intentions (CLP).
Function	Stabiliser in the processing of plastic products. They are used with hindered phenolic antioxidants in plastic food packaging. In the stabilisation process, TNPP is gradually oxidised and nonylphenol is released. TNPP is also used as a secondary antioxidant in polymer formulations.
Relevant types of plastics	PVC, LLDPE, HDPE [EURAR – TNPP 2007].
Main article groups	PVC products include shower curtains, floorings and wall coverings. LLDPE films include films for bags and food packaging. HDPE containing TNPP include blow-moulded plastic drums or outer wrapping (film) of cigarette boxes or tea boxes. Other products include tires and shoe soles. [EURAR – TNPP 2007].

Substance	TNPP (tris(nonylphenyl)phosphite)
Potential for release from plastics	Molecular weight: 689, boiling point: 180 °C at 4 hPa, decompose: > 303° C, vapour pressure 0.00008 hPa at 20 °C, log P _{ow} : 19.918 - 21.6, solubility in water: ~0 mg/l. Migration ability is uncertain. Migration will likely be low due to the high boiling point/decomposition temperature and the low vapour pressure. Will not migrate to water. Nonylphenol might migrate, as it is an impurity in the substance.
Potential for exposure of consumers	Possible, but likely to be low.
Fate of the substance by recycling	The substance is assumed mainly to remain in the plastic by mechanical recycling. By feed stock recycling or energy recovery of the plastic by incineration the substance will be decomposed.
References	<p>EURAR – TNPP (2007). Risk Assessment Report – Tris(nonylphenyl)phosphite – draft. http://echa.europa.eu/documents/10162/522e8584-1797-4a11-960b-3c813b37495f</p> <p>ECHA (2009c). Tris(nonylphenol)phosphite CAS No: 26523-78-4 Annex XV Transitional Report. http://echa.europa.eu/documents/10162/13630/trd_cover_page_tris_nonylphenol_phosphite_en.pdf</p> <p>Guidechem (2014b). Phenol, nonyl-,1,1',1"-phosphite (cas 26523-78-4) MSDS http://www.guidechem.com/msds/26523-78-4.html</p>

3.9 Blødgørere

Blødgørere tilføjes til plast for at fremme flydeegenskaber og dermed processen (indre smøremidler) eller for at blødgøre plast ved at sænke glas overgangs temperaturen (t_g). Blødgørere er enten faste stoffer med lavt smeltepunkt eller væsker med højt kogepunkt og bevirket:

- Regulering af viskositeten, som tillader hurtig overfladebehandling og lav koncentration af blødgøreren i belægningen (plastisolen).
- At bidrage til fordelagtige blandings egenskaber, hvorved der kan opnås høje produktionshastigheder.
- Fremragende modstandsdygtighed overfor misfarvning, og slid [Subramanian 2013].

Det typiske indhold af blødgørere i blødgjort plast er 10-70 % (w/w) [Hansen et al 2013].

Gruppen af blødgørere listet nedenfor omfatter ftalater, chlorparaffiner og anerkendte alternativer til disse stoffer. Migration af blødgørere til fødevarer er undersøgt i mange år med fokus på de ftalater, der giver anledning til størst sundhedsmæssig betænkelighed. Generelt gælder, at alle de angivne blødgørere må påregnes at migrere og brugen af blødgjort plast må derfor betragtes som en kilde til påvirkning af forbrugere.

Den dominerende anvendelse er til fremstilling af blødgjort PVC, men visse stoffer anvendes i andre blødgjorte plasttyper herunder opskummet polyuretan, akrylplast, polyester etc.

Det vurderes, at migrationhastigheden typisk vil være så lav, at hovedparten af blødgørerne, der tilføjes produktet, stadig vil være til stede i plasten ved slutningen af brugsfasen. I det omfang, at plasten genanvendes mekanisk vil blødgørerne også være til stede i de genanvendte materialer, mens blødgørere anvendt i hærdeplast som polyuretan vil blive nedbrudt både ved feed-stock genanvendelse og ved energi genvinding.

Det skal bemærkes, at tris(2-chloroethyl)fosfat (TCEP) (se afsnit 3.5.5) og diphenyl cresyl fosfat (se afsnit 3.5.33) også vil fungere som blødgørere udover deres funktion som flammehæmmer.

3.9.1 1,2-Benzendicarboxyl syre, di-C₇₋₁₁-grenet og linære alkyl estre

Substance	1,2-Benzenedicarboxylic acid, di-C ₇₋₁₁ -branched and linear alkyl esters (DHNUP)
CAS Number	68515-42-4
Justification	Candidate list; Registry of intentions (SVHC); CMR.
Function	Plasticiser (mainly) [Annex XV dossier].
Relevant types of plastics	PVC (mainly), foamed urethane.
Main article groups	Electrical and communication wire insulation (mainly) [Annex XV dossier] dossier.
Potential for release from plastics	DHNUP should be regarded as semivolatile (molecular weight: 362-474 g/mol, boiling point: 235-278 °C at 7 hPa, vapour pressure: <10 Pa at 20 °C). Release rates by migration are probably in the range of 0.1-1% per year or below (analogy considerations to DEHP – see section 3.9.7). Given sufficient time, a significant part of the substance will probably be released by leaching to the surface followed by evaporation or removal by washing (Partition coefficient (log value) P_{ow} : ca. 4.8). Tear and wear will also take place but be of minor importance.
Potential for exposure of consumers	Same considerations as for diisoheptylphthalate (see section 3.9.2) based on the close similarity of the substances (molecular weight, aromatic structure, ester functionality).

Substance	1,2-Benzenedicarboxylic acid, di-C₇-11-branched and linear alkyl esters (DHNUP)
Fate of the substance by recycling	Same fate as for diisoheptylphthalate (see section 3.9.2)
References	Annex XV dossier. http://echa.europa.eu/documents/10162/13640/svhc_axrep_dk_cmr_dhnup_en.pdf

3.9.2 **1,2-Benzendicarboxylsyre, di-C₆-8-grenet alkyl estre, C₇-rig (Diisoheptylftalate)**

Substance	1,2-Benzendicarboxylic acid, di-C₆-8-branched alkyl esters, C₇-rich (Diisoheptylphthalat)
CAS Number	71888-89-6
Justification	Candidate list; Registry of intentions (SVHC); CMR.
Function	Plasticiser [Annex XV dossier].
Relevant types of plastics	PVC, one-component polyurethanes and acrylics [Annex XV report].
Main article groups	Plasticiser in PVC: vinyl flooring, tile and carpet backing; moulding and coating plastisols (e.g. coating of textiles or other materials); partial replacement for other low molecular weight plasticisers (e.g. DEHP – see section 3.9.7) in extrusion, injection moulding and calendaring applications requiring improved process ability.
Potential for release from plastics	Molecular weight: 362.50 g/mol, boiling point: 393 °C at 1.013 hPa, vapour pressure: 0.0000009 hPa at 25 °C, partition coefficient (log value) log P _{ow} : 6.9 at 25 °C [Sigma-Aldrich 2014d]. Not chemically bound and will migrate. Release rates by migration are probably in the range of 0.1-1% per year or below (analogy considerations to DEHP - see section 3.9.7). Given sufficient time, a significant part of the substance will probably be released by leaching to the surface followed by evaporation or removal by washing. Tear and wear will also take place but be of minor importance.
Potential for exposure of consumers	Exposure is primarily related to soft/flexible PVC products incl. PVC packaging, secondly to polyurethane and scarcely acrylics. All types of phthalate plasticisers will migrate from the soft PVC as they are not chemically bound and as they are fairly low molecular weight plasticisers. They are also all of them added in rather high amounts to PVC (up to 50 % w/w or occasionally even more). The migration tendency depends on the solubility parameter of the phthalate (The partition coefficient K _{ow} is a good estimate), the concentration and the temperature as well as the vapour pressure and the way the exposure takes place (inhalation, orally or by contact with the skin). In the case of packaging for food it will especially be the migration to fatty food which might cause a major contamination of the food (e.g. vegetable oils).
Fate of the substance by recycling	Judged to mainly remain in the plastic by mechanical recycling due to the high boiling point. By feed stock recycling and energy recovery in incineration plants the phthalates will be decomposed.

Substance	1,2-Benzenedicarboxylic acid, di-C6-8-branched alkyl esters, C7-rich (Diisoheptylphthalat)
References	<p>Annex XV dossier. http://echa.europa.eu/documents/10162/13640/svhc_axrep_echa_cmr_DIHP_en.pdf</p> <p>Sigma-Aldrich 2014d. Diisoheptyl phthalate - Material Safety Data Sheet. http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=DK&language=da&productNumber=376671&brand=ALDRICH&PageToGoToURL=http%3A%2F%2Fwww.sigmaaldrich.com%2Fcatalog%2Fsearch%3Finterface%3DCAS%2520No.%26term%3D71888-89-6%26lang%3Den%26region%3DDK%26focus%3Dproduct%26N%3D220003048%2B219853103%2B219853286%26mode%3Dpartialmax</p>

3.9.3 Alkaner, C10-13, chlor (kort kædede chlorparaffiner - SCCP)

Substance	Alkanes, C10-13, chloro (Short Chain Chlorinated Paraffins-SCCP)
CAS Number	85535-84-8; 108171-26-2, 287-476-5
Justification	Danish list of undesired substances; Norwegian priority list; Candidate list; Registry of intentions (SVHC); CMR.
Function	Secondary plasticiser and flame retardant [US EPA, 2009a].
Relevant types of plastics	In USA use in PVC is important [US EPA 2009a]. According to [POPRC, 2007] it is not used in PVC in Europe, but primarily in rubber and elastomers (sealants etc.). Use in textile fibres cover cellulosic textiles and in other polymers.
Main article groups	Polyurethane and acrylic sealants. Fire proofing of cellulosic textiles and in other polymers. [POPRC, 2007].
Potential for release from plastics	Will not bind to the polymer matrix. Will migrate and leach/evaporate from plastic. A release factor for medium chained CPs to water for outdoor use in sealants of 0.15 % per year over the 20-to 30-year lifetime of sealants is assumed [POPRC, 2007]. A higher release factor must be assumed for short chained CP. Wear and tear will cause release also.
Potential for exposure of consumers	As the substance is used both as a flame retardant and secondary plasticiser it will be present in plastic products in rather high amounts. For this reason there will be a risk for exposure if used in consumer products as the substance group is not chemical bound to the polymer. SCCP is a liquid with <ul style="list-style-type: none"> • boiling point: >200 °C; • water solubility: 0.15 -0.47 mg/l; • Log P_{o/w}: 4.4-8.7.
Fate of the substance by recycling	Judged to mainly remain in the plastic by mechanical recycling due to the low release factor. By energy recovery in an incineration plant the substance will be decomposed. The content of chlorine may add to formation of dioxins and HCl in the chimney system.

Substance	Alkanes, C ₁₀₋₁₃ , chloro (Short Chain Chlorinated Paraffins-SCCP)
References	<p>Annex XV dossier. http://echa.europa.eu/documents/10162/13640/svhc_axrep_uk_pbt_sccp_20083006_en.pdf</p> <p>OSPAR (2009b). Background Document on short chain chlorinated paraffins. OSPAR Commission. http://www.ospar.org/documents/dbase/publications/poo397_sccp%2oupdate2.pdf</p> <p>POPRC (2007). Draft risk profile for Short-chained chlorinated paraffins. Persistent Organic Pollutants Review Committee. http://www.pops.int/documents/meetings/poprc/drprofile/drp/DraftRiskProfile_SCCP.pdf</p> <p>US EPA (2009a). Short-Chain Chlorinated Paraffins Action Plan. http://www.epa.gov/oppt/existingchemicals/pubs/actionplans/sccps_ap_2009_1230_final.pdf</p>

3.9.4 Medium kædede chlorparaffiner (MCCP)

Substance	Medium-chain chlorinated paraffins (MCCP)
CAS Number	85535-85-9
Justification	Danish list of undesired substances; Norwegian priority list.
Function	Plasticiser and flame retardant [KLIF, 2010].
Relevant types of plastics	Soft plastic, PVC, and polyester [KLIF, 2010].
Main article groups	Polyester e.g. in lifeboats. PVC - mainly wallpapers, floor coverings, cables, leisure and travel articles, [KLIF, 2010; NG 2010].
Potential for release from plastics	The substance is not chemically bound and will migrate. MCCP is a liquid with boiling point: > 200 °C, water solubility: 0.005-0.0027 g/l and log P _{o/w} : 5.52 – 8.21. MW range: 208 – 825 g/mol. In a risk assessment it is estimated that significant release will take place during in-service life of MCCP in plastics [Annex XV report]. A release factor for medium chained CPs to water for outdoor use in sealants of 0.15% per year over the 20-to 30-year lifetime of sealants is assumed [POPRC, 2007].
Potential for exposure of consumers	As the substance is used both as a flame retardant and secondary plasticiser it will be present in plastic products in rather high amounts. For this reason there will be a risk for exposure if used in consumer products as the substance group is not chemical bound to the polymer.
Fate of the substance by recycling	Judged to mainly remain in the plastic by mechanical recycling due to the low release factor. By energy recovery in an incineration plant the substance will be decomposed. The content of chlorine may add to formation of dioxins and HCl in the chimney system.

Substance	Medium-chain chlorinated paraffins (MCCP)
References	<p>Annex XV Restriction Report http://echa.europa.eu/documents/10162/13630/trd_uk_mccp_en.rtf</p> <p>KLIF (2010). Prioriterte miljøgifter i produkter - data for 2008. Klima- och forurensningsdirektoratet. Oslo. http://www.klif.no/publikasjoner/2743/ta2743.pdf</p> <p>NG (2010). Impact assessment of regulation of medium-chain chlorinated paraffins C14-17 (MCCPs) in consumer products. http://www.eftasurv.int/media/notification-of-dtr/2010-9018-en.pdf</p> <p>POPRC (2007]. Draft risk profile for Short-chained chlorinated paraffins. Persistent Organic Pollutants Review Committee. http://www.pops.int/documents/meetings/poprc/drprofile/drp/DraftRiskProfile_SCCP.pdf</p>

3.9.5 Bis(2-methoxyethyl) ftalate (DMEP)

Substance	Bis(2-methoxyethyl) phthalate (DMEP)
CAS Number	117-82-8
Justification	Danish list of undesired substances; Candidate list; Registry of intentions (SVHC); CMR.
Function	Plasticiser [Annex XV dossier].
Relevant types of plastics	Nitrocellulose, acetyl cellulose, polyvinyl acetate, polyvinyl chloride and polyvinylidene chloride (globally) [Annex XV].
Main article groups	Uses that have been reported include material to cover floors, balls for playing and exercise, hoppers and children's toys (e.g. as inflatable water products), cellulose acetate lamination films and laminated documents .There is no information whether the substance is still in use in articles on the EU market .[Annex XV dossier].
Potential for release from plastics	Molecular weight: 282.29 g/mol, boiling point: 340 °C (pressure not indicated), vapour pressure: 0.00028 mm Hg at 25 °C, partition coefficient (log value) log P _{ow} : 1.11. Not chemically bound. Will migrate. Release rates by migration are probably in the range of 0.1-1% per year or below (estimated based on [ECB 2008]). Given sufficient time, a significant part of the substance will probably be released by leaching to the surface followed by evaporation or removal by washing. Tear and wear will also take place but be of minor importance.
Potential for exposure of consumers	It is judged that the exposure for DMEP is rather limited as the use of the plasticiser is limited to plastics with low consumption (nitrocellulose, acetylcellulose and PVA). The use in PVC and PVDC is considered low, but no actual figures for the consumption in Europe are known. The rules for migration are the same as for the other phthalates. However this phthalate is more polar than the traditional ones. This is the reason for its use in polar plastics like the cellulose based.
Fate of the substance by recycling	Same fate as for diisoheptylphthalate (see section 3.9.2). The most likely recycling is by energy recovery in incineration plants.
References	Annex XV dossier. http://echa.europa.eu/documents/10162/13640/svhc_axrep_germany_cmr_bis2-methoxyethylphthalate_20110829_en.pdf

3.9.6 Benzyl butyl ftalate (BBP)

Substance	Benzyl butyl phthalate (BBP)
CAS Number	85-68-7
Justification	Danish list of undesired substances; Candidate list; Registry of intentions (SVHC, restriction); List of CMR substances in toy.
Function	Plasticiser [Annex XV].
Relevant types of plastics	BBP is or has been widely used in PVC (60% of all BBP use) [Annex XV]. Other plastics include polymethylacrylate (PMMA), polyamide, and thermoplastic polyester [Swedish Chemicals Agency, 2007].
Main article groups	PVC flooring (largest single use category, 41% of the total use volume); Also tablecloth, curtains, shower curtains and other uses. Also sealants (based on polyurethane based or acrylic-based); and other products. [Annex XV].
Potential for release from plastics	Molecular weight: 312.35 g/mol, boiling point: 370°C at 10.10 hPa, vapour pressure: 0.00112 Pa at 20°C, partition coefficient (log value) log P _{ow} : 4.84 [Annex XV dossier]. Not chemically bound. Will migrate. Release rates by migration are probably in the range of 0.1-1% per year or below (analogy considerations to DEHP – see section 3.9.7). Given sufficient time, a significant part of the substance will probably be released by leaching to the surface followed by evaporation or removal by washing. Tear and wear will also take place but be of minor importance.
Potential for exposure of consumers	Same considerations as for diisoheptylphthalate (see section 3.9.2)
Fate of the substance by recycling	Same fate as diisoheptylphthalate (see section 3.9.2)
References	Annex XV report http://echa.europa.eu/documents/10162/13640/svhc_axrep_austria_cmr_bbp_20083006_en.pdf Swedish Chemicals Agency (2007). Varuguiden. (Article guide) Database. https://webapps.kemi.se/varuguiden/VarugrupperAmne.aspx

3.9.7 Bis (2-ethylhexyl) ftalate (DEHP)

Substance	Bis (2-ethylhexyl)phthalate (DEHP)
CAS Number	117-81-7
Justification	Danish list of undesired substances; Norwegian priority list; Candidate list; Registry of intentions (SVHC, restriction); List of CMR substances in toy.
Function	Plasticiser [Annex XV dossier].
Relevant types of plastics	PVC (mainly), but also other polymer products [Annex XV dossier] e.g. polymethylacrylate (PMMA), acrylonitrile-butadiene-styrene (ABS) (0-5 %), polyamide, polystyrene (0-5 %), PVC (0-50 %) and thermoplastic polyester [Swedish Chemicals Agency, 2007].
Main article groups	DEHP has for many years been one of the dominant plasticisers for flexible PVC and used in almost all kind of products made of flexible PVC.

Substance	Bis (2-ethylhexyl)phthalate (DEHP)
Potential for release from plastics	Molecular weight: 390.6 g/mol, boiling point: 385 °C at 1013 hPa, vapour pressure: 0.000034 Pa at 20°C, partition coefficient (log value) log P _{ow} : 7.5 [Annex XV dossier]. Not chemically bound. Will migrate. Release rates by migration are probably in the range of 0.1-1% per year or below (estimate based on [ECB 2008]). Given sufficient time, a significant part of the substance will probably be released by leaching to the surface followed by evaporation or removal by washing. Tear and wear will also take place but be of minor importance.
Potential for exposure of consumers	Same considerations as for diisoheptylphthalate (see section 3.9.2). DEHP is expected still to be one of the phthalates of high concern as it still is found in a number of consumer products worldwide.
Fate of the substance by recycling	Same as for diisoheptylphthalate (see section 3.9.2)
References	<p>Annex XV dossier. http://echa.europa.eu/documents/10162/13640/svhc_axrep_sweden_cmr_DEHP_20083006_en.pdf</p> <p>ATSDR 2012d. Toxicological Profile for DEHP. Agency for Toxic Substances and Disease Registry, U.S. Dept. of Health and Human Services, Public Health Service: www.atsdr.cdc.gov/toxprofiles/index.asp</p> <p>ECB (2008). EU Risk Assessment Report - bis(2-ethylhexyl)phthalate (DEHP). European Chemicals Bureau (ECB).</p> <p>Swedish Chemicals Agency (2007). Varuguiden. (Article guide) Database. https://webapps.kemi.se/varuguiden/VarugruppenAmne.aspx.</p>

3.9.8 Di (2-ethyl-hexyl) tereftalate (DEHT)

Substance	Di (2-ethyl-hexyl) terephthalate (DEHT)
CAS Number	6422-86-2
Justification	List of alternative plasticisers.
Function	Plasticiser.
Relevant types of plastics	PVC etc.
Main article groups	DEHP-applications.
Potential for release from plastics	Molecular weight: 390.56 g/mol, boiling point: 400 °C, vapour pressure: 1 mmHg at 217 °C, log P _{ow} : no data available [Sigma-Aldrich 2014f]. Not solid bound and will migrate due to e.g. low molecular weight and medium high boiling point (characteristics similar to DEHP (see section 3.9.7)).
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling due to the low temperature in the mechanical recycling processes.

Substance	Di (2-ethyl-hexyl) terephthalate (DEHT)
References	<p>Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J. (2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Sigma-Aldrich 2014f. Dioctyl terephthalate - Material Safety Data Sheet. http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=DK&language=da&productNumber=525189&brand=ALDRICH&PageToGoToURL=http%3A%2F%2Fwww.sigmaaldrich.com%2Fcatalog%2Fproduct%2Faldrich%2F525189%3Flang%3Den</p>

3.9.9 Dibutyl phthalate (DBP)

Substance	Dibutyl phthalate (DBP)
CAS Number	84-74-2
Justification	Danish list of undesired substances; Candidate list; Registry of intentions (SVHC, restriction); List of CMR substances in toy.
Function	Plasticiser [Annex XV dossier], component in catalyst for PP (several internet sources).
Relevant types of plastics	<p>PVC (plasticiser) [Annex XV dossier], PP (catalyst).</p> <p>Today extensively used to plasticise PVA-based adhesives and as plasticiser-solvent for nitro-cellulose lacquers and similar [Gooch 2010, DBP Information Centre 2012].</p>
Main article groups	<p>DBP has for many years been one of the dominant plasticisers for flexible PVC and used in many products made of flexible PVC.</p> <p>DBP is used for producing flexible plastics that are part of many products for both industrial and consumer use. These include flooring, balls, products, footwear, articles like tablecloth, shower curtains etc. [Hansen et al, 2010].</p>
Potential for release from plastics	<p>Molecular weight: 278.34 g/mol, boiling point: 340°C at 10.013 hPa, vapour pressure: 9.7 ± 3.3 x 10⁻⁵ Pa at 25 °C, partition coefficient (log value) log P_{ow}: 4.57 at 20°C [Annex XV dossier].</p> <p>Not chemically bound. Will migrate. Release rates by migration are probably in the range of 0.1-1% per year or below (analogy considerations to DEHP – see section 3.9.7). Given sufficient time, a significant part of the substance will probably be released by leaching to the surface followed by evaporation or removal by washing. Tear and wear will also take place but be of minor importance.</p>
Potential for exposure of consumers	As for diisoheptylphthalate (see section 3.9.2)
Fate of the substance by recycling	Same fate as diisoheptylphthalate (see section 3.9.2)

Substance	Dibutyl phthalate (DBP)
References	<p>Annex XV dossier.</p> <p>http://echa.europa.eu/documents/10162/13640/svhc_axrep_austria_cmr_dbp_20083006_en.pdf</p> <p>DBP information Centre (2012). DBP-A speciality stabilizer. DBP - A speciality plasticiser. http://www.dbp-facts.com/index.asp?page=1 (Nov. 2012).</p> <p>Gooch, J.W. (2010). Encyclopaedic Dictionary of Polymers, Volume 1, 2nd edition, Springer.</p> <p>Hansen E., Maag J., Høibye L. (2010). Background data for Annex XV dossier - DEHP - SEE SECTION 3.9.7, BBP, DBP and DIBP. Environmental report No. 1362/2011. Danish Environmental Protection Agency.</p> <p>Hansen E., Christensen C.L., Høibye L. (2008). Forbrug af ftalater i Danmark i historisk perspektiv. Miljøstyrelsen, Danmark.</p>

3.9.10 Diisobutyl ftalate (DiBP)

Substance	Diisobutyl phthalate (DiBP)
CAS Number	84-69-5
Justification	Danish list of undesired substances; Candidate list; Registry of intentions (SVCH, restriction); CMR.
Function	Specialist plasticiser, gelling aid in combination with other plasticisers, plasticiser for nitrocellulose, cellulose ether (which are cellulosic plastic) and polyacrylate and polyacetate dispersions [Annex XV dossier].
Relevant types of plastics	PVC, polystyrene [Gooch, 2010], nitrocellulose, cellulose ether (which are cellulosic plastic) and polyacrylate and polyacetate dispersions [Annex XV dossier].
Main article groups	DiBP has application properties similar to DBP, and may thus be used in all products, where DBP is used. DiBP has been registered in products like crayons, bar ends of run bikes, erasers, school bags, plastic spoons and forks, boxes for microwave ovens, milk package bags, spoons, cups, plates and bowls [Annex XV dossier]. In many products DiBP may not be used intendedly and is present due to contamination.
Potential for release from plastics	Molecular weight: 278.35 g/mol, boiling point: 320 °C, vapour pressure: 0.01 Pa at 20 °C, partition coefficient (log value) log P _{ow} : 4.11 [Annex XV dossier]. The substance is not chemically bound and will migrate. Release rates by migration are probably in the range of 0.1-1% per year or below (analogy considerations to DEHP – see section 3.9.7). Given sufficient time, a significant part of the substance will probably be released by leaching to the surface followed by evaporation or removal by washing. Tear and wear will also take place but be of minor importance.
Potential for exposure of consumers	As for diisoheptylphthalate (see section 3.9.2)
Fate of the substance by recycling	Same fate as diisoheptylphthalate (see section 3.9.2)

Substance	Diisobutyl phthalate (DiBP)
References	<p>Annex XV dossier.</p> <p>http://echa.europa.eu/documents/10162/13640/svhc_axvrep_germany_cmr_diisobutylphthalate_20090831_en.pdf</p> <p>Gooch, J.W. (2010). Encyclopaedic Dictionary of Polymers, Volume 1, 2nd edition, Springer.</p>

3.9.11 Andre ftalater

Substance	Di-“isononyl” phthalate (DINP), Di-“isodecyl” phthalate (DIDP), Bis(2-propylheptyl) phthalate (DPHP), Diethyl phthalate (DEP), Diisopentyl phthalate (DIPP), Dihexyl phthalate (DHP), Dicyclohexyl phthalate, Diisoctyl phthalate
CAS Number	68515-48-0/28553-12-0, 68515-49-1/26761-40-0, 53306-54-0, 84-66-2, 605-50-5, 84-75-3 84-61-7, 68515-50-4.
Justification	DINP, DIDP, DPHP and DEP are surveyed as part of the work with the Danish list of undesired substances, Registry of intentions (CLP, SVHC); CMR.
Function	Plasticiser
Relevant types of plastics	PVC and other plastic materials including polyvinyl acetate, cellulose plastics and PUR [Chemicalland21 – DHP].
Main article groups	Plasticised articles including PVC floorings and wall coverings, expanded leather, PVC foams, films, polyurethane sealing/adhesive [Chemicalland21 – DHP].
Potential for release from plastics	Same as for diisoheptylphthalate (see section 3.9.2)
Potential for exposure of consumers	Same as for diisoheptylphthalate (see section 3.9.2)
Fate of the substance by recycling	Same fate as for diisoheptylphthalate (see section 3.9.2)
References	<p>Chemicalland21 – DHP. Dihexyl phthalate. http://www.chemicalland21.com/industrialchem/plasticizer/DIHEXYL%20PHTHALATE.htm (Nov. 2013)</p> <p>CLH report – DIHP (2013). Diisohexyl phthalate. http://echa.europa.eu/documents/10162/a062e3f3-80b9-4e90-9848-dd73c42764df (Nov. 2013)</p> <p>Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J. (2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency.</p>

3.9.12 Tributyl fosfat

Substance	Tributyl phosphate
CAS Number	126-73-8
Justification	List of CMR-substances in toy.
Function	Plasticiser.

Substance	Tributyl phosphate
Relevant types of plastics	Cellulose based plastics. Various plastics.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 266.3141 g/mol, boiling point: 289 °C (decomposes), vapour pressure: 0.003 mm Hg at 25 °C, partition coefficient (log value) log P _{ow} : 4 [ECHA 2012a]. Not solid bound and will migrate due to e.g. low molecular weight and medium high boiling point.
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling due to the medium/high boiling point.
References	ATSDR (2012e). Toxicological Profile for Phosphate Ester Flame Retardants. Agency for Toxic Substances and Disease Registry, U.S. Dept. of Health and Human Services, Public Health Service. www.atsdr.cdc.gov/toxprofiles/index.asp ECHA (2012a). Substance evaluation report – Tributyl phosphate. http://echa.europa.eu/documents/10162/3f703a8f-bbf9-4b69-8fbb-8eb69ca46467 Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.9.13 Sulfon syre, C₁₀ – C₁₈-alkaner, phenylestre

Substance	Sulfonic acids, C ₁₀ – C ₁₈ -alkane, phenylesters (ASE)
CAS Number	91082-17-6
Justification	List of alternative plasticisers.
Function	Plasticiser.
Relevant types of plastics	PVC etc.
Main article groups	DEHP applications.
Potential for release from plastics	Molecular weight: Not applicable [Santa Cruz 2010], melting point: -15 °C (decomposes by heating), vapour pressure: < 0.0001 hPa at 20 °C, log P _{ow} : > 6 [Sigma-Aldrich 2104e]. Not solid bound and will migrate due to e.g. low melting point.
Potential for exposure of consumers	Possible risk to exposure based on the chemical structure and low molecular weight (MW). The MW range is judged from the molecular formulas for the sulphonate acid esters and not from the statement in the MDS above.
Fate of the substance by recycling	It is unclear to what extent the substance will remain in the plastic materials by mechanical recycling. The substance may partly evaporate and decompose by mechanical recycling.

Substance	Sulfonic acids, C ₁₀ – C ₁₈ -alkane, phenylesters (ASE)
References	<p>Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J. (2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Santa Cruz (2010). Alkylsulfonic phenyl ester - Material Safety Data Sheet http://datasheets.scbt.com/sc-253001.pdf</p> <p>Sigma-Aldrich (2014e). Mesamoll® - Material Safety Data Sheet http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=DK&language=da&productNumber=50987&brand=FLUKA&PageToGoToURL=http%3A%2F%2Fwww.sigmaaldrich.com%2Fcatalog%2Fsearch%3Finterface%3DCAS%2520No.%26term%3D91082-17-%26lang%3Den%26region%3DDK%26focus%3Dproduct%26N%3D220003048%2B219853103%2B219853286%26mode%3Dpartialmax</p>

3.9.14 Acetyl tributyl citrat (ATBC)

Substance	Acetyl tributyl citrate (ATBC)
CAS Number	77-90-7
Justification	List of alternative plasticisers.
Function	Plasticiser.
Relevant types of plastics	PVC etc.
Main article groups	Some DEHP-applications.
Potential for release from plastics	<p>Molecular weight: 402.49 g/mol, boiling point: 326°C at 760 mm Hg, vapour pressure: 5.2 x 10⁻² mm Hg at 20 °C, log P_{ow}: 4.92 at 22°C [US EPA 2003].</p> <p>Not solid bound and will migrate due to e.g. low molecular weight and medium high boiling point.</p>
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	It is judged that the substance mainly will remain in the plastic by mechanical recycling due to the medium high boiling point.
References	<p>Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J. (2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>US EPA (2003b). Acetyl Tributyl Citrate – Appendix. Robust Summaries of Reliable Studies and QSAR Model Data. http://www.epa.gov/hpv/pubs/summaries/acetlcit/c15025rs.pdf</p>

3.9.15 Blanding af benzoater incl. DEGD

Substance	Mixture of benzoates incl. DEGD
CAS Number	Mix of 120-55-8, 27138-31-4, 120-56-9
Justification	List of alternative plasticisers.
Function	Plasticiser.
Relevant types of plastics	PVC etc.
Main article groups	Vinyl flooring, plastisol products, DBP- and BBP-applications and some DEHP applications.
Potential for release from plastics	DEGD (CAS no.: 120-55-8): Molecular weight: 314.34, melting point. -28°C, boiling point: decomposes at > 230°C without boiling, vapour pressure: 0.0000173 Pa at 25 °C, log P _{ow} : 3.2 [Velsicol 2001]. Not solid bound and will migrate due to e.g. low molecular weight and melting point.
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling due to the low temperature in the mechanical recycling processes for flexible PVC (150-170 °C). The substance may, however, partly evaporate during the process.
References	Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J. (2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency. Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014. Velsicol (2001). Diethylen glycol dibenzoate - Robust Summary http://www.epa.gov/hpv/pubs/summaries/diglydib/c13271.pdf

3.9.16 Blanding af 12-(Acetoxy)-stearinsyre, 2,3-bis(acetoxy)propylester og okta-decanoic syre, 2,3-(bis(acetoxy)propyl ester (COMGHA)

Substance	Mixture of 12-(Acetoxy)-stearic acid, 2,3-bis(acetoxy)propyl ester and octadecanoic acid, 2,3-(bis(acetoxy)propyl ester (COMGHA)
CAS Number	Mix of 330198-91-9 and 33599-07-4
Justification	List of alternative plasticisers.
Function	Plasticiser.
Relevant types of plastics	PVC etc.
Main article groups	Plastisol applications, traditional DEHP-applications (see section 3.9.7).
Potential for release from plastics	Molecular weight: 500.7 (A) and 442.6 (B) g/mol, boiling point: 300°C at 1 atm (decomposition), vapour pressure: < 2.8 x 10 ⁻⁴ Pa at 100°C, log P _{ow} : 6.4 (measured) [SCENIHR 2007]. Not solid bound and will migrate due to e.g. low molecular weight and medium high boiling point.
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling due to the low temperature in the mechanical recycling processes for flexible PVC (150-170 °C).

Substance	Mixture of 12-(Acetoxy)-stearic acid, 2,3-bis(acetoxy)propyl ester and octadecanoic acid, 2,3-(bis(acetoxy)propyl ester (COMGHA)
References	<p>Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J. (2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>SCENIHR 2007. Preliminary report on the safety of medical devices containing DEHP plasticised PVC or other plasticisers on neonates and other groups possibly at risk. EC Scientific Committee on Emerging and Newly-Identified Health Risks. http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenahr_o_008.pdf</p>

3.9.17 Diisononyl adipat (DINA)

Substance	Diisononyl adipate (DINA)
CAS Number	33703-08-1
Justification	List of alternative plasticisers
Function	Plasticiser
Relevant types of plastics	PVC etc.
Main article groups	Film/wrapping – low temperature applications
Potential for release from plastics	<p>Molecular weight: 398.62 g/mol, melting point: 225°C, boiling point: 405.8°C at 760 mmHg, vapour pressure: < 0.1 mbar at 20 °C, water solubility: Slightly soluble [Ark Farm 2013; Chemexper 2014].</p> <p>Not solid bound and will migrate due to e.g. low molecular weight and medium high melting and boiling points similar to other adipates.</p>
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling due to the low temperature in the mechanical recycling processes for flexible PVC (150-170 °C).
References	<p>Ark Farm (2013). Bis(7-methyloctyl) adipate – MSDS. http://www.chemblink.com/MSDS/MSDSFiles/33703-08-1_Ark%20Pharm.pdf</p> <p>Chemexper (2014). Diisononyl adipate – MSDS. http://www.chemexper.net/specification_d/chemicals/supplier/cas/Diisononyl%20adipate.asp</p> <p>Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J. (2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency.</p>

3.9.18 Diisononyl-cyclohexan-1,2-carboxylat (DINCH)

Substance	Diisononyl-cyclohexane-1,2-carboxylate (DINCH)
CAS Number	166412-78-8
Justification	List of alternative plasticisers
Function	Plasticiser.
Relevant types of plastics	PVC etc.
Main article groups	Toys and childcare articles, general plasticiser applications.
Potential for release from plastics	Molecular weight: 424.7 g/mol, pour point: - 54 °C, boiling point: 394 °C at 1013 hPa (decomposes > 278 °C), vapour pressure: < 0.000001 hPa at 20 °C, partition coefficient (log value) log P _{ow} : 10 at 25 °C [Evonik 2013]. Not solid bound and will migrate due to e.g. low molecular weight and pour point and medium high boiling point.
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling due to the low temperature in the mechanical recycling processes for flexible PVC (150-170 °C).
References	Evonik (2013). Elatur ®CH- Material Safety Data Sheet. http://oxo-alcohols.evonik.com/sites/dc/Downloadcenter/Evonik/Product/Oxo-Alcohols/en/safety-data-sheet-elatur%C2%AE-ch.pdf Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J. (2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency. Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.9.19 Dipropylene glycol dibenzoat (DGD)

Substance	Dipropylene glycol dibenzoate (DGD)
CAS Number	27138-31-4
Justification	List of alternative plasticisers.
Function	Plasticiser.
Relevant types of plastics	PVC etc.
Main article groups	Flooring etc., PVA-adhesives.
Potential for release from plastics	Molecular weight: 342.39 g/mol [Sigma-Aldrich 2014g], boiling point: 232 °C at 7 hPa, vapour pressure: 2.3 x 10 ⁻⁷ mmHg at 20 °C [Unitex 2008], log P _{ow} : no data available [Sigma-Aldrich 2014g]. Not solid bound and will migrate due to e.g. low molecular weight and medium boiling point.
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling due to the low temperature in the mechanical recycling processes for flexible PVC (150-170 °C).

Substance	Dipropylene glycol dibenzoate (DGD)
References	<p>Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J.(2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Sigma-Aldrich 2014g. Di(propylene glycol) dibenzoate - Material Safety Data Sheet. http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=DK&language=da&productNumber=597236&brand=ALDRICH&PageToGoToURL=http%3A%2F%2Fwww.sigmaaldrich.com%2Fcatalog%2Fproduct%2Faldrich%2F597236%3Flang%3Den</p> <p>Unitex (2008). Dipropylene Glycol Dibenzoate – MSDS. http://www.unitexchemical.com/MSDS_CURR/UPLX988_MSDS.pdf</p>

3.9.20 Glycerol triacetat (GTA)

Substance	Glycerol triacetate (GTA)
CAS Number	102-76-1
Justification	List of alternative plasticisers.
Function	Plasticiser.
Relevant types of plastics	PVC etc.
Main article groups	PVA-adhesives, coatings.
Potential for release from plastics	<p>Molecular weight: 218.206 g/mol, melting point: 3 °C, boiling point: 258 °C, vapour pressure: 0.33 torr at 25 °C, log Pow: 0.25 at 25 °C [California EPA].</p> <p>Due to the low molecular weight, low melting point, medium boiling point and chemical structure it is judged that GTA will migrate in a similar manner to the phthalate plasticisers.</p>
Potential for exposure of consumers	Exposure similar to the phthalates is foreseen due to the low molecular weight and ester structure.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling due to the low temperature in the mechanical recycling processes for flexible PVC (150-170 °C).
References	<p>California EPA. Substance Database. California Environmental Protection Agency. http://www.arb.ca.gov/db/solvents/solvent_pages/esters-HTML/glyceryl_triacetate.htm</p> <p>Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J. (2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency.</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.9.21 Trimethyl pentaryl diisobutyrat (TXIB)

Substance	Trimethyl pentaryl diisobutyrate (TXIB)
CAS Number	6846-50-0
Justification	List of alternative plasticisers.

Substance	Trimethyl pentaryl diisobutyrate (TXIB)
Function	Plasticiser.
Relevant types of plastics	PVC etc.
Main article groups	Toys, childcare products.
Potential for release from plastics	Molecular weight: 286.4 g/mol, melting/freezing point: -70 °C, boiling point: 281.5 °C, vapour pressure: < 1.5 Pa at 25 °C, partition coefficient (log value) log P _{ow} : 4.04 - 4.91 [Eastman 2014; LookChem 2008]. Not solid bound and will migrate due to e.g. low molecular weight and melting point and medium high boiling point.
Potential for exposure of consumers	Possible.
Fate of the substance by recycling	The substance will mainly remain in the plastic by mechanical recycling due to the low temperature in the mechanical recycling processes for flexible PVC (150-170 °C).
References	Eastman (2014). 2,2,4-trimethyl-1,3-pentanediol diisobutyrate - Material Safety Data Sheet http://ws.eastman.com/ProductCatalogApps/PageControllers/MSDS_PC.aspx?Product=71066420 LookChem (2008). 2,2,4-Trimethyl-1,3-pentanediol diisobutyrate. http://www.lookchem.com/cas-684/6846-50-0.html (May 2014) Mikkelsen S. H., Maag J., Kjølholt J., Lassen C., Jeppesen C. N., Clausen A.J. (2013). Survey of selected phthalates - Part of the LOUS-review. Danish Environmental Protection Agency.

3.10 Opløsningsmidler –neutrale og reaktive

Neutrale opløsningsmidler anvendes typisk tidligt i polymerisationsprocesser for at medvirke til at de reaktive monomerer kommer i tæt kontakt med hinanden ved at oplöse dem i processen og bidrage til molekylernes bevægelighed. På samme tid bidrager opløsningsmidlerne til at justere eller reducere viskositeten. Neutrale opløsningsmidler anvendes også i lime til at sammenlime forskellige plasttyper til laminater.

Reaktive opløsningsmidler fungerer både som et viskositets reducerende middel ved starten af polymerisationsprocessen og som en reaktiv monomer.

Opløsningsmidler er generelt kun til stede i lave koncentrationer i plast produkter, fordi de anvendes som mellemprodukter på et tidligt trin i polymerisationsprocessen for plast polymerer og ofte har både lav molekylvægt og kogepunkt. De vil derfor typisk fordampes hurtigt, hvilket medfører, at det ikke er sandsynligt, at der er opløsningsmidler til stede i plast ved slutningen af brugsfasen og derfor heller ikke i genanvendte materialer.

En anden årsag til den generelle vurdering, at opløsningsmidler kun vil være til stede i lave koncentrationer i færdige produkter, er at produktionen af termoplast sker ved så høje temperaturer, at flygtige opløsningsmidler vil fordampes i produktionsprocessen.

For hærdeplast er der en større risiko for, at reaktive opløsningsmidler kan være til stede i de færdige produkter. Dette kan dels forårsages af utilstrækkelig dispergering i blandingen af polymeren og hærdesystemet eller af et fejlagtigt blandingsforhold mellem de reaktive monomerer og katalysatorerne.

Ingen generelle regler eksisterer m.h.t. mængden af opløsningsmiddel anvendt ved fremstilling af polymerer og plast.

Det skal bemærkes, at styren (se afsnit 3.6.14) og butyl 2,3-epoxypropyl æter, butyl glycidyl æter (se afsnit 3.6.20) som er kemiske mellemprodukter ved fremstillingen af plast også vil fungere som reaktive opløsningsmidler.

3.10.1 2-Methoxyethanol

Substance	2-Methoxyethanol
CAS Number	109-86-4
Justification	Candidate list; Registry of intentions (SVHC); CMR.
Function	Solvent, chemical intermediate and solvent coupler of mixtures and water-based formulations [Annex XV report]. Solvent in epoxy resins and polyvinylacetate [Chemindustry.ru, 2000-2010; OSHA, 2012].
Relevant types of plastics	Epoxy resins and polyvinylacetate. The knowledge available is poor.
Main article groups	Not specified. Plastic products made of epoxy or polyvinylacetate. Emissions from new carpets have been registered. The knowledge available is poor.
Potential for release from plastics	The substance is not chemical bound (a solvent) and volatile (molecular weight: 76.09 g/mol, boiling point: 123.5 – 125.5 °C at 1013 hPa, vapour pressure: 10 hPa at 20°C, log P _{ow} : 0.77 (calculated -0.85)) and will likely migrate easily.

Substance	2-Methoxyethanol
Potential for exposure of consumers	It is judged that there will be a high risk for exposure if the substance is still present in the plastic products due to low molecular weight and boiling point. It is at the same time judged that the amount left in the plastic products is low as the solvent is used in an early stage of PVC raw polymer formulation. The strong evaporation of the substance means that occupational exposure may be given special attention.
Fate of the substance by recycling	The substance is expected to evaporate before the plastic product is discarded as waste at the "end of life stage". The substance will most likely not be present in recycled materials.
References	<p>Annex XV report (2010). http://echa.europa.eu/documents/10162/b6b959c2-14c8-4612-9e91-cf181a867dd2</p> <p>Chemindustry.ru. (2000-2010). 2-methoxyethanol. http://chemindustry.ru/Methyl_Cellosolve.php</p> <p>Nilsson N. (2014). Expert assessment by Nils Nilsson, Danish Technological Institute, Århus, April. 2014.</p> <p>OSHA (2012). Occupational Safety and Health Administration. http://www.osha.gov/SLTC/healthguidelines/2-ethoxvethanol/recognition.html</p>

3.10.2 Trichlorethylen

Substance	Trichloroethylene
CAS Number	79-01-6, 108-70-3,
Justification	Norwegian priority list; Candidate list. Registry of intentions (SVHC); CMR.
Function	<p>Intermediate or chain transfer agent for controlling molecular weight in the early stages of PVC manufacturing [Hocking 2005; Annex XV report].</p> <p>According to the EU [2004] Risk assessment report it is "apparently" no longer used as a chain transfer agent (however no information to confirm this statement has been found).</p>
Relevant types of plastics	PVC.
Main article groups	Not specified - probably all product types.
Potential for release from plastics	Molecular weight: 131.39 -131.5 g/mol, boiling point: 85.9 to 88 °C, vapour pressure: 78.7 to 86 hPa at 20°C, partition coefficient (log value) log P _{ow} : 2.29 to 2.98 [Annex XV dossier]. Very volatile. Will easily migrate and evaporate. Most of the substance will likely disappear from the products, when they still are new.
Potential for exposure of consumers	It is judged that there will be a high risk for exposure if the substance is still present in the plastic due to low molecular weight and boiling point. However it is at the same time judged that the substance typically will be present in low concentrations only as it is used as an intermediate early in the PVC polymerisation. The strong evaporation of the substance means that occupational exposure may be given special attention.
Fate of the substance by recycling	The substance is expected to have evaporated before the "end of life plastic stage". The substance will most likely not be present in recycled materials.

Substance	Trichloroethylene
References	<p>Annex XV report. http://echa.europa.eu/documents/10162/13640/svhc_axrep_france_cmr_trichloroethylene_en.pdf</p> <p>EU (2004). European risk assessment report. Trichloroethylene CAS no. 79-01-6. http://esis.jrc.ec.europa.eu/doc/risk_assessment/REPORT/trichloroethylenereport018.pdf</p> <p>Hocking (2005). Handbook of Chemical Technology and Pollution Control, 3rd Edition, Academic press, San Diego.</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.10.3 N,N-dimethylformamid (DMF)

Substance	N,N-dimethylformamide (DMF)
CAS Number	68-12-2
Justification	Danish list of undesired substances; Candidate list; Registry of intentions (SVHC); List of CMR substances in toy.
Function	Chemical intermediate/solvent.
Relevant types of plastics	polyacrylonitrile, polyurethane and polyvinylchloride.
Main article groups	Artificial fibres/artificial leather.
Potential for release from plastics	Molecular weight: 73.0938 g/mol, boiling point: 152–153°C at 1013 hPa, vapour pressure: 3.77 hPa at 20°C, partition coefficient (log value) log P _{ow} : -0.85 at 25°C [Annex XV dossier]. As a solvent it might evaporate and migrate. And as the DMF is very polar, it must be foreseen to migrate to contact medias containing water (e.g. sweat). The amount of DMF left in the plastic is however considered low.
Potential for exposure of consumers	If present it is judged that there is a high risk for exposure due to rather low molecular weight and boiling point but at the same time it is judged that the substance typically is present in low concentrations only. The strong evaporation of the substance means that occupational exposure may be given special attention.
Fate of the substance by recycling	The substance is expected to evaporate before product is discarded as waste at the "end of life stage". If still present at the "end of life stage" it is judged that the substance will be dissolved in the washing process due to the high solubility in water. The substance will most likely not be present in recycled materials. Substances used in thermosetting materials as polyurethane will be decomposed by feedstock recycling as well as energy recovery.
References	<p>Annex XV dossier – DMF. N,N-dimethylformamide. http://echa.europa.eu/documents/10162/13638/SVHC_ACCCHECK_AXREP_pub_EC200-679-5_en.pdf</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.10.4 1,2,3-Trichlorpropan

Substance	1,2,3-Trichloropropane
CAS Number	96-18-4
Justification	Candidate list; Registry of intentions (SVHC); CMR.
Function	Intermediate - Crosslinking agent [Annex XV dossier].
Relevant types of plastics	Hexafluoropropylene [Annex XV dossier] which is used as a copolymer with e.g. tetrafluoroethylene and polyvinylidenefluoride (elastomer).
Main article groups	<p>Tetrafluoroethylene-Hexafluoropropylene-Copolymer (FEP) is used:</p> <ul style="list-style-type: none"> • for the manufacture of heating cables for chemical platoon; • for the manufacture of heating tapes; • in foils; • in filaments and cables at communications; • in injection moulded components; and • in coating for valves, tubes, vessels and tanks [Mecadi, GmbH, 2012].
Potential for release from plastics	<p>Molecular weight: 147.4 g/mol, boiling point: 157 °C at 1013 hPa, vapour pressure: 10 hPa at 37 °C, partition coefficient (log value) log P_{ow}: 2.5 [Annex XV dossier].</p> <p>Solid bound due to crosslinking (reactive) behaviour. Residues (Molecular weight: 147.4 g/mol, boiling point: 157 °C at 1013 hPa - Volatile) will migrate and slowly evaporate from the plastic.</p>
Potential for exposure of consumers	If the substance is still present after cure by crosslinking it is judged that a high risk exist for exposure due to rather low molecular weight and boiling point. It is judged that the substance typically will be present in low concentrations in the finished plastic products. The strong evaporation of the substance means that occupational exposure may be given special attention.
Fate of the substance by recycling	The substance is expected to evaporate before the plastic product is discarded as waste at the “end of life stage”. The substance will most likely not be present in recycled materials.
References	<p>Annex XV dossier.</p> <p>http://echa.europa.eu/documents/10162/13640/svhc_axrep_echa_cmr_123-tcp_publ_en.pdf</p> <p>Meade GmbH. (2012). webpage: http://www.mecadi.com/en/literature_tools/encyclopedia/categorial/Thermoplastic/Tetrafluoroethylene-Hexafluoropropylene-Copolymer_FEP/</p> <p>Nilsson N. (2014). Expert assessment by Nils Nilsson, Danish Technological Institute, Århus, April 2014</p>

3.10.5 1,6-hexanediol diglycidyl æter

Substance	1,6-hexanediol diglycidyl ether
CAS Number	16096-31-4
Justification	Danish list of undesired substances
Function	Reactive dilutant, stabiliser.
Relevant types of plastics	Epoxyes, chlorinated vinyl resins.
Main article groups	No information.

Substance	1,6-hexanediol diglycidyl ether
Potential for release from plastics	Molecular weight: 230.3 g/mol, boiling point: 328.7 °C, vapour pressure: 0.002 mg Hg, partition coefficient (log value) log P _{ow} : 0.84. Low according to one of the manufacturers (DOW). Due to the two epoxide groups the substance is very reactive and if a small amount is left after cure it is expected that the epoxide groups will hydrolyse in the presence of water and the epoxide ring will open and react with water with the formation of hydroxyl groups.
Potential for exposure of consumers	Considered rather unlikely due to the high reactivity of the two oxirane rings.
Fate of the substance by recycling	The substance is judged to be present in very low amount due to the high reactivity of the oxirane rings in the end of life stage for the resins. Substances used in thermosetting materials as epoxies will be decomposed by feedstock recycling as well as energy recovery.
References	Hansen E., Christensen F.M., Kjølholt J., Jeppesen C.N., Lassen C. (2012a). Survey of 1,6-hexanediol-glycidylether - A LOUS Review Report. Danish Environmental Protection Agency. Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.10.6 Dichlormethan, methylen chlorid

Substance	Dichloromethane, methylene chloride
CAS Number	75-09-02
Justification	List of CMR-substances in toy.
Function	Intermediate.
Relevant types of plastics	Polycarbonate. Has been used as blowing agent for PUR and for gluing PVC together. In Denmark in 1998 only registered in preparations (mould release agents etc.) for moulding of plastic products [Maag 1998].
Main article groups	No information.
Potential for release from plastics	Molecular weight: 84.93 g/mol, boiling point: 40 °C, vapour pressure: 470.8 hPa at 20.0 °C, partition coefficient (log value) log P _{ow} : 1,25 [Sigma-Aldrich 2008]. Probably used as a solvent. Methylene chloride is a very low boiling solvent.
Potential for exposure of consumers	If present in the plastic, it is judged that there will be a high risk for exposure due to the low molecular weight and low boiling point but at the same time, it is judged that the substance typically will be present in low concentrations due to a fast evaporate rate. Dichloromethane used in preparations for moulding of plastic products will evaporate very quickly and not be present in end products. The strong evaporation of the substance means that occupational exposure may be given special attention.
Fate of the substance by recycling	The substance is expected to evaporate before the plastic product is discarded as waste at the "end of life stage". The substance will most likely not be present in recycled materials.

Substance	Dichloromethane, methylene chloride
References	<p>Maag J. 1998. Massestrømsanalyse for dichlormethan, trichlorethylen og tetrachlorethylen. Environmental project No. 392/1998. Danish Environmental Protection Agency. http://www2.mst.dk/common/Udgivramme/Frame.asp?http://www2.mst.dk/udgiv/Publicationer/1998/87-7909-128-8/html/default.htm</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>Sigma-Aldrich 2008. Dichloromethane - Material Safety Data Sheet http://www.frederiksen.eu/uploads/txtshop/media/862900.pdf</p>

3.10.7 1,1,2-trichlorethan

Substance	1,1,2-trichloroethane
CAS Number	79-00-5
Justification	List of CMR-substances in toy.
Function	Intermediate.
Relevant types of plastics	Teflon.
Main article groups	Tubings etc.
Potential for release from plastics	Molecular weight: 133.40 g/mol, boiling point: 113.7 °C, vapour pressure: 1.0×10^4 Pa at 50°C, partition coefficient (log value) log P _{ow} : 2.05 at 25°C [OECD SIDS 2000]. The substance will migrate easily due to the low boiling point and medium high vapour pressure.
Potential for exposure of consumers	If present in the plastic it is judged that there will be a high risk for exposure due to the low molecular weight and low boiling point, but at the same time it is judged that the substance typically will be present in very low concentrations due to evaporation. The strong evaporation of the substance means that it is relevant to give special attention to occupational exposure.
Fate of the substance by recycling	The substance is expected to evaporate before the plastic product is discarded as waste at the "end of life stage". The substance will most likely not be present in recycled materials.
References	<p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>OECD SIDS 2000. 1,1,2-Trichloroethane http://www.inchem.org/documents/sids/sids/79005.pdf</p>

3.10.8 1,4-dioxan

Substance	1,4-dioxane
CAS Number	123-91-1
Justification	List of CMR-substances in toy.
Function	Intermediate.

Substance	1,4-dioxane
Relevant types of plastics	Cellulose based polymers (cellulose acetate, ethyl cellulose, benzyl cellulose), polyvinyl polymers etc.
Main article groups	No information.
Potential for release from plastics	Molecular weight: 88 g/mol, boiling point: 101°C, vapour pressure: 40 hPa at 20°C, partition coefficient (log value) log P _{ow} : -0.27 [ECB 2002b]. The substance will migrate easily due to the low boiling point and medium high vapour pressure.
Potential for exposure of consumers	If present in the plastic it is judged that there will be a high risk for exposure due to the low molecular weight and fairly low boiling point but at the same time it is judged that the substance typically will be present in very low concentrations due to evaporation. The strong evaporation of the substance means that occupational exposure may be given special attention.
Fate of the substance by recycling	The substance is expected to evaporate before the plastic product is discarded as waste at the "end of life stage". The substance will most likely not be present in recycled materials.
References	ECB (2002b). 1,4-dioxane -EU Risk Assessment Report. http://echa.europa.eu/documents/10162/a4e83a6a-c421-4243-a8df-3e84893082aa Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.

3.11 Andre

Gruppen andre dækker en række stoffer med meget forskellige funktioner, og enkelte stoffer har adskillige funktioner. De er samlet her i gruppen "andre", da de enten er vanskelige at indplacere i de andre grupper, som er oprettet, eller pga. at deres funktion og anvendelser ikke er velidentificerede.

De identificerede funktioner omfatter monomerer, stabilisatorer, spredningsmidler, urenheder, korrosionshæmmere, buffermidler og flamme hæmmere.

Migrationsmønstrene varierer fra fast forankret til dokumenteret migration. For flere af stofferne er den foreliggende information dog spinkel og vurderingen af deres migrationsegenskaber og skæbne tilsvarende usikker.

3.11.1 Nonylphenol og dets ethoxylater

Substance	Nonylphenol and its ethoxylates
CAS Number	104-40-5, 7311-27-5, 9014-90-8, 9016-45-9, 9040-65-7, 9051-57-4, 9081-17-8, 11096-42-7, 25154-52-3, 26027-38-3, 26571-11-9, 27177-03-3, 27177-05-5, 27177-08-8, 27986-36-3, 28987-17-9, 37205-87-1, 51811-79-1, 52503-15-8, 66197-78-2, 68412-54-4, 68584-47-4, 68891-21-4, 72580-36-0, 84852-15-3, 127087-87-0
Justification	Danish list of undesired substances; Norwegian priority list; Candidate list; Registry of intentions (SVHC, restriction); List of CMR substances in toy;
Function	<p>Nonylphenol: Monomer (for phenol/formaldehyde resins), catalyst (in the curing of epoxy resins) [EU Commission, 2003].</p> <p>Nonylphenol can be reacted to form tris(4-nonyl-phenyl) phosphite (TNPP) an antioxidant (for vinyl, polyolefins, and polystyrenics). TNPP is also used as a stabilizer in plastic food packaging. [US EPA, 2010].</p> <p>Barium and calcium salts of NP are used as heat stabilizers for polyvinyl chloride (PVC). [US EPA, 2010].</p> <p>Nonylphenol ethoxylates has no use related to plastics. More than half of the tonnage of nonylphenol is used to produce nonylphenol ethoxylates surfactants [EU Commission, 2003].</p>
Relevant types of plastics	Phenol/formaldehyde plastic, epoxy [EU Commission, 2003]. Polyurethane foam (emulsifier), PVC.
Main article groups	No information.
Potential for release from plastics	<p>Molecular weight variates from substance to substance. The following physicochemical properties apply for CAS no.: 104-40-5 and 84852-15-3:</p> <p>Melting point: < -7 °C at 1 atm, boiling point: 302 °C at ca.101 kPa (decomposition may occur), vapour pressure: 0.109 Pa- 0.3 Pa at 25 °C, water solubility: ca. 5.7 -7 mg/l at 25 °C, log K_{ow}: 5.4 – 5.76 [Annex XV dossier].</p> <p>The substances are not chemically bound and will migrate. Although it does contain residual NP, TNPP has been approved for use in food packaging by the US Food and Drug Administration [US EPA 2010].</p>
Potential for exposure of consumers	Unknown.

Substance	Nonylphenol and its ethoxylates
Fate of the substance by recycling	Judged partly to evaporate and partly to remain in the thermoplastic by mechanical recycling. Thermosetting plastics can only be recycled by incineration or by feedstock recycling. In both cases the substances will be decomposed. In Denmark only incineration is practised.
References	<p>Annex XV dossier: 4-Nonylphenol, branched and linear: http://echa.europa.eu/documents/10162/59e6cb9d-f70b-4321-b7b6-557cbddca8da</p> <p>EU Commission (2003). Recommendation from the Scientific Committee on Occupational Exposure Limits for commercial nonylphenol. SCOEL/SUM/103.</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p> <p>OSPAR (2009). Background Document on nonylphenol/nonylphenol ethoxylates. http://www.ospar.org/documents/dbase/publications/p00396_npnpe%2oupdate.pdf</p> <p>RPA (1999). Nonylphenol Risk Reduction Strategy. http://archive.defra.gov.uk/environment/quality/chemicals/documents/nonylphenol_rrs.pdf</p> <p>US EPA (2010). Nonylphenol (NP) and Nonylphenol Ethoxylates (NPEs) Action Plan. http://www.epa.gov/oppt/existingchemicals/pubs/actionplans/RIN2070-ZA09_NP-NPEs%20Action%20Plan_Final_2010-08-09.pdf</p>

3.11.2 Oktylphenol og dets ethoxylater

Substance	Octylphenol and its ethoxylates
CAS Number	140-66-9, 1806-26-4, 9004-87-9, 9036-19-5, 9063-89-2, 11081-15-5, 68987-90-6, 69011-84-3
Justification	Norwegian priority list; Candidate list.
Function	<p>Octylphenol:</p> <p>Monomer (for phenol formaldehyde resin) - (major use) [UK Environment Agency, 2005].</p> <p>Antioxidant in stabilizers- (minor use) [RPA 2006].</p> <p>Octylphenol ethoxylate:</p> <p>Emulsifiers in finishing agents (mainly styrene-butadiene copolymers and PTFE) that cover textiles and leather with a thin film [UK Environment Agency, 2005].</p>
Relevant types of plastics	Phenol formaldehyde resin, PVC, styrene-butadiene copolymer.
Main article groups	<p>OP-based resins are used for secondary insulation of electrical windings (e.g. in motors and transformers) to improve insulation and bond windings together [RPA, 2006].</p> <p>Articles made of phenol, a polymer finishing that can cover textiles and leather [UK Environment Agency, 2005].</p> <p>Antioxidant in stabilisers for PVC cable jacketing.</p>

Substance	Octylphenol and its ethoxylates
Potential for release from plastics	<p>CAS no. 140-66-9: Molecular weight: 206.33 g/mol, boiling point: 281.5 °C, vapour pressure: 0.21 Pa at 20°C, log P_{ow}: 4.12 at 20.5°C [RPA (2006)].</p> <p>Most of the 4-tert-octylphenol 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 (~3-4%) of unreacted 4-tert-octylphenol [UK Environment Agency, 2005].</p> <p>The octylphenol ethoxylate is physically bound in the polymer matrix [UK Environment Agency, 2005].</p> <p>The unreacted 4-tert-octylphenol may be released (molecular weight: 206.33 g/mol, boiling point: 281.5 °C) [UK Environment Agency, 2005].</p>
Potential for exposure of consumers	Unknown, but possible for unreacted 4-tert-octylpheno.
Fate of the substance by recycling	Judged to mainly remain in the plastic by mechanical recycling due to the boiling temperature. Some evaporation of unreacted substances may, however, take place. Phenol resins can only be recycled by incineration or by feedstock recycling. In both cases the substance will be decomposed. In Denmark only incineration is practised.
References	<p>RPA (2006). 4-tert-Octylphenol Risk Reduction Strategy and Analysis of Advantages and Drawbacks. http://archive.defra.gov.uk/environment/quality/chemicals/documents/op-rrs-aad-report.pdf</p> <p>UK Environment Agency (2005). Environmental Risk Evaluation, Report: 4-tert-Octylphenol. http://ao768b4a8a31e106d8bo-5odc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/schoo405biyz-e-e.pdf</p>

3.11.3 Perfluorooaktansyre (PFOA) og tilsvarende forbindelser

Substance	Perfluorooctanoic acid (PFOA) and similar compounds
CAS Number	15166-06-0, 2395-00-8, 24216-05-5, 3108-24-5, 33496-48-9, 335-64-8, 335-66-0, 335-67-1, 335-93-3, 335-95-5, 376-27-2, 3825-26-1, 39186-68-0, 41358-63-8, 423-54-1, 53517-98-9, 68141-02-6, 68333-92-6, 69278-80-4, 72623-77-9, 72968-38-8, 85938-56-3, 89685-61-0, 90179-39-8, 90480-55-0, 90480-56-1, 90480-57-2, 91032-01-8, 93480-00-3
Justification	Norwegian priority list: Danish list of undesired substances; Candidate list, Registry list of intentions (CLP, SVHC).
Function	Dispersing agent (for production of special plastics e.g. PTFE).
Relevant types of plastics	Polytetrafluorethylene (PTFE) and fluoroethylene propylene (FEP). Polyvinylidene fluoride (PVDF).

Substance	Perfluorooctanoic acid (PFOA) and similar compounds
Main article groups	<p>PTFE is used as coating of metals, e.g. for non-stick cookware; in seals, gaskets, packings, valve and pump parts and laboratory equipment; in wire and cable insulation, moulded electrical components, insulated transformers, hermetic seals for condensers, and laminates for printed circuitry [Chanda and Roy, 2008].</p> <p>PVDF is commonly used as e.g. insulation in certain electrical wires (e.g. in computers and in airplanes, and in the chemical industry to make pipes and bottles and such that hold chemicals [Polymer science learning center. 2005].</p>
Potential for release from plastics	The substance is not chemically bound and will migrate. Experiments with heated Teflon® (Du Pont PTFE) frying pans indicate release of perfluorocarboxylic acids (i.e. PFOA) at temperatures of 360 °C (a PTFE-coated pan can reach 400 °C) [Järnberg et al, 2006].
Potential for exposure of consumers	Exposure is likely.
Fate of the substance by recycling	Unknown – Recycling is normally not practised as PTFE typically is used as coating on other materials.
References	<p>Chanda, M., Roy, S.K., (2008). Industrial Polymers, Specialty Polymers and Their Applications. Plastics Engineering Series. CRC Press, Taylor & Francis Group, Boca Raton.</p> <p>Järnberg, U., Holmström, K. van Bavel, B., Kärrman, A. (2006). Perfluoroalkylated acids and related compounds (PFAS) in the Swedish environment. http://www.swedishepa.se/upload/o2_tillstandet_i_miljon/Miljöovervakning/rapporter/miljogift/PFAS_ITMreport_06oct.pdf</p> <p>Lithner, D, Larsson, Å, Dave, G. (2011). Supplementary appendix in: Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition. Science of the total environment, 409: 3309-3324.</p> <p>Polymer science learning center. (2005). Polyvinylidene fluoride. http://www.pslc.ws/macrog/pvdf.htm</p> <p>Poulsen P.B., Jensen A.A., Wallström E. (2005). More environmentally friendly alternatives to PFOS-compounds and PFOA. Environmental Project No. 1013/2005. The Danish Environmental Protection Agency.</p>

3.11.4 Henicosfluoroundecansyre, heptacosafuorotetradecansyre, tricosafuorododecansyre, pentacosafuorotridecansyre, heptadecafluoronansyre og nonadecafluorodecansyre.

Substance	Henicosfluoroundecanoic acid, Heptacosafuorotetradecanoic acid, Tricosafuorododecanoic acid, Pentacosafuorotridecanoic acid, heptadecafluoronanoic acid and nonadecafluorodecanoic acid
CAS Number	2058-94-8, 376-06-7, 307-55-1, 72629-94-8, 375-95-1, 335-76-2
Justification	Candidate list; Registry of intentions (CLP, SVHC)).
Function	No data – assumed to correspond to function for PFOA and similar substances: (Dispersing agent (for production of special plastics e.g. PTFE)).
Relevant types of plastics	No data – assumed to correspond to PFOA and similar substances: (Polytetrafluorethylene (PTFE) and fluoroethylene propylene (FEP). Polyvinylidene fluoride (PVDF)).

Substance	Henicosfluoroundecanoic acid, Heptacosfluorotetradecanoic acid, Tricosfluorododecanoic acid, Pentacosfluorotridecanoic acid, heptadecafluoronanoic acid and nonadecafluorodecanoic acid
Main article groups	No data – assumed to correspond to PFOA and similar substances: (PTFE is used as coating of metals; PVDF is commonly used as e.g. insulation in certain electrical wires).
Potential for release from plastics	CAS no. 2058-94-8: Molecular weight: 564.09 g/mol, boiling point: 238.4 °C at 101.325 kPa (calculated), vapour pressure: 0.6 to 99.97 kPa (112 to 237.7°C) (calculated), adsorption/desorption: log Koc 3.19 – 3.41 [Annex XV dossier - Henicosfluoroundecanoic acid]. CAS no. 376-06-7: Molecular weight: 714.11 g/mol, boiling point: 270 °C at 98.6 kPa, vapour pressure: 1.37E-3 torr at 25 °C = 0.183 Pa, partition coefficient (log P): 10.823±0.914 at 25 °C (calculated) [Annex XV dossier - Heptacosfluorotetradecanoic acid]. The other substances have similar values. Migration is uncertain, but may based on analogy to Perfluorooctanoic acid (PFOA – see section 3.11.3) be considered possible.
Potential for exposure of consumers	Unknown - but may based on analogy to Perfluorooctanoic acid (PFOA – see section 3.11.3) be considered possible.
Fate of the substance by recycling	Unknown – but may based on analogy to Perfluorooctanoic acid (PFOA – see section 3.11.3) be considered irrelevant since recycling is normally not practised as PTFE typically is used as coating on other materials.
References	<p>Annex XV dossier. Henicosfluoroundecanoic acid. http://echa.europa.eu/documents/10162/13638/SVHC_ACHECK_AXVREP_pub_218-165-4_Henicosfluoroundecanoic_acid_en.pdf</p> <p>Annex XV dossier. Heptacosfluorotetradecanoic acid. http://echa.europa.eu/documents/10162/bd9c539e-19e0-4f67-a31a-0a6f5e8c9b8d</p> <p>Annex XV dossier. Tricosfluorododecanoic acid. http://echa.europa.eu/documents/10162/84bc1dc7-3898-449f-ba44-c20a56ea5452</p> <p>Annex XV dossier. Pentacosfluorotridecanoic acid. http://echa.europa.eu/documents/10162/f4be09a8-ff79-48f1-8175-54fb5c7bac90</p>

3.11.5 Poliaromatiske hydrocarboner (PAH)

Substance	PolyAromatic Hydrocarbons (PAHs)
CAS Number	50-32-8, 56-55-3, 120-12-7, 192-97-2, 193-39-5, 205-82-3, 205-99-2, 207-08-9, 218-01-9, 65996-93-2, 90640-80-5, 90640-81-6, 90640-82-7, 90640-86-1, 91995-15-2, 91995-17-4, etc. PAHs are usually present as a complex mixture of several hundred congeners.
Justification	Norwegian priority list; Registry of intentions (CLP and SVHC).
Function	Impurity in plasticisers (e.g. mineral oil and coal based extender oils) and carbon black [BfR, 2010].
Relevant types of plastics	Soft plasticised plastics, and other plastic types such as acrylonitrile-butadiene-styrene (ABS) and polypropylene (PP) [Central Experience Exchange Committee, 2008]. All plastics coloured black.

Substance	PolyAromatic Hydrocarbons (PAHs)
Main article groups	E.g. tool handles, bicycle handlebars, slippers, flip-flops, beach sandals, diver equipment, toy car tyres or clay pigeons used in skeet shooting. PAHs may also be contained in synthetic turf or in materials used for construction work, e.g. flooring material and plastic handles [BfR, 2010]. Furthermore, all plastic products coloured black might contain PAH.
Potential for release from plastics	Migration and release of PAHs from plastics etc. are discussed by [BrF, 2010]. The conclusion is that for some products significant release and thereby dermal exposure to humans can be expected.
Potential for exposure of consumers	There is a potential for exposure for PAH's from plastics with added carbon black but the level will be extremely low due to the low mobility and the high tendency to absorption in the carbon black matrix.
Fate of the substance by recycling	Judged to mainly remain in the plastic by mechanical recycling due to the low mobility and the high tendency to absorption in the carbon black matrix.
References	<p>BfR (2010). Carcinogenic polycyclic aromatic hydrocarbons (PAHs) in consumer products to be regulated by the EU - risk assessment by BfR in the context of a restriction proposal under REACH. BfR Opinion Nr. 032/2010, 26 July 2010. The Federal Institute for Risk Assessment. Germany http://www.bfr.bund.de/cm/349/carcinogenic_polycyclic_aromatic_hydrocarbons_pahs_in_consumer_products_to_be_regulated_by_the_eu.pdf</p> <p>Central Experience Exchange Committee (2008). Testing and Validation of Polycyclic Aromatic Hydrocarbons (PAH) in the course of GS-Mark Certification. Not authorized translation of original document. http://www.cnqa.org/upimg/20092167421780.pdf</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.11.6 Kalium hydroxyoktaoxodizincatdichromat

Substance	Potassium hydroxyoctaoxodizincatedichromate -see also section 3.5.2
CAS Number	11103-86-9
Justification	Norwegian priority list; Candidate list; Registry of intentions (SVHC).
Function	Corrosion inhibition (in plastic resins for primers, coatings and sealants) to metal substrates (iron, steel, galvanized steel, zinc, aluminium and aluminium alloys)
Relevant types of plastics	Epoxy, polyurethane, alkyd, isocyanate-cured polyester, acrylic resins containing pigments are used as topcoats and primers [Annex XV report].
Main article groups	Coatings in the aeronautic/aerospace sector and the automotive sector (heavy duty vehicles and trucks, military vehicles, agricultural equipment) [Annex XV report].
Potential for release from plastics	<p>Molecular weight: 418.9 g/mol, boiling point: 250 °C (as chromates) [New Jersey – Hazardous Substance Fact Sheet], vapour pressure: data not available, partition coefficient (log value) log P_{ow}: data not available (inorganic compound) [Annex XV report].</p> <p>The substance is solid bound and will not migrate. Release will only take place by wear and tear and by e.g. sandgrinding of surfaces before maintenance.</p>

Substance	Potassium hydroxyoctaoxodizincatedichromate -see also section 3.5.2
Potential for exposure of consumers	Very low as solid bound.
Fate of the substance by recycling	Unknown – Recycling is normally not practised as the substance typically is used in coatings on other materials.
References	<p>Annex XV report. http://echa.europa.eu/documents/10162/13640/svhc_axvrep_france_cmr_potassium_hydroxyoctaoxodizincatedichromate_20110829_en.pdf</p> <p>New Jersey 2008. Zinc potassium chromate – Hazardous Substance Fact Sheet. http://nj.gov/health/eoh/rtkweb/documents/fs/2042.pdf</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

3.11.7 Dinatrium tetraborater

Substance	Disodium tetraborate, anhydrous Disodium tetraborate decahydrate Disodium tetraborate pentahydrate
CAS Number	1330-43-4, 1303-96-4, 12179-04-3
Justification	Danish list of undesired substances; Candidate list; Registry of intentions (SVHC); CMR.
Function	<p>Disodium tetraborate decahydrate (1303-96-4) used as buffering agent (in formaldehyde resins).</p> <p>Disodium tetraborate pentahydrate (CAS 12179-04-3) used for production of plastics, resins, nylon. [Annex XV dossier].</p>
Relevant types of plastics	Formaldehyde resins (not further specified) - no further data [Annex XV dossier].
Main article groups	No information.
Potential for release from plastics	<p>CAS no. 12179-04-3: Molecular weight: 291.35 g/mol, melting point/ boiling point: >300 °C [Annex XV dossier], vapour pressure: negligible at 20 °C, partition coefficient (log value) log Pow: -0.757 at 25 °C [20 Mule team, 2008].</p> <p>Not possible to assess potential for release due to lack of data.</p>
Potential for exposure of consumers	If left in the formaldehyde resins it is judged that exposure might take place due to the high solubility in water expressed by the partition coefficient.
Fate of the substance by recycling	Judged to mainly remain in the plastic by mechanical recycling due to the high melting and boiling point. However the substance might dissolve in the washing processes due to the high solubility in water.

Substance	Disodium tetraborate, anhydrous Disodium tetraborate decahydrate Disodium tetraborate pentahydrate
References	<p>Annex XV dossier. http://echa.europa.eu/documents/10162/13640/svhc_axrep_denmark_cmr_tetraboron_d_isodium_en.pdf</p> <p>20 Mule team (2008). Borax Pentahydrate – Material Safety Data Sheet. http://www.hillbrothers.com/msds/pdf/n/borax-pentahydrate.pdf</p> <p>Nilsson N. (2014). Expert assessment by Nils H. Nilsson, Danish Technological Institute, Århus, April 2014.</p>

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Annex XV dossiers/rapporter.

For alle stoffer omfattet af REACH Kandidate listen findes en Annex XV dossier/rapport. Disse rapporter er alle publiceret af ECHA og er tilgængelige på internettet. Disse rapporter er angivet under de enkelte stoffer, men ikke inkluderet i den følgende referenceliste.

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Forkortelser og acronymer

ABS	Acrylonitril butadien styren
ADCA	C,C'-azodi(formamid)
ATBC	Acetyl tributyl citrat
BBP	Benzyl butyl ftalat
BPA	Bisphenol A
CAS	Chemical Abstracts Service
Cd	Cadmium
C.I.	Colour Index
CLP	Klassification, mærkning og emballering af stoffer og blandinger (EU regulering)
CMR	Carcinogen, mutagent eller giftigt for reproduktion
COMGHA	Castor oil derivatives
CP	Chlorparaffiner
CPE	Chloreret polyethylen
DBP	Dibutyl ftalat
DEHP	Bis(2-ethylhexyl)ftalat
DEHT	Di(2-ethyl-hexyl)tereftalat
DHNUP	1,2-Benzendicarboxylsyre, di-C ₇ -11-grenet og linære alkyl estre
DIKP	Diisobutyl ftalat
DIHP	Diisoheptylftalat/diisohexylftalat
DINA	Diisononyl adipat
DINCH	Di-(isononyl)-cyclohexan-1,2-dicarboxylat
DINP	Diisononyl ftalat
DMEP	Bis(2-methoxyethyl) ftalat
DMF	N,N-dimethylformamid
EC	European Community (Europeisk fællesskab)
ECHA	European Chemicals Agency (EU's Kemikalie Agentur)
EPA	Environmental Protection Agency
EPS	Ekspanderet polystyren
EU	European Union
EVA	Ethylen-vinylacetat copolymer
FEP (a)	Fluoroethylen propylen
FEB (b)	Tetrafluoroethylee-Hexafluoropropylen-Copolymer
HBCDD	Hexabromcyclododecan
HCl	Saltsyre
HDPE	Polyethylen High Density
HFC	Hydro fluoro carbon
Hg	Kviksølv
HIPS	High Impact Polystyren
hPa	Hectopascal
KLIF	Klima- og Forurensnings Direktoratet i Norge (den norske miljøstyrelse)
LDPE	Polyethylen Low Density
LLDPE	Polyethylen Linear Low Density
Log K _{o/w}	Svarer til log P _{o/w}

Log P _{o/w}	Fordelings-koefficient (oktanol/vand)
LOUS	Liste over uønskede stoffer
MCCP	Medium kædede chlorparaffiner
MDA	4,4'- Diaminodiphenylmethan
MDI	Methylen diphenyldiisocyanat
MOCA	2,2'-dichlor-4,4'-methylenedianilin
MSDS	Material safety data sheet (sikkerhedsdatablad)
MW	Molekyle vægt
NGO	Ikke regerings organisation (græsrodsbevægelse)
NIR	Near-infrared spectroscopy
NP	Nonylphenol
OBPA	10,10'-oxybisphenoxyarsin
OBDE	Octabromodiphenyl æter
OP	Oktylphenol
OPET	En særlig type PET (oriented PET)
PA	Polyamid (nylon)
PA66	Særlig type polyamid
Pa	Pascal
PAH	Polyaromatiske hydrocarboner
PBT	Polybutylen tereftalat
PBT	Persistent, bioaccumulerende og giftig
PC	Polycarbonat
PE	Polyethylen
PEEK	Polyetheretherketone
PeBDE	Pentabromdiphenyl æter
PET	Polyethylen tereftalat (polyester)
PFOA	Perfluorooaktansyre
pH	Et mål for surheden eller basiskheden af en vandig opløsning
PIB	Polyisobutylen plast
PMMA	Polymethyl methacrylat
POM	Polyoxymethylen
POP	Persistant organic pollutants (persistente organiske stoffer)
PP	Polypropylen
PPE	Polyphenylen æter
PPE-HIPS	Blanding af polyphenylen æter og high impact polystyren
PS	Polystyren
PSU	Polysulphon
PTFE	Polytetrafluoroethylen (teflon)
PU	Polyurethan
PUR	Polyurethan
PVA	Polyvinylacetat
PVC	Polyvinyl chlorid
PVDF	Polyvinyliden fluorid
REACH	REACH er EU's regulering om kemikalier og deres sikker anvendelse. Den omhandler R egistration (registrering), E valuation (vurdering), A uthorisation (autorisation) og R estriction (begrænsning) af C hemical (Kemiske) stoffer
RoHS	Restriction of Hazardous Substances (EU regulering – begrænsning af farlige stoffer i elektronik og elektriske genstande)
SAN	Styren Acrylonitril
SCCP	Kort kædede chlorparaffiner
SDS	Safety data sheet (sikkerhedsdatablad)
SIAR	OECD SIDS Initial Assessment Report
SIDS	OECDs Screening Information Dataset

SVHC	Substances of Very High Concern
TBBPA	Tetrabromobisphenol A
TBTO	Bis(tributyltin)oxid
TCEP	Tris(2-chloroethyl)fosfat
TGIC	1,3,5-Tris(oxiran-2-ylmethyl)-1,3,5-triazinan-2,4,6-trion
β -TGIC	1,3,5-Tris[(2S and 2R)-2,3-epoxypropyl]-1,3,5-triazin-2,4,6-(1H,3H,5H)-trion
TDI	Toluen-diisocyanat
Tm	Smelte temperatur for plast som indeholder krystallinske dele
TNPP	Tris(4-nonyl-phenyl) fosfat
Torr	En enhed for tryk, som svarer til 1/760 atmosfære (ca. 133.3 pascals eller 1 mm Hg)
TPU	Thermoplastisk polyurethan
UP	Umaëtted polyester
US EPA	United States Environmental Protection Agency
UV	Ultraviolet (lys)
UV/VIS	Ultraviolet/synligt lys
XPS	Extruderet polystyren
X-rays	Form for electromagnetisk stråling.
VCR	Video cassette recorders (video band optagere)
vPvB	Meget persistent og meget bioaccumulerende
w/w	Efter vægt

Bilag 1 Stoffer som sandsynligvis ikke anvendes i plast

I dette annex er angivet de kemiiske stoffer, som er vurderet som sandsynligvis ikke til stede i plast i væsentlige koncentrationer eller på mere end sporstofniveau.

De angivne stoffer tilhører følgende stoflister:

- Miljøstyrelsens liste over uønskede stoffer.
- Den opdaterede SVHC (Substances of Very High Concern – stoffer, der vækker meget store betænkeligheder) kandidat liste under REACH.
- Den Norske Prioritetsliste.
- ECHA's Register over Hensigter.
- En liste over CMR-stoffer i legetøj sandsynligvis til stede i plast legetøj udarbejdet af Teknologisk Institut.
- Anerkendte alternativer til problematiske ftalater og bromerede flammehæmmere.

Først er angivet stoffer på Miljøstyrelsens liste over uønskede stoffer, herefter stoffer på EU's kandidatliste (juni 2013) efterfulgt af stoffer eller stofgrupper på den Norske Prioritetsliste osv.

For de fleste stoffer giver den tilgængelige litteratur ikke en komplet dækning af alle anvendelser og i visse tilfælde er den foreliggende information meget sparsom. Det er derfor ofte ikke muligt med sikkerhed at konkludere at stoffet ikke på nogen måde anvendes i plast. Den nedenstående liste kan derfor omfatte stoffer, som anvendes i plast i beskeden omfang.

Screeningsmetoden og de vigtigste kilder til information er beskrevet i kapitel 2.

Substance	CAS No.	Use associated with plastic
Danish list of undesired substances		
Benzyl chloride	100-44-7	Intermediate for plasticisers - present as an impurity in BBP (< 2ppm) [Annex XV report – BBP]
Biphenyl	92-52-4	Intermediate for e.g. plastics - assessed as non-important
Bisphenol A diglycidyl ether polymer	25036-25-3	Polymer/plastic material based on bisphenol A
Boric compounds (classified)		
Sodium perborate tetrahydrate	10486-00-7	Not used in plastics
Diboron trioxide	1303-86-2	May be used in dyes for synthetic textiles [Annex XV], but no detailed information has been found
2,3-epoxypropyl neodecanoate	26761-45-5	Little information available - no indication of use in plastics
n-hexane	110-54-3	Solvent – not used in plastics
2,2'-Iminodiethanol	111-42-2	Not used in plastics
Copper(I) oxide	1317-39-1	Copper(I)chloride is used as intermediate in manufacturing of pigments - indications that copper(I)oxide and copper(II)sulphate may be used in rubbers and plastics, but no further information is available [Hansen et al 2013]
Copper(II) sulphate	7758-98-7	
Copper(I) chloride	7758-89-6	Potential occurrence in plastics is thus assessed as insignificant
Manganese(II) sulphate	7785-87-7	Not used in plastics
Methanol	67-56-1	Not used in plastics
MTBE methyl-tertiary butyl ether	1634-04-4	Not used in plastics
1-Methyl-2-pyrrolidone (NMP)	872-50-4	Spinning agent (for PVC); binder in waterborne PU topcoat, solvent [Annex XV]
Naphthalene	91-20-3 202-049-5	Intermediate used in the production of plastics - potential occurrence in plastics is assessed as insignificant
Sodium hypochlorite	231-668-3	Disinfectant, cleaning agent – not used in plastic
Calcium hypochlorite	231-908-7	
Nickel (metal)	7440-02-0	Not used in plastics
Certain oil and coal derivatives		
Mineral turpentine		Not used in plastics
Solvent naphta (petroleum), medium aliphatic	8052-41-3 64742-88-7	
Organic solvents		
Toluene	108-88-3	Toluene is used as intermediate in production of TDI and is likely not relevant to consider
Certain parabens (propyl and butyl paraben)		Used in cosmetics etc. but not in plastics.
Propyl paraben	94-13-3	
Butyl paraben	94-26-8	

Perfume ingredients		Used in cosmetics etc. but not in plastics.
PFOS (Perfluorooctanesulfonic acid or perfluorooctane sulfonate)	e.g. 4151-50-2	Used in firefighting foams, photographic industry, photolithography and semiconductors, hydraulic fluids and in metal plating industry [UNECE, 2006] - in the past used to provide soil, oil and water resistance to textiles, apparels, home furnishings and upholstery, carpets and leather products [UNECE, 2006]
N'-tert-butyl-N-cyclopropyl-6-(methylthio)-1,3,5-triazine-2,4-diamine	28159-98-0	Not used in plastics
Trisodium nitrilotriacetate	5064-31-3	Not used in plastics

Substances on the EU CANDIDATE LIST

Acids generated from chromium trioxide and their oligomers. Names of the acids and their oligomers: Chromic acid, Dichromic acid, Oligomers of chromic acid and dichromic acid.	7738-94-5, 13530-68-2	Used with sulfuric acid as an etchant for plastics such as ABS, modified polypropylene, polysulfone [Milne, 2005, Muccio, 1991]
Aluminosilicate Refractory Ceramic Fibres		Not used in plastics [Annex XV]
[4-[[4-anilino-1-naphthyl][4-(dimethylamino)phenyl]methylene]cyclohexa-2,5-dien-1-ylidene] dimethylammonium chloride (C.I. Basic Blue 26) [with ≥ 0.1% of Michler's ketone (EC No. 202-027-5) or Michler's base (EC No. 202-959-2)]	2580-56-5	Dyeing of various paper and plastic products [Annex XV]
Anthracene	120-12-7	Doping agent for polyvinyltoluene to produce a plastic scintillator. [Several internet sources, 2012] - to the best of knowledge not used in plastic
Anthracene oil	90640-80-5	Mainly intermediate in the production of pure anthracene used for production of artificial dyes - not used in plastics [Annex XV]
Anthracene oil, anthracene paste	90640-81-6	Same as antracene oil (above) - not used in plastics
Anthracene oil, anthracene paste, anthracene fraction	91995-1-2	Same as antracene oil (above) - not used in plastics
Anthracene oil, anthracene paste,distn. lights	91995-17-4	Same as antracene oil (above) - not used in plastics
Anthracene oil, anthracene-low	90640-82-7	Same as antracene oil (above) - not used in plastics

[4-[4,4'-bis(dimethylamino) benzhydrylidene]cyclohexa-2,5-dien-1-ylidene]dimethylammonium chloride (C.I. Basic Violet 3) [with ≥ 0.1% of Michler's ketone (EC No. 202-027-5) or Michler's base (EC No. 202-959-2)]	548-62-9	A component of navy blue and black dyes for polyacylonitrile fibers [Annex XV]
4,4'-bis(dimethylamino) benzophenone (Michler's ketone)	90-94-8	Intermediate in the manufacture of triphenylmethane dyes [Annex XV] - not used in plastics
4,4'-bis(dimethylamino)-4''-(methylamino)trityl alcohol [with ≥ 0.1% of Michler's ketone (EC No. 202-027-5) or Michler's base (EC No. 202-959-2)]	561-41-1	Used in inks and dyes [ECHA 2013] - may be used in dyes for polyacrylonitrile materials [Annex XV]
Bis(2-methoxyethyl) ether	111-96-6	Used as a solvent for PVC/PVA copolymer and polymethyl methacrylate [Milne, 2005] Used for purification and solvent in production of magnetic polystyrene beads [Annex XV]
α,α-Bis[4-(dimethylamino)phenyl]-4-(phenylamino)naphthalene-1-methanol (C.I. Solvent Blue 4) [with ≥ 0.1% of Michler's ketone (EC No. 202-027-5) or Michler's base (EC No. 202-959-2)]	6786-83-0	Is used for dying of plastics [Annex XV]
1,2-bis(2-methoxyethoxy)ethane (TEGDME; triglyme)	112-49-2	Substance in etchant formulation [Annex XV] used to make fluoropolymers bondable to a wide variety of articles - there is only limited information on the current use of the substance [Annex XV]
Cobalt(II) carbonate	513-79-1	Catalyst in the production of p-xylene to terephthalic acid (which is a monomer for PET) [Annex XV]
Cobalt dichloride	7646-79-9	Intermediate for other cobalt compounds, electroplating, pigments and dyes - no information of use in plastics [Annex XV; Entec, year unknown; Krebs, 2006; Environment Canada, 2011]
Cobalt(II) dinitrate	10141-05-6	Used mainly in the manufacture of catalysts and production of intermediate chemicals - not used in plastics [Annex XV]
Cobalt(II) sulphate	10124-43-3	Used in organic textile dyes (cobalt complexes of azo-dye derivates), which could be used in synthetic textiles [Annex XV]
Diboron trioxide	1303-86-2	May be used in dyes for synthetic textiles [Annex XV], but no detailed information has been found
1,2-Dichloroethane	107-06-2	Precursor in the production of vinyl chloride monomer

		for the production of PVC, (an alternative route exists) [Annex XV] Will easily evaporate - will to the best of knowledge not be present in plastic end products
Dichromium tris(chromate)	24613-89-6	Surface treatment of metals - not used in plastics [Annex XV]
1,2-dimethoxyethane; ethylene glycol dimethyl ether (EGDME)	110-71-4	Processing aid for Fluor polymer Etchant formulation, which is used to make fluoropolymers bondable to a wide variety of articles, i.e., Teflon [Annex XV]
N,N-dimethylacetamide (DMAC)	127-19-5	Spinning of textile fibres [Annex XV]
2,4-Dinitrotoluene	121-14-2	Used to make tolulenediamine which is an intermediate for tolulenediisocyanate [OECD, 2004], the intermediate for TDI which is used for making flexible polyurethane foam
2-Ethoxyethanol	110-80-5	Solvent for nitrocellulose, epoxy coatings, alkyd resins [Ash and Ash, 2007]
2-Ethoxyethyl acetate	111-15-9	<p>It is reported in the sector of rubber and plastic industry [Annex XV], but no other information to confirm this has been found</p> <p><i>Note:</i> To the best of knowledge it is not used to any significant extent in plastics</p>
Formamide	75-12-7	<p>Solvent (for synthetic leather)*, by-product in the processing of foam (EVA) [Annex XV] - solvent for polymers such as PVC and polyacrylonitrile [Swedish Chemicals Agency, 2010]</p> <p>* Besides in the Annex XV report there is no information that formamide is used in the production of synthetic leather</p>
2-Methoxyaniline o-Anisidine	90-04-0	Component of azo and naphthol pigments and dyes used in dyed and printed polymers especially in printed packing foils [Annex XV]
1-Methyl-2-pyrrolidone (NMP)	872-50-4	Spinning agent (for PVC); binder in waterborne PU topcoat, solvent [Annex XV]
Pentazinc chromate octahydroxide	49663-84-5	Used as anti-corrosive agent in primers, and colouring, hiding and anti-scaling agent in paints and coatings - not used in plastics [Annex XV]
Phenolphthalein	77-09-8	Laboratory uses etc. - not used in plastics [Annex XV]
5-tert-butyl-2,4,6-trinitro-m-xylene (musk xylene)	81-15-2	Used in fragrance formulation in household and cosmetic products - not used in plastics [EU, ≥2008]

Tetraboron disodium heptaoxide, hydrate	12267-73-1	Used in glass, ceramics, detergents, wood treatment, insulation fiberglass and various unspecified uses such as production of other borate compounds [Annex XV] - to the best of knowledge not used to any significant extent in plastics
N,N,N',N'-tetramethyl-4,4'-methylenedianiline (Michler's base)	101-61-1	Intermediate in the manufacture of dyes and pigments (including Methylene red, C.I. Basic Yellow 2, Basic Orange 14, Solvent Orange 15, and Solvent Yellow 34 and C.I. Basic Violet 3 [Annex XV]) Information on whether these pigments are used in plastics/fibres has not been found
Zirconia Aluminosilicate Refractory Ceramic Fibres...		High-temperature insulating fibre for industrial applications - not used in plastics [Annex XV]
Dipentyl phthalate (DPP)	131-18-0	May be used as plasticiser in PVC - not manufactured in EU - consumption in EU assessed as <1 tons per year [Annex XV dossier – DPP]
6-methoxy-m-toluidine (p-cresidine)	120-71-8	Intermediate, manufacture of pigments [ECHA 2013] - no other information available
4-Aminoazobenzene	60-09-3	Intermediate, manufacturing of pigment – no other information available [ECHA 2013]
o-Toluidine	95-53-4	Intermediate – no other information available [ECHA 2013]
3-ethyl-2-methyl-2-(3-methylbutyl)-1,3-oxazolidine	143860-04-2	No information available [ECHA 2013] Manufacture of substances – stated by MSDS
4,4'-methylenedi-o-toluidine	838-88-0	No information available [ECHA 2013] Manufacture of substances – stated by MSD
Diethyl sulphate	64-67-5	Intermediate - reactant in the synthesis of polymers - no other information available [ECHA 2013]
Dimethyl sulphate	77-78-1	Intermediate - synthesis of polymers - no other information available [ECHA 2013]
Furan	110-00-9	Intermediate – no other information available [ECHA 2013]
Dinoseb (6-sec-butyl-2,4-dinitrophenol)	88-85-7	Intermediate - manufacture of plastics products, including compounding and conversion - no other information available [ECHA 2013]
1,2-Diethoxyethane	629-14-1	Solvents for some resins – no other indications of use related to plastics are presented [Annex XV – Diethoxyethane]
N-methylacetamide	79-16-3	Intermediate – no other information available [ECHA 2013]
N-pentyl-isopentylphthalate	776297-69-9	May be used as plasticiser in plastic materials - not manufactured in EU - consumption in EU assessed as <1 tons per year [Annex XV dossier – PIPP]
1-bromopropane (n-propyl bromide)	106-94-5	Intermediate – manufacture of solvent for cleaning/degreasing - end use includes manufacture of plastics products, including compounding and conversion No other information available [ECHA 2013] According to MSDS use is as a solvent, generally for fats,

		waxes, or resins, or as an intermediate in the synthesis of other compounds Assessed as unimportant related to plastics
Methoxyacetic acid	625-45-6	No information indicates the substance to be used in plastics or in manufacture of plastics [Annex XV dossier – Methoxyacetic acid]
o-aminoazotoluene	97-56-3	Intermediate in the manufacture of dyes and medicines [NCBI – Aminoazotoluene] - no other information available [ECHA 2013]
4-methyl-m-phenylenediamine (toluene-2,4-diamine)	95-80-7	Intermediate - production of sulphur dyes [ECHA]
1,2-Benzenedicarboxylic acid, dipentylester, branched and linear	84777-06-0	May be used as plasticiser in plastic materials - not manufactured in EU - consumption in EU assessed as <1 tons per year [Annex XV dossier - benzenedicarboxylic acid, dipentylester]
Biphenyl-4-ylamine	92-67-1	Intermediate (according to MSDS) – no other information available - substance is not registered [ECHA 2013]
4,4'-oxydianiline and its salts	101-80-4	Intermediate - the substance is a monomer within an imported polymer [ECHA 2013] - no other information available - assessed not to be present in significant concentrations in plastic end products.

Substances on the NORWEGIAN PRIORITY LIST

1,2-Dichloroethane	107-06-2	Precursor in the production of vinyl chloride monomer for the production of PVC, (an alternative route exists) [Annex XV] Will easily evaporate - will to the best of knowledge not be present in the plastic material
Certain surfactants (DHTDMAC, DSDMAC, DTDMAC)		Used as fabric softeners etc. [Knepper et al, 2003; OECD, 1996; EU, 2009] According to one article by McLauchlin et al, [2011] DTDMAC can be used to modify clay mineral (giving a dual surfactant organoclay), which can be used (in amounts of 4 %) in the production of poly(butylene terephthalate (PBT) nanocomposites [McLauchlin et al, 2011] This has not been confirmed by other sources
Dioxins and furans		Dioxins may form during combustion of chlorinated material, e.g. PVC [UNEP, 1999]
Chlorinated alkylbenzenes	e.g. 85117-42-6	Almost no information is available - information available on the internet indicates that chlorinated alkylbenzenes may be used as chemical intermediates for the preparation of monomers and plasticisers etc. - they may also be as result of degradation or combustion processes
Hexachlorobenzene	118-74-1	HCB is no longer directly used - it was e.g. commonly

		used as a pesticide until 1965 [US EPA, 2011]
Muskxylenes	e.g. 81-15-2	Used in fragrance formulation in household and cosmetic products - not used in plastics [EU, ≥2008]
Pentachlorophenol		Biocide in textiles Can be used in thermoplastic polyester in roughly estimated amounts of (0.1-1 %) [Swedish Chemicals Agency, 2007]
PFOS (Perfluorooctanesulfonic acid or perfluorooctane sulfonate)		Used in firefighting foams, photographic industry, photolithography and semiconductors, hydraulic fluids and in metal plating industry2 [UNECE, 2006] - in the past used to provide soil, oil and water resistance to textiles, apparels, home furnishings and upholstery, carpets and leather products [UNECE, 2006]
Polychlorinated biphenyls (PCBs)		Previously used as plasticisers and polyolefin catalysts [Breivik, 2005] According the Swedish Chemicals Agency's guide on articles PBC can be used in thermoplastic polyester in roughly estimated amounts of (0.1-1 %) [Swedish Chemicals Agency, 2007] - no other information has been found to confirm this
Siloxane-D5 Decamethylcyclopentasiloxan (D5)	541-02-6	Mainly used in blending and formulating personal-care products and cosmetics [Fishlock, 2012; Environment Canada, 2012] - intermediate in the production of polydimethylsiloxane silicone polymers [Fishlock, 2011] Examples of uses in plastics have not been found
Tetrachloroethene (PER)	127-18-4	Major use as chemical intermediate, dry cleaning solvent, metal cleaning and extraction processes - used to remove lubricants in knitted or weaved synthetic fabrics [EU, 2005]
Trichlorobenzene	120-82-1	Solvent and intermediate for pesticides - as a dye carrier (mixed with a levelling agent) applied mainly to polyester materials [EU, 2003]
2,4,6 Tri-tert-butylphenol	732-26-3	Maybe used as an intermediate in the production of antioxidants for plastics [Environment Canada 2008] According the Swedish Chemicals Agency [2007] it can be used in thermoplastic polyester in roughly estimated amounts of (0.1-1 %)
ECHA's registry of intentions		
Carbetamide (ISO); (2R)-1-(ethylamino)-1-oxopropan-2-yl phenylcarbamate	16118-49-3	Intermediate – no indication of association with plastics
2-Benzyl-4-chlorophenol	120-32-1	Intermediate – no indication of association with plastics

Fenpyrazamine	473798-59-3	No information
Pirimicarb (ISO); 5,6-dimethyl-2-dimethylamino-pyrimidin-4-yl N,N-dimethylcarbamate	23103-98-2	Insecticide [Pesticides 2013]- no indication of association with plastics
Clethodim (ISO); 2-[N-{{[(2E)-3-chloroprop-2-en-1-yl]oxy}propanimidoyl]-5-[2-(ethylthio)propyl]-3-hydroxycyclohex-2-en-1-one	99129-21-2	Herbicide[Pesticides 2013] - no indication of association with plastics
Quinolin-8-ol	148-24-3	Intermediate, steel electroplating, formerly fungicide - no indication of association with plastics
1,2-dichloropropane; propylene dichloride	78-87-5	Intermediate, solvent, thinner, degreasing etc. - no indication of association with plastics [ECHA 2013]
Reaction mass of: 2-(2H-benzotriazol-2-yl)-4-methyl-5-dodecyl (linear and branched) phenol; 2-(2H-benzotriazol-2-yl)-4-methyl-6-dodecyl (linear and branched) phenol; 2-(2H-benzotriazol-2-yl)-4-methyl-5-tetracosyl (linear and branched) phenol; 2-(2H-benzotriazol-2-yl)-4-methyl-6-tetracosyl (linear and branched) phenol; 2-(2H-benzotriazol-2-yl)-4-methyl-5,6-didodecyl (linear and branched) phenol		The substance is not well identified and the meaning of the term "reaction mass of" is unclear - the substances are thus not included The substance could be a UV-stabilizer
5-Chloro-2-(4-chlorophenoxy)-phenol	3380-30-1	Disinfectant - no indication of association with plastics
N,N-dimethylacetamide (DMAC)	127-19-5	Spinning of textile fibres [Annex XV]
Chloralose (INN); (R)-1,2-O-(2,2,2-trichloroethylidene)-D-glucofuranose; glucochloralose; anhydroglucochloral	15879-93-3	Avicides, bird repellents, rodenticides [Pesticides 2013]- no indication of association with plastics
Chlorobenzene	108-90-7	Intermediate, heat transfer fluid - no indication of association with plastics [ECHA 2013]
TBHP (Hydroperoxide, 1,1-Dimethylethyl)	75-91-2	Intermediate, process regulators for polymerisation processes in production of resins, rubbers, polymers [ECHA 2013] - free radical initiator for polymerizations, copolymerization, graft polymerizations and curing of polymers [Lyondell 2013] - assumed not to be present in end plastic products
Bendiocarb (ISO); (2,2-dimethyl-1,3-benzodioxol-4-yl N-methylcarbamate)	22781-23-3	Insecticide [Pesticides 2013] - no indication of association with plastics
Thiacloprid (ISO); (Z)-N-{3-[(6-Chloro-3-pyridinyl)methyl]-1,3-thiazolan-2-yliden}cyanamide	111988-49-9	Insecticide [Pesticides 2013] - no indication of association with plastics
1-Methyl-2-pyrrolidone (NMP)	872-50-4	Spinning agent (for PVC); binder in waterborne PU topcoat, solvent [Annex XV]
Triflumizole ((E)-4-chloro-1,1,1-trifluoro-N-(1-imidazol-1-yl-2-)	99387-89-0	Fungicide[Pesticides 2013] - no indication of association with plastics
Flumioxazin (ISO); N-(7-fluoro-3,4-dihydro-3-	103361-09-7	Herbicide[Pesticides 2013] - no indication of association

oxo-4-prop-2-ynyl-2H-1,4-benzoxazin-6-yl)cyclohex-1-ene-1,2-dicarboxamide		with plastics
Polyhexamethylene biguanide hydrochloride (PHMB)	27083-27-8 or 32289-58-0	Biocide, disinfectant - no indication of association with plastics
Pencycuron (ISO); 1-(4-chlorobenzyl)-1-cyclopentyl-3-phenylurea	66063-05-6	Fungicide [Pesticides 2013]- no indication of association with plastics
Hydroxyisohexyl 3-cyclohexene carboxaldehyde (INCI); reaction mass of 4-(4-hydroxy-4-methylpentyl)cyclohex-3-ene-1-carbaldehyde and 3-(4- hydroxy-4-methylpentyl)cyclohex-3-ene-1- carbaldehyde [1]; 4-(4-hydroxy-4-methylpentyl)cyclohex-3-ene-1-carbaldehyde [2]; 3-(4-hydroxy-4-methylpentyl)cyclohex-3-ene-1-carbaldehyde [3]	-[1]; 31906-04-4 [2]; 51414-25-6 [3]	Fragrance ingredients - no indication of association with plastics
Phenol, dodecyl-, branched [Tetrapropenylphenol (TPP)]	121158-58-5	Intermediate, monomer for manufacture of thermoplastics [ECHA 2013] - member of alkylphenol family - According to Lassen et al [2013) 99% of the consumption in EU was used in the production of oil and lubricant additives while small amount was used to produce phenol/formaldehyde resins for printing inks and rubber tyre manufacturing
Sulfoxaflor (ISO); [methyl(oxo){1-[6-(trifluoromethyl)-3-pyridyl]ethyl}-6-sulfanylidene]cyanamide	946578-00-3	Insecticide [Pesticides 2013] - no indication of association with plastics
Linalool	78-70-6	Intermediate – cleaning, cosmetics etc. - no indication of association with plastics [ECHA 2013]
2-(4-tertbutylbenzyl)propionaldehyde	80-54-6	Intermediate – cleaning, cosmetics etc.- no indication of association with plastics [ECHA 2013]
Zinc phosphide; trizinc diphosphide	1314-84-7	Rodenticide [Pesticides 2013] - no indication of association with plastics
Acetochlor(2-chloro-N-ethoxymethyl-6Å'-ethylacet-o-toluidide)	34256-82-1	Herbicide[Pesticides 2013] - no indication of association with plastics
Tinuvin 123; Reaction mass of bis(2,2,6,6-tetramethyl-1-octyloxypiperidin-4-yl)-1,10-decanedioate and 1,8-bis[(2,2,6,6-tetramethyl-4-((2,2,6,6-tetramethyl-1-octyloxypiperidin-4-yl)-decan-1,10-diyl)piperidin-1-yl)oxy]octane	129757-67-1	Light stabilizer/ UV-absorber - outdoor use (professional) of HALS resulting in inclusion into a matrix, including application in coatings, adhesives and plastics [ECHA 2013] - according to [BASF 2014] only used in coatings (HALS: hindered amine light stabilizers)
Methanol	67-56-1	Not used in plastics
Bupirimate (5-butyl-2-ethylamino-6-methylpyrimidine-4-yl)	41483-43-6	Fungicide [Pesticides 2013] - no indication of association with plastics
Glutaral; glutaraldehyde; 1,5-pentanedral	111-30-8	Disinfectant - no indication of association with plastics
Fluopyram (ISO); N-{2-[3-chloro-5-(trifluoromethyl)pyridin-2-yl]ethyl}-2-(trifluoromethyl)benzamide	658066-35-4	Fungicide [Pesticides 2013]- no indication of association with plastics

Spiroxamine	118134-30-8	Fungicide [Pesticides 2013]- no indication of association with plastics
Bifenazate (ISO); isopropyl 2-(4-methoxybiphenyl-3-yl)hydrazinecarboxylate	149877-41-8	Acaricide [Pesticide 2013] - no indication of association with plastics
Phenol, dodecyl-, branched [Tetrapropenylphenol (TPP)]	121158-58-5	Intermediate, monomer for manufacture of thermoplastics [ECHA 2013] - Member of alkylphenol family - According to Lassen et al [2013] 99% of the consumption in EU was used in the production of oil and lubricant additives while small amount was used to produce phenol/formaldehyde resins for printing inks and rubber tyre manufacturing
Iodomethane	74-88-4	Fungicide, herbicide, insecticide, nematicide [Pesticides 2013] - no indication of association with plastics
Pyridaben (2-tert-butyl-5-(4-tert-butylbenzylthio)-4-chloropyridazin-3(2H)-one)	96489-71-3	Acaricide, insecticide [Pesticides 2013]- no indication of association with plastics
Geranonitril (3,7-dimethylocta-2,6-dienenitrile)	5146-66-7	Synthetic flavour -candles and soap products - no indication of association with plastics
Lenacil (ISO); 3-cyclohexyl-6,7-dihydro-1H-cyclopenta[d]pyrimidine-2,4(3H,5H)-dione	2164-08-01	Herbicide [Pesticides 2013] - no indication of association with plastics
Nitric acid	7697-37-2	Not used in plastics
Lithium sodium 3-amino-10-{4-(10-amino-6,13-dichloro-4,11-disulfonatobenzo[5,6][1,4]oxazino[2,3-b]phenoxyazine-3-ylamino)-6-[methyl(2-sulfonato-ethyl)amino]-1,3,5-triazin-2-ylamino}-6,13-dichlorobenzo[5,6][1,4]oxazino[2,3-b]phenoxyazine-4,11-disulfonate; Direct Blue FC 57087	154212-58-5	Dye for textiles, leather, fur etc. [CLH Report –Direct blue]
Fluquinconazole (3-(2,4-dichlorophenyl)-6-fluoro-2-(1H-1,2,4-triazol-1-yl)quinazolin-4(3H)-one)	136426-54-5	Fungicide [Pesticides 2013]- no indication of association with plastics
8:2 Fluorotelomer alcohol (8:2 FTOH)	678-39-7	8:2 FTOH is mainly used for coating of textiles, paper and carpets to achieve oil, stain and water repellent properties, cleaning agents and is present as residual raw materials (Dinglasan-Panlilio and Mabury, 2006) - the reaction of fluorotelomer alcohol to make fluorotelomer acrylates or methacrylate esters leaves 0.1-0.5 wt% unreacted residual FTOH [CLH report – 8:2 FTOH]
Special purpose E-glass fibres [Calcium-aluminium-silicate fibres with random orientation with the following composition (% given by weight): SiO ₂ 50.0-56.0%, Al ₂ O ₃ 13.0-16.0%, B ₂ O ₃ 5.8-10.0%, Na ₂ O <0.6%, K ₂ O <0.4%, CaO 15.0-24.0%, MgO <5.5%, Fe ₂ O ₃ <0.5%, F ₂ <1.0% with note R. Process: drawing or spinning the molten mix (at approx. 1500°C) from nozzles]		No indication of association with plastics

Special purpose 475-glass fibres [Calcium-aluminium-silicate fibres with random orientation with the following composition (% given by weight): SiO ₂ 55.0-60.0%, Al ₂ O ₃ 4.0-7.0%, B ₂ O ₃ 8.0-11.0%, Na ₂ O 9.5-13.5%, K ₂ O 1.0-4.0%, CaO 1.0-5.0%, MgO 0.0-2.0%, Fe ₂ O ₃ <0.2%, ZnO 2.0-5.0%, BaO 3.0-6.0%, F ₂ <1.0% with note R. Process: drawing or spinning the molten mix (at approx. 1500°C) from nozzles]		No indication of association with plastics
Propamocarb (Propyl 3-(dimethylamino) propylcarbamate hydrochloride)	25606-41-1	Fungicide [Pesticides 2013]- no indication of association with plastics
Picoxystrobin (Methyl (E)-3-methoxy-2-[2-[6-(trifluoromethyl)-2-pyridoxymethyl]phenyl]acrylate)	117428-22-5	Fungicide [Pesticides 2013] - no indication of association with plastics
Etridiazole	2593-15-9	Fungicide [Pesticides 2013] - no indication of association with plastics
Dodemorph	1593-77-7	Fungicide [Pesticides 2013]- no indication of association with plastics
Dodemorph acetate	31717-87-0	Fungicide [Pesticides 2013]- no indication of association with plastics
Zineb (Carbamaodithioic acid, 1,2-ethane)	12122-67-7	Fungicide [Pesticides 2013]- no indication of association with plastics
Silthiofam (4,5-Dimethyl-2-trimethylsilanyl-thiophene-3-carboxylic acid allylamide)	175217-20-6	Fungicide [Pesticides 2013]- no indication of association with plastics
Diphenylamine	122-39-4	Intermediate - chemical reaction of Diphenylamine with sulphur gives phenothiazine used as stabiliser for plastics. [RAR – diphenylamine 2008] - assessed not to be present in significant concentrations in plastic end products
Isoxaflutole	141112-29-0	Herbicide [Pesticides 2013]- no indication of association with plastics
Tebuconazole	107534-96-3	Fungicide [Pesticides 2013]- no indication of association with plastics
Disodium octaborate, anhydrate	12008-41-2	Intermediate
Disodium octaborate, tetrahydrate	12280-03-4	Biocide - wood preservative
Carvone; 5-isopropenyl-2-methylcyclohex-2-en-1-one; d/l mixture; l-carvone; [2] l-carvone; [3]	99-49-0 [1] 2244-16-8 [2] 6485-40-1 [3]	Fungicide [Pesticides 2013]- no indication of association with plastics
Coumatetralyl (ISO); 4-hydroxy-3-(1,2,3,4-tetrahydro-1-naphthyl)coumarin	5836-29-3	Rodenticide [Pesticides 2013]- no indication of association with plastics
Fyrolflex	5945-33-5	Phosphorous flame retardant for e.g. polyphenylene PC, ABS, PE, PP, HIPS etc. – for automotive and electronic purposes
(Z,E)-7,11-hexadecadien-1-yl acetate	51606-94-4	Pesticide?
(Z)-11-hexadecen-1-yl acetate	34010-21-4	Pesticide?

(Z)-13-octadecenal	58594-45-9	Pesticide?
(Z)-9-dodecen-1-yl acetate	16974-11-1	Pesticide?
E-5-decen-1-ol	56578-18-8	Pesticide?
(E)-5-decen-1-yl acetate	38421-90-8	Pesticide?
(E,Z)-7,9-dodecadien-1-yl acetate	54364-62-4	Pesticide?
(Z)-11-tetradecen-1-yl acetate	20711-10-8	Pesticide?
(Z,E)-9,12-tetradecadien-1-yl acetate	30507-70-1	Pesticide?
(Z,Z)-7,11-hexadecadien-1-yl acetate	52207-99-5	Pesticide?
(Z)-11-hexadecenal	53939-28-9	Pesticide?
(Z)-8-dodecen-1-yl acetate	28079-04-1	Pesticide?
1-tetradecanol	112-72-1	Monomers for manufacture of thermoplastics [ECHA 2013] - assessed as unimportant due to the chemical structure
(E)-8-dodecen-1-yl acetate	38363-29-0	Pesticide?
E/Z-8-dodecetyl acetate	38363-29-0 / 28079-04-1	Pesticide?
(E)-11-tetradecen-1-yl acetate	33189-72-9	Pesticide?
(E,E)-7,9-dodecadien-1-yl acetate	54364-63-5	Pesticide?
(Z)-7-tetradecenal	65128-96-3	Pesticide?
(Z)-9-tetradecen-1-yl acetate	16725-53-4	Pesticide?
Dodecan-1-yl acetate	112-66-3	Intermediate – no other information available
(E,Z)-2,13-octadecadien-1-yl acetate	86252-65-5	Pesticide?
(Z)-9-hexadecenal	56219-04-6	Pesticide?
Flonicamid	158062-67-0	Insecticide [Pesticides 2013]- no indication of association with plastics
Metosulam	139528-85-1	Herbicide [Pesticides 2013]- no indication of association with plastics
Triflusulfuron (ISO); 2-[4-dimethylamino-6-(2,2,2-trifluoroethoxy)-1,3,5-triazin-2-ylcarbamoylsulfamoyl]-m-toluic acid	126535-15-7	Herbicide [Pesticides 2013]- no indication of association with plastics
(Z)-8-dodecenol	40642-40-8	Pesticide?
Thixatrol Max	-	Used for paints, varnishes, and coatings [ECHA – Thixatrol 2012]
(E,E)-8,10-dodecadien-1-ol	33956-49-9	Pesticide?
Tralkoxydim	87820-88-0	Herbicide [Pesticides 2013]- no indication of association with plastics
(Z)-11-hexadecen-1-ol	56683-54-6	Moth control substance
Copper (I) oxide	1317-39-1	Not included – see Danish list of undesired substances
Copper sulphate pentahydrate	7758-98-7 (7758-99-8 and 12527-76-3)	Not included – see Danish list of undesired substances
Copper (II) hydroxide	20427-59-2	Not used in plastics
Tribasic copper Sulphate	12527-76-3	Not used in plastics
Bordeaux mixture	8011-63-0	Fungicide [Pesticides 2013]- no indication of association with plastics

Copper powder	7440-50-8	Not used in plastics
Proquinazid	189278-12-4	Fungicide [Pesticides 2013]- no indication of association with plastics
Copper Oxychloride	1332-40-7 or 1332-65-6	Not used in plastics
Dimethenamid-P	163515-14-8	Herbicide [Pesticides 2013]- no indication of association with plastics
Basic copper carbonate	12069-69-1	Not used in plastics
Copper (II) oxide	1317-38-0	Not used in plastics
Copper thiocyanate	1111-67-7	Not used in plastics
Tricalcium diphosphide	1305-99-3	Rodenticide [ECHA - Tricalcium diphosphide 2013]
Tebufenpyrad	119168-77-3	Acaricide, insecticide [Pesticides 2013]- no indication of association with plastics
Mandipropamid	374726-62-2	Fungicide [Pesticides 2013]- no indication of association with plastics
Ethephon	16672-87-0	Plant growth regulator [Pesticides 2013]- no indication of association with plastics
Tembotriione	335104-84-2	Herbicide [Pesticides 2013]- no indication of association with plastics
Spirotetramat	203313-25-1	Insecticide [Pesticides 2013]- no indication of association with plastics
Methyl 2,5-dichlorobenzoate	2905-69-3	Fungicide [PAN 2014b]
Fluazinam	79622-59-6	Fungicide [Pesticides 2013]- no indication of association with plastics
Tetrahydrofurfuryl alcohol (THFA)	97-99-4	Intermediate – plastic products [ECHA 2013] Epoxy resin and curing agent formulation [Chemicaland 21 –THFA]
Benzoic acid	65-85-0	Intermediate – production of phenol and plasticisers [SIDS 2001]
Fenpyroximate (ISO); tert-butyl 4-[(E)-(1,3-dimethyl-5-phenoxy-1H-pyrazol-4-yl)methylene]amino}oxy)methyl]benzoate	134098-61-6	Acaricide [Pesticides 2013]- no indication of association with plastics
Nonanoic acid	112-05-0	Disinfectant, preservative, repellent [ECHA – nonanoic acid 2013]
Octanoic acid	124-07-2	Insecticide, disinfectant [CLH report –Decanoic acid 2012]. Intermediate – production of amides -> polyamide [Chemicaland 21-caprylic acid] Assessed not to be present in significant concentrations in plastic end products
Decanoic acid	334-48-5	Insecticide, repellent, disinfectant [CLH report – Decanoic acid 2012]. Intermediate – production of amides -> polyamide [Chemicaland 21-capric acid] Assessed not to be present in significant concentrations in plastic end products

Etofenprox	80844-07-1	Insecticide [Pesticides 2013]- no indication of association with plastics
K-HDO	66603-10-9	Wood preservative
Cis-Tricos-9-ene (Muscalure)	27519-02-4	Insect attractants [Pesticides 2013]- no indication of association with plastics
CU-HDO (Bis(N-cyclohexyl-diazenium-dioxy)-copper)	312600-89-8	Not used in plastics
Imazalil	35554-44-0	Fungicide [Pesticides 2013]- no indication of association with plastics
Fenoxaprop-P-ethyl	71283-80-2	Herbicide [Pesticides 2013]- no indication of association with plastics
Cycloxydim	101205-02-1	Herbicide [Pesticides 2013]- no indication of association with plastics
Acrolein	107-02-8	Herbicide [Pesticides 2013]- no indication of association with plastics
Potassium sorbate	24634-61-5	Food preservative
3-Iodo-2-propynylbutylcarbamate	55406-53-6	Fungicide [Pesticides 2013]- no indication of association with plastics
Cymoxanil	57966-95-7	Fungicide [Pesticides 2013]- no indication of association with plastics
1,1',1"-nitrilotripropan-2-ol (TIPA)	122-20-3	Intermediate – manufacture of polyurethane – assessed not to be present in products of PUR
Amidosulfuron	120923-37-7	Herbicide [Pesticides 2013]- no indication of association with plastics
Fenoxy carb	72490-01-8	Insecticide [Pesticides 2013]- no indication of association with plastics
Warfarin (ISO); 4-hydroxy-3-(3-oxo-1-phenylbutyl)-2H-chromen-2-one	81-81-2	Rodenticide [Pesticides 2013]- no indication of association with plastics
Vinylcyclohexene (VCH)	100-40-3	Intermediate - no indication of association with plastics [ECHA 2013]
Brodifacoum (ISO); 4-hydroxy-3-(3-(4'-bromo-4-biphenyl)-1,2,3,4-tetrahydro-1-naphthyl)coumarin;	56073-10-0	Rodenticide [Pesticides 2013]- no indication of association with plastics
Perestane	847871-03-8	Disinfectant
Flocoumafen (ISO); reaction mass of: cis-4-hydroxy-3-(1,2,3,4-tetrahydro-3-(4-(4-trifluoromethylbenzyloxy)phenyl)-1-naphthyl)coumarin; trans-4-hydroxy-3-(1,2,3,4-tetrahydro-3-(4-(4-trifluoromethylbenzyloxy)phenyl)-1-naphthyl)coumarin	90035-08-8	Rodenticide [Pesticides 2013]- no indication of association with plastics
Difenacoum (ISO); 3-(3-biphenyl-4-yl-1,2,3,4-tetrahydro-1-naphthyl)-4-hydroxycoumarin	56073-07-5	Rodenticide [Pesticides 2013]- no indication of association with plastics
Difethialone (ISO); 3-[3-(4'-bromobiphenyl-4-yl)-1,2,3,4-tetrahydronaphthalen-1-yl]-4-hydroxy-2H-1-benzothiopyran-2-one	104653-34-1	Rodenticide [Pesticides 2013]- no indication of association with plastics
Bromadiolone (ISO); 3-[3-(4'-bromobiphenyl-4-yl)-3-hydroxy-1-phenylpropyl]-4-hydroxy-	28772-56-7	Rodenticide [Pesticides 2013]- no indication of association with plastics

2H-chromen-2-one		
Aluminium phosphide	20859-73-8	Insecticide [Pesticides 2013]- no indication of association with plastics
Trimagnesium diphosphide	12057-74-8	Insecticide [Pesticides 2013]- no indication of association with plastics
Chlorophacinone (ISO); 2-[(4-chlorophenyl)(phenyl)acetyl]-1H-indene-1,3(2H)-dione	3691-35-8	Rodenticide [Pesticides 2013]- no indication of association with plastics
N-ethyl-2-pyrrolidone (NEP) (1-ethylpyrrolidin-2-one)	2687-91-4	Solvent, catalyst and cationic surfactant. Process regulators for polymerisation processes in production of resins, rubbers, polymers [ECHA 2013; CLH report – NEP 2011] - no strong indication of association with plastics
Fenamiphos	22224-92-6	Insecticide, nematicide [Pesticides 2013]- no indication of association with plastics
Indoxacarb	173584-44-6	Insecticide [Pesticides 2013]- no indication of association with plastics
Aluminium-magnesium-zinc-carbonate-hydroxide	169314-88-9	Stabilizer in plastics (PVC) mainly moulded products.
Aclonifen	74070-46-5	Herbicide [Pesticides 2013]- no indication of association with plastics
Sulcotriione	99105-77-8	Herbicide [Pesticides 2013]- no indication of association with plastics
Penconazole	66246-88-6	Fungicide [Pesticides 2013]- no indication of association with plastics
2-Ethoxyethanol	110-80-5	Solvent for nitrocellulose, epoxy coatings, alkyd resins [Ash and Ash, 2007]
Ethylbenzene	100-41-4	Intermediate used for production of styrene -> PS, EPS, XPS, HIPS, ABS etc.
Amines, coco alkyl	61788-46-3	Intermediate – used for manufacture of amino ethoxylates that may be used as additives in plastics [EURAR – Amines 2008]
Amines, Tallow Alkyl	61790-33-8	Intermediate – used for manufacture of amino ethoxylates that may be used as additives in plastics [EURAR – Amines 2008]
Octadecylamine	124-30-1	Intermediate – used for manufacture of amino ethoxylates that may be used as additives in plastics [EURAR – Amines 2008]
Amines, hydrogenated tallow alkyl	61788-45-2	Intermediate – used for manufacture of amino ethoxylates that may be used as additives in plastics [EURAR – Amines 2008]
(Z)-octadec-9-enylamine	112-90-3	Intermediate – used for manufacture of amino ethoxylates that may be used as additives in plastics [EURAR – Amines 2008]
Reaction mass of 2,4,4-Trimethylpent-1-ene and 2,4,4-Trimethylpentene	25167-70-8	Intermediate – no indication of association with plastics

4-tert-butylbenzoic acid	98-73-7	Intermediate - assessed not to be present in significant concentrations in plastic end products
Nitrobenzene	98-95-3	Intermediate – production of aniline etc.
Metazachlor	67129-08-2	Herbicide [Pesticides 2013]- no indication of association with plastics
Leucomalachite Green	129-73-7	Natural metabolite of malachite green - used as a detection method for latent blood in forensic science
Fuberidazole	3878-19-1	Fungicide [Pesticides 2013]- no indication of association with plastics
Bifenthrin	82657-04-3	Acaricide, insecticide [Pesticides 2013]- no indication of association with plastics
Flufenoxuron	101463-69-8	Acaricide, insecticide [Pesticides 2013]- no indication of association with plastics
Acequinocyl	57960-19-7	Acaricide [Pesticides 2013]- no indication of association with plastics
MMTC (trichloride of methyltin)	993-16-8	Intermediate - catalyst used in a conversion of alcohol to ether
EHMA (methyltin tri(2-ethylhexyl-mercaptoacetate MMT)	57583-34-3	Heat stabilizer in PVC [CLH report – MMT(EHMA) 2010]
White spirit type 0, Solvent naphtha (petroleum), medium aliphatic	64742-88-7	Not included – see Danish list of undesired substances
Stoddard solvent (US term for white spirit, corresponding to white spirit type 1; see CAS-no. 64742-82-1)	8052-41-3	Not included – see Danish list of undesired substances
White spirit type 1, Naphtha (petroleum), hydrodesulphurised heavy	64742-82-1	Not included – See Stoddard solvent above
Abamectin	71751-41-2	Acaricide, insecticide, nematicide [Pesticides 2013]- no indication of association with plastics
Cryolite (Trisodium hexafluoroaluminate)	15096-52-3	Production of aluminium etc. - no indication of association with plastics
Cryolite (Trisodium hexafluoroaluminate)	13775-53-6	Production of aluminium etc. - no indication of association with plastics
Indium phosphide	22398-80-0	Semiconductor
Chloroform	67-66-3	Not included – see List of CMR-substances in toy
Tetrahydrofuran	109-99-9	THF is used as a solvent for a variety of plastics, dyes, elastomers, etc., as a glue in joining plastics components [Annex VI report-THF]
Di-tert-butylperoxide	110-05-4	Intermediate - process regulators for polymerisation processes in production of resins, rubbers, polymers [ECHA 2013]
Diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide	75980-60-8	Intermediate - process regulators for polymerisation processes in production of resins, rubbers, polymers [ECHA 2013]
Epoxyconazole	133855-98-8 (Formerly 106325-08-0)	Fungicide [Pesticides 2013]- no indication of association with plastics

Imidazolidine-2-thione; 2-imidazoline-2-thiol	96-45-7	Used for vulcanisation of rubber - not used in plastics [Annex XV - imidazolidine-2-thione]
Disodium 4-amino-3-[[4'-(2,4-diaminophenyl)azo][1,1'-biphenyl]-4-yl]azo] - 5-hydroxy-6-(phenylazo)naphthalene-2,7-disulphonate (C.I. Direct Black 38)	1937-37-7	Dye used for cotton, viscose, silk, polyamide fiber and its blending fabric, leather, wood, biological and plastic colour, also used as the raw material of black ink [Dye – Direct Black]
Disodium 3,3'-[[1,1'-biphenyl]-4,4'-diylbis(azo)]bis(4-aminonaphthalene-1-sulphonate) (C.I. Direct Red 28)	573-58-0	Dying of viscose, cotton, wool, silk cellulose fibres [Dye – Direct red]
Dipentyl phthalate (DPP)	131-18-0	Not included – see candidate list
Diethyl sulphate	64-67-5	Not included – see candidate list
Dimethyl sulphate	77-78-1	Not included – see candidate list
6-methoxy-m-toluidine (p-cresidine)	120-71-8	Not included – see candidate list
4,4'-methylenedi-o-toluidine	838-88-0	Not included – see candidate list
N-methylacetamide	79-16-3	Not included – see candidate list
1-bromopropane (n-propyl bromide)	106-94-5	Not included – see candidate list
4,4'-oxydianiline and its salts	101-80-4	Not included – see candidate list
Biphenyl-4-ylamine	92-67-1	Not included – see candidate list
Dinoseb (6-sec-butyl-2,4-dinitrophenol)	88-85-7	Not included – see candidate list
4-Aminoazobenzene	60-09-3	Not included – see candidate list
o-aminoazotoluene	97-56-3	Not included – see candidate list
Furan	110-00-9	Not included – see candidate list
3-ethyl-2-methyl-2-(3-methylbutyl)-1,3-oxazolidine	143860-04-2	Not included – see candidate list
o-Toluidine	95-53-4	Not included – see candidate list
4-methyl-m-phenylenediamine (toluene-2,4-diamine)	95-80-7	Not included - see candidate list
N-pentyl-isopentylphthalate	776297-69-9	Not included – see candidate list
Methoxyacetic acid	625-45-6	Not included – see candidate list
1,2-Benzenedicarboxylic acid, dipentylester, branched and linear	84777-06-0	Not included – see candidate list
1,2-Diethoxyethane	629-14-1	Not included – see candidate list
[4-[4,4'-bis(dimethylamino) benzhydrylidene]cyclohexa-2,5-dien-1-ylidene]dimethylammonium chloride (C.I. Basic Violet 3) [with ≥ 0.1% of Michler's ketone (EC No. 202-027-5) or Michler's base (EC No. 202-959-2)]	548-62-9	Dye in various materials inclusive of rubber and textiles - violet colours - dyes are not included
4,4'-bis(dimethylamino)-4"--(methylamino)trityl alcohol [with ≥ 0.1% of Michler's ketone (EC No. 202-027-5) or Michler's base (EC No. 202-959-2)]	561-41-1	Not included – see candidate list
α,α-Bis[4-(dimethylamino)phenyl]-4-(phenylamino)naphthalene-1-methanol (C.I. Solvent Blue 4) [with ≥ 0.1% of Michler's ketone (EC No. 202-027-5) or Michler's base (EC No. 202-	6786-83-0	Not included – see candidate list

959-2)]		
4,4'-bis(dimethylamino)benzophenone (Michler's ketone)	90-94-8	Not included – see candidate list
N,N,N',N'-tetramethyl-4,4'-methylenedianiline (Michler's base)	101-61-1	Not included – see candidate list
[4-[[4-anilino-1-naphthyl][4-(dimethylamino)phenyl]methylene]cyclohexa-2,5-dien-1-ylidene] dimethylammonium chloride (C.I. Basic Blue 26) [with ≥ 0.1% of Michler's ketone (EC No. 202-027-5) or Michler's base (EC No. 202-959-2)]	2580-56-5	Not included – see candidate list
Formamide	75-12-7	Not included – see candidate list
Diboron trioxide	1303-86-2	Not included – see candidate list
1,2-bis(2-methoxyethoxy)ethane (TEGDME; triglyme)	112-49-2	Not included – see candidate list
1,2-dimethoxyethane; ethylene glycol dimethyl ether (EGDME)	110-71-4	Not included – see candidate list
1,2-Dichloroethane	107-06-2	Not included – see candidate list
N,N-dimethylacetamide (DMAC)	127-19-5	Not included – see candidate list
Bis(2-methoxyethyl) ether	111-96-6	Not included – see candidate list
Aluminosilicate Refractory Ceramic Fibres		Not included – see candidate list
Phenolphthalein	77-09-8	Not included – see candidate list
Zirconia Aluminosilicate Refractory Ceramic Fibres...		Not included – see candidate list
2-Methoxyaniline o-Anisidin	90-04-0	Not included – see candidate list
1-Methyl-2-pyrrolidone (NMP)	872-50-4	Not included – see candidate list
Cobalt dichloride	7646-79-9	Not included – see candidate list
2-Ethoxyethyl acetate	111-15-9	Not included – see candidate list
Cobalt(II) carbonate	513-79-1	Not included – see candidate list
Cobalt(II) dinitrate	10141-05-6	Not included – see candidate list
Cobalt(II) sulphate	10124-43-3	Not included – see candidate list
Trichlorobenzene	120-82-1	Not included – see candidate list
1,3,5 Trichlorobenzene	108-70-3	Intermediate and process solvent in closed systems - in addition solvent, dye carrier, corrosion inhibitor and lubricant [Annex XV – TCB] - no indication of use related to plastics
1,2,3 Trichlorobenzene	87-61-6	Intermediate and process solvent in closed systems - in addition solvent, dye carrier, corrosion inhibitor and lubricant [Annex XV – TCB] - no indication of use related to plastics
	110-80-5	Not included – see candidate list
Tetraboron disodium heptaoxide, hydrate	12267-73-1	Not included – see candidate list
2,4-Dinitrotoluene	121-14-2	Not included – see candidate list
5-tert-butyl-2,4,6-trinitro-m-xylene (musk xylene)	81-15-2	Not included – see candidate list
Cyclododecane	294-62-2	Intermediate for production of chemicals used to make

		polyamides, polyesters, synthetic lubricating oils, nylon and high purity solvents [Annex XV – cyclodecane] - amount of potential residues in plastics assumed to be in- significant
1,4-Dichlorobenzene (p-dichlorobenzene)	106-46-7	Placing on the market of air fresheners and toilet blocks containing DCB
Dimethylfumarate	624-49-7	Placing on the market of articles containing Dimethylfumarate DMFu seems to be used for mould preservation of textiles - it has been registered in furniture foam in low concentrations probably due to contamination [Annex XV restriction report – DMFu]
Triadimenol (ISO); 1-(4-chlorophenoxy)-3,3-dimethyl-1-(1H-1,2,4-triazol-1-yl)butan-2-ol	55219-65-3	Fungicide [Pesticides 2013]- no indication of association with plastics
Terbutylazine (N2-tert-butyl-6-chloro-N4-ethyl-1,3,5-triazine-2,4-diamine)	5915-41-3	Herbicide [Pesticides 2013]- no indication of association with plastics
Spirodiclofen (ISO); 3-(2,4-dichlorophenyl)-2-oxo-1-oxaspiro[4.5]dec-3-en-4-yl 2,2-dimethylbutyrate	148477-71-8	Acaricide [Pesticides 2013]- no indication of association with plastics
Sodium hypochlorite	7681-52-9	Not included – see Danish list on undesired substances
Quizalofop-P-terfuryl; (RS)-Tetrahydrofurfuryl (R)-2-[4-(6-chloroquinoxalin-2-yloxy)phenoxy]propionate	119738-06-6	Herbicide [Pesticides 2013] - no indication of association with plastics
Pymetrozine (ISO); (E)-4,5-dihydro-6-methyl-4-(3-pyridylmethyleneamino)-1,2,4-triazin-3(2H)-one	123312-89-0	Antifeedants [Pesticides 2013] - no indication of association with plastics
Peroxyoctanoic acid	33734-57-5	Pesticide
N,N-diethyl-m-toluamide; deet	134-62-3	Insect repellent [Pesticides 2013]- no indication of association with plastics
Mixture of 5-chloro-2-methylisothiazol-3(2H)-one and 2-methylisothiazol-3(2H)-one	55965-84-9	For veterinary diagnostic use
Metofluthrin	240494-70-6	Insecticide [Pesticides 2013]- no indication of association with plastics
Margosa extract from the kernels of <i>Azadirachta indica</i> extracted with water and further processed with organic solvents	84696-25-3	Natural repellent - no indication of association with plastics
IDS, NA-SALZ	-	Sodium iminodisuccinate (IDS) belongs to the group of aminopolycarboxylate chelating agents - IDS is a medium-strong chelator that is able to replace EDTA - IDS as a substitute for EDTA is used in a variety of applications, including detergent formulations, corrosion inhibitors, production of pulp and paper, textiles, ceramics, photochemical processes, and as trace nutrient fertilizers in agriculture [Cokesa et al 2004]
Hymexazol (ISO); 3-hydroxy-5-methylisoxazole	10004-44-1	Fungicide, plant growth regulator [Pesticides 2013]- no indication of association with plastics
Dimethyl (2aR,3S,4S,4aR,5S,7aS,8S,10R,10aS,10bR)-10-acetoxy-3,5-dihydroxy-4-	11141-17-6	Insecticide [Pesticides 2013]- no indication of association with plastics

[(1aR,2S,3aS,6aS,7S,7aS)-6a-hydroxy-7a-methyl-3a,6a,7,7a-tetrahydro-2,7-methanofuro[2,3-b]oxireno[e]oxepin-1a(2H)-yl]-4-methyl-8-{{[(2E)-2-methylbut-2-enoyl]oxy}octahydro-1H-naphtho[1,8a-c:4,5-b'c']difuran-5,10a(8H)-dicarboxylate		
Cyanamide	420-04-2	Intermediate – plant growth initiator - no indication of association with plastics
Chlorsulfuron (ISO); 2-chloro-N-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]benzenesulphonamide	64902-72-3	Herbicide [Pesticides 2013]- no indication of association with plastics
Carboxin (5,6-dihydro-2-methyl-1,4-oxathiine-3-carboxanilide)	5234-68-4	Fungicide [Pesticides 2013]- no indication of association with plastics
4-Chloro-3-methylphenol	59-50-7	Disinfectant - no indication of association with plastics
2-methylisothiazol-3(2H)-one	2682-20-4	Preservative - no indication of association with plastics
Chrysotile	12001-29-5, 132207-32-0	The substance is a kind of asbestos fibres. The use is not related to plastics
Benzovindiflupyr (ISO); N-[9-(dichloromethylene)-1,2,3,4-tetrahydro-1,4-methanonaphthalen-5-yl]-3-(difluoromethyl)-1-methyl-1H-pyrazole-4-carboxamide	1072957-71-1	Fungicide [PAN 2014a]- no indication of association with plastics

CMR-substances in plastic toys

Chemical name	CAS No	Major use	Function	Occurrence
Acetamide	60-35-5	Plasticiser for wood – not relevant for plastic		
Nickel	7440-02-0	Nickel plating; for various alloys such as new silver, Chinese silver, German silver; for coins, electro-types, lightning rod tips, electrical contacts and electrodes, spark plugs, machinery parts (Merck Index)	Surface coating	Metallic micro-structured coatings
4,4'-carbonimidoylbis[N,N-dimethylaniline]	492-80-8	Dye for paper, cardboard, textiles, leather, oils, waxes, alcoholic solvents, lacquers, pen inks, carbon papers, & typewriter ribbons	Colorant	Paper Cardboard Leather Textiles Coatings
4-[4,4'-bis(dimethylamino) benzhydrylidene]cyclohexa-2,5-dien-1-ylidene]dimethylammonium chloride, C.I. Basic Violet 3	548-62-9	As a dye for wood, silk, paper; in inks; as a biological stain	Colorant	Violet coloured plastics, rubbers (2%) and textiles (6-8%) - dyes are not included
Benzyl violet 4B, α-[4-(4-dimethylamino-α-{4-[ethyl(3-sodiosulphonatobenzyl)amino]phenyl}benzylidene)cyclohexa-2,5-	1694-09-3	Dye for wool, nylon, leather, anodized aluminium, inks, & paper; biological & wood stain	Colorant	Violet coloured polymers

dienylidene(ethyl)ammonio]toluene-3-sulphonate				
2-butanon oxime	96-29-7	Viscosity regulation in paint and lacquer - liberated from neutral cure silicones during cure	Degradation product Solvent	Silicone rubber, neutral cured
Thiocarbamide, thiourea	62-56-6	Photographic toning agent, fixing agent and chemicals; Flame-retardant textile sizes; Flame-retardant finish for cotton; Imparting flame resistance and improved handling properties for nylon-based products	Chemical Intermediate for plastic and artificial silk Curing agent (Merck Index)	Rubber vulcanized with thiourea Cotton, flammare-tarded
4-aminophenol	123-30-8	Dyeing textiles, hair, furs, feathers; photographic developer	Chemical Intermediate for rubbers (Rapra Toxic prop)	
Aniline	62-53-3	Precursor to MDI used for manufacturing of PUR	Chemical Intermediate Degradation product	
Ethylen thiourea 2 imidazoline thione	96-45-7	Accelerator for CR rubber. Former the most common used accelerator for CR	Curing agent	CR rubber
Nickelsulphide	16812-54-7	Possible degradation product in rubber vulcanized with dithiocarbamin acid nickel salts	Degradation product	Rubber vulcanized with nickel dithiocarbamates
p-chloro-anilin	106-47-8		Chemical intermediate	
o-anisidin /p-anisidin	104-94-9		Chemical intermediate	
Benzene	71-43-2		Solvent	
Octamethylcyclotetrasiloxane	556-67-2	Component of silicone fluid mixtures; widespread use in a variety of applications including fermentation processes, instant coffee production, paper coatings and sizing, diet soft drinks, waste yeast tanks, food washing solutions, adhesives, textiles, deasphalting, boiler treatments, detergents, cleaning solutions, surfactants, cosmetic products, and polishes	Plasticiser Surfactant	Silicone rubber, water repellent coatings
<i>m</i> -phenylenediamine	108-45-2	Dyestuff manufacture, detection of nitrite, textile developing agent, laboratory reagent, vulcanizing agent – rubber chemicals	Vulcanisation agent, curing agent, chemical Intermediate for dyes	Paint, dyestuffs, coatings, rubbers, epoxies

1,3-diphenylguanidine	102-06-7	Vulcanization accelerator for natural and synthetic rubbers - 0.25-2.0 pphr. - non-staining	Curing agent	Rubbers
1,2,3,6-tetrahydro- <i>N</i> -(trichloromethyl-thio)phthalimide, captan (ISO)	133-06-2	Industrial uses include incorporation into lacquers, paints (oil based), paper, paste (wallpaper flour), plasticisers, polyethylene, rubber stabilizer, textiles, vinyl, and vinyl resins- - biocide in soap	Biocide	Paints, coatings Paper Rubber
1,4-dihydroxybenzene, hydroquinone, quinol	123-31-9	Used as a raw material to produce rubber antioxidants for fats & oils, polymerization inhibitor; stabilizer in paints; varnishes, motor fuels & oils; in human medicine for skin blemishes; chemical intermediate for dyes	Chemical intermediate Antioxidant	
1,2,3-trihydroxybenzene, pyrogallol	87-66-1	Developer in photography; as mordant for wool; staining leather; process engraving; manufacturing of various dyes; dyeing furs, hair	Chemical Intermediate for dyes	Wool textile Leather
Toluene	108-88-3	In manufacture benzoic acid, benzaldehyde, explosives, dyes, and many other organic compounds; as a solvent for paints, lacquers, gums, resins, in the extraction of various principles from plants; as gasoline additive; in fabric and paper coating, manufacture of artificial leather	Solvent	
Formamide	75-12-7	Degradation product from rubber accelerator	Degradation product	Vulcanized rubber
Carbon disulphide	75-15-0	Paints, rubber cement, vulcanized rubber, paper manufacture	Degradation product	Sulphur cured rubbers - especially thiuram and dithiocarbamate cured
Ethandial...%, glyoxal...%	107-22-2	In paper industry for sizing, washable wall paper, treating glue surface of envelopes; in textile industry for preventing shrinking and creasing; as substitute for formaldehyde in embalming	Biocide	Paper and carton Biocide treated textiles

		fluids		
Naphthalene	91-20-3	Used in the production of plastics and vulcanizes	Chemical intermediate	Trace pollutant in polymers
3-chloropropene, allyl chloride	107-05-1	Synthesis of intermediates for manufacture of polymers, resins & plastics	Chemical intermediate	Trace pollutant in some allyl based polymers
Acetaldehyde, ethanal	75-07-0	Mfr paraldehyde, acetic acid, butanol, perfumes, aniline dyes, plastics, synthetic rubber, silvering mirrors, hardening gelatin fibers (Merck Index)	Chemical intermediate	Trace pollutant in polymers
2-butenal, crotonaldehyde [1] (E)-2-butenal, (E)-crotonaldehyde [2]	4170-30-3 [1] 123-73-9 [2]	Minor amounts are used in the manufacture of maleic acid, crotyl alcohol, butyl chloral hydrate, and in rubber accelerators. In organic syntheses; as solvent in purification of mineral oils, manufacture of resins, rubber antioxidants, insecticides	Chemical Intermediate Solvent	Trace pollutant in polymers
2-furaldehyde	98-01-1	Source of furfuryl alcohol, tetrahydrofurfuryl alcohol, furan, tetrahydrofuran, poly(oxytetramethylene) glycol and a variety of synthetic resins; for the extractive distillation of butadiene and other C ₄ hydrocarbons for the manufacture of synthetic rubber; and for the production of light-coloured wood resins	Chemical intermediate	Trace pollutant in polymers and light coloured wood resins
1-chloro-4-nitrobenzene	100-00-5	Used in production of rubber chemicals	Chemical Intermediate	
n-hexane	110-54-3	Solvent, especially for vegetable oils; low-temperature thermometers; calibrations; polymerization reaction medium; paint diluent; alcohol denaturant	Solvent	Paints/coatings Glues

Chloroform, trichloromethane	67-66-3	As a solvent for coating compositions of urea or melamine resins and for preparations of lubricant additives and plasticisers; surface-active agents; lubricant additives, rubber chemicals, flotation agents, anti-foam agent; flavouring agent; reaction medium for hydrogen peroxide production; defoamer	Solvent	Trace pollutant in paints/coatings and glues
Carbon tetrachloride, tetrachloro-methane	56-23-5	Powerful solvent for asphalt, benzyl resin, bitumen, chlorinated rubber, ethylcellulose, gums, and rosin	Solvent	Trace pollutant in paints/coatings and glues
Chloroethane	75-00-3	Use in manufacture of dyes and drugs, use as a propellant in aerosols	Solvent	Trace pollutant in paints/coatings and glues
Pentachloroethane	76-01-7	Pentachloroethane is used as a solvent for cellulose acetate, certain cellulose ethers, resins and gums. Pentachloroethane is also used as a drying agent for timber /immersed in it/ at temperatures greater than 100 °C	Solvent	Paints/coatings /glues
1-vinyl-2-pyrrolidone	88-12-0	Solvent for resins, co-monomer for polymerization, binder in cosmetic and pharmaceutical preparations	Solvent	Trace pollutant in polymers
Tetrachloroethylene	127-18-4	Intermediate for chlorofluorocarbons, dry cleaning, degreasing etc.	Solvent	Paints, coatings, glues
2-hexanon	591-78-6			Trace amounts in rubber
2-Ethoxyethyl acetate	111-15-9	Solvent for lacquers	Solvent	Coatings
Isoprene	78-79-5	Monomer for isoprene rubber and butylrubber	Monomer	

Alternative plasticisers and flame retardants

Substance	CAS No.	Use associated with plastic
Brominated epoxy resin end-capped with tribromophenol	135229-48-0	Polymer
Brominated polyacrylate	59447-57-3	Polymer
Brominated polystyrene	88497-56-7	Polymer
TBBPA glycidyl ether, TBBPA poly-	68928-70-1	Polymer

mer		
Benzene, ethenyl-, polymer with 1,3-butadiene, brominated	1195978-93-8	EPS, XPS, polymer

Referencer til Annex 1:

Annex XV rapporter for stoffer på REACH Kandidat listen.

For alle stoffer omfattet af REACH Kandidat listen findes en Annex XV dossier/rapport. Disse rapporter er alle publiceret af ECHA og er tilgængelige på internettet. Disse rapporter er ikke medtaget i den følgende reference liste.

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Problematiske kemiske stoffer i plast

Rapporten præsenterer information om problematiske stoffer i plast herunder information om funktion og anvendelser af stofferne i plast, potentielle for migration og skæbne ved genanvendelse. Der er identificeret 132 kemiske stoffer eller stofgrupper som potentielt kan findes i plast og kan have problematiske egenskaber. For disse stoffer eller stofgrupper er der indsamlet, vurderet og præsenteret data i det omfang disse data har været tilgængelige om, stoffernes tekniske funktion, de relevante plasttyper (som stofferne anvendes i), de vigtigste varegrupper (som plasten med de pågældende stoffer anvendes i), potentielle for frigivelse fra plast (vil stoffet migre?), potentielle for at forbrugere udsættes for stoffet og stoffets skæbne ved genanvendelse.



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