Sectoral Guidance for Chemicals Management in the Chemical Industry with focus on the production of fertilisers and polymers

HAZBREF-project Activity 4.1 report

SVEN BOMARK, EMMI VÄHÄ OCH ET AL

REPORT 6953 • JUNE 2021

Sectoral Guidance for Chemicals Management in the Chemical Industry with Focus on the Production of Fertilizers and Polymers

HAZBREF-project Activity 4.1 report

Sven Bomark, Emmi Vähä, et al

SWEDISH ENVIRONMENTAL
PROTECTION AGENCY

Order
Phone: +46 (0)8-505 933 40
E-mail: natur@cm.se
Address: Arkitektkopia AB, Box 110 93, 161 11 Bromma
Internet: www.naturvardsverket.se/publikationer

The Swedish Environmental Protection Agency
Phone: + 46 (0)10-698 10 00 Fax: + 46 (0)10-698 16 00
E-mail: registrator@naturvardsverket.se
Address: Naturvårdsverket, 106 48 Stockholm, Sweden
Internet: www.naturvardsverket.se

ISBN 978-91-620- 6953-7
ISSN 0282-7298

Print: Arkitektkopia AB, Bromma 2021
Cover photo: Hans Geijer, Johnér Bildbyrå

1 Preface

This report is a product of the HAZBREF project *"Hazardous industrial chemicals in the IED BREFs"*. HAZBREF is funded by the EU Interreg Baltic Sea Region Programme and the implementation period is three years, from October 2017 until September 2020.

The overall aim of HAZBREF is to increase the knowledge base of the industrial sources and the reduction measures of hazardous chemicals. HAZBREF identify relevant chemicals used in industrial sectors, their use patterns, environmental characteristics and measures to prevent and reduce releases to the environment.

At EU level, the main instrument to control industrial releases is the Industrial Emissions Directive (IED), particularly through the publication of BAT Reference documents (BREFs) and their key chapter: the BAT conclusions. However, these BAT conclusions in most cases do not address hazardous substances in a systematic and comprehensive way. HAZBREF aims to develop a systematic approach that will help to exchange and utilize the existing information about hazardous substances between different regulatory frameworks (IED, REACH, Water Framework Directive, Marine Strategy Framework Directive, EU provisions on Circular Economy, Stockholm POPs Convention and HELCOM) in the preparation of BREFs.

When the use and risks of chemicals are better addressed in BAT Reference documents, the capacity to manage industrial chemicals will be enhanced among both authorities and operators. The information gathered in BREFs is also useful for the Baltic Marine Environment Protection Commission (HELCOM) in the development of actions to reduce the inputs of hazardous substances to the Baltic Sea. HAZBREF also promotes the circular economy by finding ways to better include circular economy aspects in BREFs.

HAZBREF outputs target both the policy and the enforcement level. On policy level the outputs will strengthen the links between different regulatory frameworks and their key players. On enforcement level at industrial installations the project will identify and test model solutions for hazardous chemical management.

The activities were carried out in four Work Packages:

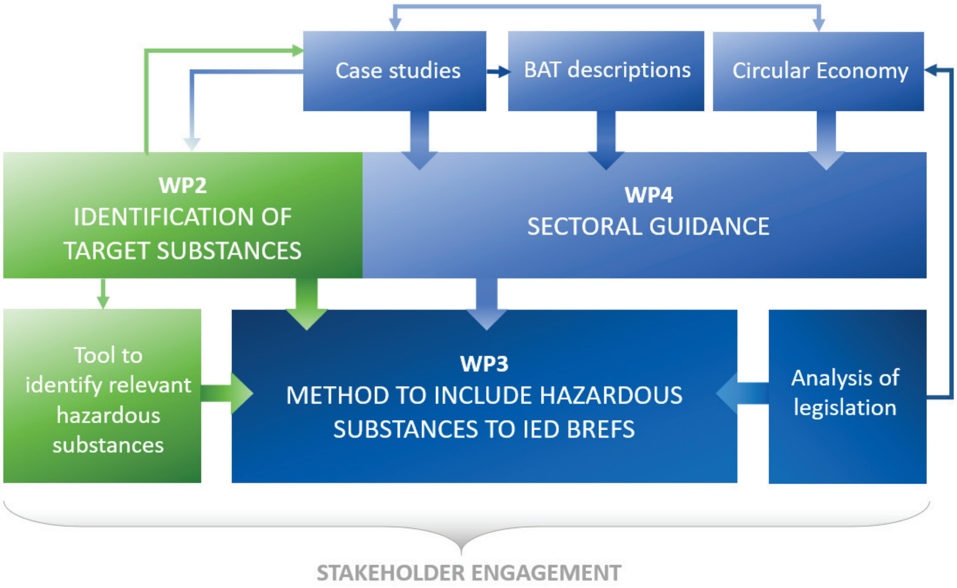
- WP1 – Project management and administration (Lead Partner SYKE) including communication and dissemination of results;
- WP2 – Identification of target substances (Lead by UBA) that include:
    - 2.1 Identification and selection of target substances
    - 2.2 Fate of substances during emission treatment;
- WP3 – Policy improvement (Lead by UBA) that include:
    - 3.1 Strengthening links between regulatory frameworks on different levels
    - 3.2 Developing a method to include substance information into BREFs, improve communication and data flow;
- WP4 – Best practices in chemicals management in industry (lead by IETU) that include:

- 4.1 Sectoral guidance for three IED sectors (chemicals, textile, surface treatment of metals and plastics)
- 4.2 Case studies in selected installations
- 4.3 BAT descriptions and model permits
- 4.4 Circular economy aspects.

The HAZBREF partnership includes 5 organizations from the Baltic Sea region: Finnish Environment Institute (SYKE) (Lead partner), German Environment Agency (UBA), Swedish Environmental Protection Agency (SWEPA), Institute for Ecology of Industrial Areas (IETU) and Estonian Environmental Research Centre (KLAB).

In addition, 27 associated organizations and a wide range of other stakeholders are involved in HAZBREF, such as ministries and governmental environmental and chemical agencies from several EU countries, permitting and supervision authorities as well as industries and environmental NGOs.
The following people and organizations have contributed in preparing this report: Sven Bomark (SWEPA), Emmi Vähä (SYKE), Kaj Forsius (SYKE), Timo Jouttijärvi (SYKE), Mariusz Kalisz (IETU), Janusz Krupanek (IETU), Karl Kupits (KLAB), Jukka Mehtonen (SYKE), Annika Månsson (SWEPA), Pia Högmander (SYKE) and Annika Johansson (SYKE). Constructive and valuable comments were received from the following stakeholders: the European Chemical Industry Council (CEFIC), the European Environment Bureau (EEB), the European IPPC Bureau (EIPPCB), the Health Board in Estonia and Käppalaförbundet in Sweden. In preparation of the report two consulting companies contributed with their knowledge and expertise regarding the chemical sector and chemical management: Adelphi and SWECO.

More information about HAZBREF can be found on our project website (www.syke.fi/projects/hazbref).



Overview of the design of the HAZBREF-project with its four work packages.

The report is a product of the HAZBREF project *"Hazardous industrial chemicals in the IED BREFs"*. The authors assume sole responsibility for the content of this report.

Stockholm June 2021

Maria Ohlman
Head of Department

Sustainable Development Department

Contents

List of tables

List of figures

Sammanfattning

Denna vägledningsrapport har tagits fram inom aktivitet 4.1 i arbetspaket 4 ”Bästa praxis för kemikaliehantering i branschen” i HAZBREF-projektet. Rapporten behandlar den kemiska industrin och dess två delsektorer: produktion av oorganiska högvolymkemikalier (med fokus på produktion av gödselmedel) och polymerer. Textilindustrin och ytbehandling av metaller och plast behandlas i separata rapporter.

Mål, intresseområden, metodik och struktur

Denna sektorsspecifika rapport ger vägledning till nyckelaktörer på nationell nivå (kemiska industrier och behöriga myndigheter) om hur man kan förbättra kemikaliehanteringen på anläggningsnivå. I detta avseende hänvisas till relevanta krav, såsom industriutsläppsdirektivet (IED) och referensdokumenten för bästa tillgängliga teknik (BREF). De resultat som redovisas i vägledningen, särskilt beträffande BAT-kandidater i kapitel 5, kommer också att ingå i kommande revision av BREF-dokument för kemisk industri (LVIC och eventuellt andra). De används vidare för HELCOM-rekommendationer om hur man kan minska utsläppen av farliga ämnen i Östersjön.

Rapporten sammanfattar viktiga resultat från intervjuer och diskussioner med HAZBREF-experter, representanter från kemisk industri och relevanta myndigheter samt från genomförda fallstudier i Finland, Estland och Sverige. Även två polymerverksamheter i Polen har analyserats med avseende på cirkulär ekonomi.

Rapporten fokuserar på tillämpningar och utmaningar relaterade till IED-tillståndsprocessen, och speciellt på användningen av farliga kemikalier i polymer- och gödselmedeltillverkning. Rapporten återspeglar också slutsatserna från andra arbetspaket i HAZBREF-projektet och hänvisar till rekommendationer som publicerats av Europeiska unionens nätverk för genomförande och efterlevnad av miljölagstiftningen (IMPEL).

Det första kapitlet i rapporten ger en kort introduktion av tillämpningsområdet.

Det andra kapitlet ger en introduktion till den kemiska sektorn med fokus på Europa och produktion av gödselmedel och polymerer.

Det tredje kapitlet beskriver relevanta farliga kemikalier relaterade till produktion av gödselmedel och polymerer, regelverk för de farliga kemikalierna och både reglerande och icke-reglerande kemiska referenslistor. Kapitlet beskriver också hur identifiering av relevanta ämnen i polymer- och gödselmedelsindustrin kan göras.

Det fjärde kapitlet beskriver krav enligt IED, REACH, CLP, WFD och annan relevant lagstiftning samt rekommendationer från HELCOM. Det innehåller också information om användning och framtagande av säkerhetsdatablad och exponeringsscenarier. Vidare beskrivs hur kemikalieinventeringar kan utvecklas och hur substansflödesanalys och materialflödesanalys kan användas. Den

innehåller också en kort beskrivning av hur man använder ett interaktivt verktyg, utvecklat i HAZBREF, för identifiering av relevanta farliga ämnen.

Bästa praxis för kemikaliehantering samt identifiering av BAT-kandidater beskrivs i det femte kapitlet. Kapitlet innehåller också vägledning om kemikaliehanterings-system, kemikalie- och råvaruinventeringar, lagring och transport av kemikalier, optimering av processintegrerad återvinning, substitution, processkartläggning av farliga ämnen, hantering av farligt avfall och avloppsvattenbehandling. Kapitlet innehåller både allmänt tillämplig praxis och rekommendationer om BAT-kandidater. De flesta av BAT-kandidaterna är allmänt tillämpliga. Alla BAT-kandidater beskrivs i detalj i bilaga 1.

Det sjätte kapitlet förklarar de olika stegen i tillståndsförfarandet enligt IED och ger vägledning, goda exempel och rekommendationer till både verksamhetsutövare och tillståndsmyndigheter om hur man utför respektive steg med särskilt fokus på bra kemikaliehantering. Frågor om cirkulär ekonomi inom polymersektorn och resultat från fallstudier beskrivs i det sjunde kapitlet.

Huvudsakliga resultat och förslag

Kemisk industri omfattar många olika typer av processer och verksamheter. Det finns många lagar som gäller för verksamheterna, och detta leder till utmaningar i kemikaliehantering för både operatörer och myndigheter. Kraven från myndigheter är lagbaserade men ofta har företagen egna program och regler som är strängare än kraven enligt gällande lag. Myndigheterna behöver mycket information om kemikaliefrågor, men denna information är inte alltid lättillgänglig.

Förslag till förbättring av kemikaliehanteringssystem

Ett kemikaliehanteringssystem ger ett systematiskt sätt att hantera kemikalier och kan integreras med miljöledningssystemet. Syftet är att ha kontroll på kemikalier och farliga ämnen inom verksamheten, öka kunskapen om kemikaliernas egenskaper, risker och påverkan samt att minska utsläppen av farliga ämnen. HAZBREF-projektet rekommenderar användning av ett kemikaliehanterings-system uppbyggt enligt de principer som beskrivs som BAT-kandidat 1 i bilaga 1. HAZBREF rekommenderar också att krav på att upprätta och underhålla ett kemikaliehanteringssystem förs in som ett krav i de reviderade BREF-dokumenten.

Förslag till utveckling av kemikalieinventeringar och databaser

För att veta vilka farliga ämnen som används eller uppkommer i verksamheten krävs en kemikalieinventering. Det är viktigt att lista alla typer av kemikalier och råvaror som används i verksamheten i en databas. Kemikalielistan eller databasen är en viktig del av kemikaliehanteringen och möjliggör systematisk riskbedömning, hantering av kemikalieflöden och kemikalielagring. Det är också användbart i tillståndsprocesserna eftersom det ger enkel åtkomst till data för de kemikalier som används i verksamheterna. Informationen i kemikalielistan/databasen måste vara sökbar och listan bör uppdateras regelbundet. Merparten av den information som behövs finns i säkerhetsdatabladen. Om viss information saknas i säkerhetsdata-bladet bör leverantören uppmanas att lämna denna. HAZBREF-projektet rekommenderar framtagande och användning av en kemikalie- och råvaruinventering enligt principerna som beskrivs som BAT-kandidat 2 i bilaga 1. HAZBREF rekommenderar också att framtagande och användning av kemikalie- och råvaruinventeringar förs in som krav i de reviderade BREF-dokumenten.

Förslag rörande kvalitet och användning av säkerhetsdatablad

För att möjliggöra effektiv kemikaliehantering måste det säkerställas att alla säkerhetsdatablad håller en god kvalitetsnivå. Om en kemikalieleverantör inte tillhandahåller säkerhetsdatablad av god kvalitet, är det både operatörens och den behöriga myndighetens skyldighet att kräva den saknade informationen från kemikalieleverantören. Bättre säkerhetsdatablad, inklusive förbättrad data om risker för miljön, och exponeringsscenarier skulle göra riskbedömning av enskilda kemikalier i specifika processer enklare för verksamheterna. Detta skulle leda till effektivare övervakning och bidra till att fokusera på de mest problematiska ämnena. Säkerhetsdatablad för råvaror bör innehålla mer information om ingående föroreningar. Kemikalieinventeringen skulle också kunna förbättras om detaljerade data om föroreningar eller avsiktligt tillsatta beståndsdelar skulle finnas tillgängliga i säkerhetsdatabladen. Exponeringsscenarier är vanligtvis inte direkt användbara för operatörerna. Sektorsspecifika miljöutsläppskategorier (SPERC), baserade på mätningar och information om ämnens karakteristik och typiska rörelsemönster på anläggningen kan hjälpa, men de har ännu inte utvecklats för många industriella användningar.

Förslag till processkartläggning av farliga ämnen

För att kunna vidta åtgärder för att minska utsläppen av farliga ämnen behövs god kunskap om produktionsprocesserna. Ett sätt att få det är att göra processkartläggningar av farliga ämnen. Syftet med metoden är att identifiera ämnets massflöde och läckagevägar. Syftet är också att optimera övervakningen och identifiera kostnadseffektiva sätt att minska utsläppen. Processkartläggningen är ett verktyg som stöder kemikalieinventeringen. HAZBREF-projektet rekommenderar kartläggning av farliga ämnen enligt principerna som beskrivs som BAT-kandidat 3 i bilaga 1.

Förslag till substitution

Substitution är en viktig åtgärd för att minimera kemiska risker vid verksamheten. Ett framgångsrikt substitutionsarbete kan utföras i fyra steg; Identifiering av farliga ämnen - Screening efter möjliga alternativ - Utvärdering och val av alternativ och Utveckling av nya alternativ. Substitution som senare kan komma att ångras bör undvikas.

Förslag till förbättring av tillståndsprocessen

Tillståndsprocessen bör effektiviseras genom mer kommunikation under ansökningsfasen mellan den sökande och tillståndsmyndigheterna och även med reningsverkets operatörer vid indirekta utsläpp. Mer samarbete mellan kemikalie-, miljö- och arbetsmiljömyndigheter föreslås för att uppnå ett smidigt informationsflöde och minska dubbelarbete. Mer utbyte av information och goda erfarenheter mellan medlemsstaterna skulle på sikt också bidra till mer harmoniserad och bättre praxis på europeisk nivå. Hur en kemikalieinventering ska vara utformad bör standardiseras. En lämplig metod ges i bilaga 5. Det är operatörens skyldighet att tillhandahålla information så att den lätt kan bedömas och att slutsatser i form av tillståndskrav och villkor lättare kan dras.

Summary

This guidance report is a product of activity 4.1 under work package 4 "Best practices in chemicals management in the industry" of the HAZBREF-project. This report addresses the chemical industry and its two sub-sectors: manufacture of large volume inorganic chemicals (with the focus on production of fertilizers) and polymers. The other case sectors are textile industry and surface treatment of metals and plastics which are addressed in separate reports.

Aims, areas of interest, methodology and structure

This sector-specific report provides guidance to key actors at national level (chemical industries and competent authorities) on how to improve chemical management at installation level. In this respect, it takes reference to relevant requirements such as the Industrial Emission Directive (IED) and the sectoral Best Available Techniques Reference Documents (BREFs). The findings of the guidance, especially concerning BAT candidates in chapter 5, will also feed into the anticipated forthcoming revision of the BREFs for the Chemical industry sectors (LVIC and possibly others). They are further used for HELCOM recommendations on how to reduce the discharge of hazardous substances into the Baltic Sea.

The document summarises key findings of interviews and discussions with HAZBREF experts, representatives from chemical industry and relevant authorities as well as insights from case studies in Finland, Estonia and Sweden. In addition to that two polymer installations in Poland were selected for analysing circular economy issues.

The report focuses on prevalent practices and challenges related to the IED permitting process, with special reference to hazardous chemicals for polymer and fertilizer installations. The report also reflects findings of other Work packages under HAZBREF and refers to recommendations published under the European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL).

The first chapter of the report provides a short introduction to the scope of this report.

The second chapter provides an introduction to the chemical sector, focusing on Europe and the production of fertilizers and polymers.

The third chapter describes relevant hazardous chemicals related to the production of fertilizers and polymers, regulatory framework for the hazardous chemicals and both regulatory and non-regulatory chemical reference lists. The section also describes how identification of relevant substances in the polymer and fertilizer industry can be done.

The fourth chapter describes legal obligations laid down in IED, REACH, CLP, WFD and other relevant legislation as well as recommendations from HELCOM. It

also contains information about using and producing safety data sheets and exposure scenarios. Furthermore, it describes how chemical inventories can be developed and how substance flow analysis (SFA) and material flow analysis (MFA) can be used. It also contains a short description of how to use an interactive scheme, developed in HAZBREF, for the identification of relevant hazardous substances.

Best practice in chemical management and identification of BAT candidates are described in the fifth section. The section also contains guidance on chemical management system (CMS), chemical and raw material inventories, chemical storage and transportation, optimization of process integrated recycling, substitution, process mapping of hazardous substances, management of hazardous waste and waste water treatment. The section contains both generally applicable practices and recommendations on BAT candidates. Most of the BAT candidates are applicable to all installations. All the BAT candidates are described in detail in Annex 1.

The sixth section explains the different steps of the IED permitting procedure and provides guidance and good practices and recommendations to both operators and permitting authorities on how to carry out the respective steps with particularly focusing on good chemicals management.

Circular economy issues in the polymer sector and findings from the case studies are described in the seventh section.

Main findings and proposals

Chemical industry covers many types of different processes and installations. There are many laws regarding the installation, and this leads to challenges in chemical management for both operators and authorities. The requirements from authorities are based on law but often the companies have their own programs and rules which are stricter than the requirements based on current law. The authorities need a lot of knowledge on chemical issues, but this information is not always readily available.

Proposal for improvement of chemical management system

A Chemical Management System (CMS) provides a systematic way of managing chemicals. The CMS can be integrated with the Environmental Management System (EMS). The purpose of the CMS is to control the chemicals and hazardous substances at the site, increase knowledge of the characteristics, risks and impact and improve the processes to reduce emissions of hazardous substances.

The HAZBREF project recommends the use of a CMS following the principles described as BAT candidate 1 in Annex 1. HAZBREF also recommends that a requirement to establish and maintain a CMS at installations is included to the revised BREFs.

Proposal for development of inventories and databases

In order to know which hazardous substances are used or generated at the site, a chemical inventory is needed. It is important to list all types of chemicals and raw materials used in all processes and activities at the site in a database. The chemical list or database is a key part of chemical management allowing for systematic risk assessment, management of chemicals flows and their storage. It is also useful in the permitting processes as it provides easy access to data for chemicals used in the installations.

The information in the chemical list/database must be searchable and the list should be updated regularly. Most of the information needed is available in the safety data sheets (SDS). If some information is missing from the SDS, the supplier should be asked to provide this.

The HAZBREF project recommends the development and use of a chemical and raw material inventory following the principles described as BAT candidate 2 in Annex 1. HAZBREF also recommends that such a requirement to perform inventories at installations is included to the revised BREFs.

Proposal for quality and use of safety data sheets

To allow for efficient chemicals management, it must be assured that all SDS keep a good quality level. If a chemical supplier fails to provide SDS with good quality, it is the duty of both the operator and the competent authority to demand the missing information from the chemical supplier.

Better SDSs, including improved data on environmental hazards, and exposure scenarios would make risk assessment of individual chemicals in specific process easier for the installations. This would lead to more efficient monitoring and help to focus more on most the problematic substances. The SDSs of raw materials should contain more information on impurities. Also, the chemical inventory could be improved if detailed data about the impurities or intentionally added constituents would be available in SDS.

Exposure Scenarios are not usually directly usable for the operators. Sector specific environmental release categories (SPERCs), based on measurements and info about the typical environmental fate of substances in the sites could help but they have not yet been developed for many industrial uses.

Proposal for process mapping of hazardous substances

In order to be able to take measures to reduce emissions of hazardous substances, good knowledge of the production processes is needed. One way to do this is to use process mapping of hazardous substances. The purpose of the method is to identify the mass flows and release routes of the substances. The purpose is also to optimise monitoring and identify cost efficient ways to reduce emissions. The process mapping is a tool which supports the chemical inventory.

The HAZBREF project recommends mapping of hazardous substances following the principles described as BAT candidate 3 in Annex 1.

Proposal for substitution

Substitution is an important measure to minimise chemical risks at the installation. A successful substitution work can be performed in four stages; Identification of hazardous substances - Screening for possible alternatives - Evaluation and choice of alternatives and Development of new alternatives. Regrettable substitution should be avoided.

Proposal for the permitting process

The permit process should be streamlined with more communication during the application phase between the applicant and permitting authorities and communication with WWTP operators should be ensured in case of indirect emissions. More co-operation between chemical, environmental and occupational health authorities is suggested to achieve smooth information flow and reduce double work. More exchange of information and good experiences between Member States would in the long run also contribute to more harmonised and better practices on European level.

The format for a chemical inventory should be standardised. An appropriate approach is given in Annex 5. It is the duty of the operator to provide information in a way that it can be quickly assessed and that conclusions in the form of permit requirements, stipulations and conditions can be more easily drawn.

1. Introduction

The main instrument on EU level to control industrial releases is the Industrial Emissions Directive (IED), particularly through the publication of BAT reference documents (BREFs) and related BAT conclusions for industrial sectors.

Environmental permitting is based on the BREFs. Currently the BREFs do not address all relevant hazardous substances which has led to a situation where some hazardous substances are missing from the environmental permits. If the substances are not addressed in the permits the control of their releases might be insufficient which might lead to situations where the effects in the environment are unknown.

Due to the wide range of products the chemical sector in Europe is wide and covers multiple processes. HAZBREF project focuses on the two sub sectors of the chemical industry: fertilizers and polymers. The sub sectors were chosen due to use of chemicals and the upcoming LVIC BREF review.

The lack of knowledge on the use and flow of specific hazardous chemicals in the industrial processes makes chemical control and reduction measures difficult. The problem is that neither the installations themselves nor the authorities always know which substances are relevant to handle and through which handling measures. This sectoral guidance contains e.g. information on uses of hazardous chemicals, the best practices in chemical management and recommendations on enhancing the permitting process in CHEM sector.

Production of inorganic fertilizers is in the scope of The Large Volume Inorganic Chemicals - Ammonia, Acids and Fertilizers (LVIC-AAF) BREF document, which was published in 2007. The BREF document also covers production of ammonia, hydrogen fluoride, hydrofluoric acid, phosphoric acid, nitric acid, sulphuric acid, oleum and phosphorus-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers). The BREF review is expected to start in 2021-2022.

Production of polymers is covered by many BREFs. The Polymer BREF (European IPPC Bureau 2007) is not a binding document but can be used as an informative guiding document and has still valid BATs for polymer production. Polymer production processes will also be covered by the WGC BREF (Common Waste Gas Treatment in the Chemical Sector), which is currently under preparation. The LVOC BREF covers production of Large Volume Organic Chemicals and is partly also relevant for polymer production.

This document sums up the findings from HAZBREF project and is based on case studies, interviews with authorities, expert judgement and input from stakeholders. The aim is to describe good practices in chemical management to be utilized by installations as well as environmental and chemical authorities. The findings of the guidance will feed into in the forthcoming revision of the LVIC BREF. They are also to be used for HELCOM recommendations on how to reduce the discharge of hazardous substances into the Baltic Sea.

2. Sector Overview

The chemical industry is one of Europe's largest manufacturing sectors and it is crucially for other sectors as more than half of EU's chemicals sold to downstream users go to other industrial sectors[1]. The main challenges described by the European Commission (EC) are access to raw materials and energy, coordination between policies and regulatory environment.

The European Chemical Industry Council (CEFIC) has described the European chemical industry in the report "2020 – Facts & Figures of the European chemical industry". Europe is the second largest chemicals producer in the world after China, and USA is the third largest producer. EU chemical sales in 2018 were EUR 565 billion divided into specialty chemicals (paints and inks, crop protection, dyes and pigments) 27%, petrochemicals 25%, polymers (plastics, synthetic rubber and man-made fibres) 21%, basic inorganic chemicals (other inorganics, industrial gases and fertilizers) 14%, consumer chemicals 12% and auxiliaries for industry 1%, More than half of the EU's chemicals are supplied to the industry. The largest chemicals producers (based on chemical sales in 2018) in Europe are Germany 32%, France 13% and Italy 9%.

There are 28 000 companies operating in the chemical sector in EU (CEFIC 2019).[2] Most of the installations are SMEs and below the threshold of Industrial Emissions Directive (IED). Chapter 4 of the European Pollutant Release and Transfer Register (all E-PRTR reporting states) lists 2 935 IED facilities registered in the chemical industry sector for 2017. The amount of IED installations specifically registered under polymers is approximately 400 and fertilizers approximately 100. According to E-PRTR and country specific information (Finland, Poland, Sweden, Estonia and Germany) the amount of IED installations (polymer and fertilizer specific) located in the Baltic Sea catchment area is 71, from which 41 are in the field of polymers and 30 in fertilizers (Table 1).

Table 1. Country specific number of fertilizer and polymer installations in the Baltic Sea catchment area. The number refers only to installations in the catchment area and not to the whole number of installations in the given country.

Number of Installations	Czech Republic	Estonia	Finland	Germany	Lithuania	Poland	Russia	Sweden	Denmark Latvia, Slovakia Norway Belarus, Ukraine
Fertilizer	0	1	2	1	2	21	1	2	Unknown/none
Polymer	3	1	14	3	0	8	Unknown /none	12	Unknown/none

[1] https://ec.europa.eu/growth/sectors/chemicals/

2 https://cefic.org/app/uploads/2019/01/The-European-Chemical-Industry-Facts-And-Figures-2020.pdf

The Baltic Sea catchment area extends to 14 countries, but while Estonia, Finland, Latvia, Lithuania, Poland and Sweden are almost entirely within the catchment, only less than half of Denmark, one eight of Germany and small fractions of Russia, Belarus, Norway, Ukraine, Czech Republic and Slovakia are situated within the catchment. Russia is an important global player in the chemical sector with approximately EUR 42 billion (3.5 trillion rubles) production in 2018.[3] The chemical companies in Russia are today mainly located outside the Baltic Sea catchment area[4], with at least one exception (EuroChem Phosphorit). There are plans to build more chemical installations in Kaliningrad.[5]

2.1. Fertilizers

The production of fertilizers is covered by IED, Annex 1, 4.3. Production of phosphorous-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers).

The Large Volume Inorganic Chemicals - Ammonia, Acids and Fertilizers (LVIC-AAF) BREF document was published in 2007[6]. The BREF document covers production of ammonia, hydrogen fluoride, hydrofluoric acid, phosphoric acid, nitric acid, sulphuric acid, oleum and phosphorus-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers). The LVIC BREF review is expected to start in 2021–2022.

The environmental issues are described in the LVIC-AAF BREF as that fertilizer production currently accounts for about 2–3 % of the total global energy consumption. The main pollutants emitted to air are NO_x, SO_2, HF, NH_3 and dust, which are, depending on the source, are emitted at high volumes. In the production of HNO_3, considerable amounts of the greenhouse gas N_2O are generated. Some by-products, e.g. phosphogypsum, are generated in high volumes. According to LVIC-AAF BREF these by-products show potential for valorisation, but transport costs, contamination with impurities and the competition with, e.g. natural resources, restrict the successful marketing. Hence, excess volumes require disposal. The possible contamination of phosphogypsum depends on the raw materials used and thereby contaminants do not always pose problems. According to the HAZBREF case studies, uncontaminated phosphogypsum could be used in many applications, also but in addition to aforementioned reasons product regulations may also hinder the use of uncontaminated by-product phosphogypsum.

---

[3] The Russian Chemists Union.

[4] http://vestkhimprom.ru/posts/khimicheskij-kompleks-segodnya

[5] The Russian Chemists Union.

[6] https://eippcb.jrc.ec.europa.eu/reference/large-volume-inorganic-chemicals-ammonia-acids-and-fertilizers

There are more than 120 manufacturers of fertilizers in Europe[7]. The European Fertilizer Product Regulation ((EU) 2019/1009) has been newly updated. The new legislation does not only set conditions on the end product (e.g. allowed levels of contaminants) but also on the raw materials used in manufacturing.

The HAZBREF fertilizer case study company is an international company with more than 20 production sites around the world. For the HAZBREF project two sites in Finland were selected as case studies.

2.2. Polymers

Production of polymers is covered by IED, Annex 1, 4.1.(h) Production of organic chemicals such as plastic materials (polymers, synthetic fibres and cellulose-based fibres).

The key environmental issues of the polymer sector are described in the Polymer BREF as emissions of volatile organic compounds, in some cases waste waters with the potential for high loads of organic compounds, relatively large quantities of spent solvents and non-recyclable waste as well as the energy demand.

The Polymer BREF (European IPPC Bureau 2007)[8] is not a binding document but can be used as an informative guiding document and has still valid BATs for polymer production. Polymer production processes will also be covered by the WGC BREF (Common Waste Gas Treatment in the Chemical Sector), which is currently under preparation[9]. The LVOC BREF covers production of Large Volume Organic Chemicals and is also partly relevant for polymer production.

Polymer additives can contain different sorts of hazardous substances and have therefore been under scrutiny recently[10]. Plastics have been under international interest due to environmental problems caused by plastics and microplastics. Polymer industry has great potential to utilise recycled plastic as raw material but there are still many issues to be solved. For these reasons HAZBREF chose polymer subsector as a case sector.

There are close to 60 000 companies operating in plastic industry in Europe. Most of them are small and medium-sized enterprises[11]. Around 45 companies in EU-15 produce the large volume thermoplastic materials which are sold to around 30 000 SMEs which process the polymers into products for end-use[12]. The world production of plastics was 348 million tons in 2017, with a European share of 64.4 million tons. The share of polyethylene in polymer demand was 18 % for low

[7] Fertilizers Europe Annual Overview 2018-2019

[8] https://eippcb.jrc.ec.europa.eu/reference/production-polymers

[9] https://eippcb.jrc.ec.europa.eu/reference/common-waste-gas-treatment-chemical-sector

[10] https://echa.europa.eu/fi/-/high-volume-plastic-additives-mapped

[11] Plastics Europe. Plastics - the Facts 2018. https://www.plasticseurope.org/en/resources/publications/619-plastics-facts-2018

[12] Polymer BREF 2007

density and linear low-density polyethylene (PE-LD and PE-LLD) and 12 % for high density and medium density polyethylene (PE-HD and PE-MD).

HAZBREF case study installations in chemical sector

Fertilizers

One international fertilizer company participated in the HAZBREF project. Two sites in Finland were chosen as case studies.

The two selected IED installations have the following production:

1. Production of phosphoric acid, sulphuric acid, nitric acid, NPK fertilizers and technical ammonium nitrate.
2. Production of nitric acid and NPK fertilizers.

Polymers

Three polymer producers in Estonia, Finland and Sweden were selected as case studies.

The three selected IED installations have the following production:

1. Two kinds of alkyd binders used for production of lacquers and paints – organic solvent (thinner) based and water based. Thinner based binders are usually alkyd resins, and water-based binders alkyd emulsions.
2. Petrochemicals (e.g. phenols, aromatics and acetone), polyethylene and polypropylene. Beside polymers, the company manufacturers fertilizers and has several production units around the world.
3. Water-soluble cellulose derivative, i.e. ethyl hydroxyl ethyl cellulose (EHEC), methyl ethyl hydroxy cellulose (MEHEC) and hydrophobically modified cellulose derivates. The products are mainly used in water-based paints and in various types of construction products.

In addition to the three installations above two polymer installations in Poland were selected for analysing circular economy issues.

3. Relevant hazardous substances

The chemical industry not only uses but also produces chemicals. This means that the installations must be well aware of the chemical legislation and its demands. Many different chemicals are used and produced in the chemical industry as a whole. In this report we are focusing on the production of polymers and fertilizers.

Chemicals used for production of different types of polymers are for example surfactants, solvents, emulsifiers, catalysts, modifiers, antioxidants, protective colloids, polymerisation initiators, inhibitors, product stabilisers and extender oils. Some of these contain hazardous substances. In the polymer case studies hazardous substances were found from e.g. catalysts, adsorbents and maintenance chemicals.

Since fertilizer products are added to the fields, they can’t contain toxic, bioavailable substances in concentrations which might cause adverse effects in the environment or indirectly to human being. But on the other hand, some essential plant nutrients, such as selenium and copper, are toxic in high concentrations. In the manufacture of fertilizers, hazardous chemicals are used e.g. as plant micronutrients (copper, zinc, selenium, manganese and boron).

Key references of regulatory frameworks for identification of hazardous substances are provided in the table 2 below. More detailed information on chemical reference list are described in chapter 3.1.

Table 2. Hazardous Substances according to regulatory framework

Hazardous Substances according to regulatory framework
• Hazardous substances referred to in CLP Regulation (1272/2008) including substances listed in Annex VI, substances meeting the criteria to be included in Annex VI, and those presenting other hazards. Thus, hazardous substances both self-classified by the manufacturer or already classified according to the harmonized classification system are meant; • Hazardous substances referred to in the Chemical Agents at Work Directive (98/24/EC) Art. 2 (b); • Substances subject to Authorization in Annex XIV of REACH (authorization list); • Restricted substances in Annex XVII of REACH; • (very) persistent, (very) bioaccumulative and/or toxic – PBT/vPvB - substances[13]; • CMR1a and CMR1b substances (for C and M classes: Directive 2004/37/EC); • Endocrine disruptors;

[13] https://echa.europa.eu/pbt

- Substances of Very High Concern (SVHC; REACH Art. 57), such as BPA, Nonylphenols and Cobalt Sulphate;
- WFD (2000/60/EC) Annex X priority substances, such as cadmium, lead, nickel and its compounds;
- Substances covered by the Stockholm Convention on Persistent Organic Pollutants, such as PFOS, PFOA, SCCPs and DecaBDE;
- Biocides regulation (528/2012);
- Dangerous substances according to Annex I of the Seveso Directive (2012/18) and
- Persistent, mobile and toxic substances – PMT.

3.1. Regulatory chemical reference lists

ECHA chemical database

ECHA maintains one of the world's largest regulatory databases on chemicals[14]. The database provides users access to information on over 22 600 chemical substances on the EU market through three layers: (i) infocard, (ii) brief profile and (iii) source data. The infocard provides the 'first tier', the most basic and relevant information (about the substance, properties of concern, how to use it safely etc.). For more detailed information one can navigate to the 'second tier' – the Brief Profile – (substance identity, classification and labelling, hazardous effects, regulatory activities, Authorization List, Restriction List, together with generalized information on uses of substance). From the Brief Profile, users can access the 'third tier', the source information compiled from the registration dossier of the substance (registrants/suppliers, physical/chemical properties, environmental fate and pathways, toxicological and ecotoxicological information) on which the summaries of the infocard and Brief Profile are based.

However, it must be said that the level of detail and quality of data might vary considerably between the different chemical datasets.

Complementing the database of registered chemicals, ECHA further provides an inventory of classification and labelling information on notified and registered substances received from manufacturers and importers. Most of the substances have undergone a so-called self-classification process carried out by the companies. The respective rules for this process are provided within the CLP Legislation. Experience shows that this process results in a wide range of different self-classifications for the same substance.

[14] https://echa.europa.eu/de/advanced-search-for-chemicals?p_p_id=dissadvancedsearch_WAR_disssearchportlet&p_p_lifecycle=0&p_p_col_id=column-1&p_p_col_count=1

REACH Candidate List of Substances of Very High Concern (SVHC) for Authorization

Candidate list of Substances of Very High Concern recommended for authorization. This list is updated twice per year by ECHA, with the first substances listed on 28th of October 2008. Companies may have immediate legal obligations following the inclusion of a substance in the candidate list on the ECHA website including in particular Articles 7, 31 and 33 of the REACH Regulation. EU and EEA suppliers of substances on the candidate list (supplied either on their own or as constituent in mixtures) have to provide their customers a safety data sheet that includes instructions for safe use of the substance. Section 15 of pre-existing safety data sheets should be updated to reflect the identification of the substance as an SVHC (Article 31(9)(a)).

For example, boric acid and disodium tetraborate are identified as Substances of Very High Concern due to the concerns related to human health (toxic for reproduction)[15]. Boron is added to fertilizer products because it is an essential plant nutrient. Many phthalates, which have been used in manufacture of polymers, have been included to Candidate list.

REACH Authorization List

The substances on the list are subject to authorization under REACH and are selected from the REACH SVHC list. These substances cannot be placed on the market or used after a given date ("sunset date"), unless an authorization is granted for their specific use, or the use is exempted from authorization.

Substances restricted under REACH

Annex XVII to REACH includes all the restrictions adopted in the framework of REACH and the previous legislation, Directive 76/769/EEC. Each entry shows a substance, a group of substances or a substance in a mixture, and the consequent restriction conditions. The list is not sector-specific, and it is regularly updated so that operators are obliged to keep themselves constantly informed. For example, the use of many phthalates has been restricted.

List of substances under Annex VI in Regulation for Classification, Labelling and Packaging

Hazardous substances referred to in CLP Regulation (1272/2008) includes substances listed in Annex VI, substances meeting the criteria to be included in Annex VI, and those presenting other hazards. Under the CLP Regulation (1272/2008) manufacturers, importers or downstream users of chemical substances must (self)classify and label hazardous substances and mixtures to ensure a high level of protection of human health and the environment. For hazards of highest concern (carcinogenicity, mutagenicity, reproductive toxicity (CMR) and respiratory sensitizers) and for other substances on a case-by-case basis,

[15] https://echa.europa.eu/fi/substance-information/-/substanceinfo/100.030.114 And https://echa.europa.eu/fi/substance-information/-/substanceinfo/100.014.129

classification and labelling is harmonised throughout the EU to ensure an adequate risk management. This is done through harmonised classification and labelling (CLH). Hazardous substances for which harmonised classification and labelling has been established at EU level are listed in Part 3 of Annex VI to the CLP Regulation.

List of pollutants under Annex II of the IED

A short list of the most relevant polluting substances as defined under the IED. Many of the listed pollutants are covered by sum parameters (e.g. PAHs, VOCs, AOX, COD) covering a wide range of substances.

Priority substances under the Water Framework Directive

In 2018, Directive 2013/39/EU listed 45 substances (or substance groups) to WFD Annex X (Annex of EU priority substances).

The European Commission reviews the list of priority substances every six years according to Art. 1 2013/39/EU. In practice, the list has been reviewed twice since it was first compiled in 2001, in 2008 (2008/105/EC) and in 2013 (Directive 2013/39/EU))[16]. Art. 16 par. 2 of the directive introduces a scientifically based methodology for selecting priority substances based on their significant risk to or via the aquatic environment. The emissions of priority substances are required to be minimized, while the emissions of priority hazardous substances must cease. Relevant substances for polymer industry include e.g. 1,2-dichloroethane, nonylphenols, DEHP and some specific lead compounds.

Regulation on persistent organic pollutants (POPs)

The regulation 2019/1021 (EC) on persistent organic pollutants prohibits or restricts the production and use, as well as the import and export of intentionally produced POPs, listed in Annex I and II to the regulation (Article 3).

Operators are responsible for knowing the substances listed in the regulation and which they are not allowed to use (in accordance with the requirements of the regulation). Competent authorities are required to monitor the implementation of the regulation.

POPs include flame retardants, such as PBDEs and HBCDD, which were used in plastic products (e.g. construction materials, electronics and car parts etc.). Now their use has diminished but they might still be problematic for the waste treatment sector still in the future.

Biocides

The European Directive 98/8/EC (Biocidal Product Directive, BPD; EC 1998) on placing biocidal products on the market was adopted in 1998. It was replaced by EU regulation No 528/2012 (Biocidal Products Regulation, BPR; EU 2012) by 1

[16] Decision No 2455/2001/EC of the European Parliament and of the Council of 20 November 2001 establishing the list of priority substances in the field of water policy and amending Directive 2000/60/EC (Text with EEA relevance), OJ L 331/1.

September 2013. Biocidal active substances are approved under the BPD (positive list in Annex I/Ia) or the BPR (list of approved substances[17]), but many biocidal substances are still under assessment.

Product regulations relevant for polymers

The regulation 10/2011 (EU), and its amendments, on plastic materials and articles intended to come into contact with food sets migration limits for specific substances (e.g. tin, boron) in plastic packaging.[18]
The Toys Safety Directive 2009/48/EC[19], and its amendments, deals with the safety of toys and contains rules on chemicals, general safety and electrical safety.

Fertilizer product legislation

The fertilizer products available in the EU market have to comply with the fertilizer product regulation 2019/1009 (EU). The regulation limits the metal (e.g. cadmium, nickel and lead) content in the fertilizer products. The regulation also sets conditions on the raw materials used in manufacturing. The new regulation applies as of 16 July 2022.[20]

3.2. Non-regulatory chemical reference lists

ChemSec – SIN List

The SIN List is a database of hazardous chemicals that are used in a wide variety of articles, products and manufacturing processes around the globe. Some chemicals on the list might be restricted or banned in the EU in the future. The SIN List is publicly available and regularly updated. The list is developed by non-profit organisation ChemSec and available at ChemSec webpages.[21]

The PRIO database

The PRIO database was developed and is managed by the Swedish Chemical Agency (KEMI) to help eliminate high hazard chemicals from products to meet the Swedish government's goal of a “non-toxic environment” by 2020. PRIO contains a database of chemicals of high concern to human health and the environment, which are divided into “phase-out” or “priority risk reduction” chemicals.[22]

[17] http://echa.europa.eu/information-on-chemicals/biocidal-active-substances

[18] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011R0010, https://ec.europa.eu/food/safety/chemical_safety/food_contact_materials/legislation_en

[19] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32009L0048

[20] https://ec.europa.eu/growth/sectors/chemicals/specific-chemicals_en

[21]https://sinlist.chemsec.org/https://sinlist.chemsec.org/

[22] https://www.kemi.se/prioguiden/english/start

3.3. Identification of industrial uses of certain hazardous substances in polymer and fertilizer industry

3.3.1. Identification of Substances of Very High Concern and Water Framework Directive Priority Substances for polymer and fertilizer industry

HAZBREF project compiled a list of SVHCs and WFD PS relevant for polymer and fertilizer industry (see Annex 6 and 7). The list of SVHCs was downloaded from the ECHA webpage[23] . At the moment of writing this report (June 2020) the list included 209 substances or substance groups identified as SVHC. The information on substance uses in the EU was compiled from the public ECHA CHEM database[24] and in Nordic countries from SPIN register[25] (Substances in Preparation in Nordic countries). If the substance had statement ”polymer” or “polymers” or “used in polymers” or “used in polymer processing” or “elastomers” etc. in the section ‘uses at industrial sites’ of the ECHA infocard, the substance was deemed to be used in polymer industry (see Annex 6). If the substance had the word ”fertilizer” in the section ‘uses at industrial sites’ of the ECHA infocard, the substance was deemed to be used in fertilizer manufacturing (See Annex 7). In addition, the REACH Annex XV dossiers were used as sources of information.

The total use volumes in the EU were derived from ECHA infocards (public ECHA CHEM database) as well. The use information from SPIN database was searched from the categories “Industrial Use (NACE)” and “Use (national)”. The use volumes in SPIN database are presented for one particular year.

There are issues concerning the quality of the data in the public ECHA CHEM database. Firstly, it is the manufacturers or importers of a substance that are providing the information in the registration dossiers used in the ECHA CHEM database. It is possible that the manufacturer/importer has indicated multiple uses for the substance even though the substance might not be used in the sector. This results in false positives in the lists and it should therefore be checked if SVHCs are really used in the sector. Secondly, the use volumes in ECHA infocards cover all the possible uses of the substance and not only the amount actually used in the POL sector (i.e. there is no information on the amount of use in the POL sector). Thirdly, the information on the industrial uses and volumes in public ECHA CHEM might be outdated. For these reasons the results may include substances, which are not used in the sector. Altogether 66 substances or substance groups were identified to be probably used in POL sector. The identified substances and information, e.g. on their uses, are presented in table 4 in Annex 6. For example, different phenols and phthalates, cadmium and lead substances as well as a PFAS

[23] https://echa.europa.eu/candidate-list-table

[24] https://echa.europa.eu/information-on-chemicals

[25] http://spin2000.net/

substance (PFBS) are most likely used in POL sector. Most substances are SVHCs, but some are both SVHC and WFD substances.

For the fertilizer industry, the result was 5 SVHC substances. Three of these are boron compounds. Boron is an essential plant micronutrient and added to SVHC list due to concerns related to human health. Boron is not classified as environmentally hazardous according to CLP classification. Two of the identified substances are cobalt salts. Cobalt is needed in nitrogen fixation reactions in legume plants. The identified substances and information e.g. on their uses are presented in the table 5 in Annex 7.

Due to the limitations described above, there may be several substances used in the manufacturing of polymers and fertilizers, which are not identified here. There may also be differences in the definition of usage categories and technical use descriptors. Further research of chemical and industrial experts on substances used in the sector in combination with additional assessment and filtering of data is therefore required before data from the ECHA chemical database can be used for BREF review purposes. Nevertheless, despite the shortcomings presented above, it is positive that European Commission, in recently published Chemicals Strategy for Sustainability[26] (EC 2020), is aware of the situation and will promote a comprehensive and transparent knowledge base on chemicals.

[26] The EU’s chemicals strategy for sustainability towards a toxic-free environment on 14 October 2020, Available at: https://ec.europa.eu/environment/strategy/chemicals-strategy_en

4. Legal Obligations and Management of Hzardous Chemicals

Industrial Emissions Directive

The Industrial Emissions Directive (IED) establishes a general framework for the integrated prevention and control of health and environmental risks arising from certain large industrial installations in the EU (listed in Annex I to the Directive), giving priority to intervention at source and ensuring prudent management of natural resources (Art. 3 para. 3 IED and Annex III of IED). As most of the health and environmental risks caused by industrial activities are based on the use, manufacturing and processing of chemical substances it is crucial for permit authorities that operators submit all relevant information with their permit applications.

In general, IED Article 3(18) states that 'hazardous substances' means substances or mixtures as defined in Article 3 of CLP Regulation (EC 1272/2008) on classification, labelling and packaging of substances and mixtures. In addition, the List of Pollutants under IED Annex II includes e.g. substances and mixtures possessing carcinogenic or mutagenic properties or properties which may affect reproduction (i.e. CMR substances), biocides and WFD substances (Annex X to WFD 2000/60/EC).

As summarized in the Impel Report on linking the IED and REACH the duties of enterprises and authorities under the IED include:[27]

<u>(1) Duty to integrate the information about substances in the process chain in the permit application</u>:

According to Art. 12 (1) IED all member states have to ensure that all applications for IED permits include among other things a description of: 1) the raw and auxiliary materials and other substances, 2) in cases where the activity involves the use, production or release of hazardous substances a baseline report on soil and groundwater and 3) the nature and quantities of foreseeable emissions from the installations into each medium as well as identification of significant effects of the emissions on the environment.

<u>(2) Duty to inform about changes</u>:

According to Art. 20 IED operators have to inform the competent authority of any planned change in the nature or functioning, or an emission of the installation, which may have consequences for the environment.

<u>(3) Duty to reference BAT conclusions in the permit conditions</u>:

[27] IMPEL (2015), Linking the Directive on Industrial Emissions (IED) and the REACH Regulation

According to Article 14(3) of the IED, BAT conclusions shall be the reference for setting the permit conditions to installations covered by the Directive. For existing installations, it is the responsibility of the competent authority to ensure that all permit conditions for the installation are revised (and where appropriate updated) in accordance with the relevant BAT conclusions within four years of their publication.

Russian BAT Bureau

Russian BAT Bureau produces and publishes BREF documents in Russia. Russian BREF 32 covers manufacturing of polymers and BREF 2 covers manufacturing of fertilizers.

REACH and Safety and health of workers

Operators are also obliged to follow REACH obligations, see more under s 3.1 and 4.1-4.5 below and to comply with the directive 24/98/EC which lays down requirements for the protection of workers from risks to their safety and health arising from chemicals. Operators must also assess the risks and take preventive risk reduction measures according to the OSH directive (391/89/EC).

Water Framework Directive

The Water Framework Directive (WFD, 2000/60/EC) specifies e.g. the objective of gradually reducing the emissions of priority substances and cease the emissions of priority hazardous substances to surface waters (Article 4). Operators have to follow WFD obligations related to the fact that environmental quality standards (EQS) for substances in surface waters are not exceeded. See more detailed information e.g. in chapter 3.1.

Seveso Directive

The Seveso III Directive (2012/18/EU), specifies obligations to prevent major chemical accidents and minimize their effects within and outside establishments where chemicals are present. The obligations apply to establishments handling or storing chemicals causing physical, health and environmental hazards in large quantities.[28] Operators are obliged to take all necessary measures to prevent major accidents and to limit their consequences for human health and the environment. The requirements of the Directive for operators include:

- Notification of all concerned establishments (Article 7)
- Deploying a major accident prevention policy (Article 8)
- Producing a safety report (Article 10)
- Producing internal emergency plans (Article 12)
- Providing information in case of accidents (Article 16).

[28] https://ec.europa.eu/environment/seveso/legislation.htm

HELCOM recommendations

Since the HAZBREF project is funded by the European Regional Development Fund Interreg Baltic Sea Region, the guidance includes references to HELCOM recommendations relevant for the chemical industry regarding discharges, emission and objectives for hazardous substances. The sector specific recommendations do not contain many specific requirements concerning chemical management and the EU's and Russian BREFs are the main guiding documents for the Baltic Sea countries;

- HELCOM Recommendation 17/6 – Reduction of Pollution from Discharges into Water, Emissions into the Atmosphere and Phosphogypsum out of the Production of Fertilizer;[29]
- HELCOM Recommendation 23/11 – Requirements for discharging of waste water from the chemical industry;[30]
- HELCOM Recommendation 25/2 – Reduction of emissions and discharges from industry by effective use of BA[31]; and
- HELCOM Recommendation 31E/1 – Implementing HELCOM's objective for hazardous substances[32]

This chapter also contains description about how to use substance flow analysis in chapter 4.6 and interactive schemes in chapter 4.7. These tools may support the operators in doing the chemical inventories and help in risk assessments.

4.1. Using safety data sheets

Safety Data Sheets (SDS) are a method for providing information on chemical substances and mixtures to their recipients in the EU. SDSs are designed to provide comprehensive safety information on substances and mixtures where a substance or a mixture meets the criteria[33] for classification as hazardous according to CLP;

- a substance is persistent, bio-accumulative and toxic (PBT) or very persistent and very bio-accumulative (vPvB), according to the criteria given in Annex XIII of REACH; or
- a substance is included in the candidate list for eventual authorization according to Article 59 (1) of REACH for any other reason (See Article 31(1) of REACH).

Article 31 of the REACH Regulation describes the specific requirements for SDS under REACH in conjunction with Annex II of REACH. All SDSs are divided in

[29] https://www.helcom.fi/wp-content/uploads/2019/06/Rec-17-6.pdf

[30] https://www.helcom.fi/wp-content/uploads/2019/06/Rec-23-11.pdf

[31] https://www.helcom.fi/wp-content/uploads/2019/06/Rec-25-2.pdf

[32] https://helcom.fi/wp-content/uploads/2019/06/Rec-31E-1.pdf

[33] Under certain conditions some chemical formulations which do not meet the criteria for classification as hazardous according to CLP also require an SDS to be prepared or be made available on request (See Article 31(3) of REACH and notes to tables 3.4.6, 3.6.2, 3.7.2, 3.8.3and 3.9.4of Annex I of CLP).

16 sections, which must contain e.g. information on possible hazards and composition/information on components of mixtures. The SDS sections with the highest relevance for good chemical management are 1, 2, 3, 9, 11 and 12 (see Annex 3 to this report). Chemical suppliers are obliged to provide end users with SDS for all relevant chemical substances or chemical products in such a way that they meet the formal requirements according to the corresponding ECHA guidelines.

SDS provide information on:

- correct handling and storage;
- measures for the protection of human health and safety at the workplace (occupational health);
- measures for the protection of the environment;
- correct responses in case of substance related emergencies; and
- correct disposal of the respective substances.

Additional information on the content and appropriate use of SDS is provided in the ECHA "Guide on Safety data sheets and Exposure scenarios".

4.2. Producing safety data sheets

ECHA have a guidance on the compilation of safety data sheets (version 3.1, November 2015) available on their website.[34]

The aim of the guidance is to assist industries in determining which tasks and requirements that have to be complied with in order to fulfil their obligations under Article 31 of REACH (Requirements for safety data sheets) and Annex II of REACH, as replaced by two Commission Regulations:

- Commission (EU) No 453/2010: alignment of the SDS with the applicable requirements arising from implementation of the changes in classification and labelling of substances and mixtures according to the CLP Regulation from 1 December 2010 and 1 June 2015 respectively.
- Commission Regulation (EU) 2015/830: adaptation to the 5th revision of the GHS and avoidance of confusion generated by two potentially conflicting amendments entering into force on the 1 June 2015.

The guidance provides information especially on:

- issues to consider when compiling an SDS;
- details of the requirements for information to be included in each Section of an SDS;
- who should compile the SDS and what competences the author should have.

[34] https://echa.europa.eu/-/guidance-on-the-compilation-of-safety-data-sheets

There is also a shorter version available on ECHAs website (version 2.0, December 2015, Guidance in a nutshell).

The guideline is currently being updated. A draft (version 4.0, April 2020) is available on the ECHA website.

Findings from the case studies:

- SDSs are kept up to date and checked regularly in some of the plants.
- SDSs are used to make short, easy-to-read safety cards to the plant operators. ECHA database is not utilised by the company but all the information is derived from the SDSs.
- The quality of SDS supplied by European chemical companies is usually at a high level required by REACH. This quality is not always guaranteed by importers of chemicals from non-EU producers (the most common shortcomings is lack of complete information of mixtures composition, associated waste codes, other emissions, environmental hazards or exposure scenarios).
- Frequently commercially competitive chemicals from outside the community provide very general SDSs to the EU market. This may be due to a lack of such information from the manufacturer, or a deliberate choice not to provide complete information.
- Sometimes the translations to other languages than English are insufficient in quality.
- Beyond the supply chain communication requirements, as stated in the REACH regulation, detailed data about the impurities or intentionally added constituents is challenging to get from the suppliers. This concerns both impurities and ingredient substances in minor concentrations, which remain below thresholds (levels of concern) triggering their presence in section 3 of SDS. Even though the concentrations of impurities might be low, the load might become significant when the used volumes of raw materials are high.

4.3. Using exposure scenarios

In the case that a hazardous substance (according to REACH) is registered in a quantity above 10 tonnes per year and registrant, an extended safety data sheet, with exposure scenarios (ES) attached, must be provided. ES are intended to provide information on the sources, use patterns and release pathways of chemicals used and to assist in the estimation of releases of chemicals to the environment. In contrast to SDS, the format of the exposure scenario is not specified by REACH. On the one hand this gives the suppliers the flexibility to present the information in different ways, on the other hand the different formats can lead to difficulties in identifying the relevant information for the recipients. To address this problem, ECHA and various stakeholders recommend a harmonised format comprising the following four sections:

- Title section
- Conditions of use affecting exposure
- Exposure estimation
- Guidance to downstream users to evaluate if their use is within the boundaries of the exposure scenario.

Obligations of downstream users with regard to Exposure Scenarios
When receiving ES as part of the extended safety data sheet, downstream users must fulfil certain obligations. As a first step they must determine whether the particular use and/or conditions of use in the installation is covered in the ES. If the respective use is covered in the ES, no further action is required in this respect. Downstream users are instead only obliged to document how the conclusion was reached (this information shall be made available to enforcement authorities on request). In case use or use conditions are not covered by the exposure scenarios received from the suppliers, downstream users can – depending on their situation - choose between the following options:

- Ask the supplier to include the relevant conditions of use in his chemical safety report and to submit an appropriate exposure scenario. Enough information must be made available to the supplier to enable him to carry out such an assessment.
- Implement the operating conditions described in the exposure scenario you have received. This option may require changes in the processes and/or products.
- Eliminate or substitute the substance or the activity with a safer alternative.
- Find another supplier who can provide the substance with SDS and exposure scenario covering your use.
- Carry out a chemical safety assessment and prepare a downstream user chemical safety report (DU CSR) for their uses and conditions of use, unless exemptions apply. The ECHA Guide 176 "How to prepare a downstream user chemical safety report" provides further details regarding this approach.

Key points to be included in the format as well as additional information on the use of exposure scenarios are provided in the ECHA "**Guide on Safety data sheets and Exposure scenarios**"[35]. Specific annotated formats can be downloaded from the website section "**Formats and templates**"[36].
The operator should be aware of the potential risks involved when using hazardous substances. This means that even when PEC is below PNEC a generic risk assessment should be done. If the PEC exceeds the PNEC, a more detailed risk assessment is needed.

SDS exposure scenarios are one source of information for hazardous chemicals risk assessment. But detailed exposure scenarios are not yet available from all

[35] https://www.reach-compliance.ch/downloads/sds_es_guide_en.pdf

[36] https://echa.europa.eu/support/guidance-on-reach-and-clp-implementation/formats

suppliers. It is also possible that key information like PNECs are missing. Further, the exposure scenarios are often all too generic, based on modelling with default emission ratios and overestimated use volumes in the sites. Exposure scenarios represent the worst-case situation. Exposure scenarios are not thus usually directly usable for the operators. Sector specific environmental release categories (SPERCs), based on measurements and information about the typical environmental fate of substances in the sites could help but they have not yet been developed for many industrial uses.

In one of the case studies, the exposure scenario for a substance for fertilizer formulation indicated that based on modelling there is a risk that the emissions from fertilizer production exceed the PNEC values (PEC/PNEC>1) in water, sediment and soil and in addition in the sewage treatment plant. This estimate however does not fit well in the production process of the case installation since the waste water from the installation is treated in its own treatment plant and the sludge is landfilled. This will decrease the emissions to water and no emissions to WWTP or to soil are generated. Also, the use volumes in the exposure scenarios were overestimations. Therefore, the risk should be estimated by using site's own measured data and calculating the flow of the substance over the process to estimate emissions to the environment. For example, available tools are STAN tool[37] (see annex 8) and the EUSES model[38]. If the exposure scenario in the SDS estimates that the PEC>PNEC then the installation should make a more detailed evaluation whether the risk is real. If the risk is real, then the emission abatement measures are needed. However, this modelling requires quite a lot of monitoring data (inputs and outputs). Further, the more there are uncertainties the more unreliable the result is.

Findings from the case studies:

- The companies use the exposure scenarios even though they are not directly usable but need to be refined to specific uses of the substances.
- The exposure scenarios are difficult to read and too generic to apply and thus not directly usable for the production units. Specific environmental release categories (SPERCs) could be helpful.
- The exposure scenarios and data on environmental hazards should be improved in the SDSs.
- Exposure scenarios are utilized and adapted to the specific uses at the installation. But all SDSs do not yet have exposure scenarios and in some the data is of poor quality, especially concerning mixtures. Sometimes the information in the SDSs is in contradiction between different suppliers of the same chemical. Thus, the information is not harmonized.

[37] http://www.stan2web.net/

[38] https://ec.europa.eu/jrc/en/scientific-tool/european-union-system-evaluation-substances

4.4. Producing exposure scenarios

ECHAs guidance on the compilation of safety data sheets (version 3.1, November 2015) contains information on:

- when attachment of Exposure Scenarios to the SDS is required (section 2.22);
- alternative ways to include the Exposure Scenario information into the SDS for substance and mixtures (section 2.23); and
- how to include relevant Exposure Scenario information into the SDS (appendix 1).

The guideline is currently being updated. A draft (version 4.0, April 2020) is available on the ECHA website[39].
ECHA also gives examples on exposure scenarios on their website.[40]

4.5. Developing chemical inventories

To allow for an effective chemical management, it is necessary to clearly identify which chemicals are used, how they should be used, and how they can be substituted if risks are identified. This requires that established inventories are continuously updated and archived. Chemical inventories allow among other things for a targeted compilation and assessment of chemical related information, which can serve the specific information requirements of different organizational units within the industrial installation. They can also serve as an important reference and information tool for stakeholders such as IED permitting authorities (e.g. to assess compliance with lists of restricted substances or other chemical related regulations), thus going beyond the mere purpose of fulfilling storage or stock-keeping requirements.

In order to ensure the availability and completeness of all information necessary for a responsible chemical management that can be used for both internal and external requirements, the inventory should include all chemical substances and products (including by-products, intermediates, residual raw materials and solvents) present throughout the production cycle.

The main and commonly used sources of data with respect to the different chemical products are the SDS[41] and - to a certain extent - the Technical Data Sheets (TDS)[42]. Other sources of relevant chemical information such as type,

[39] https://echa.europa.eu/

[40] https://echa.europa.eu/support/practical-examples-of-exposure-scenarios

[41] The short comings of SDS in terms of their comprehensiveness and quality of information need to be taken into account and may require further inquiries with the chemical supplier, particularly as far as the complete disclosure of chemical product compositions is concerned.

[42] Technical data sheets contain information on the application of the product and instructions for its use. This may include the correct dilution range, the correct temperature as well as other information of use for the process engineer.

chemical (containing) waste, production process involving chemicals as well as quantities of inputs and non-product outputs including eco-maps and process flow diagrams. Further reference on how to establish and maintain a chemical inventory is provided in section 5.2.1. The chemical inventory could be improved if detailed data about the impurities or intentionally added constituents would be available in SDS.

Some of the case study companies take part in the Responsible Care program[43]. The internal company rules and practices are often stricter than legislation or requirements of authorities. The processes which include hazardous chemicals have the most detailed rules. These rules are part of the process safety requirements: if any unknown and unwanted substance enters the sensitive process there might be a risk for explosion. Therefore, all new chemicals are assessed in detail before taking them into use in the production process. The installations are not allowed to use any chemicals before they have been tested and approved by the company.

See more about chemical and raw material inventory and chemical handling system in chapter 5.2.

[43] https://cefic.org/our-industry/responsible-care/

Information requirements for chemical inventories

According to the assessment of IED permitting authority representatives and experts from HAZBREF, it is recommended to include the following information on substances and mixtures in a chemical inventory:

- the commercial name of the products used;
- chemical characterisation of the products used, if possible, with single chemical compounds;
- identifiers, CAS/EC number of chemical substances contained;
- characterisation/description of use (input material, solvent, product, intermediate, by-product);
- details of use/details about the process;
- annual consumption of the chemical products/substances;
- the total quantity of the chemical products or substances that may be present within the total installation/operational area;
- physical/chemical/toxicological/eco-toxicological properties of the chemical products/substances;
- biodegradability/bioeliminability (in %), including information on the testing method;
- the lower content (as % by weight) of components in chemical formulations;
- The highest content (as % by weight) of the component in chemical formulations; and
- Information about possible emissions or possible reactions (e.g. decomposition) of substances in case of an incident or accident in the production process.

4.6. Substance flow analysis

One of the challenges in managing hazardous substances in the installation is understanding the flows of the substances in the processes and in the discharges outside of the installation. For that purpose, Substance Flow Analysis (SFA) and Material Flow Analysis (MFA) can be used. These are studies of physical flows of substances or materials into, through and out of a given system such as an installation. Conduction of SFA or MFA could help in the management of waste water and wastes as well as in improving material efficiency. Substance and Material flow analyses contain the following main steps:

- identification of the key parameters such as the material or substance, flow related issues;
- system analysis (selection of the relevant matter, production processes, indicator substances, and system boundaries);
- quantification of mass flows of matter and indicator substances;
- Identification of weak points in the system; and

- development and evaluation of scenarios and schematic representation, interpretation of the results.

Tools for assessing transformations of the substances can be used in the estimations of substance mass balances. The mass of the substance in each of the media (including process media, product, waste water, air emissions and waste) can be estimated as a result. It can be done by using tools such as STAN[44], which is focused especially on waste management.

STAN (short for substance flow analysis) is a freeware that helps to perform material flow analysis according to the Austrian standard ÖNorm S 2096 (Material flow analysis – Application in waste management).
After building a graphical model with predefined components (processes, flows, system boundary and text fields) you can enter or import known data (mass flows, stocks, concentrations, and transfer coefficients) for different layers (goods, substance, energy) and periods to calculate unknown quantities. All flows can be displayed in Sankey-style, i.e. the width of a flow is proportional to its value. The graphical picture of the model can be printed or exported. For data import and export Microsoft Excel is used as an interface.

A material flow analysis (MFA) was concluded in one of the case sites to assess the possible releases of the substance to environment from the production process. STAN tool was used to conduct this MFA. More information about how the analysis was done is available in Annex 8.

4.7. Interactive scheme for the identification of relevant target substances

As a help to identify relevant target substances an interactive scheme was developed in WP 2. The interactive scheme supports the plant operators to establish and complete a chemical inventory and as a second step to identify (relevant) target substances. Target substances are those expected to be released from installations with the waste water stream.

The scheme can also be used by the branch associations. The branch associations could derive standard phrases for safe handling of the substances with the help of the interactive scheme. During the BREF revision process the TWG could use the scheme to identify the substances that should be addressed in the BREFs and identify (relevant) target substances for which BAT should be derived. Other interested parties, e.g. NGOs, can also use the interactive scheme to identify substances that they consider to be regulated.

Working with the interactive scheme results in a (theoretical) current survey for a certain substance in a defined plant combined with a corresponding WWTP. This

[44] https://www.stan2web.net/

result could be the basis for implementing further abatement measures or substitution. For example, the amount of substances finally entering the WWTP could be reduced or even prevented already in the production processes. Another option could be the enhancement of WWTP's treatment capacity related to the substance assessed. This could be an improvement of the processes in the WWTP or the installation of additional devices.

Using the schemes prepared by HAZBREF project together with the substance-specific information available at the REACH databases and in the SDS clearly shows that there is a lack of useful data on (eco)toxicology as for degradation products for many chemicals. This will in some cases lead to the classification of a substance as "relevant target substance" or substance of concern leading to action although a complete set of data would suggest the opposite. At this point the support of chemical experts is needed for decision making.

Read more about the scheme in the WP 2 report "Approaches for a better use of available data to prevent or reduce releases of substances of concern from industrial installations". The scheme can also be accessed under https://hazbref.rescol.de.

5. Best Practice in Chemical Management and Identification of BAT Candidates

To avoid or reduce emissions of hazardous substances a number of approaches should be used. These approaches cover the choice of production process with raw materials and chemicals, measures within an existing production process, to the end of pipe abatement techniques. These approaches can be grouped within three main categories of measures:

- preventive
- process related
- end-of-pipe.

PREVENTIVE

Preventive measures should be the measures taken in the first place. They address new processes, chemicals or raw materials to be introduced at the facility. To achieve this, it is necessary to obtain and keep enough relevant knowledge and capacity covering the key aspects:

- development of new products and production processes,
- the relevant hazardous substances, approval and management of new chemicals,
- chemical and raw material inventory,
- control systems,
- maintenance and regular inspections of operations and equipment, and
- continuous training of staff.

PROCESS INTEGRATED OR RELATED

Process related measures mainly focus on improvement of existing production process, with support systems, within the facility. Some of these process related measures could also be used as preventive measures as described above. If preventive measures cannot be taken, process related measures should be considered as the second option. Recommended process related measures are:

- process mapping of hazardous substances
- improvements in the existing process
- substitution
- chemical storage and transportation and
- closed cycle processes.

END-OF-PIPE

End-of-pipe measures are the last option in avoiding emissions of hazardous substances. Key end-of-pipe measures are waste stream management, waste and hazardous waste management, pre-treatment of waste streams, gas and water treatment and emergency preparedness.

In the HAZBREF project, best practices regarding management of hazardous substances were identified and recommendations and BAT candidates were prepared for the chemical sector. They were developed based on information from:

- HAZBREF case studies,
- information from the industries and organisations,
- expertise of the HAZBREF project team, and
- information available in the current BREF-documents and other descriptions of BAT available.

This chapter contains both generally applicable practices and recommendations on BAT candidates. Most of the BAT candidates are applicable to all installations. BAT candidate 5 is applicable for installations producing or handling plastic pellets. All the BAT candidates are described in detail in Annex 1. HAZBREF recommends that the described relevant BAT candidates should be considered in the forthcoming revision of the BREF for the Large Volume Inorganic Chemical industry (LVIC).

5.1. Chemical Management System

A Chemical Management System (CMS) is a systematic approach regarding chemicals and substances covering several integrated administrative and practical measures. A CMS should not be equated with an Environmental Management System (such as ISO 14001 or EMS according to BAT 1 in CWW) but it can be a part of an EMS. The systematic approach Plan, Do, Check and Act (PDCA) is the same in both CMS and EMS but in a CMS the focus is on the chemicals with the aim to improve management and reduce risks.

The purpose of the CMS is to control the chemicals and hazardous substances at the site, increase knowledge of the characteristics, risks and impact and improve the processes to reduce emissions of hazardous substances. However, it should be noted that some hazardous chemicals are necessary in certain processes to achieve the required product quality and their substitution is not always possible. Similarly, there are processes in which the hazardous chemicals react further and their emissions to the environment are negligible.

CMS proposal developed in HAZBREF project as input to BREF review for WGC BREF process

In order to improve the overall environmental performance, BAT is to elaborate and implement a chemicals management system (CMS) as part of the EMS (see BAT1) that incorporates all of the following features:

I. process chemicals procurement policy to select process chemicals and their suppliers with the aim to minimise the use of hazardous chemicals such as substances of very high concern and to avoid the procurement of excess amount of process chemicals. In order to reduce total (channelled and diffuse) emissions to environment;

II. anticipatory monitoring of regulatory changes related to hazardous chemicals and safeguarding compliance with applicable legal requirements;

III. identification of the process chemicals pathways through the plant (from procured process chemicals to products, waste, waste water and emissions to air);

IV. assessment of the risks associated to the chemicals, based on the chemicals' hazards, concentrations and amounts. This may include an estimation of their emissions;

V. regular (e.g. annual) check aiming at identifying potentially new available and safer alternatives to the use of hazardous chemicals (e.g. process integrated techniques and measures or use of other chemicals with no or lower environmental impacts);

VI. goals and action plans to avoid or reduce the use of hazardous chemicals; and

VII. development and implementation of procedures for the handling, storage and use to prevent or reduce the emission to the environment.

HAZBREF recommends that such a BAT for CMS is also included to the forthcoming revised LVIC BREF, adapted to the specifics of the sector.

A general Chemical Management System follows the PDCA-cycle: Plan, Do, Check and Act.

It is important to have an established plan for the chemical work.

The Chemical Management System is described in more detail as BAT candidate 1 in Annex 1.

5.2. Chemical and raw material inventory and chemical handling system

In order to know which hazardous substances are used or generated at the site, a chemical inventory is needed. See more about chemical inventories in chapter 4.5.

It is important to include all types of chemicals and raw materials used in all processes and activities at the site. That is to include chemicals used for example in maintenance, cleaning, firefighting in all parts of the site including chemicals used by contractors and others conducting activities at the site.

In a chemical inventory, there must be information regarding product name, information about ingredients, CAS numbers, a hazard statement, quantity stored and where the chemical is stored. The information in the chemical list must be searchable and there must be routines in place to update the information in the chemical list regularly.

Most of the information needed is addressed using the safety data sheet (SDS). See more about SDSs in chapter 4.1. If some information is missing from the SDS, the supplier should be asked to provide this. Good routines to handle new and updated SDS are crucial to have an up to date and reliable chemical database. These routines should involve on-site handling and updates as well as communication with suppliers on how SDS are delivered. One scenario is paper distribution along with the physical product. However, manual handling might increase the risk of information being lost on site and never reaching the responsible person. A more efficient way is through established automatically processed digital distribution of SDS connected to the sales/purchase systems.

A chemical inventory also provides information to the inventories of waste water and waste gas streams required in BAT 2 in the CWW BREF, see more in Annex 4.

An example of a chemical and raw material inventory is described in more detail as BAT candidate 2 in Annex 1. HAZBREF recommends that such a BAT for an inventory is also included to the forthcoming revised LVIC BREF, adapted to the specifics of the sector.

5.3. Chemical storage and transportation

Storage in tanks

The first example is double-walled tanks (see EFS BREF section 4.1.6.1.13.). A double-walled tank can have different designs. The double wall can be placed on the outside of the tank with a distance to the inner wall, adjacent to the inner wall or inside the tank. The double wall is normally applied in combination with a double tank bottom and leak detection for the storage of flammable substances or substances hazardous in contact with water.

Single-walled tanks is another option if they are combined with tank bunds (see EFS BREF section 4.1.6.1.14.). The tank bund shall be designed for large spills and must contain the volume of the tank in case of e.g. shell rupture or a large overfill. The bund consists of a wall around the outside of the tank (or tanks) to contain any product in the event of a spill. The wall must be fully impermeable to avoid leakage to the ground.

All IBCs, small tanks and drums should be placed on a secondary containment (see EFS BREF section 3.1.13.1.). Secondary containment refers to additional protection against storage tank releases over and above the inherent protection provided by the tank container itself.

Storage based on the substance

For storage of hazardous substances, it is important to consider the physio-chemical properties. For instance, hazardous materials that could react with other substances, potentially leading to dangerous gases or fumes, should be stored separately. Storage cells is one option for separate storage (see EFS BREF section 3.1.13.1). In Figure 2, there is one example of a storage-class-compatibility check used in Germany containing a list of storage classes and how they should be stored (joint or separate).

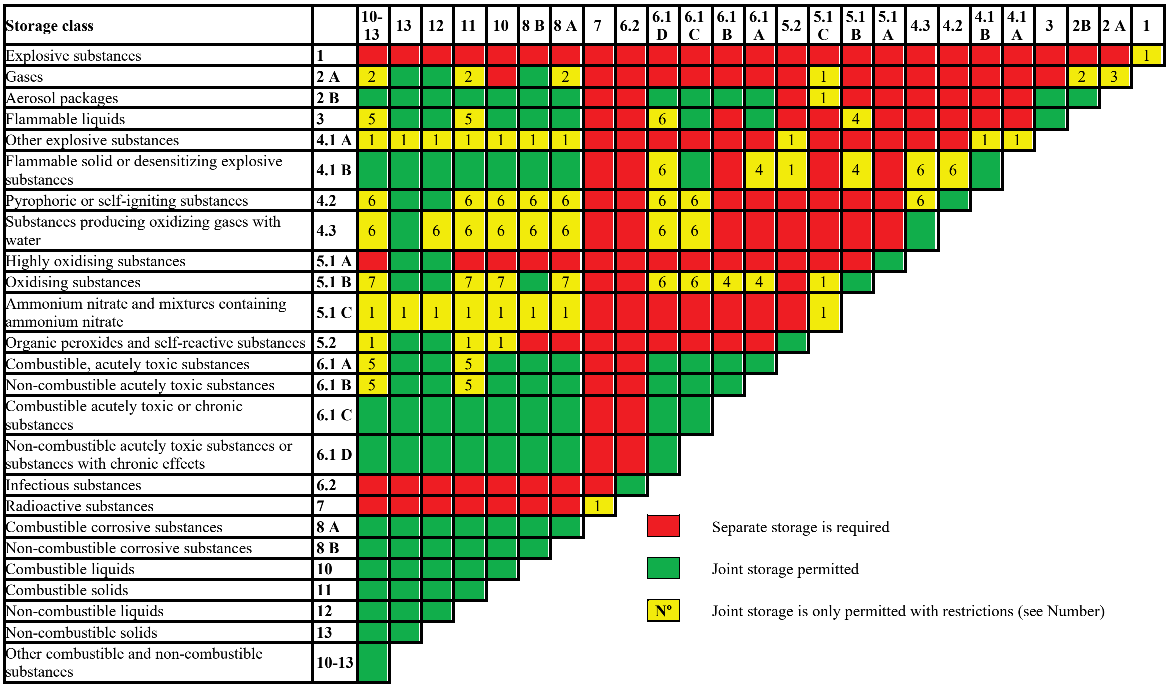


Figure 1: Storage-class-compatibility check containing a list of storage classes and if they should be stored joint or separately

(Source: Technical rules for hazardous substances, TRGS 510)

There could also be dedicated systems for tanks and equipment where these are only used for one group of products. This makes it possible to install and use technologies specifically tailored to the products stored (and handled), thereby preventing and abating emissions efficiently (see EFS BREF section 4.1.4.4.).

Transfer

The transfer of hazardous substances is another potential environmental issue where emissions can occur. To reduce the emissions and the risk of leakage, there should be risk-based inspection plans and proactive maintenance plans as well as leak detections and repair programmes. For valves, a diaphragm, bellows or double-walled valves should be used (see BREF document Section 4.2.9.).

Additionally, there should be a dedicated unloading area for trucks with precautionary measures in case of spills. These precautionary measures could be for instance a valve or a tank underground, to catch accidental releases of chemicals during unloading.

5.4. Optimization of process integrated recycling

Establishing recirculation in one process step could lead to big savings in resource use as smaller amounts of new materials have to be added in the process. By recirculating chemicals that are not needed in the final product and that would otherwise go to waste, both the chemical input and the unwanted output could be reduced.

One example of a recirculating process step is from one of the case studies and its production of polyethylene. The process is based on the operation of loop and gas-phase reactors in series. The output from the second loop is a polymer powder containing residual hydrocarbons that have the potential for material recovery.

In a separation step, the residual hydrocarbons are separated from the powder by nitrogen purging and fed to distillation columns where light and heavy compounds are separated. Various hydrocarbon fractions are separated in several distillation units for different purposes. Oligomers are used for energy production; light hydrocarbons are recycled for use in another process for olefin production as feedstock and unreacted hydrocarbons are recycled back to the loop and gas-phase reactors as an input to the process.

A recirculation will result in environmental benefits such as decreased emissions to air due to efficient use of hydrocarbons, a minimised use of hazardous chemicals and hence reduced emissions of hazardous substances to the environment.

An example of an optimization of process integrated recycling is described in more detail as BAT candidate 4 in Annex 1.

5.5. Substitution

A successful substitution work can be performed in four stages;

1. Identification of hazardous substances
2. Screening for possible alternatives
3. Evaluation and choice of alternatives
4. Development of new alternatives.

1. Identification of hazardous substances

Strategical decisions on what to screen for and creating a control over the products used in the production processes. An effective tool to manage the identification is to use a structured inventory for all chemicals as mentioned in chapter 5.2.1. Such a system can help to identify hazardous substances and some of them also have screening methods for substances that are structurally similar to the identified hazardous substance.

2. Screening for possible alternatives

The screening process starts with the understanding of the function of the identified hazardous substance with help of three main questions:

- Why is this product/substance used?
- What is the function of the identified hazardous substance?
- Is that function needed? If yes, can the function be achieved through a substitute?

When the function of the identified hazardous substance and the actual need for the product/process is established the screening process can focus on finding solutions with an equivalent function. The new solution does not need to be identical, but it must solve the requested function. This means searching for chemicals but also non-chemical alternatives, materials or other technical solutions.

3. Evaluation and choice of alternatives

This process requires both chemical and toxicological knowledge combined with knowledge regarding the production site where the substitute is going to be used. Key considerations are the hazardous properties of the substitute, relative exposure (compare the difference in total exposure between the current substance and the substitute), technical performance, and long-term cost at full production (not at pilot scale)). The new solution often brings new questions to light, or alternative production methods that must be taken into the equation during the evaluation.

4. Development of new alternatives

The fourth step of the substitution process involves developing new sustainable substances or techniques. In the absence of available alternatives, new innovations and/or techniques may be necessary.

It is important that the needs of certain functions are communicated within the supply chain all the way from the manufacturers down to the end users. Depending on the role of the production facility in the supply chain, this step involves different tasks. Transparency in the supply chain is one of the key issues for a successful development.

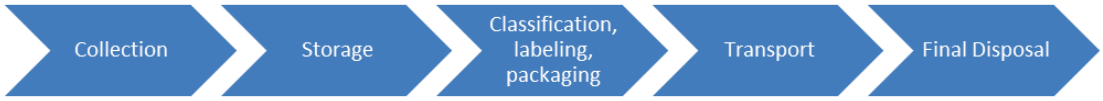
5.6. Process mapping of hazardous substances

To be able to take actions for reducing emissions of hazardous substances, good knowledge of the production processes is needed. One example of how to do this is by working with process mapping of hazardous substances. The purpose is to identify the flows of substances and plan cost-efficient monitoring and abatement measures.

The process mapping of hazardous substances includes different steps: identification, calculation of mass balances, sampling and analysis, implementation of actions and verification, and is described in more detail as BAT candidate 3 in Annex 1.

5.7. Management of hazardous waste

Hazardous waste management can pose a risk when it comes to the discharge of hazardous substances. Examples of routines to have in place for collection, storage, classification-labelling-packaging, transport and final disposal follow below.



Routines for collection

- Separating hazardous waste from other waste and
- Training for employees handling hazardous waste, with focus on the different types of hazardous waste, the characteristics and risk with different hazardous waste fractions, how to handle them and use of necessary Personal Protective Equipment (PPE).

Routines for storage

- Hazardous wastes should be stored protected from precipitation and on a surface impermeable to water
- Liquid hazardous waste should be stored in a secondary containment
- Acids, bases, solvents and other chemicals should be stored separated from each other
- Regular inspections of the storage area.

Routines for classification, labelling, packaging

- Classification, packaging and labelling must be performed by a trained waste chemist
- Documentation of hazardous waste fraction (type, amounts, classification) in a transportation document that will follow the transport of the waste to final disposal.

Routines for transport and final disposal

- According to national and local regulations
- Requirements on contracted waste vendors
- Regular auditing of waste vendors to check compliance with requirements.

5.8. Waste water treatment

In order to reduce emissions to water an integrated waste water management and treatment strategy should be used. Process-integrated techniques can be used to prevent or reduce the generation of water pollutants. Pollutant recovery techniques can be used at source to minimise the discharge to the waste water system. Pretreatment can be carried out at the source or in combined streams. The final waste water treatment should contain necessary techniques to minimise emissions of pollutants in the specific waste water.

An example of a waste water treatment process, applicable for installations producing or handling plastic pellets, is described in more detail as BAT candidate 5 in Annex 1.

The INTERREG Baltic Sea Region project Better Efficiency for Industrial Sewage Treatment (BEST) developed recommendations and guidance for industrial waste water treatment for both operators and authorities. The materials are available at the project website: https://bestbalticproject.eu/outputs/

6. Permitting Process and Management

The IED stipulates that IED installation may not be operated without a valid permit that meets the IED requirements. Such a permit must contain emission limit values (for emissions to air, water and soil), which are based on BAT listed in the sector specific BREF. Furthermore, the permit must contain all relevant conditions and stipulations (also based on BAT) on:

(1) integrated pollution prevention measures (such as the prevention of applying certain chemicals, not to carry out certain processes, establishment of waste water, waste and chemicals inventories);
(2) self-monitoring, storage and handling of chemicals;
(3) health and safety aspects, especially concerning the application of hazardous toxic chemicals;
(4) the right of the competent authorities to carry out inspections any time, to take waste water samples any time; and
(5) measurements of emissions to air by certified third-party institutions at a certain frequency etc.

In addition to the sector specific BREF, other relevant BREFs should be taken into account in the permit application. In chemical industry there might be several relevant BREFs for one site. These complementary and relevant BREFs are listed in the scope of the BREF document.

The HAZBREF case studies and interviews with representatives from permitting authorities in five countries[45] indicate significant differences between the respective permitting procedures regarding detail as well as frequency of information on substances to be submitted. Furthermore, while some countries apply BREFs and BAT conclusions directly (e.g. Sweden), others transpose it into national law (e.g. Germany).

Differences in the permitting requirements are also visible within countries. For example, while in one German federal state IED installations are required to submit a list of chemicals products used on an annual basis, in other federal states no such requirements are in place.

[45] Analysis of the interfaces, possible synergies or gaps between Industrial Emission Directive, REACH Regulation, Water Framework Directive, Marine Strategy Framework Directive and the POP Regulation concerning hazardous substances available at https://www.syke.fi/en-US/Research__Development/Research_and_development_projects/Projects/Hazardous_industrial_chemicals_in_the_IED_BREFs_HAZBREF/Publications

6.1. Environmental permitting and inspection cycle

In the following, the steps of the IED permitting and inspection cycle will be addressed with particular regard to tools and references as well as common challenges for permit writers, competent permitting authorities and operators. Figure 3 below provides an overview of the steps, inputs, links between the steps and how they work together.

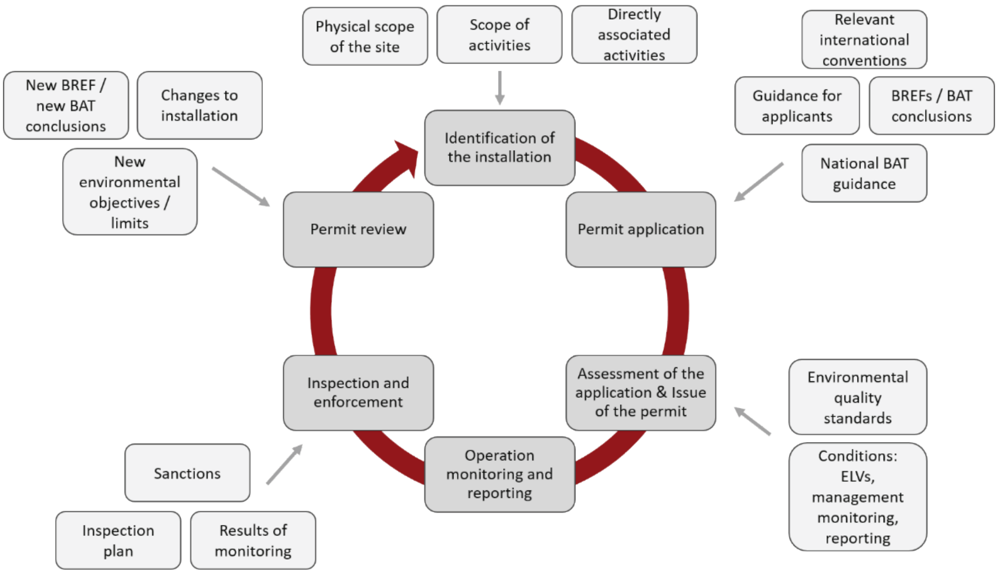


Figure 2: IED permitting and inspection cycle[46]

According to Finland's environmental protection legislation, permits are needed for all activities involving the risk of pollution of the air and water or contaminating the soil. One important condition for permits is that emissions are limited to the levels obtainable by using Best Available Techniques (BAT). Applications must be made to the relevant authority, as defined in the Environmental Protection Act and Decree. The authority will then make the application public as appropriate, giving the relevant authorities and anyone affected by the plans time to comment and make proposals concerning the requirements for the permit. Complaints against permit decisions may be made to the Administrative Court, then to the Supreme Administrative Court (Figure 4).

[46] Based on: IMPEL, Linking the Directive on Industrial Emissions (IED) and the REACH Regulation, 2013)

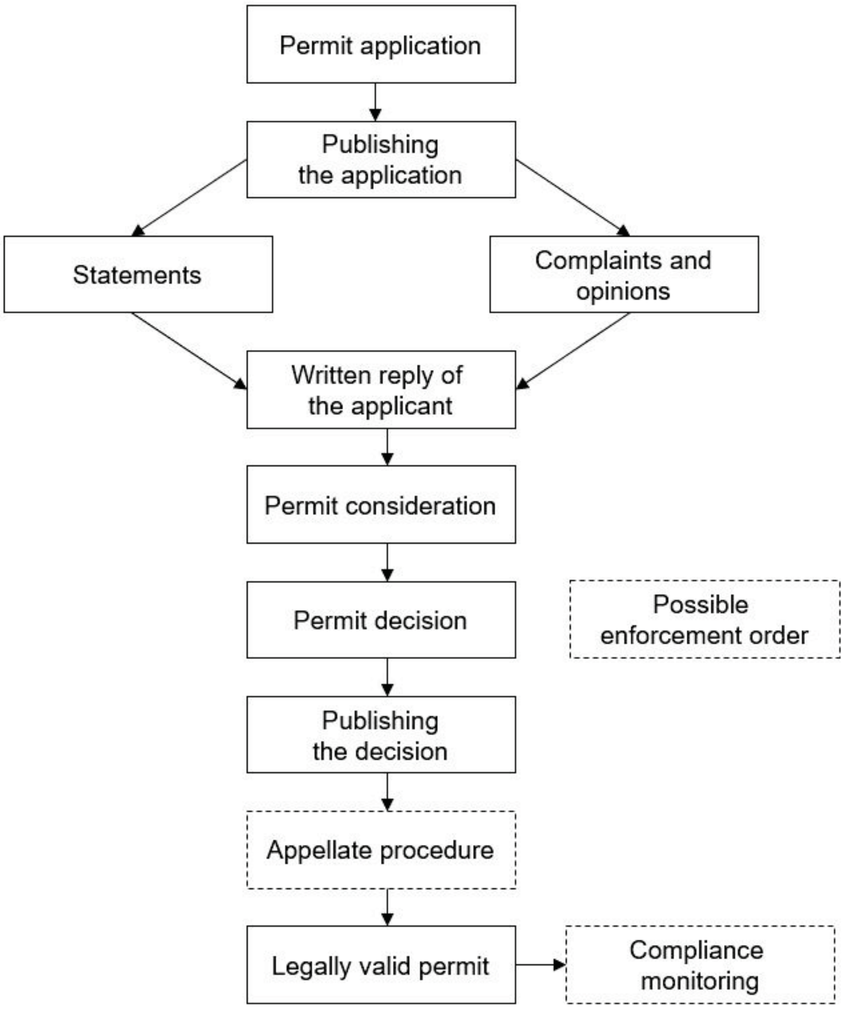


Figure 3. General flow chart of the permitting procedure in Finland

According to Estonian law, the obligation to apply for a permit depends on the type of emission in question. Requirements for permits for air emission depend on emission values and/or facility size (e.g. power of combustion engines). Permit for water emission is required regardless of quantities of pollutants discharged (even if background values are higher than those in discharged water). If facility size is above IED threshold values all emissions must be described in application.

6.1.1. Permit Application

Before starting to prepare a permit application, it is recommended that operators contact the competent authority and get an overview of the available templates and guidance materials. A list of available reference documents and tools is provided in Annex 2. It is the duty of the operator to submit sufficient data according to both article 26 of REACH and article 12 of IED to the competent authority. The competent authority is responsible to inform the operator about the extent and format of required chemical information.

According to Article 12 of the IED, the permit application must include descriptions of the following aspects related to chemical management:

- the installation and its activities;
- the raw and auxiliary materials, other substances and the energy used in or generated by the installation;
- the sources of emissions from the installation;
- the conditions of the site of the installation;
- where applicable, a baseline report in accordance with Article 22(2);
- the nature and quantities of foreseeable emissions from the installation into each medium as well as identification of significant effects of the emissions on the environment;
- the proposed technology and other techniques for preventing or, where this is not possible, reducing emissions from the installation;
- measures for the prevention, preparation for re-use, recycling and recovery of waste generated by the installation; and
- measures planned to monitor emissions into the environment.

It should be highlighted that in the permit application the following chemicals (see also Table 2) are to be specifically checked:

- hazardous substances referred to in CLP Regulation (1272/2008) including substances listed in Annex VI and substances meeting the criteria to be included in Annex VI. Thus, hazardous substances both self-classified by the manufacturer or already classified according to the harmonized classification system are relevant;
- Substances of Very High Concern (SVHC) under REACH;
- Persistent, Bioaccumulative and Toxic substances – PBT;
- very Persistent and very Bioaccumulative substances – vPvB;
- CMR1a and CMR1b substances;
- biocides regulation (528/2012);
- EU WFD substances;
    - Priority Hazardous Substances (PHS) and Priority Substances (PS) under WFD Annex X
    - Nationally selected RBSPs which are used in IED sector of concern
    - Substances relevant for groundwater protection being subject to threshold value setting (GWD Annex II pollutants).
- substances subject to Authorization in Annex XIV of REACH;
- restricted substances in Annex XVII of REACH;
- substances covered by the Stockholm Convention on Persistent Organic Pollutants; and
- dangerous substances according to Annex I of the Seveso Directive (2012/18)

The SDSs are important sources of information. If some information is missing from the SDS, the supplier should be asked to provide this. Additional supporting information can be obtained from public databases, such as the ECHA chemical databases (see section 3.1 and 3.2 and annex 2).
It is the competent authority's duty to ensure that the operator submits the chemical inventory (see section 5.2 and BAT candidate 2 in Annex 1) as complete as possible. Using the data provided in the chemical inventory the competent authority can:

- identify chemical products containing hazardous and non-biodegradable substances;
- develop permit conditions such as emission limit values for certain compounds;
- develop recommendations to substitute certain chemical products or at least to reduce their consumption; and
- set requirements for monitoring and abatement techniques.

The same applies to requirements for handling and storage of chemicals at the installations. For example, chemical products, which can spontaneously decompose resulting in explosions (e.g. hydrogen peroxide) or fires (e.g. sodium dithionite) must be stored separately with adequate security measures (see also section 5.3.1).

Although the IED does not address compliance with REACH duties as such, several European member states, which were interviewed for the IMPEL Report on "Linking the Directive on Industrial Emissions (IED) and the REACH Regulation", stated that IED and REACH are already linked directly or indirectly in their legislation (e.g. through reference on REACH in legislation and guidance documents or supporting tools). In the electronic IED application software (ELiA) REACH duties are for instance checked in the Template "Chemical Safety". In many other countries, REACH duties are not systematically checked during the IED permitting process.

Good practices:

Electronic tool for submission of applications (ELiA, Germany)

ELiA is an IT solution designed for the application and approval of installations under the IED resp. the German Clean Air Act (BImSchG). With this tool, companies or the engineering offices commissioned, can electronically prepare IED permit applications and send them to the competent permitting authority in encrypted form. The aim is to ensure that even extensive permitting procedures for the erection and operation of installations (or for their substantial change) are carried out more uniformly, effectively, efficiently and in accordance with the BImSchG. ELiA is currently used by 8 of the 16 German federal states and can be downloaded free of charge from the websites of the respective state governments.

Electronic chemical database (KemiDigi, Finland)

KemiDigi is a national chemical information resource and service which pulls together national chemical data. Suppliers or importers of chemicals will upload the chemical notices to KemiDigi. Companies (users of the chemicals) can use the KemiDigi system to compile their lists of chemicals used in production. Chemical, environmental and safety authorities are able to see the chemical lists in KemiDigi and use them for their supervision or permitting activities. **https://www.kemidigi.fi/**

Electronic tool for submission of applications (Estonia)

In Estonia all environmental permits are applied and managed in electronic platform (https://kotkas.envir.ee/). Applicant fills the forms. System makes preliminary logic tests (e.g. if given working hours are equal or less to total hours of entire year). Details are so far checked by authority specialist. Permits are issued in the same system. Permit owner receives reminders from system to

More open communication during the permitting process would make the whole process more effective and faster. Also, more communication between the environmental and chemical authorities would be valuable, e.g. the information regarding the use amounts of chemicals must be reported to many different authorities. It is extremely difficult for the applicant (=installation) to receive information during the process. More open communication and involvement of all stakeholders during the application phase could lead to fewer complaints and an overall faster and more streamlined process.

6.1.2. Assessment of the application documents and permit decision

The competent authority must assess the environmental performance of the installation. Chemical-related data are evaluated based on the chemical inventory (see section 5.2.1 and BAT candidate 2 in Annex 1). A major challenge for an efficient assessment of chemical-related information is the lack of systematic evaluation approaches and the lack of comprehensive and accessible information sources. The most important sources of information regarding relevant substances are the SDSs (see section 4.1.1). Other sources include chemical databases such as those made available by ECHA or national organisations (see section 3.1 and 3.2), as well as various checklists or reference tools. SDS exposure scenarios can serve as an additional valuable source of information (see section 4.1.3) if they are available. An exemplary compilation of suitable tools and references for hazardous substances is presented in Annex 2.

Good practice: Norway

The Norwegian Environmental Agency has developed a flow chart which is mainly used as a working tool by permit writers. The flowchart gives an overview of the different chemical regulations that apply when working with IED approvals and further contains a link to the Norwegian Chemicals Database. Searching by substance name, CAS or EC this database provides results which include the respective provisions of the National Priority List, the REACH Candidate List, the REACH Authorization List, the REACH Restriction List, CLP and possible other provisions (e.g. related to biocides).

Good practice: Germany (Schleswig-Holstein)

In Schleswig-Holstein, an interdepartmental team of experts was formed to pool expertise on IED applications and chemicals legislation and to make the relevant information more easily accessible. Consisting of experts in chemical law enforcement and environmental inspectors, the experts can advise both applicants and competent authorities on questions relating to chemical law aspects in the field of IED permitting and plant monitoring. Their work includes the evaluation of chemical inventories, the reference to obligations under chemicals law (in particular REACH obligations), the formulation of ancillary provisions for permitting, as well as the monitoring of chemicals legislation (general, implementation of actions, participation in monitoring of plants with regard to issues of chemicals legislation).

6.1.3. Monitoring, reporting and inspections

To ensure compliance with the emission limit values (ELVs) for the pollutants listed under Annex II IED and specified based on the chemical inventory (see section 5.2.1 above), installations should be subject to regular monitoring. The monitoring should address the nature of the pollutants as well as the possible cross-media effects (e.g. in case of scrubbers using water). In German federal states and in Sweden the operators are further obliged to establish and maintain a chemical inventory as part of the self-monitoring. In Finland a chemical inventory should be part of the permit application. According to the frequency defined in the permit, the operator has to update the chemical inventory, including:

- the major changes in the past year (new chemical products applied, recently identified/classified hazardous chemicals);

- measures taken or foreseen to prevent and abate emissions of hazardous chemicals;
- a compilation of all monitoring results of emissions to water and to air; and
- the type and quantity of hazardous waste listed together with the disposal route.

BAT conclusions shall be the reference point for setting the monitoring scheme (e.g. parameters to be monitored, test method to be applied and required frequency of reporting). The detailed monitoring program should then be done based on the chemical inventory at each installation.

According to Article 23 of the IED, the competent authority should regularly carry out environmental inspections. The inspections should be based on an individual inspection plan and monitoring programme. The determination of the period between site visits should be based on a systematic assessment of the environmental risks of the installation concerned (between 1 and 3 years). The characteristics of the chemicals processed or produced in the installation concerned play an important role in the risk assessment. However, as presented above, the chemicals management is also subject to annual reporting.

If the inspection reveals non-compliance with the permit conditions, an additional on-site visit must be carried out within 6 months after the first inspection according to Article 23 IED. Article 23 also states that non-routine inspections shall be carried out in order to investigate serious environmental damage, serious chemical and environmental accidents or incidents of non-compliance. The inspections should be carried out as soon as possible and, where appropriate, before the permit is granted, reviewed or updated.

Findings from the case studies:

- Some companies use consultants to carry out monitoring, environmental auditing and to help with securing that legal requirements are followed.
- In addition to monitoring program, company's own monitoring is carried out and certificates and audits are utilized. Company internal standards and requirements for chemicals are often stricter than permit conditions.
- In many cases the monitoring program can be updated even if the environmental permit is not updated with the approval of the supervisor.
- Monitoring requires resources and measuring and analysing certain parameters is more challenging and expensive than others. Therefore, the term "technically and economically feasible" would need more clarification also in relation to monitoring.
- The personnel at case installation would like the monitoring to be based on chemical inventory so that the amount of substances monitored would be reasonable and justified based on environmental fate of the substances and significant releases.
- There have been some misunderstandings about how the monitoring should be done. Therefore, the permit conditions and the monitoring program should be clear and unambiguous to all parties so that the authorities do not argue among themselves on how the requirements should be fulfilled.
- The personnel at some installation criticize the setting of different emission limits values in the environmental permits for the same parameters in different sites. It is not always clear for the operator what the limit values are based on. Therefore, a clear justification (e.g. lower emission limit values based on local conditions) is recommended from the authority.

6.1.4. Review of the permit

Competent authorities should regularly check whether substances manufactured or used in the installation are included in the SVHC list or whether they are subject to REACH authorization or restrictions. Changes should be considered when evaluating new measures and reviewing the permit. Furthermore, Art. 21 (1) of IED requires the competent authorities to ensure that, no later than four years after publication of the BAT conclusions, all permit conditions have been reviewed and, if necessary, updated to ensure compliance with the relevant provisions and that the operators of the installation have taken appropriate measures.

To improve the permit review process, it is recommended to include a stipulation in the permit that requires installations to submit a chemical inventory (as described under section 5.2.1 and in BAT candidate 2 in Annex 1) on an annual basis. This would allow for a regular screening of the applied chemicals/chemical products and thus minimise the risk of hazardous chemicals being used.

In Sweden IED and BAT conclusions are implemented as general binding rules. Therefore, instead of reviewing the permit after the publication of new BAT conclusions, operators are required to prepare an annual environmental report including a summary of all measures taken to ensure compliance with the general rules of consideration, the permit conditions and the BAT conclusions. A review of the permit is only required in case the installation is upgraded in response to the new regulations.

6.1.5. Challenges and recommendations with regard to environmental permitting

A common challenge for both the operators of IED installations and competent permitting authorities is the access to and evaluation of information on hazardous substances.

A lot of expertise on chemicals is needed among the permitting and supervising authorities. One solution could be establishment of chemical units (example from Germany[47]) or specific co-operative groups focusing on chemicals among authorities as has been done at national level in Finland[48]. Another solution could be a database where chemical lists and SDS are available for all relevant authorities, which is done e.g. in Finland[49]. Good practice is also to arrange regular meetings and trainings together with environmental and chemical authorities where the participants can share knowledge. Another good practice is to have continuous co-operation between chemical and environmental authorities. It would also be useful to regularly exchange information on identified problems and solutions between Member States' authorities.

One recommendation from HAZBREF is that there would be more discussion and co-operation between the applicant and different authorities during the permitting process. Open communication would clarify issues before the permit is issued and make the whole process more effective and faster.

It is the duty of the operator to submit sufficient data according to both REACH[50] and IED[51] to competent authority. The competent authority is responsible to inform the operator about the extent and format of required chemical information. For example, in Finland there is a specific table to be filled in for the permit application (see Annex 5). Usually operators simply compile chemical information from the SDSs and send a list together with the SDS for all chemical products

[47] Schleswig-Holstein, see chapter 5.1.3

[48] So-called "KEHYS group" considering only chemicals and containing supervising and permitting authorities from all regions of Finland

[49] KemiDigi

[50] Art. 36 of REACH

[51] Art 12 of IED

used. The evaluation of this chemical data is often too time consuming and difficult for the competent authority.

The format for a chemical inventory should be standardised. An example is given in Annex 5. It is the duty of the operator to provide information in a way that it can be quickly assessed and that conclusions in the form of permit requirements, stipulations and conditions more easily can be drawn.

There are first approaches to standardise the IED permit application requirements regarding information on chemicals used (e.g. ELiA Germany), but most IED requirements regarding the provision of information on used (hazardous) substances are by no means standardised at both either international or national levels. Therefore, section 6.1.2 and 6.1.3 and Annex 5 of this report provide an overview of chemical information requirements that should be available during environmental permitting.

If a chemical supplier fails to provide a SDS of sufficient quality, it is the duty of both the operator and the competent authority to request the missing information.

Availability of staff and expertise on chemicals pose a challenge for competent authorities. Short-staffed authorities are not able to dedicate enough time to each IED installation, hampering their ability to carry out extensive and in-depth evaluations of chemical inventories. Analysing measurement results and mass flows also requires a lot of time. Ideally, the staff composition of relevant authorities should gather expertise in the areas of chemical and environmental engineering, legal requirements and sectoral process technology.

7. Circular Economy Issues for Polymer and Plastic Production

The aim of circular economy (CE) is to eliminate waste and to use resources sustainably. For polymer manufacturers implementation of CE priorities means finding a reliable source of secondary raw materials (SRM). Environmental requirements of waste processing and the respective costs are key factors which determine waste management in the companies.

Hazardous substances may hamper polymer processing when SRM are used as raw material for polymer production. This issue has been discussed in numerous papers (an example of a multithreaded analysis is the study conducted by Stenmarck Å et al [52]).

For the industrial and market applications the polymer manufacturer usually provides the polymer in its basic form (e.g. PE, PP, PA or PS). The final composition of the plastic product is determined by the so-called “compounding” process, usually run by another entity further down in the value chain. In the POL BREF these processes are briefly characterized for polyamides as processes for changing polymer formulations with a wide range of molecular weight, mostly compounding grades.[53] In the compounding process, the polymers are modified according to the product requirements. Numerous chemicals (including hazardous substances), may be used in this process. The desired product properties are obtained through modifications of key parameters such as mechanical strength, heat resistance or flame retardation. Moreover, during the polymers production the risk of synthesis of hazardous substances during the process must be considered.

Accessibility of information on polymer composition significantly determines the opportunities of efficient processing of plastic waste. Hence, the most valuable waste stream for recycling is production waste from polymer manufacturing industry, with known composition and high purity (i.e. not contaminated with other polymers or other components). Correct coding and identification of hazardous wastes are very important. This mainly applies to "mirror codes". The hazardous entry must be chosen if this waste contains any dangerous substance(s) at or above hazardous levels.[54] The risk of hazardous substances is identified and characterized in the SDS and relates to specific substances. As the example of polyamides production these substances can be both the polymer components themselves - i.e. monomers (e.g. caprolactam), and additives (e.g. flame retardants as melamine cyanurate or antimony trioxide). Customer requirements plays an important role in

[52] Stenmarck Å et al, Hazardous substances in plastics – ways to increase recycling, TemaNord 2017

[53] https://eippcb.jrc.ec.europa.eu/reference/production-polymers

[54] Environment Agency Hazardous Waste: Interpretation of the definition and classification of hazardous waste (3rd edition 2013)

the final composition of plastic products due to use of process additives, which may include hazardous substances.

A tool supporting transfer of information on substances in the supply chain is the SCIP-database (**S**ubstances of **C**oncern **I**n articles, as such or in complex objects (**P**roducts) developed by ECHA.[55] The companies will need to submit information to the database on SVHCs[56] in articles from 2021 onwards, in addition to the obligation to inform customers (REACH Art. 33(1)). The aim of the database is "to promote the substitution of hazardous chemicals and a circular economy" by providing information of hazardous substances for consumers and waste operators. For companies to be able to fulfil the obligation to send information to the SCIP database, information flow is required from downstream users of chemicals in the value chain.

Findings from the case studies:
Each industry has a number of technical and legal standards for raw materials and products, which has to be fulfilled. The use of recycled plastics does not exempt from meeting the quality requirements. Therefore, the use of secondary raw materials is challenging for many polymer producers and some plastics are not usable for reuse in polymer production.

Plastics can be recycled mechanically or chemically (chemical processing is also called feedstock recycling). Mechanical recycling is widely used, but for the time being there is no economically viable method to chemically recover polymers back to monomers. For some polymers as e.g. expanded polystyrene, methods of physico-chemical treatment by dissolution in organic solvents are implemented. It allows for the recovery of high-quality raw feedstock for further PS production, as well as separation and removal of hazardous substances (as for example polybrominated flame retardants such as HBCDD).

In feedstock recycling the polymers are broken down to monomers and other basic chemical elements (by a depolymerization process). This is an option for polymers that are difficult to recycle mechanically due to low quality, composite nature or low economic value. These monomers can be used as virgin material alternatives in manufacturing new polymers.[57] However, undesirable chemicals may be a significant pollutant in chemical recycling processes. In the case of the previously mentioned polybrominated flame retardants, apart from being toxic, they increase the corrosion of the process equipment during hi-temperature depolymerization.

There are commercial applications for depolymerization processes already on the market, however the wide use is still limited and the whole technology is still under

[55] SCIP database will improve transparency on hazardous substances in articles (https://echa.europa.eu/-/scip-database-will-improve-transparency-on-hazardous-substances-in-articles)

[56] Candidate List of substances of very high concern for Authorization (https://echa.europa.eu/candidate-list-table)

[57] https://www.ceguide.org/Strategies-and-examples/Dispose/Feedstock-recycling

development and there are many economic and technical challenges to be solved. The challenges are confirmed by experiences of polyamide producers in Polish case installations. Despite the challenges, chemical recycling, where the raw material is produced by depolymerisation, appears to be the way forward for implementing Circular Economy issues in the polymer production sector.

Findings from the Polish case studies:

- One of the Polish case study operators has carried out depolymerization of solid waste to recover the monomer caprolactam, to produce polyamide. The installation was shut down in 1996, for financial reasons.
- The most valuable secondary raw material for polymer manufacturers are, due to the quality requirements, own post-production waste or well characterized waste from compounding processes.
- If secondary raw materials from external suppliers is considered, the raw material must meet high quality requirements.
- Good practice is to sort waste, taking into account possible contaminated materials.
- Good practise is avoiding hazardous waste storage by improvement of logistics. An example from a Polish case installation producing polystyrene is direct pumping of waste liquid mixture of styrene and ethylbenzene into tank trucks of a waste treatment company. The liquid waste is reused by an external operator.

8. Annexes

Annex 1 – Recommendations on BAT candidates

1. Chemical Management System

In order to reduce emissions of hazardous substances in the chemical industry, it is important to introduce a systematic approach for handling chemicals. It is possible to start by implementing individual actions and sub-measures and when it is fully implemented it can be called a Chemical Management System (CMS). A CMS should not be equated with an Environmental Management System (such as ISO 14001 or EMS according to BAT 1 in CWW) but it can be a part of an EMS. The systematic approach (PDCA) is the same in both CMS and EMS but in a CMS the focus is on the chemicals with the aim to improve management and reduce risks.

The purpose of the CMS is to get good control of chemicals and hazardous substances at the site, increase the knowledge of the characteristics, risks and impact and improve the processes to reduce emissions of hazardous substances, in a systematic way. As an example, through the chemical management system, a routine is established on how to minimize the use of hazardous chemicals and releases of hazardous substances.

The CMS is useful for handling obligations in different legislations like IED, REACH and SEVESO. Read more about obligations in chapter 4.

A general Chemical Management System follows the classical PDCA-cycle as any management system: Plan, Do, Check, Act. See figure 5 below.

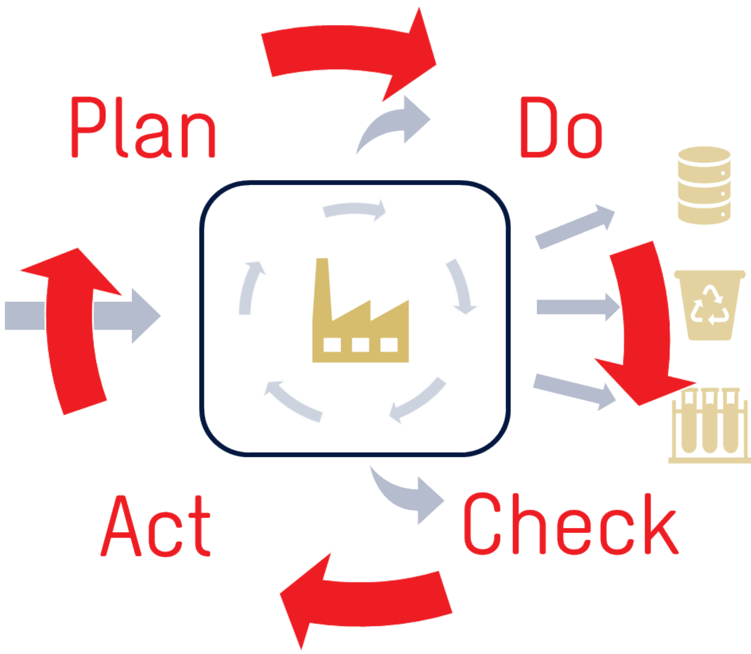


Figure 4: The PDCA-cycle related to chemical management

Plan

To allow for an effective chemical management, it is necessary to clearly identify which chemicals are used, how they should be used, and how the risks can be minimized. This requires that inventories established are continuously updated. Chemical inventories allow, for example, for a targeted compilation and assessment of chemical related information, which can serve the specific information requirements of different organizational units within the industrial facility.

I. Process chemicals procurement policy to select process chemicals and their suppliers with the aim to minimize the use of hazardous chemicals and to avoid the procurement of excess amounts of process chemicals. This is to reduce total releases to water and air.
II. Set goals and action plans to avoid or reduce the use of hazardous chemicals. However, it should be noted that some hazardous chemicals are necessary in certain processes and their substitution is not always possible. Similarly, there are processes in which the hazardous chemicals are fully consumed and their emissions to the environment are negligible.

As for all management systems, it is important to have a statement from the top management in the company, including:

- What chemicals or substances are approved/not approved to use on the site.
- How to ensure compliance with relevant legislation.
- How reduction of hazardous substances can be reached.
- How many undesirable chemicals can be substituted.

Do

Actions are taken according to the plan. For example, improvement of chemical and raw material inventory, conduct training to raise awareness, changing production procedures, etc.

III. Monitoring of regulatory changes related to hazardous chemicals and safeguarding compliance with applicable legal requirements.
IV. Identification of the process chemicals pathways through the plant (from procured process chemicals to products, waste, waste water and emissions to air).
V. Assessment of the risks associated with the chemicals, based on the chemicals' hazards, concentrations and amounts. This may include an estimation of their emissions to water and air.

Check

The result of the actions and implementation work are evaluated and analysed. The result must be reported so that current decision-makers are able to take action and establish new plans.

VI. Regular (e.g. annual) checks aiming at identifying any newly available and safer alternatives rather than continuing to use the same hazardous chemicals (e.g. process integrated techniques and measures or use of other chemicals with no or lower environmental impacts).

Act

Decisions on new changes for improvements, which then go into the planning phase again.

VII. Development and implementation of procedures for the handling, storage and use to prevent or reduce the emission to water and air.

Name of the technique	**Chemical Management System (CMS)**
Description of the technique	See the description above. Chemical Management System (CMS) is a way of working that will affect the organization in many ways. There is a need for commitment from the management and communication that these issues are of high importance for the company.
Technical description	BAT is to elaborate and implement a chemicals management system (CMS) that incorporates the following features: I. process chemicals procurement policy to select process chemicals and their suppliers with the aim to minimise the use of hazardous chemicals such as substances of very high concern and to avoid the procurement of excess amount of process chemicals. In order to reduce total (channelled and diffuse) emissions to environment; II. anticipatory monitoring of regulatory changes related to hazardous chemicals and safeguarding compliance with applicable legal requirements; III. identification of the process chemicals pathways through the plant (from procured process chemicals to products, waste, waste water and emissions to air); IV. assessment of the risks associated to the chemicals, based on the chemicals' hazards, concentrations and amounts. This may include an estimation of their emissions; V. regular (e.g. annual) check aiming at identifying potentially new available and safer alternatives to the use of hazardous chemicals (e.g. process integrated techniques and measures or use of other chemicals with no or lower environmental impacts); VI. goals and action plans to avoid or reduce the use of hazardous chemicals; VII. development and implementation of procedures for the handling, storage and use to prevent or reduce the emission to the environment.

Achieved environmental benefits	With an implemented CMS in place there are prerequisites to set the right focus on chemical handling and work with continuous improvements. The aim of the CMS is to achieve an improved handling of chemicals with a reduced risk of discharging hazardous substances to the environment. Targets are set by management and the resources allocated by the management.
Environmental performance with regard to hazardous substances and operational data	N/A
Cross-media effects	No cross-media effects are expected from this implementation.
Technical considerations relevant to applicability	A CMS can be implemented within the whole chemical sector and it can be adapted to each type of industry with the focus needed.
Economics	Above all, it is about appointing an organization with a team that can lead the changes. First, in the form of a project, but when the appointed actions are in place and implemented in the operations it will be a natural part in the ordinary procedures at the site.
Driving force for implementation	Costumer-specific requirements, requirements from insurance companies or other stakeholders can be a driving force for implementing a CMS.
Example plants	The chemical industry in Sweden working with production of organic chemicals (polymers) used in pharmaceutical industries (not a case study installation).
Reference literature	Framework and certification from internationally recognized management systems such as ISO 9001 or ISO 140001 may be referenced and/or utilized in developing a chemicals management system. **https://www.iso.org/standards.html**

2. Chemical and raw material inventory

The main purpose with a chemical inventory is to gain control and acquire a good overview of all chemicals, including raw materials/products for production, maintenance- and cleaning products. A structured inventory is a key factor for further actions and work to maintain a successful chemical management. This type of system can be built up in different ways and include small or large amounts of data that can be used for screening of hazardous substances used at a specific site. Depending on the size of the company and the amount and variation of chemicals/products that are used, different datasets should be included in the system. The basic information, besides the product names, is some type of material identification. If available, the CAS or EC numbers should be added to the inventory.

This type of basic inventory can be built up in a simple Excel list with the ability to evolve and stretch out the information added during the work process. Basic information extracted from an SDS should be included in the inventory;

- product name;
- producer;
- type of product (Chemical categorization);
- CAS number (Raw material and substances);
- content of hazardous substances in weight-% for individual substances in mixtures;
- CLP hazards;
- SDS date; and
- if available, information from the exposure scenario.

The purpose of this basic data is to provide a possibility to track and pinpoint hazardous substances and to identify products in the facilities that contain these substances. The CAS numbers gives an identification commonly used in legislative and customers band and restriction listings. There are no given legal applications on how old an SDS can be, so the SDS date is added to evaluate how old the given information is and to monitor the need for a review. The operator should ask the chemical supplier for updated information when needed.

The quality of the SDS can be a risk factor for inaccurate safety information. Since not all classifications are harmonized, different manufacturers can provide contradictory information on the same substance. For monitoring and evaluating information of hazardous chemicals, there are many tools on the ECHA webpage and industry sector NGOs that can assist in conducting a high-quality-risk assessment for substances of concern.

For a complex system, toxicological, and physical data can be added to the inventory for further advanced evaluations and screenings in the CMS process, both for approval evaluations and substitution, but also physical parameters useful for the process mapping of hazardous chemicals and handling and storage processes.

Basic information						**Advanced tox data used for evaluation and approvals**							**Storage**		
Commercial Name	Producer	Process application	CAS	CLP hazard	SDS date	Cont. haz. Substances in [weight-%] for indiv. subst.	Biolog. degradation/ testing method	BOD/COD value	Toxicity to bacteria EC50	Toxicity to algae EC50	Toxicity to daphnia EC50	Toxicity to fish LC50	Flashpoint	Annual consumption (kg)	Max quantity stored

Depending on the number of chemicals used at the site, there can be different solutions for a chemical inventory. In the simplest case with handling of up to 200 chemicals, an Excel file with the setup described above can be suitable.

But if the number of chemicals is greater or used in facilities with different units, a commercial chemical handling system that can be business-integrated or as a stand-alone system is preferred. Beside the fact that such a system can handle and structure a larger number of products, such systems also provide good support functions such as; access to safety data sheets, risk assessment functions, direct contact and update to legislative, classification and labelling changes.

The main advantage with a digital chemical database in the aspect of hazardous substances is the possibility of screening through all products used in a company against various substance lists, governmentally and customer integrated. Keeping the register up to date is crucial for all further work with detecting, monitoring and actions for prevention and reduction of hazardous substances.

Following is a list of important functions to request in a chemical handling tool;

- List of all chemical products used
- Identification of chemical products with high acute or chronic aquatic toxicity (CLP classification)
- Identification of WFD priority substances (PS), priority hazardous substances (PHS) and SVHC substances (CMRs 1A/1B)
- Identification of national authority databases e.g., Swedish Chemical Agency PRIO-list
- Identification of chemical products that are non-biodegradable
- Identification of VOC, and any other environmentally relevant properties (PBT, vPvB), which are not based on CLP hazard classification
- Identification of all combustible/flammable products and those that can decompose (thermally or by reaction with other chemicals)
- Compilation of relevant data required for planning and implementing adequate storage and handling
- Assessing compatibility of substances and preparing according storage layout plan and allowable storage volumes
- Compilation of data relevant for communication, reporting and/or certification purposes such as for authorities or customers

- Cross-referencing with manufacturing restricted substances lists (e.g. ECHA authorized and restricted substances) or specific customer's substance lists

Name of the technique	**Chemical and raw material inventory.**
Description of the technique	A Chemical inventory brings structure and a solid handling tool for revue and further preventive and safety work with chemical products. It is the first step for an organized ad structured work and a key to a successful chemical management system.
Technical description	Specific data for all the chemical products used are entered in a database from where targeted information can be searched. The main sources of information used for the different chemical products are the safety data sheets (SDS). A commercial inventory can also provide tools for updated substance lists e.g. REACH (SVHC, ANNEX XIV and ANNEX XVII), RoHS, POP or WFD PS. The digital lists can be implemented in the system and used for scanning to identify products or substances that contain listed substances or targeted classifications.
Achieved environmental benefits	A well-arranged and up to date chemical inventory is the key tool for further preventive work with reduction of hazardous substances. Combined with different filtering and evaluation methods the system helps identifying substances with undesired characteristics.
Environmental performance with regard to hazardous substances and operational data	A procedure on how to bring in new chemicals aligned with an approval process can ensure that all chemicals get evaluated and brought into the inventory. Besides this approval process that can ensure the registration of a new product, a good maintenance system has to be implemented to ensure the information in the system being up to date. Communication and good routines should be implemented with the suppliers.
Cross-media effects	SDS quality and information not harmonized can be an issue. Different suppliers can present contractually data on the same substance.
Technical considerations relevant to applicability	This technique is applicable to any industry as a key part of a chemicals management system. The necessary software application for the establishment of such an inventory and search and evaluation tools can either be obtained by a range of commercial software systems available on the market (as part of an integrated business system or stand-alone application) or developed in-house.
Economics	The investment and operating costs for a chemical data base depend on the intended use and need of advanced searching systems and integrations with other systems. Commercial software is available as simple lists up to advanced systems that can be integrated into other

	business systems. Savings usually arise from being able to streamline stocks, manage surplus chemicals, simplify or automate the procedures/process as well as indirectly from reducing environmental management costs.
Driving force for implementation	Companies may be required/recommended by authorities to maintain a chemical inventory, for example: German Hazardous Substances Ordinance (GefStoffV), Finnish National Chemical Register (KemiDigi) and Swedish Chemical Agency Product Register on Chemical Products and Biotechnical Organisms (Products Register). A chemical inventory is also required in the environmental permit application in Finland, Estonia and Sweden. The minimum requested information meets the example on base set information given above.
Example plants	Example plants from relevant case studies where chemical inventories are described, both from the polymer, STM and textile sector.
Reference literature	REACH: https://echa.europa.eu/information-on-chemicals SCIP: Substances of Concern In articles as such or in complex objects (Products) https://echa.europa.eu/sv/scip-database Swedish law: Regulation (2008:245) on chemical products and biotechnological organisms. https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-2008245-om-kemiska-produkter-och_sfs-2008-245 Finnish law on chemical information notification 553/2008 https://www.finlex.fi/fi/laki/alkup/2008/20080553 Examples of commercial systems for chemical inventories: Ichemistry https://intersolia.com/en/ichemistry/ EcoOnline https://www.ecoonline.com/ Yordas https://www.yordasgroup.com/hive/software Sphera https://sphera.com/spheracloud/

3. Process mapping of hazardous substances

To be able to take actions for reducing emissions of hazardous substances, it is necessary to gain good knowledge of the production processes. An example of how to do this is process mapping of hazardous substances. The process mapping includes six different steps; identification, mass balances, sampling and analysis, implementation of actions and verification. See the project process in figure 6 below.

Figure 5: Six steps of process mapping of hazardous substances

1. The first step of the process mapping is to review all the chemicals that are part of the production processes at the site and sort these into the category SOC (Substances of Concern) or as Not SOC, defined by the company.

In addition, the SOC category is divided into subcategories based on the inherent properties of the chemicals (such as harmful to the aquatic environment, toxicity, bioaccumulation, biodegradability, etc.). The different subcategories then have different strategies for further investigation.

To acquire a manageable number of substances to focus on, there is a need to prioritize. Table 3 below presents an example about how to prioritize. In this example, substances classified as harmful to the aquatic environment and substances with a PEC/PNEC >1 are prioritized (Category no. 1). Prioritization can be performed in other ways, depending on the number and types of substances.

Table 3: Example of prioritizing substances of concern (SOC)

SOC/NSOC	Catagory number	Description	Further handling
SOC	1	- Harmful to the aquatic environment, Carcinogenic & organ toxic - PEC/PNEC > 1	Need more detailed investigations and analysis (theoretically & by sample testing). Mitigating actions may be needed.
SOC	2	Metals Solvents	Ensure handling, volumes, etc.
SOC	3	Bioaccumulation, biodegradability	1. Review the concentration of outgoing water 2. Check for binding in sludge
SOC	4	Other chemicals that is not included above but potenitially could have a negative effect on the recipient.	Need of further investigations regarding potential negative effect in recipient.
Micro plastics	MP	Micro plastics	Does not need any investigations at the moment but may need further focus in the future
Not SOC	N/A	Other chemicals with no negative effect on the environment	N/A

2. Step two concerns initiating the mapping work itself, the scope of which depends on the nature of the chemical, i.e. subcategory in the SOC classification. The most hazardous chemicals require in-depth examination with theoretical mass balances, sampling and discussion of possible measures. The goal is for all chemicals to have a minimal negative impact on the recipient.

3. In step three, depending on the results from the theoretical mass balances of each substance, it may be necessary with sampling and analysis to verify the theoretical mass balances.

4. Step four involves identification of necessary actions and implementation of such. The actions depend on the processes but can be abatement measures, such as separation of waste streams or residual process water for waste handling or pre-treatment or changes in the production methods to obtain a higher yield and minimize the emissions, etc.

5. In step five, when a new procedure is implemented, it is important to verify the results of the action.

6. The final step, step six, is to follow up the entire process, mapping progress to make sure that the goal of the project has been achieved.

Name of the technique	**Process mapping of hazardous substances**
Description of the technique	See the description above. Process mapping of hazardous substances is a type of inventory of the hazardous substances at the site. This can be implemented as a project or as a part of the normal procedures.
Technical description	Process mapping of hazardous substances is not a technical solution. It is a procedure or a project, as described above. The output of the process mapping can be different technical measures.
Achieved environmental benefits	These can be many: -in-depth knowledge of chemicals and substances in the processes -higher yield and reduction of chemicals used -substitution of hazardous substances -development of abatement techniques -when working with measures closer to the source, there will be less volumes to be addressed The environmental benefits are all aimed

	at reducing emissions of hazardous substances.
Environmental performance with regard to hazardous substances and operational data	The purpose of the process mapping is to achieve a reduction of the emissions of hazardous substances. The measures can range from simple process adjustments to extensive pre-treatments, depending on the outcome of steps 1-4. This will affect the environmental performance.
Cross-media effects	No cross-media effects are expected from this implementation.
Technical considerations relevant to applicability	A project for process mapping of hazardous substances can be implemented within the whole chemical sector and it can be adapted to each type of industry with focus on relevant substances. In cases with a very large number of processes and production steps it can be necessary to prioritize.
Economics	To achieve the desired results the organization must manage the work. In addition to a project leader, there must be representatives from the production department, development department (R&D-function), the environmental department, as well as analytical competence within the organization. Depending on how many substances are prioritized, the project can last for many years.
Driving force for implementation	Instead of a large investment in a new waste water treatment plant with very complex treatment techniques, the solution is to reduce the hazardous substances at source, which is less expensive. In addition, it is more efficient to introduce measures at source, see comment above regarding volumes.
Example plants	Chemical industry in Sweden working with production of organic chemicals (polymers).
Reference literature	-

Another example of process mapping follows, from Case Study No. 4 (Finland), where the use of the information in the exposure scenarios in the extended SDS is utilized in EUSES models or in the STAN tool, to indicate need of measurements for different substances in the production processes.

Challenges for these types of modelling is the lack of specific and process adjusted data. This modelling requires quite a lot of monitoring data (inputs and outputs). In addition, the more there are uncertainties, the more unreliable the result is.

Name of the technique	**Application of SDS exposure scenarios**
Description of the technique	The exposure scenario in the SDS indicates where the substance ends up in various processes. These are made with the EUSES model, which gives an estimate whether the PNEC values in environmental compartments might be exceeded. The model uses default values, which leads to "worst case scenarios". This means that the exposure scenario produces rather vague risk ratios for a specific industrial process. Due to the numerous different industrial processes, it is not possible to calculate accurate risk ratios for all of them. Therefore, the exposure scenario's risk ratios should be refined and recalculated to the specific process in each facility.
Technical description	When the exposure scenario in the supplier's SDS does not cover the use even after scaling: - either because of larger than assessed amounts used or - the usage conditions differ from the description of the exposure scenario Or when the use in the exposure scenario indicates a risk as the PEC/PNEC ratio in the ES >1 A site-specific risk ratio calculation should be done for the hazardous chemicals used in the processes: WFD priority substances, SVHC substances and substances labelled as hazardous to the environment (GHS hazards H400, H410, H411, H412 and H413). The risk ratio can be based either for sector SPERCs if available or estimated by using measured data and by calculating substance flow over the process to estimate emissions to the environment. For example, available tools are STAN tool and the EUSES model. For the modelling data inputs and outputs to/from the process are needed.
Achieved environmental benefits	Once the relevant substances are identified, monitoring and abatement measures can be focused.
Environmental performance with regard to hazardous substances and operational data	
Cross-media effects	No cross-media effects identified

Name of the technique	**Application of SDS exposure scenarios**
Technical considerations relevant to applicability	Generally applicable. Modelling requires quite a lot of monitoring data (inputs and outputs) and the more there are uncertainties, the more unreliable the result is. Another challenge is that these detailed exposure scenarios are often missing from the SDSs. Despite missing exposure scenarios, the modelling exercise should be performed for all necessary chemicals indicated in point "Technical description".
Economics	The modelling tools are freely available but require specific competence to apply.
Driving force for implementation	Modelling techniques and measures can be used as supporting tools in identifying relevant emissions to the environment.
Example plants	
Reference literature	STAN tool http://www.stan2web.net/ EUSES model https://ec.europa.eu/jrc/en/scientific-tool/european-union-system-evaluation-substances

4. Optimization of process integrated recycling

Establishing recirculation in one process step could lead to big savings in resource use as smaller amounts of new materials have to be added in the process. By recirculating chemicals that are not needed in the final product and that would otherwise go to waste, both the chemical input and the unwanted output could be reduced.

One example of a recirculating process step is from the Case Study No1 (Finland) and the production of polyethylene. The process consists of the steps pre-treatment, loop and gas-phase reactors in series, gas recycling and processing.

The output from the loop reactors is a polymer powder that is lead through a flash tank where residual unreacted hydrocarbons that have the potential for material recovery are separated. The residual hydrocarbons are separated from the powder by nitrogen purging and fed to distillation columns where light and heavy compounds are separated. Various hydrocarbon fractions are separated in several distillation units for different purposes. Oligomers are used for energy production; light hydrocarbons are recycled to another process for olefin production as feedstock and unreacted hydrocarbons are recycled back to the loop and gas-phase reactors as an input to the process.

Recirculation will result in environmental benefits such as decreased air emissions due to efficient use of hydrocarbons, a minimised use of hazardous chemicals and hence reduced emissions of hazardous substances to the environment.

The technique can be used in different types of polymer production where monomer recycling is possible. However, there might be a need for modifications in the recycling process.

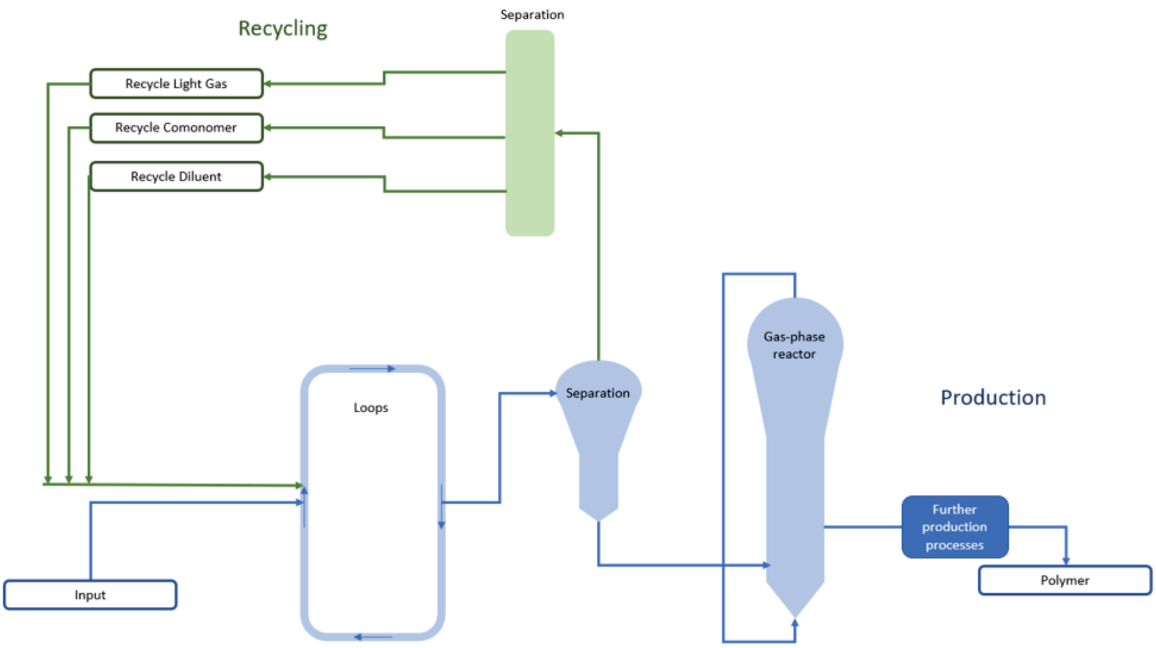


Figure 6: Simplification of process steps in the polymer production

Name of the technique	**Optimization of recirculation process**
Description of the technique	The polymer powder contains still a lot of hydrocarbon gases before pelletizing. The hydrocarbon gases must be cleaned from the powder prior to pelletizing, to eliminate the risk of explosion. Hydrocarbons can be recycled if they are cleaned and separated.
Technical description	Optimization of intermediate gas flows through automatic process control (APC system, advanced process control) to enhance material recovery and to minimize flaring. Residual hydrocarbons are separated from polymer powder by nitrogen purging. Hydrocarbons are fed to the distillation columns where light and heavy compounds are first separated. Oligomers are removed and used for energy production. Various hydrocarbon fractions are separated in several distillation units. Unreacted hydrocarbons are fed back to the loop and gas phase reactors. Light hydrocarbon fractions are recycled to the olefin production as feedstock.
Achieved environmental benefits	Emissions to air are minimized due to the efficient use of hydrocarbons. The use of nitrogen is optimized and the use of additional/booster fuel for the flare is minimized.
Environmental performance with regard to hazardous substances and operational data	With efficient process control, good chemical management and process integrated techniques, a good level of environmental performance is achieved without end-of-pipe abatement techniques.
	This also minimizes the use of hazardous chemicals and reduces the emissions of hazardous substances into the environment.
Cross-media effects	Efficient use of raw materials Energy efficiency The known trade-offs of the process exist between the use of nitrogen and use of fuel: too much nitrogen will cause dilution of flare gas stream possibly causing incomplete combustion and flame out of the flare, too little will not remove all hydrocarbons. The used amount of nitrogen also affects the NO_x emissions. The optimal use of nitrogen is enough to **replace** all hydrocarbons but is not

	too much to cause excessive NO_x emissions and excessive use of fuel in the flare.
Technical considerations relevant to applicability	Automatic process control system is required A receiving facility is needed for the return gases. Preferably the gases shall end up in material recovery, secondly in energy recovery. In this sight the return gases are fed to steam cracker as feedstock.
Economics	After investment, savings in raw material, energy and CO_2-emission allowance costs.
Driving force for implementation	Financial reasons, minimized flaring and CO_2-emissions.
Example plants	Case Study No1, Finland (and 2 other sites in Europe)
Reference literature	Case Study No1 (Finland)

5. Waste water Treatment in polymer production site

A drum filter is an added technique for waste water treatment to prevent pollutions of plastic particles form a LD/HD-production plant (Sweden). This added waste water treatment is part of the plant's project "Zero pellets lost". The filter is a technical solution that can be added in waste water treatment of all polymer producing plastic pellets.

Name of the technique	**Additional treatment step in waste water treatment plant**
Description of the technique	As part of the plants work program for zero pellets lost, the plant has installed an additional treatment step with removal of micro particles down to 10 µm in water leaving the site. There is treatment both for process water and storm water in separate flows.
Technical description	Drum filter with removal of particles down to 10 µm. Capacity to treat water flows up to 250 m^3/h. The process water filter is placed after oil separation and before final equalisation pond. The storm water filter is placed before the equalization pond.
Achieved environmental benefits	Reduce plastic particles down to 10 µm in water discharged from the production unit, even rainwater is filtrated. The water is finally discharged to the sea.
Cross-media effects	No cross-media effects are expected from this implementation.
Technical considerations relevant to applicability	This technique is applicable in facilities producing polymer pellets. The example plant has operational issues with dewatering the residues from back flushing of the drum filter treating the storm water. Project on-going for finding solutions for these issues.
Economics	The example plant has not provided information on the financial investment for this installation.
Driving force for implementation	As a plastic producer, the example plant is doing everything possible to minimize the risk for plastic particles ending up outside of the production plant - "zero pellet loss". They identified three risk areas for

	spreading of pellets; via transports, water effluents and snow. Therefore, they have implemented measures connected to all these risks and the filtration of all water flows is one of them.
Example plants	LD/HD-production plant (Sweden)

Annex 2 – Overview of selected references and tools

The following list provides an overview of available, sector specific tools for good chemical management of substances and mixtures (general and textile). The list does not claim to be an exhaustive list of references and tools which could be applied in the sector. Other tools may exist, or may be developed, which could also be considered for good chemicals management.

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps[58]
CHEmical Safety Assessment and Reporting tool (CHESAR)	https://chesar.echa.europa.eu/home	Chesar is an application developed by the European Chemicals Agency (ECHA) to help companies to carry out their chemical safety assessments (CSAs) and to prepare their chemical safety reports (CSRs) and exposure scenarios (ESs) for communication in the supply chain. Chesar enables registrants to carry out their safety assessments in a structured, harmonised, transparent and efficient way. This includes the importing of substance-related data directly from IUCLID, describing the uses of the substance, carrying out exposure assessment including identifying conditions of safe use, related exposure estimates and demonstrating control of risks. Based on this, Chesar automatically generates the CSR and exposure scenarios for communication as a text document, and export information on use and exposure to IUCLID. Chesar also facilitates the re-use (or update) of assessment elements generated in a single Chesar instance or imported from external sources.		general	PA, M
Database of the C+L directory at ECHA	http://echa.europa.eu/de/information-on-chemicals/cl-inventory-database	This database contains information on classification and labelling (C&L) of notified and registered substances submitted to ECHA during substance registration under REACH or notification under CLP, including harmonised classifications (Table 3.1 in Annex VI of CLP). ECHA maintains the list but does not check the validity of this information.	All European languages		PA, AA, R, M
Database on REACH-registered substances at ECHA	https://echa.europa.eu/information-on-chemicals/registered-substances	The data contained here are taken from the registration dossiers submitted to ECHA. In addition to the classification, this database also contains other information on the substances, such as physical data or study summaries.	All European languages	Yes, see findings of HAZBREF, WP2	PA, AA, R
ECETOC's Targeted Risk Assessment (TRA) tool	http://www.ecetoc.org/tools/targeted-risk-assessment-tra/	ECETOC TRA ("Targeted Risk Assessment") is a tool for exposure assessment, developed by the ECETOC research group. The instrument will be used as preferred level 1 model for workplace exposure estimation.	English		AA
eChemPortal by OECD	http://www.echemportal.org	The eChemPortal enables the search for reports and data sets of chemicals by substance name, CAS number and the like. It	English		PA, AA

[58] I (Identification of the installation); PA (Permit Application); AA (Assessment of the application documents); PI (Involvement of the Public); PD (Permit Decision) M (Monitoring, reporting and inspections), R (Review of the Permit)

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps[58]
		contains links to hazard and risk analyses and national and regional classifications. Information on exposure and use of the substances is also available.			
ES Modifier	Not available	This tool, jointly developed by TNO (Netherlands), Confederation of Danish Industry was meant to support end users in checking and modifying suppliers' exposure scenarios (ES) to fit their own conditions, formulators in preparing ES for preparations as well as support preparation of Downstream user Chemical Safety Reports (CSR).		Current status unknown	
European Union System for the Evaluation of Substances (EUSES)	https://ec.europa.eu/jrc/en/scientific-tool/european-union-system-evaluation-substances	EUSES was developed to enable government authorities, research institutes and chemical companies to carry out rapid and efficient assessments of the general risks posed by chemical substances	Various		AA
GESTIS Substance Database	www.dguv.de/ifa/stoffdatenbank	The GESTIS substance database contains information on more than 8700 substances with regard to identification, physical, toxicological and eco-toxicological properties, occupational medicine, first aid and safe handling as well as relevant regulations. Information on classification and labelling is partly taken from SDS from manufacturers or distributors.	German, English		PA, AA, R
GisChem Hazardous Substance Information System of the German Employers' Liability Insurance Association for Raw Materials and Chemical Industries (BG RCI) and the German Employers' Liability Insurance Association for Wood and Metal (BGHM)	http://www.gischem.de/suche/index.htm	The database contains data sheets and draft operating instructions. The search for hazardous substances can be carried out by name, CAS no., branches of industry or procedure. In addition, selection is also possible via a complete list. Under the GisChem Interactive the site also offers free-of-charge assessment tools such the "mixture calculator" which provide assistance in finding the correct classification and labelling for any substance mixtures whatsoever in the GHS system	German, with sections in English		PA, AA, R
GSBL - Common Substance Data Pool Federation/States	http://www.gsbl.de/	In the data pool of the BMU and the environment ministries of the German states, up-to-date, comprehensive information on environmentally relevant properties of chemical substances and mixtures is available for all areas of environmental protection and hazard prevention. Access to the complete GSBL database is reserved for representatives of the authorities.	German		PA, AA, R
Hazardous substance database of the	https://www.gefahrstoff-info.de/	The common hazardous substance database of the authorities of all federal states responsible for the state monitoring of hazardous substance legislation in the field of occupational health and safety	German		AA, M, R

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps[58]
Federal states in Germany (GDL):		(GDL) contains information on hazards and protective measures as well as legal regulations/limit values of individual substances and substance groups. Important aspects from relevant national and EU legislation are integrated into the database on a substance or substance group basis.			
IGS - Information system for hazardous substances:	http://igsvtu.lanuv.nrw.de	IGS is provided by the State Office for Nature, Environment and Consumer Protection of North Rhine-Westphalia. In IGS-Public, the publicly accessible part of the substance data information system, the focus is on the substance-related mapping of legal sources.	German, English		PA, AA, R
Information about Chemicals	https://echa.europa.eu/information-on-chemicals	Important and comprehensive source of information on chemicals produced in or imported into Europe. It covers hazardous properties, classification, labelling and information on their safe use. Since 20 January 2016, information on some 120,000 chemicals has been available in complex form. It is divided into three levels: an information map, a short profile and detailed source data. Statistical evaluations of the different classifications from the C&L inventory are also available for many substances.	All European languages		PA, AA
KemiDigi	https://www.kemidigi.fi/	KemiDigi is a national chemical information resource and service which pulls together national chemical data. KemiDigi aims to create a streamlined electronic service for companies managing their reporting obligations related to chemicals. The core elements of KemiDigi comprises (i) a chemical register of the dangerous chemicals on the market; (ii) a substance register of substances and the groups comprising the substances; and (iii) lists of chemicals by companies, which utilise information from the chemical and substance registers.	Finnish, Swedish, English	no	PA, AA
Norwegian Chemical database	http://miljodirektoratet.no/kjemikaliesok/	This database is a search tool for substances, by name or CAS- and EC-numbers. The search results in which chemical regulations a substance is covered by the national priority list, REACH candidate list, REACH authorization list, REACH restricted substance list, CLP and possible other regulations like for biocides.	Norwegian		PA, AA, R
OECD Substitution and Alternatives Assessment Tool Selector	http://www.oecdsaatoolbox.org/Home/Tools	This website allows the user to identify and link to various tools designed for providing information on online resources and software that can be used in conducting chemical substitutions or alternatives assessments. The Tool Selector is divided into two categories: (i) Tools, which provide users with the ability to evaluate a chemical, material, process, product and/or technology for attribute analysis with an alternatives assessment, and (ii) data sources, which contain a repository of organized information but no mechanism for data manipulation for outside users.			PA, AA, R, M

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps[58]
Chemsec SIN list	https://sinlist.chemsec.org/	The SIN List is a database of hazardous chemicals that are used in a wide variety of articles, products and manufacturing processes around the globe. Some chemicals on the list might be restricted or banned in the EU in the future. The SIN List is publicly available and regularly updated.	English	No	
ChemSec Market place	https://marketplace.chemsec.org/	Marketplace is a platform where companies can find safer alternatives to hazardous chemicals, enabling buyers and suppliers to start substituting chemicals of concern.	English	No	
Other tools					
PRIO (Sweden)	https://www.kemi.se/en/prio-start	PRIO was developed by the Swedish Chemical Inspectorate (KEMI) to help eliminate high hazard chemicals from products to meet the Swedish government's goal of a "non-toxic environment" by 2020. PRIO contains a database of chemicals of high concern to human health and the environment, which are divided into "phase-out" or "priority risk reduction" chemicals. "Phase-out" chemicals should be avoided or substituted, and the tool provides a seven-step process for identifying safer alternatives. For "priority risk reduction" chemicals, further assessments are recommended to ensure risk minimization. Users search databases based on authoritative lists by specific substance, hazard properties, chemical category, or specific database. If a specific substance is not in the database, users can research substance properties and compare against PRIO criteria.	Swedish		AA, M, R
Rigoletto (UBA)	https://webrigoletto.uba.de/rigoletto/public/language.do;jsessionid=A3C82B85A5DC7C9949C6472AAFE1ECDD?language=english	This web-based information tool has been established by the Umweltbundesamt, Germany to support users in determining the water hazard classes (WGK) of substances and mixtures (e.g. 1: slightly hazardous to water, 2: obviously hazardous to water, 3: highly hazardous to water.) on the basis of the Ordinance on Facilities for Handling Substances that are Hazardous to Water (Verordnung über Anlagen zum Umgang mit wassergefährdenden Stoffen (AwSV)) of 18 April 2017	German/ English		PA, AA, R
SPIN - Substances in Preparations in Nordic Countries	http://spin2000.net/	SPIN is a database on the use of Substances in Products in the Nordic Countries. It is a publicly accessible database, which can be used free of charge. The user can find information on the chemicals that are used in the Nordic countries. The information includes quantities, industries in which it is used (NACE and national) and the function it is used for (USE Category).	English		AA
Stoffenmanager	https://gestis.stoffenmanager.com	Developed by TNO (Netherlands, Arbo Unie and BECO (EY) in 2003, this online instrument helps users identify the chemical hazards, control the exposure at workplaces and communicate in an understandable, transparent manner to managers, employees	German, English	General comment: Paid and free version	PA

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps[58]
		and external stakeholders, thus helping them to comply with the regulatory and broader ethical and sustainability requirements.			
SubSelect (UBA)	https://www.umweltbundesamt.de/en/document/subselect-guide-for-the-selection-of-sustainable	This guide helps you to select more sustainable chemicals. The selection of sustainable chemicals has beneficial effects for occupational safety, consumer and environmental protection. In the medium run, sustainability leads to more innovative uses of chemicals, and is therefore also economically attractive. More sustainable products mean: fewer pollutants, greater acceptance, less adverse impacts on the environment and to society, with simultaneous success in the market. SubSelect help you as a manufacturer, formulators or end-users of substances to put a greater emphasis on sustainability aspects: in the selection of substances and use of chemicals in the company.	German, English, Baltic languages		R
EUSES	https://ec.europa.eu/jrc/sites/jrcsh/files/EUSES_2.1.2_installation_and_docs.zip	Estimate Predicted Environmental Concentrations (PEC) - The European Union System for the Evaluation of Substances (EUSES) is a free tool developed by the European Commission to assist authorities, research institutes and companies to estimate environmental exposure levels of industrial chemicals and biocides. EUSES is easy to use. Only a few data on substance properties are needed to calculate PECs for tier 1 assessment. If the use of default exposure estimates and tier 1 assessment do not lead to PEC/PNEC<1, a refined assessment is possible in EUSES by including more specific information on releases.			
PubChem	https://pubchem.ncbi.nlm.nih.gov/	PubChem is an open chemistry database at the National Institutes of Health (NIH). PubChem mostly contains small molecules, but also larger molecules such as nucleotides, carbohydrates, lipids, peptides, and chemically-modified macromolecules. We collect information on chemical structures, identifiers, chemical and physical properties, biological activities, patents, health, safety, toxicity data, and many others. PubChem records are contributed by hundreds of data sources. Examples include government agencies, chemical vendors, journal publishers, and more.	English		

Annex 3 – Safety Data Sheets – Good example

The following table includes examples and description of good practice for selected SDS sections. The selection of the sections covered is based on a technical assessment of their relevance for good chemical management. Where appropriate, the sections also include a brief explanation of the contents and recommendations for operators and competent IED authorities on how to use the information contained. Further guidance on the assessment and correct use of SDS is provided in the ECHA "**Guide on Safety data sheets and Exposure scenarios**".

SDS Section	Explanation and Recommendations for Use
Section 1 – Identification	
1.1 Product Identifier Trade Name: […] Product No: […]	The product identifier shall be provided in accordance with Article 18(2) of Regulation (EC) No 1272/2008 in the case of a substance and in accordance with Article 18 (3) (a) of Regulation /(EC) No 1272/2008 in the case of a mixture, and as provided on the label in the official language(s) of the Member State(s) where the substance or mixture is placed on the market, unless the Member States(s) concerned provide(s) otherwise. For substances subject to registration, the product identifier shall be consistent with that provided in the registration and the registration number assigned under Article 30(3) of this Regulation shall also be indicated

1.2 Relevant identified uses of the substance or mixture and uses advised against Use of the substance/mixture: • textile auxiliaries • Detergents and cleaning agents	At least the identified uses relevant for the recipient(s) of the substance or mixture shall be indicated. This shall be a brief description of what the substance or mixture is intended to do. Where applicable the uses which the supplier advises against and the reasons why shall be stated (Example: Do not use for injecting and spraying In many cases, information in the registration dossiers about uses of substances is limited because downstream users do not have an incentive to provide sufficient information about their uses to the upstream provider of chemicals
1.3 Details of the supplier providing the safety data sheet Manufacturer/Supplier: Name / Name Address / Address Information Contact / Information Contact Email (competent person) / Email (competent person) Importer: - Information-providing department:	Contact details of manufacturer need to be available and shall match with the information provided on the respective chemical containers. In case of non-EU supplier of chemicals, the contact details of the local importer or distributor need to be indicator. In view of the fact that the majority of chemicals used in the textile sector are manufactured outside the EU, special attention should be paid to the availability of information regarding importers and distributors.

1.4 Emergency contact: • +49 7071 154 0 (Germany, 24h) • +41 71 763 88 11 (Switzerland, 24h)	A 24-hour emergency contact number of the manufacturer, importer and/or distributor needs to be indicated in the SDS (as well as on the chemical container). Most EU Member States, with exception of Germany, Poland, Italy, and France, have appointed an official emergency response center, whose contact information must be listed in Section 1.4 of the SDS. In Germany, manufacturers and importers may optionally notify one of several poison centers in the country, or they may provide their own number, given certain conditions. France now lists the National Research and Safety Institute for the Prevention of Occupational Accidents and Diseases (INRS) as its official emergency contact to be listed in Section 1.4 of the SDS. For further information about the contact points, refer to the downloadable list of emergency telephone numbers available from the ECHA website **https://echa.europa.eu/support/helpdesks**

<table>
<tr><td>Section 2 – Possible Hazards</td><td></td></tr>
<tr><td>2.1 Classification of the substance or mixture:
Classification (REGULATION (EC) No 1272/2008):
Irritant effect on the skin, category 2
• H315: Causes skin irritation.
Severe eye damage, Category 1
• H318: Causes severe eye damage.
Long-term (chronic) water hazard, category 3
• H412: Harmful to aquatic organisms, having long term effects.</td><td>The classification of the substance or the mixture which results from the application of the classification criteria in Regulation (EC) No 1272/2008 shall be given in the SDS.
The classification provided here should be consistent with the information provided in the SDS Sections 9 to 12, covering the most important adverse physical, human health and environmental health and environmental effect. The information needs to be presented in a way that allows non-experts to identify the hazards of the substance or mixture.</td></tr>
</table>

2.2 Labelling elements Labelling (Regulation (EC) No 1272/2008): Hazard pictograms  Signal word • Danger Hazard Statements • H315 Causes skin irritation • H318 Causes severe eye damage • H412 Harmful to aquatic organisms, with long-term effects Safety instructions - Prevention: • P264 Wash skin thoroughly after use. • P273 Avoid release into the environment. • P280 Wear protective gloves/ eye/ face protection.	This section of the SDS should show how the substance or mixture should be labelled. For both substances and mixtures, the label elements are to be indicated according to the CLP Regulation. If a substance on its own or in a mixture is subject to REACH authorization, the authorization number (see the ECHA-term (**https://echa-term.echa.europa.eu/**) for a definition) must be included here. In such case, more information regarding authorization should be available in SDS Section 15. The label elements indicated here need to correspond to those on the product (container, packaging).

Safety instructions – Reaction: • P305 + P351 + P338 + P310 IN EYE CONTACT: Rinse gently with water for several minutes. Remove contact lenses if possible. Continue rinsing. Call the POISON CENTER/physician immediately. • P332 + P313 In case of skin irritation: seek medical advice. Safety instructions - Disposal: • P501 Contents/ container to be disposed of in an approved waste disposal facility Hazard-determining component(s) for labelling: • Isotridecanolethoxylate • Alcohols, C12-15 branched and linear, ethoxylated propoxylated • 2-[2-(2-Butoxyethoxy)ethoxy]ethanol • Acrylic acid polyethylene-polypropylene glycol monoallyl ether copolymer	
2.3 Other hazards This substance/mixture does not contain components at concentrations of 0,1 % or higher that are either persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB).	In case the substance is a PBT or vPvB, this needs to be indicated in form of a statement here.

Section 3 - Composition/Information on Components

3.2 Mixtures

Chemical characterization:

- Mixture of fatty alcohol alkoxylates

Hazardous components

Substance name	CAS-No. EG-No. Registration number	Classification	Concentration (% w/w)
Isotridecanolethoxylat	69011-36-5 Polymer	Eye Dam. 1; H318 Aquatic Chronic 3; H412	>= 20 - < 25
Alkohole, C12-15-verzweigt und linear, ethoxyliert propoxyliert	120313-48-6 Polymer	Skin Irrit. 2; H315 Eye Dam. 1; H318 Aquatic Acute 1; H400 Aquatic Chronic 3; H412	>= 10 - < 20
2-[2-(2-Butoxyethoxy)ethoxy]ethanol	143-22-6 205-592-6 01-2119475107-38	Eye Dam. 1; H318	>= 3 - < 10

Section 3 provides information on the composition of the chemical product. If it is a substance, the information is provided in Section 3.1. If the chemical is a mixture, the information is in Section 3.2, usually in form of a table.

This table should include (i) the name and/or trade name, and (ii) other identifiers (such as CAS number, registration number, etc.) of the substances, ingredients or impurities, which

- contribute to the overall hazard classification; or
- are present at concentrations above certain levels of concern; or
- have occupational exposure limits.

Usually an ingredient must be disclosed, if it meets GHS classification criteria as a hazardous substance and its content exceeds relevant cut-off value (usually 0.1 % or 1 % depending on hazards). For example, a carcinogen must be disclosed in SDSs, if its concentration is above or equal to 0.1 %.

In the EU, disclosure of non-hazardous substances is required, if there are union workplace exposure limits for them or if they belong to PBT and vPvB substances.

Chemical suppliers may like to withhold exact substance name and exact concentration or concentration ranges in this section 3 claiming these are

Isotridecanolethoxylat	69011-36-5 Polymer	Eye Irrit. 2; H319 Aquatic Chronic 3; H412	>= 2,5 - < 10
Acrylsäure-Polyethylen-Polypropylenglykolmonoal-lylether Copolymer	205327-92-0 Polymer	Skin Corr. 1B; H314	>= 3 - < 5
Alkohole, C16-18, ethoxyliert	68439-49-6 Polymer	Eye Irrit. 2; H319	>= 1 - < 10
3,6,9,12 Tetraoxahexadecan-1-ol	1559-34-8 216-322-1	Eye Irrit. 2; H319	>= 1 - < 10
2-(2-Butoxyethoxy)ethanol	112-34-5 203-961-6 01-2119475104-44	Eye Irrit. 2; H319	>= 1 - < 10

confidential business information. In the EU, this requires with prior approval according to CLP, article 4.

Section 9 - Physical and chemical properties

9.1 Information on the basic physical and chemical properties:

Appearance: fluid

Colour: Colourless, light, yellowish

Odour: Characteristic

pH: 3,5 - 4,1 (20 °C)

This section contains information about the basic physical and chemical properties of the chemical substance or mixture (such as appearance, odour, pH, boiling point etc.) which are relevant to the classification and the hazards.

Information of this SDS section is relates to further characteristics as described in SDS section 10 (stability and reactivity). The latter section informs about the stability of the substance or mixture, hazardous reactions

Concentration: 100 g/l Melting point/Melting range: No data available Boiling point/Boiling range: No data available Ignition point: 100 °C Evaporation speed: Not applicable Upper explosive limit: Not applicable Lower explosion limit: Not applicable Vapour pressure: No data available Relative vapour density: Not applicable Density: - 1.03 g/cm3 (20 °C) **Solubility(s)** Water solubility: miscible Distribution coefficient: n-octane/water - Not applicable **Viscosity** Viscosity, dynamic • 90 - 150 mPa.s (20 °C) • Brookfield LVT • 50 rpm • Spindle 2 Oxidizing properties: Not applicable	that could occur under certain conditions of use or if released into the environment, conditions to avoid, incompatible materials, hazardous decomposition products. No sections should be kept blank. If data is not available, it should be clearly indicated in form of a corresponding statement (“no data available”)

9.2 Other disclosures Conductivity: not determined Spontaneous ignition: not self-igniting	

Section 11 - Toxicological information	
11.1 Information on toxicological effects **Acute toxicity** • Product: • Acute oral toxicity: • LD50 (rat): > 2 000 mg/kg • conclusion by analogy Acute inhalative toxicity: • On the basis of the available data, the classification criteria are not met. Acute dermal toxicity: • On the basis of the available data, the classification criteria are not met. Ingredients:	Section 11 of a GHS-SDS contains detailed information about the adverse health effects that result from exposure to the product, as well as data about how these effects are influenced by dosage and route of exposure. While all SDS sections are important for user health & safety, the information contained in this section is vital should an employee or other user ever experience uncontrolled, accidental exposure to a product. It is of utmost importance to medical professionals and toxicologists and is used primarily in emergency situations during medical treatment. The information will help medical professionals and emergency responders evaluate long-term and short-term health risks. Accordingly, this SDS section should provide following information for the substance and/or components as identified in SMDS section 3.2: o Relevant health hazards and corresponding toxicological data o Likely routes of exposure o Potential adverse health effects that may occur upon exposure

<table>
<tr>
<td>
Isotridecanolethoxylate:

Acute oral toxicity:
• LD50 (rat): > 5 000 mg/kg
• literature value

Acute dermal toxicity:
• LD50 (rat): > 2 000 mg/kg
• Method: OECD test guideline 402
• literature value
Alcohols, C12-15 branched and linear, ethoxylated propoxylated:

Acute oral toxicity:
• LD50 (rat): > 2 000 mg/kg
• conclusion by analogy

2-[2-(2-Butoxyethoxy)ethoxy]ethanol:

Acute oral toxicity:
• LD50 (rat): 5 170 mg/kg

Acute dermal toxicity:
• LD50 (rabbit): 3 480 mg/kg

Isotridecanolethoxylate:

Acute oral toxicity:
• LD50 (rat): > 5 000 mg/kg
</td>
<td>
o Delayed and immediate effects, due to both short-term and long-term exposure
o Numerical measures of toxicity
o Relevant interactions with other substances
o Information about other adverse health effects that do not fall into GHS classification

• With regard to the health hazard references should cover at least

o Acute toxicity
o Skin corrosion/irritation
o Serious eye damage/irritation
o Respiratory and skin sensitization
o Germ cell mutagenicity
o Carcinogenicity
o Reproductive toxicity
o Single target organ toxicity/single exposure
o Single target organ toxicity/repeated exposure
o Aspiration hazards
It may not always be able to obtain information on the hazards of a substance or mixture. In cases where data on the specific substance or mixture are not available, data on similar substances or mixture, if appropriate, may be used, provided the relevant similar substance or mixture is identified. In case data is not available, this shall be clearly indicated rather than leaving blanks.

It is important to make sure that results as well as testing guidelines applied are clearly indicated.
</td>
</tr>
</table>

• Method: OECD test guideline 401 • literature value Acute dermal toxicity: • LD50 (rat): > 5 000 mg/kg • literature value 2-(2-Butoxyethoxy)ethanol: Acute oral toxicity: • LD50 (rat): > 2 000 mg/kg • Method: OECD test guideline 401 Acute dermal toxicity: • LD50 (rabbit): > 2 000 mg/kg • Method: OECD test guideline 402 **Etching/irritant effect on the skin** • […] **Eye damage/irritation** • […] **Sensitization of the respiratory tract/skin** • […] **Germ cell mutagenicity**	

• […] **Carcinogenicity** • […] **Reproductive toxicity** • […] **Specific target organ toxicity at single exposure** • […] **Specific target organ toxicity for repeated exposure** • […] **Aspiration toxicity** • […]	

Section 12 - Environmental disclosures	
12.1 Toxicity **Product**: Toxicity to fish: • No data available for the product itself. Toxicity to daphnia and other aquatic invertebrates: • EC50 (Daphnia magna (large water flea)): 5,8 mg/l • exposure time: 48 h • Method: OECD test guideline 202 Toxicity to algae: • No data available for the product itself. Toxicity to microorganisms: • EC50 (activated sludge): > 1 000 mg/l • exposure time: 3 h • Method: OECD test guideline 209 **Ingredients**: **Isotridecanolethoxylate**:	Section 12 contains ecological and eco-toxicological data for both terrestrial and aquatic environments. The information shall describe on the effects of the chemical on the environment if released as well as its environmental fate (What happens to the chemical after its release into the environment?). This section is designed to assist environmental stewardship, prevent harmful effects to the health of local ecosystems, as well as help businesses evaluate one product against another. This information forms the basis for deciding on waste and waste water treatment practices, how to handle spills and control of releases. The content of this section provides the basis for the classification and risk management measures given in the safety data sheet. The information in Sections 2, 3, 4, 6, 7, 8, 9, 13, 14, and 15 should be consistent with the ecological information provided here. This SDS section, with its subsections on (i) eco-toxicity, (ii) persistence and degradability, (iii) bioaccumulation potential, (iv) mobility in ground, and (v) results of the PBT and vPvB assessment, should also outline how the chemical was tested for toxicity, persistence and degradability, bioaccumulative potential, and mobility in soil, together with the test results. It should also contain the results of a PBT and vPvB assessment, if one has been carried out as part of a chemical safety assessment. The eco-toxicological test data for aquatic organisms used to determine GHS classifications should be provided, such as

Toxicity to fish: • LC50 (Oncorhynchus mykiss (rainbow trout)): > 1 - 10 mg/l • exposure time: 96 h • (Classified according to CESIO recommendations) Toxicity to daphnia and other aquatic invertebrates: • EC50 (Daphnia magna (Great Water Flea)): > 1 - 10 mg/l • exposure time: 48 h • (Classified according to CESIO recommendations) Toxicity to algae: • EC50 (algae): > 1 - 10 mg/l • Exposure time: 72 h • Method: OECD test guideline 201 • (Classified according to CESIO recommendations) • EC10 (algae): > 1 - 10 mg/l • Exposure time: 72 h • Method: OECD test guideline 201 • (Classified according to CESIO recommendations) Toxicity to microorganisms: • EC50 (activated sludge): > 1 000 mg/l • exposure time: 16 h • Method: DIN 38412, part 8 • conclusion by analogy Toxicity to daphnia and other aquatic invertebrates (chronic toxicity): • NOEC: 1 mg/l	○ Fish: 96 hours, Lethal concentration (LC) 50, chronic No Observed Effect Level (NOEC) or Effective Concentration (ECx) ○ Crustaceans: 48 hours, Lethal concentration (LC) 50, chronic No Observed Effect Level (NOEC) or Effective Concentration (ECx) ○ Algae & aquatic plants: 72 or 96 hours, effectice reduction of growth rate concentration (ErC50), chronic No Observed Effect Level (NOEC) or Effective Concentration (ECx) Important details to include throughout this section include species, media, test duration and test conditions. The information in this section 12 should be consistent with the other sections of the SDS. The eco-toxicological (EC50, NOEC) endpoints should be consistent with the aquatic toxicity categories, respectively. Since some components in a mixture may behave very differently from the mixture as a whole when released to the environment, eco-toxicological information should be given for all relevant ingredients. Any information that indicates possible impact on waste water treatment plants, like degradability and inhibitory effects on microorganisms, should be mentioned.

• Species: Daphnia magna (Great Water Flea) • literature value Assessment of ecotoxicity Long-term (chronic) water endangering: • Harmful to aquatic organisms with long-term effects (classified according to CESIO recommendations). **Alcohols, C12-15 branched and linear, ethoxylated propoxylated:** • […] **2-[2-(2-Butoxyethoxy)ethoxy]ethanol:** • […] **Isotridecanolethoxylate**: • […] **2-(2-Butoxyethoxy)ethanol:** • […]	
12.2 Persistence and degradability **Product**: Biodegradability: • Type of test: DOC-CO2 measurement • Biological degradation: 68%. • Method: OECD 302 B with CO2 (mineralisation)	Biodegradation is the process by which organic substances are broken down by living organisms such as bacteria and fungi. Biodegradation can happen in surface water, sediment and soil. With regard to expressing the biodegradability of a substance, it is important the type of test, methods, circumstances and results are specifically outlined to allow for a proper interpretation of the information.

• Type of test: DOC measurement • Biological degradation: 95%. • Method: OECD 302 B with CO2 (elimination) • The product is inherently bio-degradable according to OECD criteria. • • Type of test: O2 measurement • Biological degradation: 76%. • Method: OECD 301 F (mineralisation) The product is readily biodegradable according to OECD criteria. The surfactant contained in this mixture fulfils the conditions of biodegradability as laid down in Regulation (EC) No. 648/2004 on detergents. Documents confirming this will be kept available for the competent authorities of the Member States and will only be made available to them at their direct request or at the request of a detergent manufacturer. Biochemical oxygen demand (BOD): • 180 mg/g • Incubation time: 5 d • Method: DIN EN 1899-1 (H 55) Chemical oxygen demand (COD): • 1 240 mg/g • Method: DIN 38409-H-41 **Compounds**:	For example, common methods for determining the biodegradability include OECD 301 A-F (Ready biodegradability), OECD 302 A-C (inherent biodegradability). The pass levels for ready biodegradability are 70 % removal of Dissolved organic carbon (DOC) and 60 % of theoretical oxygen demand (ThOD) or theoretical carbon dioxide (ThCO2) production for respirometric methods (OECD 301).

Isotridecanolethoxylate: Biodegradability: • Type of test: CO2 measurement • Result: Easily biodegradable. • Biological degradation: > 60%. • exposure time: 28 d • Method: OECD 301 B (mineralisation) • (Classified according to CESIO recommendations) • Type of test: DOC measurement • Result: Easily biodegradable. • Biological degradation: > 90%. • exposure time: 28 d • Method: OECD 301 E (elimination) • **Alcohols, C12-15 branched and linear, ethoxylated propoxylated:** Biodegradability: • Type of test: CO2 measurement • Result: Easily biodegradable. • Biological degradation: > 60%. • exposure time: 28 d • Method: OECD 301 B (mineralisation) • conclusion by analogy	

<table>
<tr>
<td>
2-[2-(2-Butoxyethoxy)ethoxy]ethanol:
[…]
Isotridecanolethoxylate:
[…]
2-(2-Butoxyethoxy)ethanol:
[…]
</td>
<td></td>
</tr>
<tr>
<td>
12.3 Bioaccumulation potential
Product:
Bioaccumulation:
There is no data available for the product itself.
Distribution coefficient: n-octanol/water:
Not applicable
Ingredients:
2-(2-Butoxyethoxy)ethanol:
Coefficient of partition: n-octane/water:
log Pow: 1 (20 °C)
pH value: 7
Method: OECD 117
</td>
<td>
Information on bioaccumulation is vital for understanding the environmental behaviour of a substance. The information on bioaccumulation is used in 1) PBT assessment, 2) hazard classification, and 3) chemical safety assessment. The information on bioaccumulation is also a factor in deciding whether long-term ecotoxicity testing might be necessary

Bioconcentration Factor (BCF) is an indicator of a chemical substance’s tendency to accumulate in the living organism. It can be obtained by calculation method based on logKow/logPow or bio-accumulation test. Calculated BCF values are unitless and generally range from one to a million.

If an aquatic bioconcentration test (usually on fish) is conducted, BCF will be the concentration of test substance in/on the fish or specified tissues thereof (as mg/kg) divided by the concentration of the chemical substance in the surrounding medium (BCF = Concentration of the substance in fish (mg/kg)/Concentration of the substance in water (in mg/L)).
</td>
</tr>
</table>

	n-octanol/water partition coefficient (Kow) is used as a screening test for bio-accumulation test. The assumption behind this is that the uptake of an organic substance is driven by its hydrophobicity. A chemical substance with high BCF will generally have low water solubility, a large Kow (octanol/water partition coefficient), and a large Koc (soil adsorption coefficient). As per EU REACH, a substance with a BCF>2000 will be regarded as bio-accumulative (B). A substance with a BCF>5000 will be regarded as very bio-accumulative (vB). For organic substances with a logKow value below 4.5 it is assumed that the affinity for the lipids of an organism is insufficient to exceed the bio-accumulation criterion i.e. a BCF value of 2000. Substances with very high logKow values (i.e, >4.5) are of greater concern because they may have the potential to bio-concentrate in living organisms. It is important that the specific testing guidelines for measuring Bioaccumulation in Fish (i.e. OECD 305) and for Kow/logKowis or log POW (e.g. OECD 117) are mentioned in the SDS.
12.4 Mobility in the ground or soil **Product**: Mobility: • No data available	This subsection should indicate the soil Adsorption Coefficient (Kd/Koc) of a substance, measuring the mobility of a substance in soil. Koc is a very important input parameter for estimating environmental distribution and environmental exposure level of a chemical substance. A very high value (e.g. Koc > 100,000 or log Koc >5) indicate that the substance is strongly adsorbed onto soil and organic matter and does not move throughout the soil. In such case, additional terrestrial toxicology tests may be

	conducted to confirm the toxicity of a substance to soil organisms. A very low value (Koc >10 or log KOC <1) means it is highly mobile in soil. It is important that the testing guideline (e.g. OECD 106 or OECD 121) is indicate as well.
12.5 Results of the PBT and vPvB assessment **Product**: Rating: • This substance/mixture does not contain components at concentrations of 0,1 % or higher classified as either persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB).	

12.6 Other adverse effects **Product:** **Adsorb. org. bound halogen (AOX):** • Due to the fact that it does not contain organically bound halogens, this product cannot contribute to the AOX contamination of waste water. **Other ecological information:** • According to our current state of knowledge, the product does not contain any heavy metals or compounds of the EC Directive 2000/60/EC.	

y

1.1 Annex 4 – BAT of interest in existing BREFs

There are some BREF documents of interest concerning handling of chemicals for the sub sectors polymers and fertilizers. The BREF documents are Emissions from storage, EFS (2006), Production of polymers, POL (2007), Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilizers, LVIC-AAF (2007) and Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector, CWW (2016). BAT conclusions concerning handling of chemicals are listed below. The BREF documents with BAT conclusions are available on the European IPPC Bureau´s webpage.[59]

Emissions from storage, EFS (2006)

Section	Comments
5.1 Storage of liquids and liquefied gases	BAT conclusions on tanks, storage of packaged dangerous substances, basins and lagoons, atmospheric mined caverns, pressurised mined caverns, salt leached caverns and floating storage.
5.2 Transfer and handling of liquids and liquefied gases	BAT conclusions on general principles to prevent and reduce emissions and considerations on transfer and handling techniques.
5.3 Storage of solids	BAT conclusions on open storage, enclosed storage, storage of packaged dangerous solids and preventing incidents and (major) accidents.
5.4 Transfer and handling of solids	BAT conclusions on general approaches to minimise dust from transfer and handling and considerations on transfer techniques.

Production of polymers, POL (2007)

Generic BAT conclusion under section 13.1	Comments
BAT 1	BAT is to implement and adhere to an Environmental Management System
BAT 2-4	Fugitive emissions
BAT 5	Dust emissions
BAT 6	Start ups and stops
BAT 9	Prevent water pollution
BAT 10	Separate different water and gas streams
BAT 11	Treatment of air purge

59 https://eippcb.jrc.ec.europa.eu/reference/

BAT 15	Re-use of waste
BAT 17	Buffer for waste water
BAT 18	Waste water treatment

Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilizers, LVIC-AAF (2007)

Common BAT conclusion in section 1.5	**Comments**
section 1.5.1	BAT on monitoring of key performance parameters and to establish and maintain mass balances
section 1.5.1	BAT on recycling or re-routing mass streams
section 1.5.1	BAT on reducing waste water volumes and loads by recycling condensates, process and scrubbing waters
section 1.5.2	BAT is to implement and adhere to an Environmental Management System.

Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector, CWW (2016)

BAT conclusions	**Comments**
BAT 1	BAT is to implement and adhere to an environmental management system
BAT 2-4	BAT on inventories of waste water and waste gas streams and monitoring
BAT 5	BAT on diffuse VOC emissions
BAT 7-11	BAT on handling of waste water
BAT 12	BAT on waste water treatment
BAT 13-14	BAT on handling of waste
BAT 15	BAT on recovery of compounds and reduction of emissions to air
BAT 16, 19	BAT on emissions to air

1.2 Annex 5 – Examples of Information how to take chemicals better into consideration in the environment permit applications.

Table 4 below is an annex for the environmental permit application to be filled in by the applicant in Finland.[60] It has been used since 2002 in Finland and it has increased significantly the consideration of chemicals in the environment permit process (Mehtonen & Knuutila 2014).

Table 4. Environmental application to be filled in by the applicant in Finland

Chemical list					**VOCs**					**Chemical fate**				
Chemical or mixture	Constituents (individual substances)	Percentage (%)	CAS number	Classification (CLP)	Vapour pressure at 20°C (kPa)	Boiling point at 101,3 kPa (°C)	Use volume (max, t/a)	Average use (t/a)	Function in the process	Ends up to product (%)	Ends up to water (%)	Ends up to air (%)	Ends up to waste (%)	Intermediate etc use

[60] https://www.ymparisto.fi/fi-fi/asiointi_luvat_ja_ymparistovaikutusten_arviointi/luvat_ilmoitukset_ja_rekisterointi/ymparistolupa/Miten_ymparistolupa_haetaan__ohjeet_ja_lomakkeet

Annex 6 – SVHC and WFD PS relevant for polymer industry

The list of SVHC substances was downloaded from the ECHA webpage (**https://echa.europa.eu/candidate-list-table**). At the moment of doing this survey (April 2020) the list included 205 substances or substance groups identified as SVHC. The information on substance uses in EU was compiled from the public ECHA CHEM database (**https://echa.europa.eu/information-on-chemicals**) and in Nordic countries from SPIN register (Substances in Preparation in Nordic countries **http://spin2000.net/**). If the substance had statement ”polymer” or “polymers” or “used in polymers” or “used in polymer processing” or “elastomers” etc. in the section ‘uses at industrial sites’ of the ECHA infocard, the substance was deemed to be used in POL industry. The total use volumes in EU were derived from ECHA infocards (public ECHA CHEM database) as well. The use information from SPIN database was searched from the categories “Industrial Use (NACE)” and “Use (national)”. The use volumes in SPIN database are presented for one particular year. If the use volume value in SPIN database is “0” it means that the volume is below the limit of accuracy, which is 100 kg.

There are issues concerning the quality of the data in the public ECHA CHEM database. Firstly, the use information in public ECHA CHEM database is provided by the manufacturers or importers of a substance in the registration dossiers. It is possible that the manufacturer/importer has indicated multiple uses for the substance even though the substance might not be used in POL sector. This results in false positives in the lists and therefore more it should be checked if SVHCs are actually used in POL sector. Secondly, the use volumes in ECHA infocards cover all the possible uses of the substance and not only the used amount in POL sector (i.e. there is no information on amount of use in POL sector). Thirdly, the information on the industrial uses and volumes in public ECHA CHEM might be outdated (the year information is originating/based on is unknown). For these reasons the table 4 may include substances, which are not used in POL sector. Additionally, the use information on PFAS substances identified as SVHC in ECHA CHEM is very scarce. It is possible that they really are not used or that the public ECHA CHEM database is not good information source for use of PFAS. Due to lack of data most PFAS were left out of the table.

Additionally, the utilization of chemical use information in polymer sector from SPIN database turned out to be very difficult, because the polymer sector (or term polymer production or even term polymer) is not available and therefore can not be searched from SPIN database. The only available possibly POL related terms in SPIN register category “Industrial Use (NACE)” are related to manufacture of rubber and plastics. More precise information, e.g., “raw materials for production of rubber products and plastics“ was found from category “Use (national)” in SPIN register, but only for few substances.

Altogether 66 substances or substance groups were identified to be probably used in POL sector. The identified substances and information e.g. on their uses are presented in the table 4. For example, different phenols and phthalates, cadmium and lead substances as well as a PFAS substance (PFBS) are most likely used in POL sector. Most substances are SVHCs, but some are both SVHC and WFD substances.

SVHC substances are regulated under REACH with the intention to phase out their use and to reduce exposure. Note that the SVHC substance list is updated twice a year. Substances with the following hazard properties may be identified as SVHCs:

Substances meeting the criteria for classification as carcinogenic, mutagenic or toxic for reproduction (CMR) category 1A or 1B in accordance with the CLP Regulation.

Substances which are persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB) according to REACH Annex XIII.
Substances on a case-by-case basis, that cause an equivalent level of concern as CMR or PBT/vPvB substances.

Table 5. REACH substances of very high concern (SVHC) and WFD priority substances (PS) / priority hazardous substances (PHS) which have registered uses in POL industry based on REACH registration information in the public ECHA chemical database.

Annex XV = substance specific dossiers on "Proposal for identification of a substance as a category 1A or 1B CMR, PBT, vPvB or a substance of an equivalent level of concern" under REACH Annex XV, available in the ECHA chemical database separately from the REACH registration information.

Substance (SVHC / WFD substance)	CAS	Use in POL sector (ECHA/SPIN)	Total imported or manufactured for all uses in EU (public ECHA CHEM database) / for POL in Nordic countries (SPIN database) (tons/a) [1]	"Fate" in waste water treatment plant [2]	Other information
1,2,3-trichloropropane SVHC	96-18-4	ECHA: rubber products and plastic products Annex XV: manufacture of polymers SPIN: no data	ECHA: 1 000 – 10 000 tons/a SPIN: no data	not evaluated in HAZBREF	
1,2-Benzenedicarboxylic acid, di-C6-10-alkyl esters SVHC	68515-51-5	ECHA: polymers, manufacture of plastic and rubber products Annex XV: used in polymer processing, preparations and compounds, manufacture of plastic products, including compounding and conversion SPIN: no POL related uses	ECHA: 0 – 10 tons/a No POL related uses in SPIN.	not evaluated in HAZBREF	Manufacture ceased in 2018. Included in the Annex XIV of REACH (Authorization list). This substance may still be used because there is still time to apply for authorization (Latest application date 27/08/2021; Sunset Date 27/02/2023). Thus, the use of substance without authorization is possible in EU until 27.2.23. And use is possible also after sunset date if authorization has been applied.
1,2-dichloroethane SVHC WFD PS	107-06-2 •	ECHA: polymers	ECHA: 1 000 000 – 10 000 000 tons/a No POL related uses in SPIN.	66% to surface water 1% to sludge	Included in the Annex XIV of REACH (Authorization list).

		Annex XV: production of vinyl chloride, manufacture of ethylene amines and vinylidene chloride SPIN: no POL related uses		0% biodegradation 33% volatilization (Simple Treat –model, Mannio et al. 2011)	
1,6,7,8,9,14,15,16,17,17,18,18-Dodecachloropentacyclo[12.2.1.16,9.02,13.05,10]octadeca-7,15-diene ("Dechlorane Plus"™) SVHC	13560-89-9	ECHA: polymers, manufacture of plastic products Annex XV: manufacture of plastics products (including compounding and conversion), formulation of polymers, non-plasticizing flame retardant in polymers SPIN: no POL related uses	ECHA: 100 – 1 000 tons/a No POL related uses in SPIN.	not evaluated in HAZBREF	
1-Methyl-2-pyrrolidone (NMP) SVHC	872-50-4	ECHA: no POL-related uses Annex XV: acrylic and styrene latexes SPIN: raw materials for production of plastics*, manufacture of rubber and plastic products**	ECHA: 10 000 – 100 000 tons/a SPIN: 0 tons/a (2015)*, 11 tons/a (2017)**	8,0% to surface water 0% to sludge 92% biodegradation 0% volatilization	
2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol (UV-328) SVHC	25973-55-1	ECHA: polymers, manufacture of plastic products Annex XV: UV-stabilisers, UV-protection agents for plastics, rubber and polyurethanes SPIN: raw materials for production of plastics	ECHA: 100 – 1 000 tons/a SPIN (2017): 0,3 tons/a	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorization list).

2,2'-dichloro-4,4'-methylenedianiline (MOCA) SVHC	101-14-4	ECHA: polymers, manufacture of plastic products Annex XV: used primarily to produce polyurethane articles SPIN: manufacture of rubber and plastic products	ECHA: 100 – 1 000 tons/a SPIN (2017): 1,5 tons/a	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorization list).
2-benzyl-2-dimethylamino-4'-morpholinobutyrophenone SVHC	119313-12-1	ECHA: polymers, manufacture of plastic products Annex XV: photoinitiator in polymer production SPIN: manufacture of plastic and rubber products	ECHA: 100+ tons/a SPIN (2013): 0 tons/a, no POL related uses after 2013.	not evaluated in HAZBREF	
2-ethylhexyl 10-ethyl-4,4-dioctyl-7-oxo-8-oxa-3,5-dithia-4-stannatetradecanoate (DOTE) SVHC	15571-58-1	ECHA: polymers, manufacture of plastic products Annex XV: processing of polymers, manufacture of plastics products, including compounding and conversion SPIN: raw materials for production of plastics*, manufacture of rubber and plastic products**	ECHA: 1 000 – 10 000 tons/a SPIN: 2 tons/a (2015)*, 12 tons/a (2017)**	not evaluated in HAZBREF	
2-methyl-1-(4-methylthiophenyl)-2-morpholinopropan-1-one SVHC	71868-10-5	ECHA: manufacture of plastic products Annex XV: photoinitiator in polymer production SPIN: manufacture of rubber and plastic products	ECHA: 1 000+ tons/a SPIN (2012): 0 tons/a, no POL related uses after 2012.	not evaluated in HAZBREF	

4-(1,1,3,3-tetramethylbutyl) phenol SVHC WFD PS	140-66-9	ECHA: polymers Annex XV: a monomer for polymer preparations, intermediate for manufacture of ethoxylates, component in coatings and tackifier in the production of rubber products SPIN: raw materials for production of rubber products	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 0,1 tons/a	not evaluated in HAZBREF	
[4-[[4-anilino-1-naphthyl][4-(dimethylamino)phenyl]methylene]cyclohexa-2,5-dien-1-ylidene] dimethylammonium chloride (C.I. Basic Blue 26) SVHC	2580-56-5	ECHA: polymers, manufacture of plastic products Annex XV: dyeing of plastic products SPIN: no POL related uses	ECHA: 0 – 10 tons/a No POL related uses in SPIN.	not evaluated in HAZBREF	Manufacture ceased in 2020. This substance may still be used in polymer sector.
4,4'-Diaminodiphenyl methane (MDA) SVHC	101-77-9	ECHA: polymers Annex XV: Processed to methylenediphenyl diisocyanate (MDI). MDI is further used for polyurethane production. SPIN: manufacture of rubber and plastic products	ECHA: 10 000 – 100 000 tons/a SPIN (2012): 0 tons/a, no POL related uses after 2012.	50,7% to surface water 49,3% to sludge 0% biodegradation 0% volatilization	Included in the Annex XIV of REACH (Authorization list).
4,4'-isopropylidenediphenol (bisphenol A; BPA)	80-05-7	ECHA: polymers, manufacture of plastic products Annex XV: manufacture of polymers	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 0,5 tons/a	7,5% to surface water 6,4% to sludge 86,1% biodegradation	Certain uses restricted in the EU.

SVHC		SPIN: raw materials for production of plastics		0% volatilization	
4,4'-oxydianiline + its salts SVHC	101-80-4	ECHA: polymers, manufacture of chemicals and plastic products Annex XV: no information on use* SPIN: no data	ECHA: 10 – 100 tons/a SPIN: no data	not evaluated in HAZBREF	******The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.*
4-Nonylphenol, branched and linear (incl. ethoxylated NPE) SVHC WFD PHS	Substance group, no CAS number presented in ECHA database. 84852-15-3 (branched), 26027-38-3 (ethoxylated), 127087-87-0 (branched, ethoxylated) 68412-54-4 (Nonylphenol, branched, ethoxylated)	ECHA: polymers (CAS 84852-15-3) Annex XV: polymer industry SPIN: manufacture of rubber and plastic products, industry for plastics in primary forms	ECHA: CAS 84852-15-3 10 000 – 100 000 tons/a CAS 26027-38-3 1 – 10 tons/a CAS 127087-87-0 0 – 10 tons/a or no data (inconsistent data in ECHA CHEM) CAS 68412-54-4 100+ tons/a or 1 000+ tons/a (inconsistent data in ECHA CHEM) SPIN (2017): 0 tons/a	p-nonylphenol (NP): 3,4% to surface water 62% to sludge 34,3% biodegradation 0,3% volatilization	Certain uses are Restricted under REACH at EU level but not polymer use. NP is formed due to the degradation of NPE.
4-tert-butylphenol SVHC	98-54-4	ECHA: polymers Annex XV: polymers	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 0,2 tons/a	not evaluated in HAZBREF	

		SPIN: raw materials for production of rubber products and plastics			
Benzene-1,2,4-tricarboxylic acid 1,2 anhydride (trimellitic anhydride) (TMA) SVHC	552-30-7	ECHA: polymers Annex XV: manufacture of polymers and esters SPIN: no POL related uses	ECHA: 10 000 – 100 000 tons No POL related uses in SPIN	not evaluated in HAZBREF	
Benzyl butyl phthalate (BBP) SVHC	85-68-7	ECHA: no data Annex XV*: plasticiser for PVC or other polymers SPIN: manufacture of rubber and plastic products	ECHA: 1– 10 tons/a SPIN (2015): 0,3 tons/a, no POL related uses after 2015.	8% to surface water 42% to sludge 50% biodegradation 0% volatilization (Simple Treat – model, ECB 2007)	* Annex XV Restriction report – four phthalates Included in the Annex XIV of REACH (Authorization list). Use above 0.1% by weight restricted in plastics, toys and childcare articles (some exemptions exist). See **https://echa.europa.eu/documents/10162/aaa92146-a005-1dc2-debe-93c80b57c5ee** for details.
Bis (2-ethylhexyl) phthalate (DEHP) SVHC WFD PHS	117-81-7	ECHA: polymers, manufacture of chemicals and plastic products Annex XV: plasticiser in polymers SPIN: raw materials for production of rubber products and plastics*, manufacture of rubber and plastic products**	ECHA: 10 000 – 100 000 tons/a SPIN: 91 tons/a (2011)*, 126 tons/a (2017)**	2,6% to surface water 78,6% to sludge 18,8% biodegradation 0% volatilization	Included in the Annex XIV of REACH (Authorization list). Use above 0.1% by weight restricted in plastics, toys and childcare articles (some exemptions exist). See **https://echa.europa.eu/documents/10162/aaa92146-a005-1dc2-debe-93c80b57c5ee** for details.
Bis(2-methoxyethyl) ether (Diglyme)	111-96-6	ECHA: polymers, manufacture of chemicals and plastic products	ECHA: 100 – 1 000 tons/a SPIN (2007): 0 tons/a, no use after 2007.	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorization list).

SVHC		Annex XV: production of magnetic polystyrene beads and manufacture of rubber and plastic products SPIN: manufacture of rubber and plastic products			
Boric acid SVHC	10043-35-3	ECHA: no POL related uses Annex XV: preservatives for rubber and polymerised materials, raw materials for production of rubber, flame retardants etc. SPIN: raw materials for production of rubber products	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 0,1 tons/a	not evaluated in HAZBREF	
Cadmium carbonate SVHC WFD PHS	513-78-0	ECHA: polymers, manufacture of chemicals and plastic products Annex XV: polymers SPIN: no data	ECHA: 10 – 100 tons/a SPIN: no data	Cadmium: 19% to surface water 81% to sludge 0% biodegradation 0% volatilization(modelling + measured data; Vieno 2014)	
Chromium trioxide SVHC	1333-82-0	ECHA: manufacture of plastic products Annex XV: catalyst in production of polyethylene and other plastics SPIN: no POL related uses	ECHA: 10 000 – 100 000 tons/a No POL related uses in SPIN.	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorization list).
Cobalt (II) diacetate SVHC	71-48-7	ECHA: polymers, manufacture of chemicals and plastic products	ECHA: 100 – 1 000 tons/a SPIN (2011): 0 tons/a,	not evaluated in HAZBREF	

		Annex XV: production of other chemicals and polymers (intermediate), cobalt salts are used to improve the adhesion of rubber to steel SPIN: manufacture of rubber and plastic products	no POL related uses after 2011.		
Cyclohexane-1,2-dicarboxylic anhydride (HHPA) and all possible combinations of the cis- and trans-isomers SVHC	85-42-7 (HHPA), 14166-21-3 (trans-HHPA), 13149-00-3 (cis-HHPA)	ECHA: polymers Annex XV: manufacture of alkyd resins, plasticizers and as hardener in epoxy resins. Industrial use as monomer in the manufacture of resins. SPIN: manufacture of rubber and plastic products	ECHA: 10 000 – 100 000 tons/a SPIN (2016): 0 tons/a, no POL related uses after 2016.	not evaluated in HAZBREF	
Decamethylcyclopentasiloxane (D5) SVHC	541-02-6	ECHA: polymers, intermediate Annex XV: used as a monomer in the production of silicone polymers, resins and other organosilicon substances, used as a feedstock for the production of silicone polymers SPIN: manufacture of rubber and plastic products	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 1,2 tons/a	2,0% to surface water 74,9% to sludge 0% biodegradation 23,1% volatilization	
Diazene-1,2-dicarboxamide (C,C'-azodi(formamide)) (ADCA)	123-77-3	ECHA: polymers and laboratory chemicals, manufacture of plastic products and rubber products Annex XV: manufacture of plastics products, including compounding	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 116,8 tons/a	99,8% to surface water 0,2% to sludge 0% biodegradation 0% volatilization	

SVHC		and conversion, a blowing agent in the rubber and plastics industry SPIN: raw materials for production of rubber products and plastics			
Diboron trioxide SVHC	1303-86-2	ECHA: intermediate, manufacture of chemicals Annex XV: borates polymer production SPIN: no POL related uses	ECHA: 1 000 – 10 000 tons/a No POL related uses in SPIN.	not evaluated in HAZBREF	
Dibutyl phthalate (DBP) SVHC	84-74-2	ECHA: manufacture of plastic products, intermediate Annex XV: polymer industry: softener (plasticizer in PVC) SPIN: raw materials for production of plastics*, manufacture of rubber and plastic products**	ECHA: 1 000 – 10 000 tons/a SPIN: 3 tons/a (2009)*, 0 tons/a (2013)**, no POL related uses after 2013.	9% to surface water 33% to sludge 58% biodegradation 0% volatilization (Simple Treat model, ECB 2003)	Included in the Annex XIV of REACH (Authorization list). Use above 0.1% by weight restricted in plastics, toys and childcare articles (some exemptions exist). See **https://echa.europa.eu/documents/10162/aaa92146-a005-1dc2-debe-93c80b57c5ee** for details.
Dicyclohexyl phthalate (DCHP) SVHC	84-61-7	ECHA: polymers Annex XV: manufacturing of compounds for PVC, rubber and plastic compounds (use as co-plasticizers) SPIN: manufacture of plastics in primary forms	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0,2 tons/a	not evaluated in HAZBREF	
Diethyl sulphate SVHC	64-67-5	ECHA: polymers, manufacture of chemicals Annex XV: no information on use*	ECHA: 1 – 10 tons/a SPIN: no data	not evaluated in HAZBREF	*****_The available use information is provided in the registration dossiers (authorities with access_

		SPIN: no data			*rights only) or on ECHA's dissemination website.*
Diisobutyl phthalate (DIBP) SVHC	84-69-5	ECHA: polymers, manufacture of plastic products and chemicals Annex XV: specialist plasticizer, gelling aid in combination with other plasticizers SPIN: manufacture of rubber and plastic products	ECHA: 1 – 10 tons/a SPIN (2017): 1,2 tons/a	5,3% to surface water 9,2% to sludge 70,1% biodegradation 15,4% volatilization	Included in the Annex XIV of REACH (Authorization list). Use above 0.1% by weight restricted in plastics, toys and childcare articles (some exemptions exist). See https://echa.europa.eu/documents/10162/aaa92146-a005-1dc2-debe-93c80b57c5ee for details
Diisopentyl phthalate (DIPP) SVHC	605-50-5	ECHA: no data Annex XV: May be used as plasticiser for PVC products and other polymers. SPIN: no data	ECHA: 1 – 10 tons/a or 10 – 100 tons/a (inconsistent data in ECHA CHEM) SPIN: no data	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorization list).
Dimethyl sulphate SVHC	77-78-1	ECHA: polymers, manufacture of chemicals Annex XV: no information on use* SPIN: no POL related uses	ECHA: no data* No POL related uses in SPIN.	not evaluated in HAZBREF	This substance may still be used in polymer sector. **The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.*
Dinoseb (6-sec-butyl-2,4-dinitrophenol) SVHC	88-85-7	ECHA: polymers, manufacture of chemicals and plastic products, production of resins, rubbers, polymers Annex XV: no information on use* SPIN: no data	ECHA: 1 000 – 10 000 tons/a SPIN: no data	not evaluated in HAZBREF	Also used as herbicide. **The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.*

Dioxobis(stearato) trilead SVHC	12578-12-0	ECHA: polymers, manufacture of plastic products Annex XV: no information on use* SPIN: manufacture of plastic products	ECHA: 1+ tons/a or 1 000+ tons/a (inconsistent data in ECHA CHEM) SPIN (2009): 0 tons/a, no use after 2009.	not evaluated in HAZBREF	**The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.*
Disodium tetraborate, anhydrous SVHC	1330-43-4, 1303-96-4 (Borax), 12179-04-3 (pentahydrate)	ECHA: manufacture of chemicals, intermediate Annex XV: production of plastics, resins, rubbers, nylon, elastomers, used as: industrial fluids, adhesives, flame retardants, reagent chemicals SPIN: manufacture of rubber and plastic products	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 0 tons/a	7,9% to surface water 0% to sludge 91,6% biodegradation 0,5% volatilization	
Dodecamethylcyclohexasiloxane (D6) SVHC	540-97-6	ECHA: intermediate Annex XV: Use as a monomer in the production of polysiloxane polymers and resins. Use as intermediate. SPIN: no POL related uses	ECHA: 10 000 – 100 000 tons/a No POL-related uses in SPIN.	1,9% to surface water 89,4% to sludge 0% biodegradation 8,7% volatilization	
Ethyldiamine (EDA) SVHC	107-15-3	ECHA: adhesives and sealants, manufacture of chemicals Annex XV: monomer use in epoxy, PU, adhesives, coatings and other polymers, use of polymer - residual monomer SPIN: manufacture of rubber and plastic products	ECHA: 10 000+ tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	

Fatty acids, C16-18, lead salts SVHC WFD PS	91031-62-8	ECHA: polymers, manufacture of plastic products Annex XV: no information on use* SPIN: no data	ECHA: 1 000 – 10 000 tons/a SPIN: no data	not evaluated in HAZBREF	**The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.* Potential REACH restriction in preparation
Formaldehyde, oligomeric reaction products with aniline SVHC WFD PS	25214-70-4	ECHA: intermediate Annex XV: intermediate in MDI and high performance polymer production, hardener in epoxy resins and in adhesives SPIN: manufacture of rubber and plastic products	ECHA: 100 – 1 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorization list).
Hexahydro-4-methylphthalic anhydride SVHC	19438-60-9	ECHA: polymers Annex XV: manufacture of polyester and alkyd resins, plasticizers for thermoplastic polymers, as hardeners for epoxy resins and chain cross-linkers for thermoplastic polymers SPIN: manufacture of rubber and plastic products	ECHA: 1 000 – 10 000 tons/a SPIN (2016): 142 tons/a	not evaluated in HAZBREF	
Hexahydromethyl phthalic anhydride SVHC	25550-51-0	ECHA: used in in formulation or re-packing and at industrial sites Annex XV: manufacture of polyester and alkyl resins and plasticizers for thermoplastic polymers, hardeners for epoxy resins and chain cross-linkers for thermoplastic polymers	ECHA: 1 000 – 10 000 tons/a SPIN (2010): 0 tons/a, no POL related uses after 2010.	not evaluated in HAZBREF	

		SPIN: manufacture of rubber and plastic products			
Hydrazine SVHC	302-01-2, 7803-57-8	ECHA: polymers, manufacture of chemicals and plastic products Annex XV: wide use as an intermediate, use as a monomer in polymerisations (mostly for polyurethane coatings and adhesives) SPIN: no POL related uses	ECHA: 1 000 – 10 000 tons/a No POL related uses in SPIN.	not evaluated in HAZBREF	
Imidazolidine-2-thione (2-imidazoline-2-thiol) SVHC	96-45-7	ECHA: manufacture of rubber products Annex XV: polymer preparations and compounds, process regulators for polymerisation processes in production of resins, rubbers, polymers SPIN: raw materials for production of rubber*, manufacture of rubber and plastic products**	ECHA: 1 000 – 10 000 tons/a SPIN: 10 tons/a (2011)*, 0 tons/a (2012)**, no POL related uses after 2012.	99,9% to surface water 0% to sludge 0% biodegradation 0,1% volatilization	
Lead SVHC WFD PS	7439-92-1	ECHA: polymers Annex XV: formulation or repacking etc. SPIN: raw materials for production of plastics	ECHA: 1 000 000 – 10 000 000 tons/a SPIN (2017): 0 tons/a	11% to surface water 89% to sludge 0% biodegradation 0% volatilization (modelling + measured data; Vieno 2014)	Most likely not used as elemental lead but as different lead salts. Use of lead and lead compounds in PVC stabilizers has ceased in EU in 2015 (REACH restriction). REACH restriction in preparation.
Lead chromate molybdate	12656-85-8	ECHA: polymers, manufacture of plastic products	ECHA: 1 000 – 10 000 tons/a	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorization list).

sulphate red (C.I. Pigment Red 104) SVHC WFD PS		Annex XV: vinyl and cellulose acetate plastics, rubber and plastic formulation for commercial applications and export SPIN: manufacture of rubber and plastic products	SPIN (2015): 6,3 tons/a No POL related uses after 2015.		
Lead monoxide (lead oxide) SVHC WFD PS	1317-36-8	ECHA: polymers and adsorbents Annex XV: no information on use* SPIN: manufacture of rubber and plastic products	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 0 tons/a	Lead: 11% to surface water 89% to sludge 0% biodegradation 0% volatilization (modelling + measured data; Vieno 2014)	******The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.* Use of lead and lead compounds in PVC stabilizers has ceased in EU in 2015 (REACH restriction).
Lead oxide sulfate SVHC WFD PS	12036-76-9	ECHA: polymers Annex XV: no information on use* SPIN: no data	ECHA: 1 – 10 tons/a or 100 – 1 000 tons/a (inconsistent data in ECHA CHEM) SPIN: no data	Lead: 11% to surface water 89% to sludge 0% biodegradation 0% volatilization (modelling + measured data; Vieno 2014)	******The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.* Use of lead and lead compounds in PVC stabilizers has ceased in EU in 2015 (REACH restriction).
Lead sulfochromate yellow (C.I. Pigment Yellow 34) SVHC	1344-37-2	ECHA: polymers, manufacture of plastic products Annex XV: coloration of plastics, coating of plastic material	ECHA: 1 000 – 10 000 tons/a SPIN (2015): 0 tons/a, no POL related uses after 2015.	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorization list).

WFD PS		SPIN: manufacture of rubber and plastic products			
Methyloxirane (Propylene oxide) SVHC	75-56-9	ECHA: polymers Annex XV: no information on use* SPIN: raw materials for production of plastics	ECHA: 1 000 000 – 10 000 000 tons/a SPIN (2017): 1 885 tons/a	4,0% to surface water 0% to sludge 16,7% biodegradation 79,3% volatilization	**The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.*
N,N-dimethylacetamide (DMAC) SVHC	127-19-5	ECHA: intermediate Annex XV: Spinning solvent in the production of fibres of various polymers including acrylic, polyurethanepolyurea copolymer and meta-aramid. Also used as a solvent for production of films of polyimide. SPIN: no POL related uses	ECHA: 1 000+ tons/a No POL related uses in SPIN.	22,5% to surface water 0,1% to sludge 77,4% biodegradation 0% volatilization	
N,N-dimethylformamide SVHC	68-12-2	ECHA: used in laboratory chemicals, intermediate Annex XV: use as a process solvent for the manufacture of substances including polymers used e.g. in plastics, artificial leathers, coatings, resins, use as a cleaning solvent, e.g. in textile and plastics industries and laboratories SPIN: manufacture of rubber and plastic products	ECHA: 10 000 – 100 000 tons/a SPIN (2011): 0 tons/a, no POL related uses after 2011.	not evaluated in HAZBREF	
Octamethylcyclosiloxane (D4)	556-67-2	ECHA: manufacture of chemicals, rubber and plastic products	ECHA: 100 000 – 1 000 000 tons/a	2,6% to surface water	

SVHC		Annex XV: feedstock for the production of silicone polymers SPIN: industry for plastics in primary forms, raw materials for production of rubber products and plastics	SPIN (2017): 2,5 tons/a	48,4% to sludge 0% biodegradation 49% volatilization	
Orange lead (lead tetroxide) SVHC WFD PS	1314-41-6	ECHA: polymers and adsorbents, manufacture of chemicals and plastic products Annex XV: no information on use* SPIN: manufacture of rubber and plastic products	ECHA: 10 000 – 100 000 tons/a SPIN (2010): 0 tons/a, no POL related uses after 2010.	Lead: 11% to surface water 89% to sludge 0% biodegradation 0% volatilization (modelling + measured data; Vieno 2014)	**The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.* Use of lead and lead compounds in PVC stabilizers has ceased in EU in 2015 (REACH restriction).
p-(1,1-dimethylpropyl) phenol SVHC	80-46-6	ECHA: polymers, manufacture of chemicals and plastic products Annex XV: not found SPIN: no POL related uses	ECHA: 100 – 1 000 tons/a No POL related uses in SPIN.	not evaluated in HAZBREF	
Pentalead tetraoxide sulphate SVHC	12065-90-6	ECHA: polymers, manufacture of plastic products and chemicals Annex XV: no information on use* SPIN: manufacture of plastic and rubber products	ECHA: 10 000 – 100 000 tons/a SPIN (2006): 0 tons/a, no use after 2006.	not evaluated in HAZBREF	**The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.* Use of lead and lead compounds in PVC stabilizers has ceased in EU in 2015 (REACH restriction).
Perfluorobutane sulfonic acid	375-73-5	ECHA: polymers, manufacture of plastic products	ECHA: 0 – 10 tons/a	not evaluated in HAZBREF	

(PFBS) and its salts SVHC		Annex XV: catalyst in polymer manufacture and as catalyst in chemical synthesis, additive/reactant in polymerisation processes in e.g. polycarbonate production SPIN: no data	SPIN: no data		
[Phthalato(2-)] dioxotrilead SVHC WFD PS	69011-06-9	ECHA: polymers, manufacture of plastic products Annex XV: no information on use* SPIN: manufacture of rubber and plastic products	ECHA: 0 – 10 tons/a SPIN (2007): 0 tons/an no use after 2007.	not evaluated in HAZBREF	*****_The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website._ Use of lead and lead compounds in PVC stabilizers has ceased in EU in 2015 (REACH restriction).
Sulfurous acid, lead salt, dibasic SVHC WFD PS	62229-08-7	ECHA: polymers, manufacture of plastic products Annex XV: no information on use* SPIN: manufacture of rubber and plastic products	ECHA: 0 – 10 tons/a SPIN (2009): 0 tons/a, no use after 2009.	not evaluated in HAZBREF	*****_The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website._ Use of lead and lead compounds in PVC stabilizers has ceased in EU in 2015 (REACH restriction).
Terphenyl hydrogenated SVHC	61788-32-7	ECHA: polymers, manufacture of chemicals and plastic products Annex XV: additive in plastic applications	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	

		SPIN: manufacture of rubber and plastic products			
Trilead dioxide phosphonate SVHC WFD PS	12141-20-7	ECHA: polymers, adhesives and sealants, manufacture of plastic products, chemicals and rubber products Annex XV: no information on use* SPIN: manufacture of rubber and plastic products	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	******The available use information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.* Use of lead and lead compounds in PVC stabilizers has ceased in EU in 2015 (REACH restriction).
Tris(4-nonylphenyl, branched and linear) phosphite (TNPP) with = 0.1% w/w of 4-nonylphenol, branched and linear (4-NP) SVHC	Mixture of two substances, no CAS number presented in ECHA database 26523-78-4 [Tris(nonylphenyl) phosphite]	ECHA: polymers, manufacture of rubber and plastic products Annex XV: used as an antioxidant to stabilise polymers, use of formulated polymer in manufacturing, coatings and adhesives SPIN: industry for plastics in primary forms, raw materials for production of plastics	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 0,2 tons/a	not evaluated in HAZBREF	
Trixylyl phosphate SVHC	25155-23-1	ECHA: polymers, manufacture of plastic products Annex XV: starting material for polymer foam production, manufacturing and use of plastic products	ECHA: 100+ tons/a or 1 000+ tons/a (inconsistent data in ECHA CHEM) No POL related uses in SPIN.	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorization list).

		SPIN: no POL related uses			

[1)] Information taken from ECHA chemical database (**https://echa.europa.eu/fi/information-on-chemicals**) 1.4.2020, indicates total imported/manufactured amount in EU (tons per year) in all uses, no information on use specifically in POL sector. The years information is based on is unknown.
Information taken from SPIN database (**http://spin2000.net/**) 1.4.2020, indicates total imported/produced volume in POL sector in the Nordic Countries in one particular year (tons per year).
[2)] GoA2.2 mini-report

References:

- Annex XV dossier 1,2,3-trichloropropane
- Annex XV dossier 1,2-dichloroethane
- Annex XV dossier 1-methyl-2-pyrrolidone
- Annex XV dossier 2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol (UV-328)
- Annex XV dossier 2,2'-dichloro-4,4'-methylenedianiline
- Annex XV dossier 4-(1,1,3,3-tetramethylbutyl)phenol
- Annex XV dossier [4-[[4-anilino-1-naphthyl][4-(dimethylamino)phenyl]methylene]cyclohexa-2,5-dien-1-ylidene] dimethylammonium chloride (C.I. Basic Blue 26)
- Annex XV dossier 4,4-Oxydianiline
- Annex XV dossier 4-Nonylphenol, branched and linear, ethoxylated
- Annex XV dossier Bis(2-ethylhexyl)phthalate
- Annex XV dossier bis(2-methoxyethyl) ether (Diglyme)
- Annex XV dossier Boric acid
- Annex XV dossier C,C'-azodi(formamide) (ADCA)
- Annex XV dossier Dibutyl phthalate
- Annex XV dossier Diisobutyl phthalate
- Annex XV dossier Diethyl sulphate
- Annex Xv dossier Diisopentylphthalate (DIPP)
- Annex XV dossier Dimethyl sulphate
- Annex XV dossier Dinoseb(ISO); 6-sec-butyl-2,4-dinitrophenol
- Annex XV dossier Dioxobis(stearato)trilead
- Annex XV dossier Disodium tetraborate, anhydrous
- Annex XV dossier Fatty acids, C16-18, lead salts
- Annex XV dossier Formaldehyde, oligomeric reaction products with aniline
- Annex XV dossier Hexahydromethylphthalic anhydride Hexahydro-4-methylphthalic anhydride Hexahydro-1-methylphthalic anhydride Hexahydro-3-methylphthalic anhydride
- Annex XV dossier Hydrazine
- Annex XV dossier Imidazolidine-2-thione (2-imidazoline-2-thiol)
- Annex XV dossier Lead chromate molybdate sulfate red (C.I. Pigment Red 104)
- Annex XV dossier Lead monoxide [Lead oxide]
- Annex XV dossier Lead oxide sulfate
- Annex XV dossier Lead sulfochromate yellow (C.I. Pigment Yellow 34)
- Annex XV dossier Methyloxirane [Propylene oxide]
- Annex XV dossier N,N-Dimethylacetamide (DMAC)
- Annex XV dossier N,N-dimethylformamide
- Annex XV dossier Orange lead [Lead tetroxide]
- Annex XV dossier Pentalead tetraoxide sulphate
- Annex XV dossier [Phthalato(2-)]dioxotrilead
- Annex XV dossier Sulfurous acid, lead salt, dibasic
- Annex XV dossier Trilead dioxide phosphonate
- Annex XV dossier Trixylyl phosphate
- Annex XV report 1,6,7,8,9,14,15,16,17,17,18,18-Dodecachloropentacyclo[12.2.1.16,9.02,13.05,10]octadeca-7,15-diene (“Dechlorane Plus”TM) [covering any of its individual anti- and syn-isomers or any combination thereof]
- Annex XV report 1,2-Benzenedicarboxylic acid, di-C6-10-alkyl esters;

- Annex XV report 2-methyl-1-(4-methylthiophenyl)-2-morpholinopropan-1-one
- Annex XV report 2-ethylhexyl 10-ethyl-4,4-dioctyl-7-oxo-8-oxa-3,5- dithia-4-stannatetradecanoate (DOTE)
- Annex XV report 4,4'-Diaminodiphenylmethane (MDA)
- Annex XV report 4,4'-isopropylidenediphenol (Bisphenol A)
- Annex XV report 4-tert-butylphenol
- Annex XV report Benzene-1,2,4-tricarboxylic acid 1,2-anhydride
- Annex XV report Cadmium carbonate
- Annex XV report Chromium trioxide
- Annex XV report Cobalt(II) diacetate
- Annex XV report Decamethylcyclopentasiloxane; D5
- Annex XV report Dicyclohexyl phthalate (DCHP)
- Annex XV report Dodecamethylcyclohexasiloxane
- Annex XV report Ethylenediamine (ethane-1,2-diamine)
- Annex XV report Lead (lead powder and lead massive)
- Annex XV report Octamethylcyclotetrasiloxane, D4
- Annex XV report Perfluorobutane sulfonic acid (PFBS) and its salts
- Annex XV report Terphenyl, hydrogenated
- Annex XV report Tris(4-nonylphenyl, branched and linear) phosphite (TNPP) with ≥ 0.1% w/w of 4-nonylphenol, branched and linear (4-NP)1
- Annex XV restriction report – four phthalates
- ECB 2003. European Union Risk Assessment on Dibutyl phthalate. European Union Risk Assessment report 29. European Chemicals Bureau.
- ECB 2007. European Union Risk Assessment on Benzyl butyl phthalate. European Chemicals Bureau.
- Mannio, J. Mehtonen, J., Londesborough, S., Grönroos, M., Paloheimo, A., Köngäs, P., Kalevi, K., Erkomaa, K., Huhtala, S., Kiviranta, H., Mäntykoski, K., Nuutinen, J., Paukku, R., Piha, H., Rantakokko, P., Sainio, P. & Welling, L. 2011. Vesiympäristölle haitallisten teollisuus- ja kuluttaja-aineiden kartoitus vesiympäristössä. Suomen ympäristö 3/2011. 97 p. Finnish Environment Institute.
- Mehtonen, J. 2009. Hazardous substances of specific concern to the Baltic Sea. Baltic Sea Environment Proceedings No. 119. 95 s. Helsinki Commission.
- Vieno, N. 2014. Haitalliset aineet jätevedenpuhdistamoilla -hankkeen loppuraportti. Vesilaitosyhdistyksen monistesarja nro 34.

Annex 7 – SVHC and WFD PS relevant for fertilizer industry

The list of SVHC substances was downloaded from the ECHA webpage (**https://echa.europa.eu/candidate-list-table**). At the moment (April 2020) the list includes 205 substances or substance groups identified as SVHC. The information on substance uses in EU was compiled from the public ECHA CHEM database (**https://echa.europa.eu/information-on-chemicals**) and in Nordic countries from SPIN register (Substances in Preparation in Nordic countries **http://spin2000.net/**). If the substance had word '"fertilizer" in the section 'uses at industrial sites' of the ECHA infocard, the substance was deemed to be used in fertilizer industry. The total use volumes in EU were derived from ECHA infocards (public ECHA CHEM database) as well. The use information from SPIN database was searched from the categories "Industrial Use (NACE)" and "Use (national)". The use volumes in SPIN database are presented for one particular year. If the use volume value in SPIN database is "0" it means that the volume is below the limit of accuracy, which is 100 kg.

There are issues concerning the quality of the data in the public ECHA CHEM database. Firstly, the use information in public ECHA CHEM database is provided by the manufacturers or importers of a substance in the registration dossiers. It is possible that the manufacturer/importer has indicated multiple uses for the substance even though the substance might not be used in the fertilizer sector. This results in false positives in the lists and therefore more it should be checked if SVHCs are actually used in fertilizer sector. Secondly, the use volumes in ECHA infocards cover all the possible uses of the substance and not only the used amount in fertilizer sector (i.e. there is no information on amount of use in fertilizer sector). Thirdly, the information on the industrial uses and volumes in public ECHA CHEM might be outdated (the year information is originating/based on is unknown). For these reasons the table 5 may include substances, which are not used in fertilizer sector.

Altogether 5 substances or substance groups were identified to fertilizer sector. Three of these are boron compounds. Boron is an essential plant micronutrient and added to SVHC list due to concerns related to human health. Two of the identified substances are cobalt salts. Cobalt is needed in nitrogen fixation reactions in legume plants. The identified substances and information e.g. on their uses are presented in the table 5.

SVHC substances are regulated under REACH with the intention to phase out their use and to reduce exposure. Note that the SVHC substance list is updated twice a year. Substances with the following hazard properties may be identified as SVHCs:

Substances meeting the criteria for classification as carcinogenic, mutagenic or toxic for reproduction (CMR) category 1A or 1B in accordance with the CLP Regulation.

Substances which are persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB) according to REACH Annex XIII.

Substances on a case-by-case basis, that cause an equivalent level of concern as CMR or PBT/vPvB substances

Table 6: REACH substances of very high concern (SVHC) and WFD priority substances (PS) / priority hazardous substances (PHS) which have registered uses in fertilizer industry based on REACH registration information in the ECHA chemical database.

Annex XV = substance specific dossiers on "Proposal for identification of a substance as a category 1A or 1B CMR, PBT, vPvB or a substance of an equivalent level of concern" under REACH Annex XV, available in the ECHA chemical database separately from the REACH registration information.

Substance (SVHC / WFD substance)	CAS	Use in Fertilizer sector (ECHA/SPIN)	Total imported or manufactured for all uses in EU (ECHA database) / for STM in Nordic countries (SPIN database) (tons/a)[1]	"Fate" in waste water treatment plant[2]	Other information
Boric acid SVHC	10043-35-3	ECHA: fertilizers Annex XV: non-electrolytic metal coatings, metal surface treatment agents, corrosion inhibitors, rust preventive agents SPIN: crop and animal production, agriculture, fertilizers	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 42,2 tons/a	not evaluated in HAZBREF	
Cobalt dichloride SVHC	7646-79-9	ECHA: metal surface treatment products, manufacture of chemicals and fabricated metal products Annex XV: nitrate fertilizers SPIN: no fertilizer related uses	ECHA: 1 000 – 10 000 tons/a No fertilizers related uses in SPIN.	not evaluated in HAZBREF	
Cobalt (II) carbonate SVHC	513-79-1	ECHA: fertilizers Annex XV: adhesion: ground coat frit, production of other chemicals (intermediate) SPIN: manufacture of food products, nutrients, fertilizers	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	

Disodium octaborate SVHC	12008-41-2	ECHA: fertilizers Annex XV: micronutrient fertilizers SPIN: no fertilizers related use	ECHA: 1 000 – 10 000 tons/a No fertilizers related use in SPIN.	not evaluated in HAZBREF	
Disodium tetraborate, anhydrous SVHC	1330-43-4, 1303-96-4 (Borax), 12179-04-3 (pentahydrate)	ECHA: fertilizers Annex XV: metal production, metal surface refining (pentahydrate) SPIN: crop and animal production, agriculture, fertilizers	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 0 tons/a 343,5 tons/a (Borax) 159,2 tons/a (pentahydrate)	7,9% to surface water 0% to sludge 91,6% biodegradation 0,5% volatilization	

References:
2 Annex XV reports of boric acid, cobalt dichloride, cobalt (II) carbonate, disodium octaborate, disodium tetraborate
3 http://www.ipni.net/publication/nutrifacts-na.nsf/0/5D2097137F73C07F85257EA8006297B0/$FILE/NutriFacts-NA-15.pdf

Annex 8 – Substance flow analysis

In the HAZBREF case study the exposure scenario of a substance for fertilizer formulation indicated that based on modelling there is a risk that the emissions from fertilizer production exceed the PNEC values (PEC/PNEC>1) in water, sediment and soil and in addition in sewage treatment plant. This estimate however does not fit well in the NPK production process of the case installation since the waste water from the installation is treated in its own treatment plant and the sludge is landfilled. This will decrease the emissions to water and no emissions to STP or to soil are generated. Also, the use volumes in the exposure scenarios were overestimated.

A material flow analysis (MFA) was concluded in one of the case sites to assess the possible releases of the substance to environment from the production process. STAN tool was used to conduct this MFA and this annex explains the method in brief.

Material flow analysis is a method for assessing flows of materials during a given time period and within a defined system boundary (1). The material can be a good or a substance, and if it is a substance the method is referred to as a substance flow analysis. The basic principle, which material and substance flow analysis relies on, is the law of mass conservation, which implies that the sum of all inputs of the material to the system must be equal to the sum of outputs from the system. See Brunner & Rechenberger (2) for a detailed overview of the MFA method.

In this analysis a material and substance flow analysis software, STAN 2.6 version was used. STAN has built-in computation algorithms for error propagation and data reconciliation, securing a viable system without gross errors while balancing the flows, thereby satisfying the law of mass conservation.

These steps to follow when executing the analysis with STAN:

1) Choosing the substance to analyze.
2) Defining the system boundary in space and time.
3) Identifying goods containing the chosen substance in step 1).
4) Identifying processes and flows related to the identified goods in step 1).
5) Building the graphical model in STAN based on the processes and flows in step 4).
6) Defining the layers of goods and substances.
7) Entering data regarding the mass flows and mass fractions for the layers defined in step 6).
8) Performing the calculation with STAN.

The STAN-software relies on error propagation, which means that all data used in STAN should also have standard errors. It is recommended in the STAN manuals that if no error is known, an assumption or estimate is better than no (or 0) error. The standard sample error is computed by the formula

Equation I

•

$$\sigma = \frac{s}{\sqrt{n}}$$

where s is the sample standard deviation (the sample-based estimate of the standard deviation of the population) and n is the number of observations in the sample.

The substance was chosen (referred here as substance X) (step 1). The system boundary was set to be the production plant and its immediate surrounding area, including the area for unloading the raw-materials and packing the product (step 2), as well as the water treatment plant in connection with the production plant. The timeline for the model was chosen to be one year. The material flows containing substance X were identified (step 3). The identification of processes and flows was done by combining information about the plant infrastructure and its waste water treatment plant (step 4), and a graphical model was built in STAN based on this information (step 5). Two layers were defined, a layer of goods containing the substance X and the substance layer (step 6).

The analysis of the flow of X started with identifying which substances may contain substance X and understanding if or when these flows may be in contact with the surroundings of the plant. The flows were drawn and the masses of substance X were calculated or estimated, when data was not available. Standard errors were computed for the values where there was more than 1 measurement on the mass or mass fraction. To estimate the standard errors of the input values without comprehensive measurement data, the mean of the relative standard errors was computed (32,33 %). This estimate was used for the rest of the input data, except for the amount of substance X in the products, which can be assumed to be more controlled since the product composition should be known. in the products, which can be assumed to be more controlled since the product composition should be known.

The results were computed with STAN (step 8). Since not all import and export flows were known, the software can not apply the method of data reconciliation.

STAN is a suitable tool for evaluating the outflow of a substance into the environment, provided that the data is comprehensive enough. An analysis similar to this one can be difficult to conduct with other substances if the data basis is limited compared to the data used in this analysis, or if there are more or larger uncertainties than in this analysis. Therefore, the method is only suitable for calculating substance flows if there is enough measured data on the substances and the substance is relatively inert in the process.

9. References

Institute for Water Quality, Resource and Waste Management, Technische Universität Wien, Karlsplatz 13/226, A-1040 Vienna,. stan2web. [Online] 2012. [Cited: 09 12, 2019.] http://www.stan2web.net/.

Brunner, Paul H. and Rechberger, Helmut. Practical handbook of material flow analysis. s.l. : Lewis Publishers, CRC Press LLC, 2000 N.W. Corporate Blvd., Boca Raton, Florida 33431, USA, 2004.Aguado J. at all; European trends in the feedstock recycling of plastic wastes. Global NEST Journal, Vol 9, No 1, pp 12-19, 2007

Bassil, Jade H.; Dreux, Gabrielle; and Eastaugh, Gwendolyn A., "Chemical Recycling of Polystyrene Using Pyrolysis" (2018). Senior Design Reports (CBE). 103.
https://repository.upenn.edu/cgi/viewcontent.cgi?article=1104&context=cbe_sdr

Brunner, Paul H. and Rechberger, Helmut. Practical handbook of material flow analysis. s.l. : Lewis Publishers, CRC Press LLC, 2000 N.W. Corporate Blvd., Boca Raton, Florida 33431, USA, 2004.

Chem Sec, SIN List, Substitute It Now https://sinlist.chemsec.org/

Cefic. 2020 - Facts & Figures of the European chemical industry https://cefic.org/app/uploads/2019/01/The-European-Chemical-Industry-Facts-And-Figures-2020.pdf

Cefic. Responsible Care https://cefic.org/our-industry/responsible-care/

ECHA, European Chemicals Agency https://echa.europa.eu/home

ECHA CHEM database https://echa.europa.eu/information-on-chemicals

ECHA, High-volume plastic additives mapped https://echa.europa.eu/fi/-/high-volume-plastic-additives-mapped

European Commission. Chemicals https://ec.europa.eu/growth/sectors/chemicals/

European IPPC Bureau. BREF documents with BAT conclusions https://eippcb.jrc.ec.europa.eu/reference/

European Plastics Recyclers (PRE) (2016). Reach for plastics recyclers. http://plasticsrecyclers.eu/reach-plastics-recyclers

EUSES, The European Union System for the Evaluation of Substances https://ec.europa.eu/jrc/en/scientific-tool/european-union-system-evaluation-substances

Fertilizers Europe. Annual Overview 2018/2019 https://www.fertilizerseurope.com/wp-content/uploads/2019/08/Fertilizers_Europe_Annual_Overview_2018-2019_web.pdf

Institute for Water Quality, Resource and Waste Management, Technische Universität Wien, Karlsplatz 13/226, A-1040 Vienna,. stan2web. [Online] 2012. [Cited: 09 12, 2019.] http://www.stan2web.net/.

Karaduman A; Pyrolysis of Polystyrene Plastic Wastes with Some Organic Compounds for Enhancing Styrene Yield. Energy Sources, 24: 667-674, 2002

Mehtonen, J. & Knuutila J. 2014. Kemikaalien parempi huomioiminen ympäristöluvissa – esiselvitys. Suomen ympäristökeskus (SYKE). In Finnish. 69 p. https://www.ym.fi/download/noname/%7B440CF8B5-0673-4CD7-8DA3-D48F6EB096CD%7D/103875

Scheirs J, Kaminsky W: Feedstock Recycling and Pyrolysis of Waste Plastics: Converting Waste Plastics Into Diesel and Other Fuels. Wiley, 2006

Stenmarck Å et al, Hazardous substances in plastics – ways to increase recycling, TemaNord 2017

Plastics Europe. Plastics - the Facts 2018 https://www.plasticseurope.org/en/resources/publications/619-plastics-facts-2018

Plastics Europe. Recycling and energy recovery https://www.plasticseurope.org/en/focus-areas/circular-economy/zero-plastics-landfill/recycling-and-energy-recovery

The Russian BAT Bureau, EIPC https://eipc.center/en/main/

The Russian Chemists Union http://www.ruschemunion.ru/en/

SGS Polymer Solutions Incorporated. Plastics Recycling: A Cycle or a Dead End? https://www.polymersolutions.com/blog/plastics-recycling-a-cycle-or-a-dead-end/

STAN tool, Substance Flow Analysis tool http://www.stan2web.net/

Sectoral Guidance for Chemicals Management in the Chemical Industry with focus on the production of fertilisers and polymers

REPORT 6953

SWEDISH EPA
ISBN 978-91-620-6953-7
ISSN 0282-7298

HAZBREF-project Activity 4.1 report

SVEN BOMARK, EMMI VÄHÄ OCH ET AL

This Sector-Specific Report Provides Guidance To Key Actors At National Level (Chemical Industries And Competent Authorities) On How To Improve Chemical Management At Installation Level. In This Respect, It Takes Reference To Relevant Requirements Such As The Industrial Emission Directive (Ied) And The Sectoral Best Available Techniques Reference Documents (Brefs). The Findings Of The Guidance, Especially Concerning Bat Candidates In Chapter 5, Will Also Feed Into The Anticipated Forthcoming Revision Of The Brefs For The Chemical Industry Sectors (Lvic And Possibly Others). They Are Further Used For Helcom Recommendations On How To Reduce The Discharge Of Hazardous Substances Into The Baltic Sea.

The Document Summarises Key Findings Of Interviews And Discussions With Hazbref Experts, Representatives From Chemical Industry And Relevant authorities as well as insights from case studies in Finland, Estonia and Sweden. In addition to that two polymer installations in Poland were selected for analysing circular economy issues.

The report focuses on prevalent practices and challenges related to the IED permitting process, with special reference to hazardous chemicals for polymer and fertilizer installations. The report also reflects findings of other Work packages under HAZBREF and refers to recommendations published under the European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL).

Swedish EPA SE-106 48 Stockholm. Visiting address: Stockholm - Virkesvägen 2, Östersund - Forskarens väg 5 hus Ub, Tel: +46 10 698 10 00, e-mail: registrator@swedishepa.se Internet: www.swedishepa.se **Orders** Ordertel: +46 8 505 933 40, e-mail: natur@cm.se Address: Arkitektkopia AB, Box 110 93, SE-161 11 Bromma. Internet: www.swedishepa.se/publications