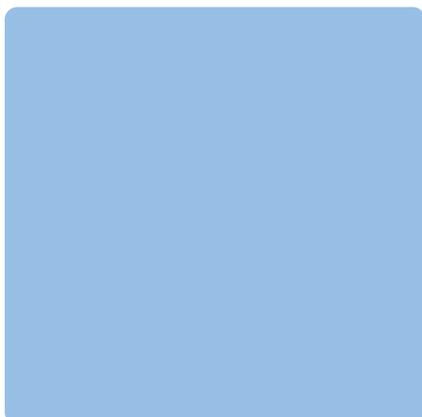
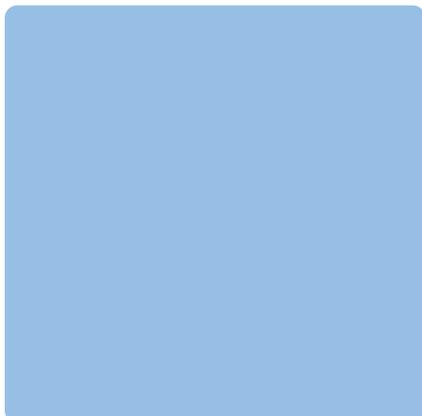


Sectoral Guidance for Chemicals Management in the Surface treatment of metals and plastics Industry

HAZBREF-project Activity 4.1 report

JANUSZ KRUPANEK OCH ET AL

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Janusz Krupanek et al

HAZBREF

Interreg
Baltic Sea Region



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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 from October 2017 until January 2021.

The overall aim of HAZBREF is to increase the knowledge base of the industrial sources and the reduction measures of hazardous chemicals. HAZBREF identifies relevant chemicals used in industrial sectors, their use patterns, environmental characteristics and measures to prevent and reduce releases to the environment. On the EU level, the main instrument to control industrial releases is the Industrial Emissions Directive (IED), particularly through the publication of Best Available Techniques (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 POP 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 aim to strengthen the links between different regulatory frameworks and their key players. On enforcement level at industrial installations the project has identified and tested model solutions for hazardous chemical management.

The activities have been 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.

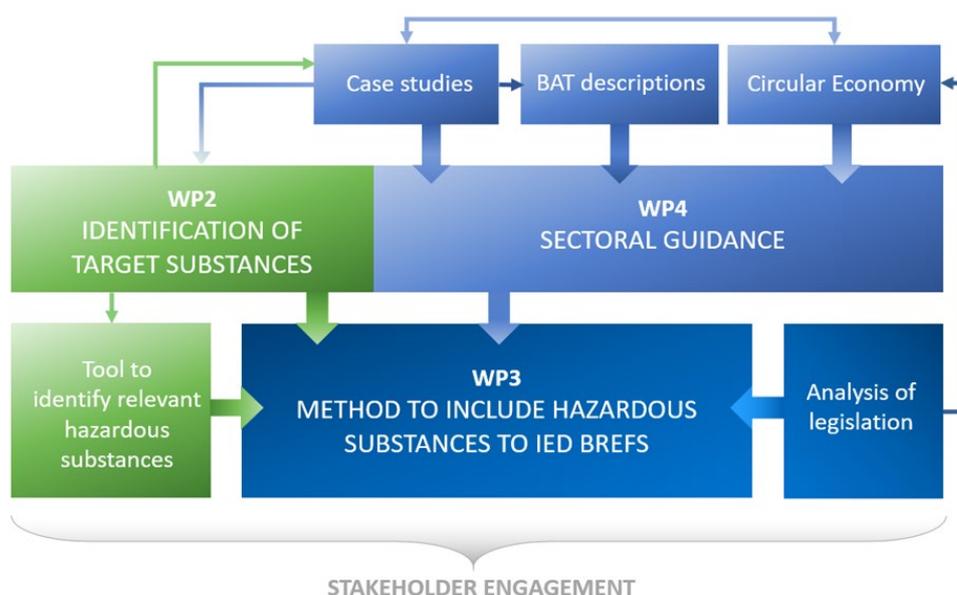


Figure 1. Overview of the design of the HAZBREF-project with its four work packages.

The HAZBREF partnership includes 5 organisations 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 organisations and a wide range of other stakeholders have supported and contributed to the HAZBREF work. These stakeholders include ministries and governmental environmental and chemical agencies from several EU countries, permitting and supervision authorities as well as industries and environmental NGOs. More information about HAZBREF can be found on our project website (www.syke.fi/projects/hazbref).

The following people and organizations have contributed in preparing this report: Janusz Krupanek (IETU), Emmi Vähä (SYKE), Kaj Forsius (SYKE), Pia Högmänder (SYKE), Annika Johansson (SYKE), Timo Jouttijärvi (SYKE), Jukka Mehtonen (SYKE), Mariusz Kalisz (IETU), Karl Kupits (KLAB), Sandra Leuthold (UBA), Sven Bomark (SWEPA) and Annika Månsson (SWEPA).

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 document two consulting companies contributed with their knowledge and expertise regarding STM sector and chemical management: Adelphi and SWECO.

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

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List of Abbreviations

BAT	Best Available Technique
BREF	Best Available Technique Reference Document
CAS	Chemical Abstract System
CAW	Chemical Agents at Work
CLP	Classification, Labelling and Packaging Regulation
CMR	Carcinogenic, Mutagenic, or Toxic for Reproduction
CMS	Chemical Management System
ECHA	European Chemical Agency
EFS BREF	Emissions from Storage BREF
ES	Exposure scenario
EQS	Environmental Quality Standards
eSDS	Extended safety data sheet
GHG	Green House Gases
GHS	Globally Harmonised System of classification and labelling of chemicals
IED	Industrial Emissions Directive
IMPEL	European Union Network for the Implementation and Enforcement of Environmental Law
KEMI	Swedish Chemical Agency
MEC	Measured Environmental Concentration
MFA	Material Flow Analysis
MSDS	Material safety data sheet
OC	Operational Conditions
OSH	Occupational Safety and Health
PBT	Persistent, bio-accumulative and toxic
PCB	Printed Circuit Board
PEC	Predicted Environmental Concentration
PNEC	Predicted No-Effect Concentration
POPs	Persistent Organic Pollutants
REACH	Regulation concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals
RMM	Risk Management Measure
ROM	Monitoring of Emissions to Air and Water from IED Installations (JRC Reference Report on Monitoring (ROM))
SFA	Substance Flow Analysis
SDS	Safety Data Sheet
SME	Small and medium-scale enterprise
STAN	subSTance flow ANalysis
STM BREF	Surface Treatment of Metals and Plastics BREF
STS BREF	Surface Treatment Using Organic Solvents BREF
SVHC	Substance of very high concern
TDS	Technical Data Sheet

UBA	Federal Environment Agency, Germany
vPvB	Very persistent and very bio-accumulative
WFD	Water Framework Directive
WT BREF	Waste Treatment BREF
WWTP	Waste water treatment plant

Sammanfattning

Bakgrund

Det huvudsakliga instrumentet på EU-nivå för att kontrollera utsläpp från industrin är industriutsläppsdirektivet (IED), särskilt genom publicering av BAT-referensdokument (BREF) och relaterade BAT-slutsatser, som är referensen för att fastställa tillståndsvillkoren i hela EU för IED-verksamheter. De hittills publicerade BREF-dokumenterna innehåller emellertid inte tillräckligt med information om specifika farliga kemikalier som används och släpps ut från industrin vilket gör kontrollen svår för industrin och tillstånds- och tillsynsmyndigheterna.

En av sektorerna som valts ut i HAZBREF-projektet är ytbehandling av metaller och plast (STM). Denna sektor valdes på grund av användningen av kemikalier, potentiella utsläpp, det breda utbudet av produkter samt tekniska processer och den kommande STM BREF-revideringen. De andra sektorerna HAZBREF har fokuserat på är textilindustri och kemisk industri, som behandlas i separata rapporter.

Bristen på kunskap om användning och flöde av specifika farliga kemikalier i de industriella processerna gör det svårt att kontrollera och minska kemikalierna. Problemet är ofta att varken verksamhetsutövare eller myndigheter vet vilka ämnen som är relevanta att åtgärda och vilka skyddsåtgärder som behöver vidtas. Ytbehandling av metaller och plast omfattas av STM BREF-dokumentet, som publicerades 2006. Enligt EIPPCB: s senaste arbetsprogram planeras revideringen av STM BREF att börja 2021.

Dokumentets syfte

Denna vägledning innehåller information om användning av farliga kemikalier, bästa praxis inom kemikaliehantering och rekommendationer för att förbättra tillståndsprocessen inom STM-sektorn. Detta dokument sammanfattar resultaten från HAZBREF-projektet och baseras på fallstudier, intervjuer med myndigheter och expertbedömning. Syftet är att beskriva god praxis inom kemikaliehantering som ska användas av STM-verksamheter samt miljö- och kemikaliemyndigheter. Dessa inkluderar tekniska, organisatoriska och hanteringsaspekter och konkreta verktyg som stöder kemikaliehantering.

Rapporten behandlar STM-sektorn som helhet i Europa, även om huvuddelen av resultaten härrör från verksamheter som har deltagit i fallstudierna och andra erfarenheter i Östersjöregionen. Dokumentet innehåller också allmänna beskrivningar av BAT-förslag relaterade till hantering av farliga kemikalier och ämnen. Dessa resultat i vägledningen kommer att ingå i den kommande revideringen av STM BREF. De kan vidare användas för HELCOM-rekommendationer om hur man kan minska utsläppen av farliga ämnen i Östersjön.

Dessutom ger dokumentet en översikt över tillämpliga lagkrav, förfaranden och andra skyldigheter för verksamhetsutövare beträffande användning av kemikalier och utsläpp av farliga ämnen. Detta inkluderar vägledning för hur man kan

identifiera och bedöma relevanta farliga ämnen som används och släpps ut från STM-anläggningarna.

Huvudsakliga resultat och förslag

Förbättring av kemikaliehanteringssystemet

Ett kemikaliehanteringssystem ger ett systematiskt sätt att hantera kemikalier genom hela processen på anläggningen. De flesta av företagen har implementerat olika standarder som ISO 9000, ISO 14000, EMAS och integrerade EHS-program som också behandlar vissa aspekter av kemikaliehantering. Kvaliteten på kemikaliehanteringssystem i företagen varierar beroende på deras storlek, ägarförhållanden och medvetenhet. Integrering av god praxis för kemikaliehantering i redan implementerade ledningssystem stärker förmågan att minska miljörisker. HAZBREF-projektet rekommenderar upprättande och regelbunden användning av ett kemikaliehanteringssystem vid IED-verksamheter.

Utveckling av en kemikalieinventering

Att upprätta och underhålla en kemikalieinventering är en viktig förutsättning för en effektiv och ansvarsfull kemikaliehantering inom STM-sektorn. Alla kemikalier och råvaror som används i alla processer och aktiviteter på anläggningen bör, tillsammans med information om deras egenskaper, listas i en databas. En sådan databas är en viktig del av kemikaliehanteringen och möjliggör systematisk riskbedömning, hantering av kemikalieflöden och lagring.

Informationen i kemikalielistan/databasen måste vara sökbar och bör uppdateras regelbundet. Merparten av den information som behövs finns i säkerhetsdatabladet (SDS). Om viss information saknas i säkerhetsdatabladet bör leverantören uppmanas att lämna denna. Bra rutiner för att hantera nya och uppdaterade säkerhetsdatablad är avgörande för att ha en uppdaterad och pålitlig kemikaliedatabas. Dessa rutiner bör omfatta hantering och uppdateringar på plats samt kommunikation med leverantörer om hur säkerhetsdatablad levereras.

Välskötta kemikalielistor/databaser kan avsevärt förenkla ansökan om miljötillstånd för både verksamhetsutövare och tillståndsmyndigheter.

Bättre användning av verktyg för kemikaliehantering och utbildning av personal

Många referenser och verktyg finns tillgängliga för att stödja STM-företag och behöriga myndigheter i genomförandet av den goda kemikaliehanteringen som krävs i IED. HAZBREF rekommenderar verksamhetsutövare att använda lämpliga verktyg för riskbedömning och utvärdering av kemikaliehanteringsens effektivitet.

Användning och förbättring av riskbedömningsverktyg som utökade säkerhetsdatablad och analys av materialflöden bör främjas bland verksamhetsutövare i detta avseende. HAZBREF-projektet har utvecklat ett omfattande verktyg som hjälper verksamhetsutövarna att identifiera platsspecifika farliga ämnen som bör beaktas i strategiska och operativa beslut.

Att öka medvetenheten och att utbilda personal i användningen av verktyg för kemikaliehantering och kemikaliehanteringssystem är avgörande för genomförandet av god kemikaliehanteringspraxis vid verksamheterna.

Substitution

En regelbunden kontroll som syftar till att identifiera potentiellt nya tillgängliga och säkrare alternativ till de farliga kemikalier som används 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 kan riktas mot alla farliga kemikalier som används på verksamheten där det behövs för att skydda miljön eller människors hälsa. Substitution som senare ångras (dvs. byta till att använda en ny kemikalie som är lika eller mer farlig än den substituerade kemikalien eller som resulterar i tvärmedieeffekter) måste undvikas.

Bedömning och förbättring av säkerhetsdatablad

Effektiv kemikaliehantering kräver hög kvalitet på säkerhetsdatablad (SDS). Säkerhetsdatabladet bör beskriva de kemiska egenskaperna tillräckligt och innehålla information om exponering (inklusive användning och utsläpp), ekotoxikologi och korrekt lagring och hantering. Ett SDS måste också innehålla information om huruvida den kemiska produkten innehåller SVHC-ämnen, prioriterade ämnen enligt vattendirektivet WFD och POPs-konventionen. Om en kemikalieleverantör inte tillhandahåller ett säkerhetsdatablad av tillräcklig kvalitet är det både verksamhetsutövaren och den behöriga myndighetens skyldighet att kräva informationen som saknas. Detta krävs redan enligt lag i vissa länder, t.ex. i Tyskland. Det är också viktigt att verksamhetsutövarna vet hur man tar fram och sammanfattar relevant information från säkerhetsdatabladet till sina tillståndsansökningar och verifierar kvaliteten på olika informationskällor.

För att förbättra riskbedömning av enskilda kemikalier, som används i specifika processer, kan ett utökat säkerhetsdatablad inklusive exponeringsscenarioer och förbättrade data om miljöeffekter underlätta. Detta skulle leda till effektivare övervakning och hjälp med att fokusera på ämnen som är farliga. För att få mer fullständiga kemikalieinventeringar kan förbättrade säkerhetsdatablad för råvaror med information om föroreningar eller tillsatser underlätta.

Kontinuerlig förbättring av implementeringen av BAT

Implementeringen av BAT måste kontinuerligt övervakas och förbättras vid verksamheten med beaktande av platsspecifika tekniska, ekonomiska och miljöaspekter. Resultaten från de polska HAZBREF-fallstudierna är att uppfyllandet av BAT-kraven kan vara utmanande om alla förbättringar behöver göras på kort tid. Till exempel anses slutna system vara nödvändiga ytterligare processintegrerade tekniker som det är viktigt att implementera steg för steg i verksamheten.

Cirkulär ekonomi

STM-sektorn är en betydande användare av icke förnybara resurser (metaller), och återvinning av återvunna metallinnehållande material såsom metallsubstrat eller elektrolyter tillbaka till processen är god praxis. Sådana återvinningsprocesser

används ofta för basiska metaller, såsom zink, koppar och nickel, som används som värdefulla sekundära råvaror (SRM). Höga kostnader för återvinningsprocesser och hög energianvändning samt de många olika kemikalier och metaller som används i STM-processer hindrar ofta återvinning. I de fall återvinning inte är möjlig är förbehandling av förorenat avloppsvatten på plats och efterföljande behandling av genererat metallhaltigt slam praxis.

Tillståndsprocessen

Förutom bästa praxis inom kemikaliehantering utarbetades även rekommendationer för att förbättra tillståndsprocessen inom STM-sektorn. Man kan dra slutsatsen att den befintliga allmänna strukturen och innehållet i tillståndsansökningsförfarandena som sådana är tillräckliga för att hantera farliga ämnen och kemikalier. I praktiken kan tillståndsprocessen ändå förbättras med mer kommunikation mellan den sökande och tillståndsmyndigheten under ansökningsfasen. Mer samarbete mellan kemikalie-, miljö- och arbetsmiljömyndigheterna föreslås för att uppnå ett smidigt informationsflöde och minska dubbelarbete avseende krav enligt olika lagstiftning om kemikalier och farliga ämnen. I vissa länder, till exempel i Finland, måste praxis för tillsyn och övervakning i olika delar av landet harmoniseras så att alla verksamheter behandlas lika. Detta kräver mer och bättre kommunikation mellan miljö- och kemikaliemyndigheter i landet.

Det förbättrade informationsutbytet och exempel på goda erfarenheter mellan medlemsstaterna skulle också på sikt bidra till mer harmoniserad och bättre praxis på europeisk nivå.

Summary

Background

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, which is the reference for setting the permit conditions throughout EU for IED installations. However, the BREFs published so far do not contain adequate information on specific hazardous chemicals used and released from industry which makes the control difficult for the industry and the permitting and supervising authorities.

One of the case sectors in the HAZBREF project is the surface treatment of metals and plastics (STM). This sector was chosen due to the use of chemicals, potential emissions, the wide range of products as well as technological processes and the upcoming STM BREF review. The other HAZBREF case sectors are textile industry and chemical industry which are addressed in separate reports.

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 often neither plant operators nor authorities know which substances are relevant to be treated and which handling measures are needed. Surface treatment of metals and plastics is covered by the STM BREF document, published in 2006. According to the last work programme of the EIPPCB the review of the EU STM BREF is planned to start in 2021.

Purpose of the document

This sectoral guidance contains information on uses of hazardous chemicals, the best practices in chemical management and recommendations on enhancing the permitting process in the STM sector. This document sums up the findings from HAZBREF project and is based on industrial case studies, interviews with authorities and expert judgment. The aim is to describe good practices in chemical management to be utilized by STM installations as well as environmental and chemical authorities. These include technical, organisational and management aspects and concrete tools supporting chemical management.

The report addresses the STM sector as a whole in Europe, although the main part of the findings is generated from HAZBREF case installation and other experiences in the Baltic Sea Region. The document provides also general descriptions of BAT proposals related to management of hazardous chemicals and substances. These findings of the guidance will feed into in the forthcoming revision of the STM BREF. They are also to be used for HELCOM recommendations on how to reduce the discharge of hazardous substances into the Baltic Sea.

Moreover, the document provides an overview of applicable legal requirements, procedures and other obligations of installation operators regarding use of chemicals and releases of hazardous substances. This includes guidance for tools to

identify and assess relevant hazardous substances used and released from the STM installations.

Main findings and proposals

Improvement of chemical management system

A Chemical Management System provides a systematic way of managing chemicals through the whole process on the site. Most of the companies have implemented quality management standards such as ISO 9000, ISO 14000, EMAS and integrated EHS programs which also address certain aspects of chemical management. The quality of chemical management systems in the companies differs depending on the scale of operation, ownership and awareness. Integration of good practices of chemical management within already implemented management systems strengthens the ability to reduce environmental risks. HAZBREF project strongly recommends the establishment and regular use of a chemical management system at IED installations.

Development of a chemical inventory

The establishment and maintenance of a chemical inventory is an important prerequisite for effective and responsible chemicals management in the STM sector. All chemicals and raw materials along with information on their properties used in all processes and activities at the site should be listed in a database. Such a database is a key part of chemical management allowing for systematic risk assessment, management of chemicals flows and their storage.

The information in the chemical list/database must be searchable and 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. Good routines to handle new and updated SDSs 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 SDSs are delivered.

Well-managed chemical inventories can significantly simplify the environmental permit application process both for the operators and the permitting authorities.

Better use of Chemical Management Tools and training of staff

Numerous references and tools are available to support STM companies and competent authorities in implementing the good chemical management required in the IED. HAZBREF recommends that operators use proper tools for risk assessment and evaluation of the efficiency of chemical management.

Use and improvement of risk assessment tools such as extended SDS and material flow analysis should be promoted among installation operators in this respect. The HAZBREF project has developed a comprehensive tool that helps the operators to identify the site-specific hazardous substances that should be considered in strategic and operational decisions.

Awareness raising and training of staff in the use of chemical management tools and systems is crucial for implementation of good chemical management practices at the installations.

Substitution

A regular check aiming at identifying potentially new available and safer alternatives to the hazardous chemicals used 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.

Substitution can be aimed for any hazardous chemical used at installation level where it is needed in order to protect environment or human health. However, regrettable substitution (i.e. move to use new chemical that is equally or more hazardous than the substituted chemical or results in cross-media effects) must be avoided.

Assessment and improvement of SDS

Efficient chemicals management requires high quality of the Safety Data Sheets (SDS). The SDS should sufficiently describe the chemical properties and include information about exposure (including use and emissions), eco-toxicology and proper storage and handling. A SDS must also contain information on whether the chemical product contains substances on the SVHC list, priority substances under the Water Framework Directive WFD and the POPs convention. In case a chemical supplier fails to provide a SDS of sufficient quality, it is the duty of both the operator and the competent authority to demand the missing information. This is already required by law in some countries, e.g. Germany. It is also important that the operators know how to extract and consolidate the relevant information from the SDS to their permit applications and verify the quality of different information sources.

The development of an extended SDS including exposure scenarios and improved data on environmental effects would facilitate better risk assessment of individual chemicals used in specific processes. This would lead to more efficient monitoring and help focusing on substances of concern. Improved SDSs for raw materials with information on impurities or additives would facilitate more complete chemical inventories.

Continuous improvement of BAT implementation

The implementation of BAT needs to be continuously monitored and improved at the installation considering site specific technological, economical and environmental aspects. The findings from Polish HAZBREF case studies is that fulfilment of BAT requirements can be challenging if all improvements need to be done in a short time period. For example, closed-loop systems are considered necessary additional process-integrated techniques that it is important to implement step by step in the installations.

Circular economy

The STM sector is a significant user of non-renewable resources (metals), and recycling of recovered metal containing materials such as metal substrates or electrolytes back to the process is good practice. Such recovery processes are widely used for basic metals, such as zinc, copper and nickel, which are used as valuable secondary raw materials SRM. High costs of recovery processes and high energy consumption as well as the variety of chemicals and metals used in STM processes often hinders recycling. In cases where recycling is not feasible, pre-treatment of contaminated waste water on site and subsequent off-site treatment of generated metal containing sludges is standard practice.

Permitting process

Beside best practices in chemical management, the project also elaborated recommendations on enhancing the permitting process in the STM sector. It can be concluded that the existing general structure and content of the permit application procedures are as such sufficient to deal with hazardous substances and chemicals. Nevertheless, in practice the permit process could be improved with more communication between the applicant and the permitting authority during the application phase. More co-operation between chemical, environmental and occupational health authorities is suggested to achieve a smooth information flow and reduce double work regarding requirements under different legislations concerning chemicals and hazardous substances. In some countries, for example in Finland, the supervising practices in different parts of a given country need harmonising so that all installations are treated equally. This requires more and better communication between the respective environmental and chemical authorities within the country.

The improved exchange of information and examples of good experiences between Member States would also, in the long run, contribute to more harmonised and better practices on European level.

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, which is the reference for setting the permit conditions throughout EU for IED installations. However, the BREFs published so far do not contain adequate information on specific hazardous chemicals used and released from industry which makes the control difficult for both the industry and the permitting and supervising authorities.

HAZBREF project addresses the sector of surface treatment of metals and plastics (STM) as one case sector. This sector was chosen due to use of chemicals, potential emissions, the wide range of products as well as processes and the upcoming STM BREF review. The other HAZBREF case sectors are textile industry and chemical industry, which are addressed in separate reports also available on the HAZBREF website.

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 often neither installations' operators nor authorities always know which substances are relevant to be addressed and by which measures they need to be managed. The pollution from this sector has also been acknowledged in the Baltic Sea Region and the electroplating sector was identified as a Hot Spot by HELCOM in the St. Petersburg area. However, the situation has improved, and this Hot Spot has been removed from the HELCOM list of Hot Spots.

Surface treatment of metals and plastics is covered by the STM BREF document, which was published in 2006. According to the last work programme of the EIPPCB the review of the EU STM BREF is planned to start in 2020/2021.

The Russian BREF was published in 2017 and covers the Surface treatment of metals and plastics using electrolytic or chemical processes.

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 STM sector. This document sums up the findings from the HAZBREF project and is based on case studies, interviews with authorities and expert judgment. The aim is to describe good practices in chemical management to be utilized by installations as well as environmental and chemical authorities. Although, the report addresses the STM sector as a whole in Europe the main findings come from work done in the Baltic Sea Region. The findings of the guidance will feed into in the forthcoming revision of the STM 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 surface treatment of metals and plastics is carried out in more than 18 000 installations (mostly non-IED sized) in Europe, ranging from small companies to facilities owned by multinational corporations. Most of them are specialist sub-contractors ('jobbing shops') while the remainder provide surface treatment within another installation, usually a micro, small or medium-scaled enterprise (SME). A few large installations are owned by major companies although the vast majority are SMEs, typically employing between 10 and 80 people.

Surface treatment of metals consumes a lot of chemicals, including heavy metals. The key emissions of concern are metals (nickel, chromium, copper, zinc) which are used as soluble salts. Depending on the process, emissions may contain cyanides, as well as surfactants which may have low biodegradability and accumulate in organisms. Most of hazardous waste is spent process solutions contaminated with heavy metals.

In the surface treatment sector, metals and plastics are treated to change their surface properties for: decoration and reflectivity, improved hardness and wear resistance, corrosion prevention and as a base to improve adhesion of other treatments such as painting.

The market structure is dominated by automotive applications, construction, food and drink containers, electrical industry, electronics, steel semis (components for other assemblies), industrial equipment, and aerospace industry. To a lesser degree there are other applications such as home utensils.

HAZBREF case studies

Seven case studies were conducted in the STM sector – two each in Estonia, Poland and Germany respectively, and one in Finland. As already mentioned, the STM sector is very diverse and the number of HAZBREF case studies were limited. However, a broad variety of processes, items to be treated/coated and also chemicals were covered by the case studies.

The case studies cover basically all relevant processes of substrate pre-treatments such as: degreasing, pickling, passivation, deburring, blasting and polishing. The only process missing is pickling of plastics as pre-treatment for chromium plating with chromosulfuric acid.

For the surface treatment itself the project team managed to ensure that the major processes with the main coating materials are covered, such as zinc coating, chromium, nickel, copper, tin, silver plating, anodizing of aluminium etc. With chromium trioxide, boric acid, cobalt nitrate, nickel, lead, cadmium and cyanides, the most relevant hazardous substances for the sector were each found in at least one of the case study installations.

The only sector which is not covered by the case studies but is in the scope of the STM BREF is Printed Circuit Board (PCB) manufacturing. The sector is a rather small one in Europe and very specialized. Apart from gold plating and the

use of photoactive resists most of the metals and other chemicals needed in the PCB manufacturing are also used in other STM processes and are hence covered by the case studies. To sum up, it can be said that the processes and chemicals used in the STM sector and described in the STM BREF are largely covered by the case studies.

STM installations in Europe often operate a mixture of small and large production lines, and a mixture of electrolytic and chemical processes, as well as associated activities.

Installations in the STM sector are subject of the requirements of IED if the volume of the treatment vats exceeds 30 m³. Apart from the STM BREF, other reference documents which may be relevant for the STM installations are Waste Treatment (WT BREF) and Surface Treatment Using Organic Solvents (STS BREF) as well as the BREF for emissions from storage (EFS) and the JRC Reference Report on Monitoring of Emissions to Air and Water from IED Installations (ROM).

The E-PRTR database supports the assumption that a vast majority of installations in Europe are below the IED threshold. The number of IED installations registered in E-PRTR in 2017, under STM sector, is around 2530. According to E-PRTR and country specific information, 339 of these are located within the Baltic Sea catchment area (Table 1). The Baltic Sea catchment area extends to 14 countries: Estonia, Finland, Latvia, Lithuania, Poland and Sweden are almost entirely within the catchment, while only less than half of Denmark, only one eighth of Germany and a small fraction of Russia, Belarus, Norway, Ukraine, Czech Republic and Slovakia are situated within the catchment area.

Overview of the STM installations in Baltic Sea Region is presented in the table 1 below.

Table 1. Country specific number of STM-installations in the Baltic Sea catchment area according to E-PRTR. The number doesn't refer to the whole number of installations in the given country.¹

Country	Czech Republic	Denmark	Estonia	Finland	Germany	Latvia	Norway	Poland	Slovakia	Sweden	Russia, Lithuania, Belarus, Ukraine
Number of Installations	13	14	5	45	3	1	1	182	1	74	Unknown

The surface treatment industry in Europe comprises a set of activities including corrosion protection with the following processes: conversion coatings, coil coatings, etc. cleaning such as: alkaline degreasing, anodizing, passivation etc., and plating. Surface treatment is performed for metals such as: iron and steel, aluminium and plastics such as acrylonitrile butadiene styrene (ABS). Plating and coating can be done with application of trivalent and hexavalent chromium, nickel, zinc and to lesser degree copper, cobalt and tin and precious metals: gold, platinum and silver.

The sector is very diverse in terms of the production profile, size, processes used and technical solutions. Simple processes such as zinc plating are applied as well as complex plating such as triple plating, which involves plating the steel first with copper and then nickel before the final chromium plating. One of the complex plating examples is the process of printing circuit boards.

Process lines are normally modular and assembled from a series of tanks. Large installations are typically highly specialized and capital intensive. Treatment baths are either prepared on site based on different ingredients (acids, metals) or used as ready-to-use baths purchased from specialized vendors.

Many existing installations in the Baltic Sea Region (BSR) were restructured based on former facilities. It poses certain limitations to further development and implementation of environmental protection measures. Apart from the large-scale production installations dedicated to automobile and aviation industries, most of the installations are small-scale with diversified profiles. Many of them are not obliged to fulfil IED requirements since they do not exceed the IED threshold of 30 m³ for the vat volume.

It must be emphasized that the economic and technical capacity of small STM facilities is limited. Thus, the socio-economic aspects have to be considered. Extensive requirements for a new (updated) permit might force them to close-down or reduce their activities.

The main environmental impacts in the sector relate to water and raw materials consumption, emissions to surface and ground waters, energy use, generation of

¹ Data for EU countries except for Poland from E-PRTR. Data for Poland: Polish Ministry of Environment 2014.

solid and liquid wastes and the site condition on decommissioning. Basically, the production line comprises the preparation of the workpiece or substrate to be treated, plating, and rinsing stages in between. Both the process and end-of-pipe techniques affect the amount of raw materials used, the quantity and quality of waste water, as well as the type and quantity of solid and liquid wastes produced.

Most of the STM installations discharge waste water to external municipal sewer systems, often after pre-treatment on site.

The STM installation includes main activities such as electroplating and coating and connected associated activities which may affect emissions and pollution. The associated activities may involve:

- storage and handling of input chemicals and anode metals
- raw water preparation
- mechanical, chemical, liquid or vapour pre-treatment of workpiece or substrate
- rinsing and drying of the workpiece or substrate being treated
- post-treatment of the workpiece or substrate (where necessary to complete the surface treatment)
- waste gas extraction and waste gas abatement system
- waste water treatment
- handling of spent process fluids
- handling of wastes.

Typical metals related to STM processes are zinc (zinc chloride), copper (copper sulphate, metal electrode), nickel (nickel sulphate, nickel dinitrate, nickel chloride) and chromium³⁺ and chromium⁶⁺ (chromium trioxide and chromic acid). To a lesser degree lead (lead carbonate, lead acetate), cadmium (cadmium oxide, metal) and cobalt (cobalt dichloride, cobalt sulphate) are applied. Non-metals used (although decreasingly) in cyanide plating are cyanide compounds (potassium cyanide, sodium cyanide, copper cyanide, silver cyanide).

One of the most harmful processes from environmental point of view is chromium plating with application of hexavalent chromium in bright decorative and technical applications but also lead and cadmium plating. Due to legislative actions under REACH, a lot of discussion has been going on in the STM sector regarding the use of hexavalent chromium (Cr VI). There has been a development towards phasing out this chemical where possible, but still it is used because of properties that are well received by customers in certain technical applications but also for decorative purposes. However, for etching of plastics which are to be plated with chromium there is not yet an alternative chemical ready for large-scale application. Apart from metals and metalloids used in electroplating, chemicals used in the sector include:

- corrosion protection chemicals such as: conversion coatings, coil coatings, etc. plating chemicals and other chemicals
- degreasing agents, auxiliary chemicals, pickling etching solutions
- cleaners such as: alkaline degreasers
- anodizing chemicals, passivation agents etc.

In waste water treatment use of hypochlorite can potentially cause formation of Adsorbable Organic Halides (AOX). A wide range of surfactants with a variety of functions are used such as dispersing agents, emulsifiers, detergents (alcohols, C12–14, ethoxylated, propoxylated), wetting agents and brightening agents (brighteners). In plating processes additives, such as stabilisers (sodium tetraborate, boric acid) are commonly used and fluoride compounds as additives to chromating, anodising and magnesium coating baths.

Complexing agents used in plating include: Ethylenediaminetetraacetic acid (EDTA), tartrate, Ethylenediamine-N,N'-disuccinic acid (EDDS), Nitrilotriacetic acid (NTA), gluconate, quadrole, sodium dithionite. Some organic substances are also used in plating, e.g. benzothiazol-2-ol, hexamethylenetetramine and 1,2-ethanediamine.

Large amounts of acids and alkalis are used in the sector including the following: hydrochloric, nitric, phosphoric, sulphuric, hydrofluoric and acetic acid.

Solvents that are used for degreasing include trichloroethylene (TRI), tetrachloroethylene (PER) and methylene chloride. The chlorinated compounds are usually used in closed systems. Chlorine can be used in treatment of cyanide waste water.

Chemicals are delivered in liquid and/or solid phases and metals as electrodes are used in the processes.

The main streams of potentially hazardous wastes in STM:

- wastes from abrasive blasting of non-ferrous metals
- waste from the chromic/sulfuric acid etching and other processes
- deburring and/or tumbling wastes (may be contaminated with oils and surfactants)
- waste from blasting with pellets of dry ice (remains from remove of oil and grease as well as particles, paint, etc.)
- discarded acidic/alkaline pickling agents
- discarded acidic etching solutions
- bare printed circuit board wastes (may include wide range of heavy metals, rare earth elements, and other chemicals).

Another key issue is waste management as the STM plating produces essential amounts of wastes classified as hazardous listed above. They are well managed externally but the opportunities for their management with respect to circular economy are currently limited (see chapter 5).

3. Legal Obligations and Identification of Hazardous Substances

3.1. Legal obligations with reference to hazardous substances for plant operators

The following section briefly highlights the legal obligations in EU regulatory frameworks and HELCOM recommendations with reference to hazardous substances. In case of Russia, Russian BAT bureau produces and publishes corresponding BREF documents.²

3.1.1. REACH

Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) is a European Union regulation dating from 18 December 2006.³ REACH addresses the production and use of chemical substances, and their potential impacts on both human health and the environment. Chemical agents commonly used in STM are REACH registered substances for which risk assessment is done according to REACH regulation and risk information is provided according to CLP regulation (GHS codes). Substances for which authorisation as stated in Annex XIV of REACH is required and substances listed in Candidate list according to art 59 of REACH Regulation are used in the STM sector.

The use of some of the substances, such as Chromium trioxide (Cr VI), is allowed only if the use is granted authorisation by the EU Commission REACH Committee.⁴ The authorisation process aims to ensure that substances of very high concern (SVHCs) are replaced by less dangerous substances or technologies where technically and economically feasible alternatives are available.⁵ If the authorisation is granted, the use of the substance is subject to the conditions described in the chemical safety report submitted in the application.⁶ The authorisation decision may also require additional conditions for use, e.g. regular monitoring of emissions to water. The authorisation holder should also continue the search for safer alternatives for the substance.⁷ End-users, i.e. manufacturers, importers, distributors or consumers⁸ who use substance(s) or mixture(s) in the

² The Russian BREF: ITS 36-2017 'Surface treatment of metals and plastics using electrolytic or chemical processes'.

³ <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32006R1907>

⁴ Annex XIV of REACH.

⁵ <https://echa.europa.eu/substances-of-very-high-concern-identification-explained>

⁶ <https://echa.europa.eu/regulations/reach/registration/information-requirements/chemical-safety-report>

⁷ It is important to note that the quest for substitutes is mandated in REACH as of the moment a substance is identified as an SVHC (Art. 55) and CAW Art. 6 (2), which applies to all hazardous substances as defined in Art. 2 (b) of the same legal text, and closely related to the application of the definition in CLP Art. 3.

⁸ It must be emphasized that workshops, craftsmen and service providers in principle have the same obligations as other end users.

context of industrial or professional activities and do not supply these substances (on their own or in mixtures) to customers further down the supply chain, have to comply with the obligations listed in the text box below⁹.

Obligations for downstream users under REACH:

- Apply appropriate risk management measures (RMMs) and operational conditions (OC) proposed in the core section of the (extended) safety data sheet (eSDS) or other information received from your supplier to adequately control the risks identified.
- Communicate to your suppliers any information that might call into question the appropriateness of the RMM and OC recommended.
- In case available: Check compliance with exposure scenarios (ES) attached to SDS received from your supplier. Note that according to Article 37 (2) you have a right to inform the supplier about your use of the substance, in case it is not identified in SDS. The supplier is then obliged to update the CSR accordingly. This provision applies to hazardous and non-hazardous substances.
- Decide on which actions to take if you use the substance or mixture outside the exposure scenario communicated by your supplier. In this respect, you may decide to conduct your own Chemical Safety Assessment for your specific use, document it in a Chemical Safety Report (CSR) and to notify the specific use to ECHA according to requirements outlined in Article 38.
- If the substance – on its own, in a mixture or in an article – requires an authorisation before use, it should be stated in the SDS or in other communication from your supplier. If an authorisation has been granted ensure that it covers your use(s), check if you comply with the authorisation conditions and report to ECHA the use of the substance under the authorisation of an actor up the supply chain.
- If you incorporate a substance of very high concern (SVHC) into an article to supply it further down the supply chain you have to provide information to your customers under Article 33 of the REACH Regulation (see Guidance on requirements for substances in articles, section 4.3) or you must (indeed it is known that many companies handle the “shall” in the text as a “may”).)respond to consumers upon request within 45 days when SVHC are contained in your article(s). In addition to that, all companies that produce, import or supply articles containing Candidate List substances have to submit information on these articles placed on EU market to the SCIP database, as from 5 January 2021, as stipulated in Waste Framework Directive Article 9.
- Communicate to your suppliers any new or additional information on the hazards of substances when new information becomes available to you.

⁹ ECHA Guidance on REACH and CLP implementation: <https://echa.europa.eu/support/guidance-on-reach-and-clp-implementation/identify-your-obligations/navigator/-/navigator/obligation/26>

The complete Guidance for Downstream Users (DU) provides detailed information on the various obligations and options downstream users have, depending on the situation and the information they receive from their suppliers. Downstream users may also gain additional insight and relevant information by consulting the following sources:

The “Downstream users” web page on the ECHA website¹⁰

Practical Guide 13 “How downstream users can handle exposure scenarios”¹¹

Questions and answers on DU reports¹²

The “Guidance on the compilation of safety data sheets (ECHA 2020)”¹³

The “ECHA Navigator” tool which helps to identify industry’s obligations.¹⁴

3.1.2. 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). 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 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. As summarized in the Impel Report on linking the IED and REACH the duties of enterprises and authorities under the IED include.¹⁵

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

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

¹⁰ <https://echa.europa.eu/regulations/reach/downstream-users>

¹¹ https://echa.europa.eu/documents/10162/13655/du_practical_guide_13_en.pdf/2c3bc624-fb3c-4515-a581-87b79d460d38

¹² <https://echa.europa.eu/support/qas-support/browse/-/qa/70Qx/view/scope/REACH/Downstream+users+reports>

¹³ https://echa.europa.eu/documents/10162/23036412/sds_en.pdf/01c29e23-2cbe-49c0-aca7-72f22e101e20

¹⁴ <https://echa.europa.eu/support/guidance-on-reach-and-clp-implementation/identify-your-obligations>

¹⁵ IMPEL (2015), Linking the Directive on Industrial Emissions (IED) and the REACH Regulation.

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 (see 3.3 below).

(2) Duty to inform about changes:

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.

(3) Duty to reference BAT conclusions in the permit conditions:

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.

In the absence of BAT conclusions, STM operators should continue to ensure that they meet the highest standards of environmental control based on BATs and the related STM BAT reference documents (see chapter 4 and annex 1).

3.1.3. CLP regulation

The European Union CLP Regulation on classification, labelling and packaging of substances and mixtures from 2008 (EC 1272/2008) aligns the European Union system of classification, labelling and packaging of chemical substances and mixtures to the Globally Harmonised System (GHS). The CLP Regulation provides harmonized criteria for classification of substances and mixtures and rules on labelling and packaging for hazardous substances and mixtures.¹⁶ It sets obligations to manufacturers, importers and downstream users of chemicals.

3.1.4. Water Framework Directive

The Water Framework Directive¹⁷ (WFD, 2000/60/EC) specifies e.g. the objective of progressively reduce emissions of priority substances and cease emissions of priority hazardous substances to surface waters (Article 4). Operators are to follow WFD obligations related to e.g. that environmental quality standards (EQS) for substances in surface waters are not exceeded. See more detailed information e.g. in chapter 3.2.

¹⁶ <https://osha.europa.eu/en/legislation/directives/regulation-ec-no-1272-2008-classification-labelling-and-packaging-of-substances-and-mixtures>

¹⁷ Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ L 327, 22.12.2000, p. 1–73. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32000L0060>

3.1.5. 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 potentially causing physical, health and environmental hazards in large quantities.¹⁸ 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 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).

3.1.6. Chemical agents at work directive

The Council Directive (98/24/EC)¹⁹ is aimed to protect workers from the risks related to chemicals. The Directive provides for the drawing up of occupational exposure limit values as well as biological limit values at EU level. The directive states that the employer must determine whether any hazardous chemicals are present at the workplace and assess any risk caused by their presence. The assessment has to be kept up to date. The employer must take the necessary preventive measures set out in the OSH framework directive (Safety and Health at Work, 391/89/EC)²⁰ and risks must be eliminated or reduced to a minimum. The risk reduction measures include for example substitution, fire safety measures, protective equipment etc.

3.1.7. EU POPs Regulation

The POPs Regulation 850/2004/EU regulates the substances listed in the Stockholm Convention on Persistent Organic Pollutants (POPs). This regulation prohibits or restricts the production, placing on the market and use of internationally regulated substances which are particularly problematic due to their health and environmental hazards. The regulation also contains provisions on unintentionally formed substances, waste management and environmental monitoring.

The most relevant substance for the STM sector listed in the POPs Regulation is perfluorooctane sulfonates/perfluorooctane sulfonic acid (PFOS). Since 27 June 2008, the use of PFOS has been banned in the EU (with certain exemptions) due to

¹⁸ Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC, OJ L 197, 24.7.2012, p. 1–37. Available at: <https://ec.europa.eu/environment/seveso/legislation.htm>

¹⁹ Council Directive 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work, OJ L 131, 5.5.1998, p. 11–23, Available at: <https://osha.europa.eu/fi/legislation/directives/75>

²⁰ Article 6 of Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work, OJ L 183, 29.6.1989, p. 1–8, Available at: <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A31989L0391>

its high persistence, its carcinogenicity, toxicity and bioaccumulation, in addition to a high potential for long range environmental transport and poor biodegradability of PFOS-containing wetting agents. Since 24 August 2010, Regulation (EU) No. 757/2010 amending the EU POPs Regulation has been in effect regulating the phase-out of PFOS as soon as the use of safer alternatives is technically and economically feasible. After the expiration of the derogation for wetting agents for use in controlled electroplating systems on 26 August 2015, the only specific exemption on the use of PFOS in electroplating will apply to "mist suppressants for non-decorative hard chromium (VI) plating in closed loop systems".

3.1.8. National laws

The operators of STM installations in the first place oblige common EU regulations including IED transposed into national law. Nevertheless, there are country specific requirements of national law in BSR countries related to emissions of contaminants, waste regulations and permit procedures. Some good examples of legal solutions and administrative practices are presented in the box below.

Germany

Emissions of industrial installations to water are regulated in the Waste Water Ordinance²¹. Annex 40 regulates STM installations and sets minimum requirements for direct emissions to the water body as well as indirect emissions via a central WWTP by setting ELVs on aluminium, ammonia nitrogen, COD, iron, fluoride, nitrite nitrogen, hydrocarbons, phosphorous, toxicity to fish eggs, AOX, barium, lead, cadmium, chlorine, chromium, chromium VI, cyanide, cobalt, copper, nickel, mercury, selenium, silver, sulphide, tin and zinc.

Emissions to air are regulated in the Technical Instruction on Air Quality²² with common ELVs but also sector-specific regulations (chapter 5.4.3.10). For STM installations there is only one sector specific ELV for nitrogen oxides. This specific ELV (NO_x) is for the use of nitric acid, for all other emissions the common ELVs are relevant.

Poland

After 2018, administrative practice has forced informal harmonization of the procedures for issuing permits in the field of waste management (including integrated permits). The procedure for issuing sectoral permits in the field of waste management is based on the Waste Act²³, while the procedure for issuing integrated permits is based on the Environmental Protection Law²⁴. These procedures differ significantly. To harmonise the procedures some elements were

²¹ Abwasserordnung, <http://www.gesetze-im-internet.de/abww/>

²² TA Luft, https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Luft/taluft.pdf

²³ USTAWA z dnia 14 grudnia 2012 r.o odpadach, Dz. U. 2013 poz. 21. Available at: <https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20200000797/U/D20200797Lj.pdf>

²⁴ U S TAWAz dnia 27kwietnia 2001r.Prawo ochrony środowiska, Dz. U. 2001 Nr 62 poz. 627. Available at: <http://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20010620627/U/D20010627Lj.pdf>

included in the procedure of issuing integrated permits taken from the Waste Act. These are:

- the obligation to consult the competent commune head, mayor or city president in the area of which the installation is located, in the process of issuing and changing the integrated permit;
- the obligation to carry out by the Voivodship Environmental Protection Inspectorate inspections with the participation of a representative of the competent authority, inspections of installations, a constructed facility or its parts or places of waste storage, where waste processing or collection of waste is to be carried out, in terms of meeting the requirements set out in environmental protection regulations.

Finland

In Finland it is a common practise to make waste water agreements between the STM installation and a municipal waste water treatment plant (WWTP) when the installation is discharging the waste water to the municipal sewer. The agreements are done in co-operation with the operators of the installation and the WWTP. Commonly they include limit values to key contaminants (e.g. Cr, Ni, cyanides) in the discharge and monitoring requirements. Sometimes the waste water agreement is required in the environmental permit of the STM installation. Waste water agreements are a good way to enhance the co-operation between the industry and WWTPs. Finnish Water Utilities Association has published an **Industrial waste water guide** which is available also in English at their [webpage](#).

3.1.9. 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 STM sector regarding discharges, emission and objectives for hazardous substances. The sector specific recommendations do not contain many specific requirements concerning chemical management and the EU BREFs are the main guiding documents for the Baltic Sea countries being EU Member States and the Russian BREF is applicable in Russia:

- HELCOM Recommendation 23/7 – Reduction of discharges and emissions from the metal surface treatment²⁵
- HELCOM Recommendation 25/2 – Reduction of emissions and discharges from industry by effective use of BAT²⁶
- HELCOM Recommendation 31E/1 – Implementing HELCOM’s objective for hazardous substances²⁷.

²⁵ <https://helcom.fi/wp-content/uploads/2019/06/Rec-23-7.pdf>

²⁶ <https://www.helcom.fi/wp-content/uploads/2019/06/Rec-25-2.pdf>

²⁷ <https://helcom.fi/wp-content/uploads/2019/06/Rec-31E-1.pdf>

3.2. Identification of hazardous substances

Most of the technological processes in the STM sector are well known and applied for many years. Many of them are well-described in the current STM BREF which also includes various issues on hazardous chemicals. The result shows that the case study companies have information on chemical agents and individual substances used in their operations.

For operators the legal requirements are the most important incentives in identification and management of hazardous substances. For identification and characterisation of hazardous chemicals, Safety Data Sheets prepared according to CLP and REACH Regulation, are used by the operators. For management of hazardous substances both the environmental and occupational health issues are considered. This is linked to companies' liabilities related to legal requirements imposed by the relevant permits for operations.

Key references of regulatory frameworks for identification of hazardous substances are provided in the table below. More detailed information on the chemical reference list is described in chapter 3.2.1 and 3.2.2.

Table 2. Hazardous Substances according to regulatory framework.

Hazardous Substances according to regulatory framework
<ul style="list-style-type: none">• 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 Authorisation in Annex XIV of REACH (authorisation list)• Restricted substances in Annex XVII of REACH• (very) persistent, (very) bioaccumulative and/or toxic – PBT/vPvB²⁸• CMR1a and CMR1b substances (for C and M classes: Directive 2004/37/EC)• Biocides regulation (528/2012)• Substances of Very High Concern (SVHC) (REACH Art. 57)• Persistent, mobile and toxic substances – PMT• Dangerous substances according to Annex I of the Seveso Directive (2012/18)• WFD (2000/60/EC) Annex X priority substances such as cadmium, lead, nickel and its compounds• Endocrine disruptors• Substances covered by the Stockholm Convention on Persistent Organic Pollutants such as PFOS

²⁸ <https://www.echa.europa.eu/web/guest/pbt>

For many of the HAZBREF case installation operators and their permitting authorities, the identification of substances of very high concern (SVHC, Candidate List), EU decisions on authorisation requirements under REACH and also priority substances under Water Framework Directive (WFD), in cases of direct discharges to water bodies and discharges to external WWTP, have priority over other obligations regarding chemicals. According to HAZBREF case studies the operators of IED installations are in general aware of the legal obligations imposed and are informed on the EU policy. The hazardous substances identified according to CLP Regulation are considered in the permit application. Based on the Finnish experiences the WFD substances are routinely checked within environmental permitting but the restricted or authorised substances under REACH regulation are usually not considered.²⁹ One finding from the Finnish case study is that the knowledge base of the environmental authorities on REACH requirements is not always sufficient. The same applies to Germany, where often different authorities, which are not collaborating, are in charge of REACH enforcement and IED permitting. In another HAZBREF study³⁰ this problem has been brought up in Estonia, Finland, Germany and Poland. This finding supports the recommendation by HAZBREF to enrich the BREFs with information of REACH restricted substances.

The main requirements set on operators to control the releases of specific hazardous substances are based either on nationally transposed EU obligations or specific national requirements. Companies may also follow voluntary programmes that set specific requirements on chemicals use. The key references concerning releases of pollutants to the environment are:

- IED BAT references and reference limit values for emissions;
- WFD quality standards; environmental quality standards (EQS) National legislation, such as the German Waste Water Ordinance;
- National/local standards i.e. requirements imposed by the external WWTP operator based on legal requirements or voluntary agreements.

In most of the STM case installations no tools dedicated to the identification of substances of concern specific for the installation were used. In one of the German case studies the company uses the GESTIS Database initiated by the German Social Accident Insurance with detailed chemical data.³¹ The Finnish case study uses the OECD eChem Portal to examine chemicals.

The level of required quality of chemicals depends on the company management standards and process requirements. This sets demands on information provided by chemical suppliers. Some of the STM case companies develop their own electrolytes, auxiliaries, etc. for optimal product quality. Usually individual inorganic chemicals are used in preparing basic working baths. Ready-to-use mixtures also contain organic compounds as additives to plating or auxiliary

²⁹ HAZBREF Act 3.1 Final report

³⁰ Suhr et al. 2020

³¹ [http://gestis-en.itrust.de/nxt/gateway.dll/gestis_en/000000.xml?f=templates\\$fn=default.htm\\$vid=gestiseng:sdbeng\\$3.0](http://gestis-en.itrust.de/nxt/gateway.dll/gestis_en/000000.xml?f=templates$fn=default.htm$vid=gestiseng:sdbeng$3.0)

processes. Quality of the chemicals is of importance due to product quality issues as well as for avoiding any internal unwanted reaction with impurities.

Some companies and authorities are facing a general problem in that there are electrolytes, surfactants or other auxiliaries containing chemicals which do not have to be listed in the SDS due to their very low concentration. However, due to the high consumption they may still end up in the waste waters in considerable amounts causing break-down of WWTPs or damage to the ecosystem. Among authorities and operators there is a wish that all chemicals added to the composition must be listed in SDS to select the best possible treatment method (e.g. a very specific ion-exchange resin). It is recommended that the operators and the authorities are active in seeking the knowledge via further questions to the supplier, chemical analysis or external expert knowledge.

Key challenges in the industry are related to hazardous substances with special environmental requirements imposed by the law, especially REACH authorisation e.g. hard chromium plating, limitations for use of cadmium, cobalt and lead. There are also installation specific issues related to other substances classified according to CLP. The sector undergoes changes regarding uses of the substances, processes technologies with such examples as nonyl and other alkyl phenyl ethoxylates (NP/NPEs) and PFOS which is regulated under the EU POP regulation.

Issues related to hazardous substances in the current STM BREF (STM BREF, 2006):

- Most of the hazardous wastes are spent process solutions containing heavy metals (generated when raw materials are being dragged out of process solutions by the workpieces, and into rinse-waters).
- Depending on the process, emissions may contain cyanides, as well as surfactants with low biodegradability and accumulative effects (e.g. fluorinated surfactants).
- The treatment of effluent containing cyanides may result in the formation of different toxic cyanide compounds. Complexing agents can interfere with the removal of metals in waste water treatment or remobilise metals in the aquatic environment.
- Typical pollutants relevant for water environment protection are salts (or “ionic compounds” – none of them should be considered acids or bases for any practical purpose, even if of course chloride is the conjugate base of hydrochloric acid): e.g. chlorides, sulphates, phosphates, nitrates and anions containing boron, as well as PFAS (e.g. PFOS) from surfactants. Solvents are used in some degreasing operations.
- Other ionic acids, bases and anions containing boron may be significant.
- Hazardous substances end up in sludges from waste water treatment.
- The STM industry is not a major source of emissions to air, but some emissions may be locally important. Emissions to the air are e.g. NO_x, HCl, HF and acidic particulates from pickling operations, hexavalent chromium mist released from hexavalent chromium plating, and ammonia from copper etching in PCB manufacture and electroless plating. Dust, as a combination of abrasives and abraded substrate, is generated by the mechanical preparation of treated products/items.

For minimisation and prevention of waste in surface treatment processes, key activities are:

- **reducing** the amount of **hazardous material** in the waste **by substitution**
- extension of the service lifetime of the process solutions (Process Solution Maintenance)
- decrease of the drag-out of process solutions
- feedback of the dragged-out process solutions into the process tanks.

3.2.1. Regulatory chemical reference lists

To minimise the release of hazardous substances into the environment (and to protect workers from exposure), an improved, systematic consideration of relevant substances must be achieved in both the forthcoming revision of the STM BREFs and the formulation of BAT conclusions for the sector. Ultimately, by complying with the revised STM BREF and BAT conclusions, public authorities and operators have to be able to ensure that the use of substances of concern is reduced or – in case that this is not possible – to at least reduce their release into the environment by applying minimisation and mitigation techniques consistent with BAT. The

following sections provide an overview of available references on chemical substances as well as guidance on how chemicals of particular relevance to the STM sector can be identified in the STM installations themselves. Ideally all the relevant hazardous substances should be identified and assessed at installation level by a chemical inventory performed by the operator and considered by the environmental and chemical authorities. A prioritisation must be carried out in practice because usually the operators are managing a high number of CLP hazardous substances. For that reason, shorter prioritized regulatory chemical lists under different legislations are presented below. These already “prioritized” substances are to be primarily considered at installation level regarding e.g. chemical management and environmental permitting, before taking all other relevant chemicals into account, such as substances with harmonized hazardous classification as well as substances classified as hazardous by companies.

List of Pollutants under Annex II of the IED

A short list of the most relevant polluting substances is defined under the IED. Many of the listed substances are sum parameters (bulk parameters), covering a wide range of substances. The list includes e.g. substances and mixtures which have been proved to possess carcinogenic or mutagenic properties or properties which may affect reproduction (CMR), biocides and WFD substances (Annex X to Directive 2000/60/EC).

CLP – substances classified as hazardous

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.

Currently around 4 600 substances pose the harmonised classification which means that they are classified as hazardous in a coordinated way based on harmonization procedure at EU level.³² Additionally, the substances classified as hazardous by companies themselves are also relevant, and their number is very high compared to the number of substances with harmonized hazardous classification. The substances referred to by CLP Art. 3 (in its broad sense) also correspond quite well to those mentioned in CAW Art. 2 (98-24-EC).

Priority substances under the Water Framework Directive

In 2018, Directive 2013/39/EU³³ 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 was reviewed twice: in 2008 (2008/105/EC) and in 2013 (Directive 2013/39/EU) since the setting of the priority

³² <https://echa.europa.eu/regulations/clp/cl-inventory>

³³ Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy, OJ L 226, 24.8.2013, p. 1–17.

substance list for first time in 2001.³⁴ Art. 16 par. 2 WFD introduces a scientifically based methodology for selecting priority substances based on their significant risk to or via the aquatic environment.

Besides the set of priority substances laid down in 2013/39/EU, which are regulated and monitored at EU level, the EU Member States need to identify pollutants of regional or local importance (River Basin-Specific Pollutants, RBSP) and provide environmental quality standards (EQS), monitoring schemes and regulatory measures for them. The number of RBSPs differs between Member States from a small two-digit number to a small three-digit number of substances, which in total amounts to around 300 pollutants throughout Europe.

Substances listed in Annex X of the WFD and relevant in the STM sector are e.g. cadmium, lead and nickel.

REACH Candidate List of substances of very high concern (SVHC) for authorisation

The Candidate List of substances of very high concern recommended for authorisation is updated at regular intervals by ECHA, with the first substances listed on 28 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.

SVHC substances are regulated under REACH with the intention to phase out their use and to reduce exposure (Art. 55). The SVHC substance list is to be updated twice a year. Substances with the following hazard properties may be identified as SVHCs (Art. 57):

- 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.

SVHCs relevant for STM are presented in the Annex 6 of this report.

REACH Authorisation List

Annex XIV to REACH contains a list of substances subject to authorization under REACH. Substances on this list are selected from the REACH SVHC list and they must not be placed on the market or used after a given date (“sunset date”), unless an authorization is granted (or applied for) for their specific use, or the use is exempted from authorization.

ECHA authorizes specific uses, such as “formulation of mixtures” or “Passivation of tin-plated steel (ETP)” and adds obligations, e.g. on monitoring of the waste

³⁴ 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, OJ L 331/1.

water composition. The authorizations are published as EU Commission decisions and will be reviewed after 4 to 12 years depending on the predicted necessity of the specific use.

The STM companies using substances under authorisation (e.g chromium trioxide (Cr VI)), have to fulfil the requirements imposed by the Authorisation decisions. In this matter the IED permitting authorities should know about the REACH requirements and have to address them in the permits if necessary. The consideration of REACH substances as well as other substances such as WFD substances would be promoted if these substances are specially emphasized already in the environment permit application. This in order to ensure that the operator will pay attention specifically (but not only) on those substances and respective requirements on them.

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 either a substance or a group of substances or a substance in a mixture, and the consequent restriction conditions.

Biocides

The European Directive 98/8/EC (Biocidal Product Directive³⁵, BPD) on placing biocidal products on the market was adopted in 1998. It was replaced by EU regulation No 528/2012 (Biocidal Products Regulation³⁶, BPR) by 1 September 2013. Biocidal active substances are approved (Chapter II of the BPR) under the BPD (positive list in Annex I/Ia) or the BPR (list of approved substances³⁷), but many biocidal substances are still under assessment.

POP Regulation

List of chemicals covered by the Stockholm Convention on Persistent Organic Pollutants

The Stockholm Convention on Persistent Organic Pollutants was adopted in 2001 and entered into force in 2004. The convention is implemented in the EU with the POP regulation (EU 1021/2019) which has been amended (and new substances added) several times. The Stockholm Convention on Persistent Organic Pollutants (POP) prohibits or restricts the production and use, as well as the import and export, of the intentionally produced POPs listed in Annex A and B to the Convention (Article 3). Relevant POPs for STM include PFOS, which is listed to the annex B and PFOA in the annex A and PFHxS, which is currently reviewed by the POPs Review committee. PFOS is not completely forbidden but still allowed to be used for hard chromium plating with closed-loop systems.

³⁵ Directive 98/8/EC of the European Parliament and of the Council of 16 February 1998 concerning the placing of biocidal products on the market, OJ L 123, 24.4.1998, p. 1–63.

³⁶ Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products, OJ L 167, 27.6.2012, p. 1–123.

³⁷ <http://echa.europa.eu/information-on-chemicals/biocidal-active-substances>

3.2.2. Non-regulatory chemical reference lists

The below mentioned non-regulatory chemical lists are an exemplary selection of lists that STM sector representatives and experts commonly refer to.

ECHA chemical database

Use of ECHA databases is not required as legal obligation although they are directly established by REACH Regulation. ECHA maintains one of the world's largest regulatory databases on chemicals.³⁸ Users have access to information on 120,000 chemical substances on the EU market through three layers: (i) infocard, (ii) brief profile and (iii) source data. However, the level of detail and quality of data might vary considerably between the different chemical datasets.

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. Chemicals on this 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.³⁹

The PRIO database

The PRIO database was developed and is managed 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, divided into chemicals for “phase-out” or “priority risk reduction”.⁴⁰

Example: Käppala Association, Sweden

The Käppala Association, responsible for waste water treatment in Stockholm area, uses different databases such as ECHA Chem database, PRIO, and PubChem together with information about handling/application, structure, amounts used, stability/degradation, ecotoxicity etc. to make an assessment whether the chemical is unwanted or not in the WWTP. With this approach they also identify substances that the WWTP operator does not want into the sewer even if there are no hits in the databases on hazardous substances of high concern such as PRIO. The identified unwanted chemicals released to the sewer are presented to the company, which must present a plan for phasing out these (by substitution or collecting it). The association uses a tool (Envomap by Gemit solutions AB) for searching databases on chemicals. According to the organisation representative it is a great benefit to use different databases which are supplementing each other. Nevertheless, in some cases more information regarding specific substances must be searched or the operator needs to have additional chemical knowledge.

³⁸ 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

³⁹ <https://sinlist.chemsec.org/>

⁴⁰ <https://www.kemi.se/prioguiden/english/start>

This is done annually within the frames of Revaq certification issued by the Association. For more information see:
<https://www.svensktva.en.se/va.entjanster/avlopp-och-miljo/kretslopp-och-uppstomsarbete/revaq-certifiering/>

3.2.3. HAZBREF strategies to identify relevant substances

HAZBREF project team developed different strategies to identify relevant hazardous substances in different industrial sectors. These approaches are intended for the whole industry, and public institutions active in BREF revision and other activities related to management of hazardous substances. They allow for identification of substances of concern relevant in the STM sector. All four HAZBREF strategies were tested for the textile sector⁴¹ and they are described in detail in the report on HAZBREF Work Package 2.⁴²

One of the HAZBREF strategies was applied for STM sector and is described in full detail in Annex 6. In this strategy the starting point was to identify which WFD priority substances and SVHCs are used in the STM sector.

The list of SVHC substances was downloaded from the ECHA webpage (April 2020).⁴³ The list included at that time 205 substances or substance groups identified as SVHC. The information on substance uses in EU was compiled from the public ECHA chemical database⁴⁴ and in Nordic countries from SPIN register⁴⁵ (Substances in Preparation in Nordic countries). If the substance had statement ‘manufacture of fabricated metal products’ or ‘metal surface treatment products’ or ‘surface treatment’ or ‘coating products’ or ‘coating of metals’ etc. in the section ‘uses at industrial sites’ of the ECHA infocard, the substance was deemed to be used in STM 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. SPIN data is not perfect and covers only Nordic countries, but it is valuable as it provides STM sector specific data on use volumes of hazardous chemicals.

Altogether 81 substances or substance groups were identified to be potentially used in the STM sector.⁴⁶ The identified substances and information e.g. on their uses are presented in Annex 6. For example, several phthalates, cadmium, cobalt, chromium and lead substances as well as PFAS substances (PFBS and PFNA) are

⁴¹ HAZBREF Sectoral guidance for Chemicals Management in Textile Industry, available at https://www.syke.fi/en-US/Research_Development/Research_and_development_projects/Projects/Hazardous_industrial_chemicals_in_the_IED_BREFs_HAZBREF/Publications

⁴² DRAFT available at <https://www.syke.fi/projects/hazbref>

⁴³ <https://echa.europa.eu/candidate-list-table>

⁴⁴ <https://echa.europa.eu/information-on-chemicals>

⁴⁵ <http://spin2000.net/>

⁴⁶ Updated in 22.6.2020.

most likely used in STM sector. Most substances are SVHCs but some are both SVHC and WFD substances. The result of strategy C was checked with the information from HAZBREF case studies: 13 out of 81 substances were in use in HAZBREF case installations (see Annex 6).

There are issues concerning the quality of the public data from the ECHA database. Firstly, the use information in ECHA website 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 STM sector. This results in false positives in the lists and therefore it should be checked more if the identified SVHCs are actually used in the STM sector. Secondly, the use volumes in public ECHA infocards cover all the possible uses of the substance but there is no information on use volume in a specific sector such as the STM. Nevertheless, sector specific information on use volumes has been gathered from companies (chemical manufacturer or importer) under REACH (Chemical Safety Reports, CSR), but it is not public and may be neither uniform nor easily extractable. Thirdly, the information on the industrial uses might be outdated. For these reasons the Annex 6 may include substances, which are not used in STM sector. Additionally, the use information on PFAS identified as SVHC in ECHA CHEM database is very scarce.⁴⁷ It is possible that the chemicals are not actually used and that the public ECHA CHEM database is not a good source of information regarding PFAS use. It is possible that due to lack of use data some PFAS could not be identified to be used at STM sector.

Due to the limitations described above, there may be several substances used in the STM sector 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 the Commission, in recently published Chemicals Strategy for Sustainability⁴⁸ (EC 2020), is aware of the situation and will promote a comprehensive and transparent knowledge base on chemicals.

3.3. Instruments for the identification of hazardous substances

3.3.1. Using safety data sheets

Safety Data Sheets (SDS) are a method for the provision of information on chemical substances and mixtures to downstream users and distributors of chemicals in the EU. They form an integral part of the REACH Regulation (EC No 1907/2006 (Annex II, Art. 31 lit. a)-c) REACH). SDSs are designed to provide

⁴⁷ It may also come from the fact that very few PFAS are identified as SVHCs, despite their recognised hazard provide of extreme persistency coupled with varying degrees of toxicity, mobility and bioaccumulability.

⁴⁸ 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

comprehensive safety information on substances and mixtures where⁴⁹ a substance or a mixture meets the criteria for classification as hazardous according to CLP, especially when:

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;

a substance is included in the candidate list for eventual authorisation according to Article 59 (1) of REACH for any other reason (See Article 31(1) of REACH).

Article 31 of the REACH Regulation requires chemical suppliers to provide relevant information to downstream users of substance or product (mixture). The information is provided according to the specific requirements defined under REACH Annex II. The SDSs must meet formal requirements according to the corresponding ECHA guidelines. All SDSs are divided in 16 sections, which must contain e.g. information on hazards and components of mixtures. The SDS sections with the highest relevance for good chemical management are 1, 2, 3, 9, 11 and 12. One of the most important information concerns the protection of the working staff when using the product or substance.

SDS for mixtures is prepared in two ways, either the producer/importer compiles information on the individual substances with content above 0.1% weight or characterizes the information on environmental hazards for the mixture considered as a whole.

SDS should contain information on:

- correct handling and storage of the chemical product
- measures for the protection of human health and safety at the workplace (occupational health)
- measures for the protection of the environment (measures for controlling emissions to the environment under the defined operational conditions)
- correct responses in case of substance related emergencies or accidental releases
- correct disposal of the respective substances.

Additional information on the content and appropriate use of MSDS is provided in the ECHA “Guide on Safety data sheets and Exposure scenarios” (ECHA 2018) -

https://echa.europa.eu/documents/10162/22786913/sds_es_guide_en.pdf

The development and use of systematic approaches and tools for SDS evaluation can help operators and authorities to better use the information provided in the SDS. However, only a few tools are available on the European market. According to the report by European Union Network for the Implementation and Enforcement

⁴⁹ 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, 3.8.3 and 3.9.4 of Annex I of CLP).

of Environmental Law (IMPEL) on Linking the IED and REACH Regulation, a region in Italy (IED permitting authority) is one of the first that uses an electronic database for the assessment of SDSs during permitting process. Tools that specifically support the proper preparation and assessment of SDS include among others a NEXPO checklist⁵⁰ (for both suppliers and recipients) developed by ECHA in cooperation with the (Enforcement) Forum (Nordic Exposure Group (NEXPO)); Checklist – Exposure Scenarios in REACH⁵¹ and the online tool SDS-Check⁵² which is specifically designed for recipients of SDS.

If end-users identify information deficiencies in SDS they have the right to demand the missing information on chemical substances and particularly formulations from their chemical suppliers. As many chemicals nowadays are supplied from outside the EU, the end-users often face practical challenges during this process. Given the various difficulties connected to the evaluation and verification of information in SDS, a precise assessment of chemical properties and compliance with IED regulations often poses a challenge to competent authorities. Since ecotoxicological data is often lacking, authorities have problems with identifying the environmental relevance of substances. Another problem is that hazardous chemicals are sometimes part of mixtures in such a low concentration that they do not need to be listed but due to high usage, they may end up in the environment in considerable amounts.

Although there is no time-bound obligation to revise the SDS, it is highly recommended to check whether they are updated on a regular base. In accordance with Article 31 (9) of the REACH Regulation SDS generally remain up to date until new information is available. Suppliers shall update the safety data sheet immediately as soon as (1) new information which may have an impact on risk management measures or new information on hazards becomes available, (2) an authorisation has been granted or refused or (3) a restriction has been imposed. The new, updated version of the information shall be made available to all previous customers who have bought the substance or mixture in the previous 12 months.

Annex 3 of this report provides an example of commented SDS, also containing references to the relevance of the information for the environmental permit requirements.

In order to close information gaps in safety data sheets, it is recommended to further specify Annex II of the REACH Regulation regarding the minimum information requirements of the SDS. To this regard especially aspects such as complete data on biodegradability and mixture composition should be considered.

⁵⁰ <https://echa.europa.eu/de/regulations/reach/safety-data-sheets/checklist>

⁵¹ https://issuu.com/nordic_council_of_ministers/docs/na2017906_web

⁵² <https://www.sds-check.nl/>

Findings from HAZBREF case studies:

- The STM case study operators in general see the quality of SDSs as good and think that the data has been quite well available.
- In some cases, usually SDSs prepared outside of EU, the quality is poor, often lacking even the basic chemical information. Sometimes there are problems with the translations of the SDSs, especially when the supplier translates the text to national languages.⁵³
- In one of the case studies the data provided by REACH together with SDSs is used by the operator to find out properties of chemicals, and to assess their fate in the WWTP.
- The personnel of another case facility use the OECD database as the main data source, since the ECHA database is not considered to be easy to use.

Establishing, implementing and updating chemical inventories

According to IED rules the operators have to prepare an inventory of chemicals used at the installation in the permit application (Art. 12 (1.b)) and when preparing the baseline report (Art. 22 (2)). The minimum requirements are set by national rules. The following information of the substance is required in application of the Integrated Permit:

- name of the substance
- function of the substance in the technological process
- yearly used volumes
- amount of stored and storing requirements
- GHS hazard and risk codes.

Depending on the country specific rules, changes in the use of the chemicals might require changes in the permit. The inventory can be extended with information contained in SDS including such parameters as biodegradability and toxicity for biota including WWTP bacteria. In HAZBREF project a standard for integrated database is proposed (Annex 1 BAT recommendations: Chemicals and raw materials inventory).

The operators are obliged to prepare a chemical inventory as part of the permit application and the baseline report according to IED. Completeness of the information on hazardous substances provided by the operators is relevant for permitting. The practices vary in different countries. For example, in German permits, the list of chemicals/mixtures is quite fixed, and the operator must inform the authority if he wants to change the chemicals in use. In Poland the list of substances in the Integrated Permits contain information on individual substances or groups of substances/agents with the similar function. This gives a certain flexibility to the operator in managing the chemicals used. But in the permit application and the baseline reports the list is more informative with listing of all substances contained in the chemical agents and their characterisation with quantities used and stored, storage provisions and GHG phrases. In Finland the

⁵³ It concerns the responsibility of the importer and the Only Representative. Through appointing an OnIR, non-EU manufacturers or formulators are enabled to take care of the REACH obligations.

operator must provide a detailed table of hazardous chemicals used in processes in the permit application.⁵⁴

Current practice – Poland’s example

In Poland, the knowledge of the authorities issuing integrated permits regarding chemicals including hazardous substances used in the IED installation comes only from the information contained in applications for the integrated permit, and in fact from baseline reports (according to art. 208 of the Environmental Protection Act⁵⁵) or analyses on the absence of the need to prepare the baseline report. The type and amount of energy, materials, raw materials and fuels (including hazardous substances) used are specified in integrated permits in accordance with art. 188 of the Environmental Protection Act. In practice, in most integrated permits, only the mass balance of raw materials and waste is given, and those assumed to be important from the point of view of environmental protection requirements. In turn, the baseline report or the analysis on the absence of the need to prepare the baseline report contains a wider range of information on hazardous substances. It is a record of all substances that may cause risks associated with the operation of IED installation. This is not subject to substantive verification and the only element of verification is in terms of its formal correctness, i.e. whether it meets the formal requirements contained in the Regulation of the Minister of the Environment of 1 September 2016, on how to assess soil surface pollution (Journal of Laws 2016 item 139556). It is important to include a competent authority when it comes to chemical substances and to force some form of substantive verification.

⁵⁴ https://www.ymparisto.fi/fi-FI/Asiointi_luvat_ja_ymparistovaikutusten_arviointi/Luvat_ilmoitukset_ja_rekisterointi/Ymparistolupa/Miten_ymparistolupa_haetaan_ohjeet_ja_lomakkeet

⁵⁵ <https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20200001219>

⁵⁶ <http://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20160001395>

The chemical inventory concerns all chemicals, but the hazardous chemicals listed in chapter 3.2 are to be specifically focused on.

Information requirements for chemical data base (HAZBREF approach)

According to the assessment of authority representatives and experts from HAZBREF, it is recommended to include (at least) the following information on substances and mixtures in a chemical data base:

- 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 maximum quantity of the chemical products or substances that are present within the site
- physical, chemical, toxicological, eco-toxicological properties of the chemical products/substances
- biodegradability/bioeliminability [%], including information on the testing method
- the lower content (as % by weight) of components in chemical formulations

To allow for an effective chemical management, it is necessary to clearly identify which hazardous 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.

A Chemical inventory can also serve as an important reference and information tool for stakeholders such as environmental 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.

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

The main and commonly used sources of data of different chemical products are the SDS⁵⁷ and – to a certain extent – the Technical Data Sheets (TDS)⁵⁸. Other sources are eco-maps and process flow diagrams which provide such information as type, chemical (containing) waste, production process involving chemicals as well quantities of inputs and non-product outputs. Further reference on how to establish and maintain a chemical inventory is provided in chapter 4.2 and Annex 1 –Recommendations: 2 Chemical and raw material inventory.

Insufficient quality of SDS provided by chemical suppliers might obstruct the establishment of a complete chemical inventory.

Using exposure scenarios

In the case that a hazardous substance (according to CLP Regulation) is registered in a quantity 10 or more tonnes per year, the registrant (producer or importer) must provide an extended safety data sheet (eSDS), with exposure scenarios (ES) attached. ESs 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.

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” (ECHA 2018).⁵⁹ Specific annotated formats can be downloaded from the website section “Formats and templates”.⁶⁰

⁵⁷ It should be noted that the shortcomings of SDS regarding their comprehensiveness and quality of information must be taken into account and may require further inquiries with the chemical supplier, in particular regarding the full reporting of chemical product compositions.

⁵⁸ 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.

⁵⁹ https://echa.europa.eu/documents/10162/22786913/sds_es_guide_en.pdf

⁶⁰ <https://echa.europa.eu/sv/support/guidance-on-reach-and-clp-implementation/formats>

Available exposure scenarios relevant for STM (Source: Safety Data Sheets):

- nickel compounds: nickel chloride, nickel sulphate, nickel nitrate, nickel acetate, nickel metal <https://www.nickelconsortia.eu/downstream-user-exposure-scenarios.html>
- boric compounds: sodium tetraborate, boric acid (Occupational Health) <https://www.borax.com/resources/exposure-scenarios/english>
- chromic compounds: potassium dichromate for sealing after anodizing applications by the aerospace sector, where the key functionalities of corrosion resistance or corrosion inhibition are necessary for the intended use <https://ramboll.com/-/media/files/reh/GCCA-Potassium-Dichromate-Exposure-Scenario.pdf>
- organic compounds: ethylenediamine (EDA) <https://www.alliancechemicals.com/wp-content/uploads/2011/09/EDA-sds.pdf>

There are multiple ways in which the information regarding Exposure Scenarios can be provided for substances and mixtures:

- ESs are provided for each mixture component or substance to customer without consolidation,
- information on Risk Management Measures (RMMs) and Operational Conditions (OCs) can be extracted and included in the main body of the product SDS,
- consolidate the received Exposure Scenario into “Mixture ES” annexed to SDS and
- for individual substances the ES can be provided separately or integrated with SDS as extended SDS.

Exposure scenarios of hazardous chemicals are in most cases not referred to in the integrated environmental permits (according to IED) and other permits (chemical permits, emission permits) in BSR countries. It should be underlined that ES are available for only some of hazardous substances used in the STM processes. The information can be checked in ECHA portals (Risk Assessment Dossiers).

Exposure scenarios can be used as a screening tool for identifying main problems with hazardous substances releases. Exposure scenarios for some substances are also provided by industrial associations i.e. nickel by Nickel Consortia⁶¹ and cobalt⁶².

The risk assessment in eSDS is based on a comparison between the identified exposure and the exposure that can be accepted, based mainly on results from animal laboratory studies. In environmental risk assessment the key element of exposure scenario is Predicted No-Effect Concentration (PNEC). It is the concentration of a substance in any environment below which adverse effects will most likely not occur during long term or short-term exposure. PNECs is compared

⁶¹ <https://www.nickelconsortia.eu/downstream-user-exposure-scenarios.html>

⁶² Study Report on The Conditions of Use of Five Cobalt Salts, final report May 2017.

to actual measured environmental concentrations (MEC) or predicted environmental concentration (PEC) to determine if the risk of a substance is acceptable or not. In some cases, PNEC values are also provided in basic SDS (e.g. zinc oxide⁶³). The models are based on so called description factors which are supposed to reflect the actual exposure. The more accurate the factor, the more accurate exposure output. Each additional tier level requires an extensive request of protective actions or material. Even if an acceptable exposure level can be reached in the tier system, the economic burden⁶⁴ of additional actions might in fact be so extensive that such a low level of risk for most operators in reality is impossible to achieve.

The ratio between the level of exposure and the level of exposure causing harm, meaning the ratio between PEC and PNEC, is ultimately used as an indicator of risk, allowing it to be quantitatively assessed. If PEC/PNEC ratio is <1, the risk is acceptable. If the PEC is greater than the PNEC (i.e. PEC/PNEC ratio >1), the risk to the environment is not considered acceptable and PEC/PNEC assessment has to be refined and if the criterion of risk acceptability is not met then reduction of exposure is needed through use of Risk Management Measures (RMM).

Use of eSDS – Sweden's example

National requirements concerning use of exposure scenarios for substances used in the amount of 10 or more tons in Sweden. With this respect local and regional authorities carry out inspections for environmental issues among downstream users. Focus in these inspections is to control that the companies comply with the information given in exposure scenarios and safety data sheets and that substances subject to authorization or restriction are used according to the provisions. The Swedish Environmental Protection Agency is the national authority responsible for providing guidance etc. The SDS and eSDS constitute essential safety information for professional users of substances and mixtures, and function as an information basis at authority checks of plant facilities and when permit controls take place. The SDS information is often stored in administrative computer systems at company seats.

Although ES documents are a practical reference source for both operators and permitting authorities, they are only rarely used in the STM sector. As one of the reasons for the low application rate – in particular by the competent authorities – the lack of regulatory requirements has been identified. Additionally, HAZBREF experts found that both the industry and the competent authorities often do not have sufficient chemical expertise with respect to biodegradability, environmental

⁶³ Safety data sheet Carl Roth GmbH + Co KG, Safe Work Australia - Code of Practice, Zinc oxide ≥99 %, extra pure article number: 9348 Version: GHS 2.0 date of compilation: 2016-09-13 Revision: 2017-01-2.

⁶⁴ According to stakeholders comments the economic assessment is also skewed by the fact that the polluter pays principle is hardly ever applied. For this reason, damage caused to others (e.g. the environment) is neither monetised nor included in the assessment.

fate, behaviour and occurrence of substance in the different environmental media to make use of ES.

If extended SDSs are available, the operators are obliged to include them in the chemical management practices.

Obligations of downstream users regarding Exposure Scenarios

When receiving ES as part of the extended safety data sheet, downstream users must fulfil certain obligations. As a first step they should 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.

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 the 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. Sufficient information must be made available to the supplier to enable him to make such an assessment.
- Implement the operating conditions described in the exposure scenario he has 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 his 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.

Further practical guidance for the procedure described above is provided in the ECHA Practical Guide Nr. 13 “[How downstream users can handle exposure scenarios](#)”.

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

Tools for assessing transformation of substances can be used to estimate their mass balances. The mass of the substance in each of the media (including process media, product, waste water, air emissions, waste) can be estimated as a result. This approach is rarely used in the STM sector. It can be done by using tools such as STAN (subSTance flow ANalysis), which is focused especially on waste management.

STAN 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, text fields) you can enter or import known data (mass flows, stocks, concentrations, 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.

Combining material flow analysis (MFA) with substance flow analysis (SFA) can be useful for decision making in waste management. Both MFA and SFA are based on the mass balance principle. While MFA alone has been applied often for analysing material flows quantitatively and hence to determine the capacities of waste treatment processes, the SFA focuses on the transformations of wastes during waste treatment. Valuable as well as hazardous substances and their transformations are followed through the entire waste management system. A substance-based approach is required because the economic and environmental properties of the products of waste management – recycling goods, residues and emissions – primarily are determined by the content of specific precious or harmful substances.

3.3.2. 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 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.

As an example, 6:2 fluorotelomer sulfonic acid (6:2 FTS or H4PFOS, CAS no.: 27619-97-2), a widely used chemical in surfactants for chromium plating processes, was used in part I of a draft of the interactive scheme. The result leads to the conclusion that 6:2 FTS is a target substance as it ends up in wastewater and is not eliminated in the WWTP. Part II of the draft scheme leads to the result that 6:2 FTS is a relevant target substance, for which urgent action is needed (e.g. substitution or end-of-pipe abatement techniques). The rationale behind this result is that information on toxicity, persistency, mobility and other relevant properties is not yet available for this substance leading to a "yes" as this equals the answer "unknown". Since this substance is not yet regulated by REACH or other legislation (including national law) plant operators and permitting authorities need to take action.

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 www.hazbref.rescol.de.

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

This chapter presents a general outline of good practices in Chemical Management supported with information from HAZBREF case studies also covering techniques described in the current STM BREF (2006). Moreover, the chapter provides initial proposals of BAT candidates derived from the basis of the case studies. The BAT candidates described in Annex 1 are prepared in general terms which can be used to define generic and process specific BATs.

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

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

PREVENTIVE MEASURES

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 MEASURES

Process related measures focus on improvement of existing production processes, along 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 implemented, 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 MEASURES

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, waste gas and water treatment and emergency preparedness.

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

- the case-studies produced within the HAZBREF project,
- approaching the industries and organisations,
- expertise and experiences,
- list of hazardous substances relevant for the sector and
- information available in the current BREF-documents and other descriptions of BAT available.

The identified good chemical management practices with references to BAT candidates proposed by HAZBREF are described below.

4.1. Chemical Management System, Rules and Practices

An integrated chemical management system is a key tool for a chemical user to control hazardous chemicals and the release of hazardous substances to the environment. A Chemical Management System (CMS) is a systematic approach 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 (based on PDCA scheme: Plan-Do-Check-Act) is the same in both CMS and EMS but in a CMS the focus is on the chemicals, this with the aim to improve management and reduce risks. A properly functioning CMS can also be viewed as a precondition of a proper EMS.

The purpose of the CMS is to control the chemicals and hazardous substances at the site, increase the knowledge of the characteristics, risks and impacts and improve the processes to reduce emissions of hazardous substances. It is a systematic approach involving all parts of the industry from daily activities in production to development of the planning of new or existing processes and installations. It should result in reduced emissions as well as reduced costs for abatement through end-of-pipe solutions or waste management. Chemical management could and should address all relevant chemicals and substances. However, the description below addresses hazardous substances specifically.

Chemical management is also important in the development of new processes and in the construction of new plants.

CMS proposal developed in HAZBREF project as input to BREF review for textile sector and accepted for the revised draft TXT BREF by EIPPCB (2020)

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 BAT candidate proposal 1, Annex 1) that incorporates all the following features:

- I. process chemical procurements policy to select process chemicals and their supplier with the aim to minimize the use of hazardous chemicals such as substances of very high concern and to avoid the procurement of excess amount of process chemicals;
- II. anticipatory monitoring of regulatory changes related to hazardous chemicals and safeguarding compliance with applicable legal requirements;
- III. chemicals inventory;
- IV. identification of the process chemicals pathways through the plant (from procured process chemicals to products, waste and emissions);
- V. assessment of the risks associated to the chemicals, based on the chemicals' hazards, concentrations and amounts. This may include an estimation of their emissions to the environment;
- VI. regular (e.g. annual) check aiming at identifying potentially new available and safer alternatives to the use of hazardous chemicals (e.g. changes of process(es) or use of other chemicals with no or lower environmental impacts);
- VII. goals and action plans to avoid or reduce the use of hazardous chemicals;
- VIII. development and implementation of procedures for the handling, storage, use and return of process chemicals.

A general Chemical Management System follows the classical PDCA-cycle⁶⁵ as any management system: Plan, Do, Check and Act.

It is important to have an established plan for the chemical work to answer the following questions:

- What chemicals or substances are acceptable/not acceptable for use on the site?
- Does it comply with relevant legislation?
- How shall reduction of hazardous substances be reached?
- How many non-wanted chemicals can be substituted?

When objectives and plans are established <<plan>>, the planned measures are taken <<do>>. These measures could cover update of routines, improvements of knowledge of substances and their use and flow within the production process, monitoring of emissions etc. The outcomes of the measures are then <<checked

⁶⁵ Sometimes called PDSA-cycle where S denotes *study*. Also see the Deming and Shewhart cycles and "Lean production".

and studied>>, to be a base for identifying the actions needed <<act>> to improve the process when returning to a new planning phase.

The analysed HAZBREF case study installations in STM sector have evolved certain technological standards related to management of hazardous substances after the current STM BREF was released. In the first place, they implement and adhere to environmental and other management systems (according to STM BREF, 2006). The case studies show that improvements in responsible chemical management can already be achieved by implementing good housekeeping practices. This includes, but is not limited to, implementing chemical awareness and adequate unloading, handling and storage of chemicals within the production facilities. In all the case study companies Quality Management Systems (QMS) are in place. They address environmental and Occupational Health and Safety aspects. The systems are based on, for example ISO standards which define requirements for internal operations and upstream and downstream processes.

The Chemical Management System is described more in detail as a BAT-candidate in Annex 1.1.

Findings from the case studies

In Sweden, Germany and Finland, most of the companies use some sort of chemical management system, although there are smaller installations which do not. Often, bigger companies have well developed CMS and QMS and in some cases they are tightly connected. The implementation of CMS also has a strong impact e.g. the selection of chemicals, product quality, waste (including waste water) management issues and environmental responsibility. In the Polish HAZBREF case study installations essential progress in chemical management practices was achieved after 2006 when the current STM BREF was published. Benchmarking and sharing of experiences played an essential role in the process.

Organisation of production is also an important aspect in the chemical management of the case installations. The operational plans concern such aspects as setting the production lines, use of appropriate risk prevention measures including avoidance of spills and accidents, proper integration of environmental protection measures and production set ups. According to operators (Polish case study) use of simple risk management to design, construct and operate an installation according to BATs helps to protect the environment, particularly soil and groundwater. These measures are often limited by the historic context of the installation development and depend on business opportunities for changes of activities and modernisation of the installation (STM cases in Poland).

4.2. Chemical and raw material inventory and Chemical handling system

Key aspects of chemical management are related to sources (Safety Data Sheets) and management of information on chemicals in the companies (inventories).

Another key issue is the identification of chemicals of concern through risk evaluation procedures.

The development of a chemical and raw material inventory is essential in order to know which hazardous substances are used, generated or released from the site.

The inventory should include chemicals used for example in the processes, maintenance, cleaning and firefighting in all parts at the site.

A chemical inventory must include information on:

- product name,
- information on ingredients,
- CAS numbers,
- hazard statements,
- in what quantity and
- where the chemical is stored.

The information in the chemical list needs to be searchable and there must be routines in place to update the information in the chemical list regularly.

Main part of the information needed is available from the safety data sheets (SDS). Good routines to handle new and updated SDSs is crucial to have an up to date and reliable chemical database. These routines should involve on-site handling and update and communication with suppliers on how SDSs are delivered. The simplest scenario is distribution by paper along with the physical product. A more efficient way is through established automatically processed digital distribution of SDSs connected to the sales/purchase systems. If some information is missing from the SDSs, the operator should ask the supplier to provide this information.

An approval process must be established to ensure that the restrictions on chemicals and substances set up in a chemical policy or in chemical guidelines are followed. This should include routines to review and approve the purchase of chemicals. There may be a total ban on purchases of some substances. For other substances an exemption may be required which also specifies handling regulations to ensure that handling will not contribute to unintended exposure or emissions.

An effective purchase routine also involves communication with suppliers of these bans and restrictions to prevent occurrence of forbidden or restricted substances in the production steps were a change is harder to force. One way to establish this is through use of ban- and restriction lists as part of the business agreements and long-term relationship declarations, involving the suppliers of chemical products to confirm absence of listed substances in their products.

An example of a Chemical and raw material inventory is described more in detail as a BAT-candidate in Annex 1.2. See also chapter 4.3. The BAT proposal for process mapping (Annex 1.5.) presents ways to estimate the substance flows through the installation. Chapter 3.3. of this report presents Material Flow Analysis as a tool to support chemical management of the installation.

Findings from the case studies

It is viewed by the operators of a STM case study installation that REACH requirements⁶⁶ generally speaking have led to increased risk management trainings, better and harmonized labelling of chemicals and improvement of storage conditions for chemicals. The REACH requirements have increased the amount of labour since the classifications have to be calculated for all the baths used but this is seen as a positive thing because it has led to better awareness of the chemicals used.

The operators of HAZBREF case study installations select the chemicals carefully and are aware of their use in the production processes. The operators use ready-to-use working baths, their own recipes and auxiliary agents. They check and test appropriateness of their application including any possible impact on the waste water treatment system and resolve potential problems accordingly. Usually the evaluation concerns the whole working system.

4.3. Chemical storage and transportation

There are several measures to reduce the environmental impact from chemical storage. Many examples are found in IPPC's Reference Document on Best Available Techniques on Emissions from Storage (EFS BREF). To some extent the STM BREF also provides recommendations on handling of chemicals. Some measures in the EFS BREF and STM documents are well suitable for storage of hazardous substances and they are discussed in the following paragraphs.

Storage based on the substance

For storage of hazardous substances, it is important to consider the physico-chemical properties. For instance, hazardous materials that could react with other substances which could lead to dangerous gases or fumes, should be stored separately. Storage cells are one option for separate storage (see EFS BREF document Section 3.1.13.1.). In the Technical Rule on Hazardous Substances (Technische Regel für Gefahrstoffe – TRGS 510)⁶⁷ 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) – see Figure 3.

⁶⁶ Authors note: The operators consider in this respect CLP Regulation, IED (EFS BREF), worker safety legislation and possibly the Seveso legislation.

⁶⁷ https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/pdf/TRGS-510.pdf?__blob=publicationFile&v=2

Storage class		10-13	13	12	11	10	8 B	8 A	7	6.2	6.1 D	6.1 C	6.1 B	6.1 A	5.2	5.1 C	5.1 B	5.1 A	4.3	4.2	4.1 B	4.1 A	3	2B	2A	1		
Explosive substances	1																											
Gases	2 A	2			2			2									1									2	3	1
Aerosol packages	2 B																1											
Flammable liquids	3	5			5						6						4											
Other explosive substances	4.1 A	1	1	1	1	1	1	1								1												
Flammable solid or desensitizing explosive substances	4.1 B										6			4	1		4			6	6							
Pyrophoric or self-igniting substances	4.2	6			6	6	6	6			6	6								6								
Substances producing oxidizing gases with water	4.3	6			6	6	6	6			6	6																
Highly oxidising substances	5.1 A																											
Oxidising substances	5.1 B	7			7	7	7	7			6	6	4	4			1											
Ammonium nitrate and mixtures containing ammonium nitrate	5.1 C	1	1	1	1	1	1	1									1											
Organic peroxides and self-reactive substances	5.2	1			1	1																						
Combustible, acutely toxic substances	6.1 A	5			5																							
Non-combustible acutely toxic substances	6.1 B	5			5																							
Combustible acutely toxic or chronic substances	6.1 C																											
Non-combustible acutely toxic substances or substances with chronic effects	6.1 D																											
Infectious substances	6.2																											
Radioactive substances	7																											
Combustible corrosive substances	8 A																											
Non-combustible corrosive substances	8 B																											
Combustible liquids	10																											
Combustible solids	11																											
Non-combustible liquids	12																											
Non-combustible solids	13																											
Other combustible and non-combustible substances	10-13																											

■ Separate storage is required
■ Joint storage permitted
■ Joint storage is only permitted with restrictions (see Number)

Figure 2. 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 effectively (see EFS BREF document Section 4.1.4.4.).

Storage in tanks

There are general recommendations regarding storing of chemicals in tanks such as: double-walled tanks (see EFS BREF document 4.1.6.1.13.) and trays to collect the spills. Single-walled tanks are another option if they are combined with tank bunds (see EFS BREF document Section 4.1.6.1.11.). The double wall is normally applied in combination with a double tank bottom and leak detection for the storage of flammable substances or substances which are hazardous in contact with water.

All intermediate bulk containers (IBCs), small tanks and drums should be placed on a secondary containment (see EFS BREF document 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.

Transfer

Emissions can also occur during the transfer of hazardous substances. There should be risk-based inspection plans and proactive maintenance plans as well as leak detections and repair programmes in order to reduce the emissions and the risk of leakage. For new installations, aboveground closed piping should be used for transfer. Fit diaphragm, bellows or double-walled valves should be used for valves (see EFS 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 an underground tank to catch accidental releases of chemicals during unloading.

4.4. Closed loop

Establishing a closed loop 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.

A closed cycle will result in environmental benefits such as decreased water amount and a minimised use of hazardous chemicals and hence reduced emissions of hazardous substances to the environment. It can also be a requirement for continued use of restricted chemicals as it is done in the EU-POPs regulation where the use of PFOS is only allowed for hard chromium plating in closed-loop systems. Therefore, an advanced rinsing-cascade system with feedback to the electrolyte, scrubbers and evaporators must be used in order to keep the chromium trioxide and PFOS in the system.

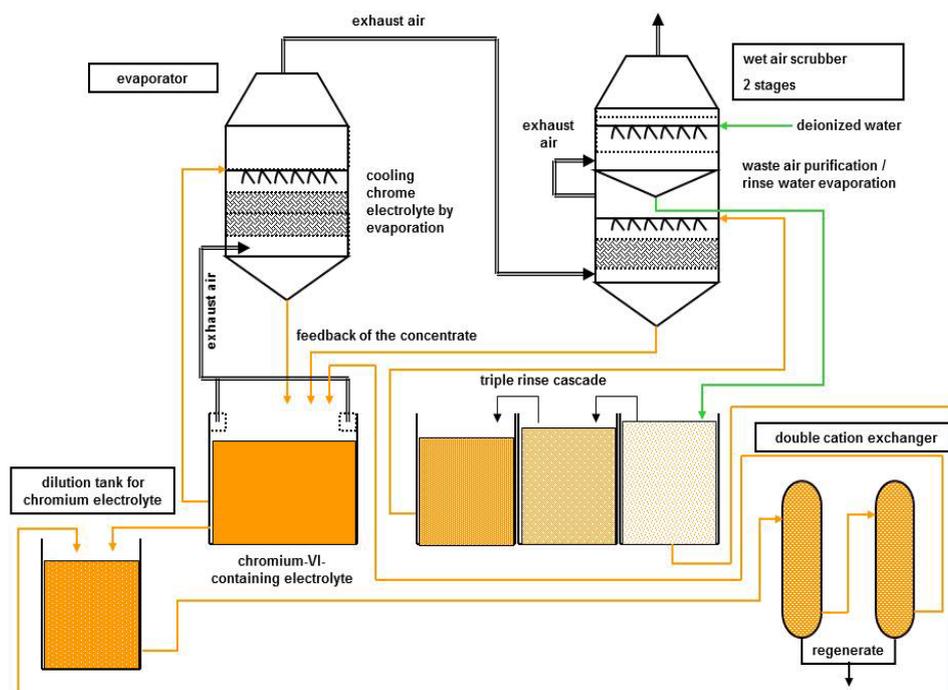


Figure 3. Process flow chart: Multiple rinse technique with evaporation technique, waste air scrubber and ion exchange for electrolyte purification (UNEP/POPS/COP.7/INF/21 2015).

An example of a closed cycle process is described more in detail as a BAT-candidate in Annex 1.3.

4.5. Substitution

Substitution can be aimed for any hazardous chemical used at an installation in order to protect environment or human health. Thus, substitution is not a specific procedure meant specifically for chemicals under REACH (e.g. SVHCs and authorisation substances), CAW Directive (Art. 6) and Biocidal Product Directive.

A successful substitution work can be performed in five stages:

1. identification of Hazardous substances
2. screening for possible alternatives
3. evaluation and choice of alternatives
4. life cycle approach of alternative substances
5. development of new alternatives.

1. Identification of Hazardous substances:

Strategic decisions on what to screen for and creating 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. Such a system can help to identify hazardous substances, and in some cases, there are also 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. This means searching for chemicals or 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 process 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 cost. Regrettable substitution (i.e. move to use new chemical that is equally or more hazardous than the substituted chemical or is less hazardous but must be used in a larger amount and thus leading to equal damage) must be avoided.

Regrettable substitution has taken place for instance with per- and polyfluoroalkyl substances (PFAS). In order to avoid this large group of chemicals there is an ongoing restriction proposal within REACH by Germany for PFHxA (C6) including their salts and precursors. Additionally, Netherlands and Germany, with support from Norway, Denmark and Sweden, have shown interest in preparing a restriction proposal to cover a broad range of PFAS uses. PFAS have to be addressed as a group rather than individually (grouping approach), not only to speed up the use restriction process but also to help avoid regrettable substitution⁶⁸. In general, managing chemicals in groups has been identified as a key approach for

⁶⁸ Simpson et al. 2020

preventing regrettable substitution and for making regulatory risk assessment and management less fragmented and more efficient and transparent. ECHA and member states have started working with group-wise handling of chemicals within REACH⁶⁹ and industrial operators should be efficiently informed on this issue in order to speed up sensible substitution.

4. Life cycle approach of substitution:

In order to avoid regrettable substitution special attention needs to be paid to one of the central BAT aspects – the cross-media effects. Therefore, research must be conducted, especially if data on toxicity, degradation products etc. is incomplete. This may also include the most important life cycle aspects from the production of the substitute, the use in the STM installation and sometimes even the product, if it has an impact on the recyclability etc. For example, reducing the concentrations of hazardous substances in waste water might increase emissions in air or make the product less recyclable, durable etc. Similarly, substituting hazardous substance with non-hazardous substances might increase the impact of primary production significantly. So, it must be kept in mind that substitution is not a goal per se, but the goal is to reduce overall environmental impact (inside and outside of the installation). Production, usage, emissions, fate of substitute and impact to product (also circular economy issues) must be considered based on current data. This must be compared with current substance. If there is not enough data, it must be acquired before deciding on substitutions.

5. Development of new alternatives:

The fourth step of the substitution process involves developing new substances or techniques with a lower negative impact on the environment and health. In the absence of available ready to use alternatives, innovations and/or new techniques may be necessary.

The needs of certain functions should be communicated within the supply chain all the way from the manufacturers down to the end users. Transparency in the supply chain is one of the key issues for a successful development.

According to HAZBREF case studies both the companies and the sector as a whole undertake efforts to replace hazardous chemicals. Replacement of Cr VI was successfully carried out in decorative chromium plating except for some applications. Changes in legislation should be considered when evaluating new measures and reviewing the environmental permit. Furthermore, Art. 21 (1) of IED requires 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 STM installations to submit a chemical inventory on an annual basis. This would allow for a regular screening of the applied chemicals/chemical products.

⁶⁹ Rudén 2020

4.6. Process mapping of hazardous substances

To be able to act for reducing emissions of hazardous substances, good knowledge of the production processes is needed. One way to achieve this is 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, mass balances, sampling and analysis, implementation of actions and verification. This approach is proposed as BAT-candidate and is described more in detail in Annex 1.5. Process mapping supports the compilation of chemical inventory (see chapter 4.2.).

Findings from case studies

The installations in HAZBREF case studies use techniques for prolonging the life of working baths by increasing drip-off times and by using advanced rinsing-systems with cascades. The process chemicals from the first cascade are recycled back to the bath. There are also many good examples of application of rinsing techniques, preparation of baths and dosing techniques, proper handling of hangers and working baths, which allow for essential reduction in chemicals losses.

Process mapping can lead to high efficiency of raw materials usage resulting from proper process modifications in STM sector. It can improve the implementation of BATs as defined in current STM BREF (2006) as well as the implementation of new technological concepts and techniques. Among others, the current STM BREF describes a set of techniques and measures which help to minimise material losses by retaining raw materials in process vats and by minimising water use.

4.7. Management of hazardous waste

Hazardous waste management can pose a risk when it comes to the discharge of hazardous substances. Below are examples of good routines in place for collection, storage, classification, labelling and packaging, transport and final disposal:

Routines for collection

- To separate hazardous waste from other waste streams (including other hazardous waste) and
- training for employees handling hazardous waste, with focus on the different types of hazardous waste, the characteristics and risk of different hazardous waste fractions, how to handle them and 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 and

- regular inspections of the storage area have to be carried out.

Routines for classification, labelling, packaging

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

Routines for transport and final disposal

- established according to national and local regulations
- including requirements on contracted waste vendors and
- regular auditing of waste vendors to check compliance with requirements.

It is a common practice to segregate the wastes as far as possible for both legal and economic reasons. For many smaller companies one of the key issues is high water content in hazardous liquid wastes (e.g. spent process baths, liquid wastes from degreasing, sludges from waste water treatment). These wastes are usually of high volumes and need to be transported for treatment in external waste treatment facilities.

Prevention of hazardous waste generation is an important aspect. For example, most of the hazardous wastes are spent process solutions containing heavy metals. Avoiding of dragging metals out of the process bath and feed the dragged-out solution back in the process tanks is one of the key aspects for process optimization and further waste management (see STM BREF, 2006; chapters 5.4 and 5.6). Substitution (see STM BREF (2006; chapter 5.5) and extension of the service lifetime of the process solutions (Process Solution Maintenance) are common practices for minimization and prevention of the generation of hazardous waste in STM installations.

Findings from the case studies

The HAZBREF case study installations carry out a systematic inventory and management of hazardous waste according to STM BREF and legal obligations. These installations produce large quantities of waste. To some extent the process waste is recycled internally, or its generation is prevented by the application of closed-loop systems with recovery of water. In HAZBREF case study installations liquid waste, like spent working baths, are in most cases neutralised within auxiliary treatment installations or transferred to specialised waste management companies. To some extent wastes are also reused directly. In other cases, the operators treat the wastes on-site e.g. neutralize acids and base liquid wastes or neutralise the spent baths in wastewater treatment system. Sometimes the operators seek opportunities together with the recycling companies for recovery of materials from the wastes.

Many techniques are applied in the HAZBREF case studies also for bath regeneration instead of their replacement or neutralization. Where possible, materials are recovered e.g. in anodising process or recovery of precious metals and copper. Despite the successful approaches, recovery of materials is limited for technical and economic reasons.

4.8. Waste gas and waste water treatment

Management of waste waters at STM plants includes different measures, such as minimising the use of water, separation of different waste water streams, recycling of process waters and application of adequate treatment for each final flow. The separated waste water streams are generally pre-treated and then jointly neutralized before discharging for external waste water treatment. The operators also recycle internally the pre-treated waste water, when possible. Common practices for air abatement measures include treatment of exhaust gases from working baths in wet scrubbers.

Findings from case studies

Examples of measures to reduce the discharge of hazardous substances were found in the HAZBREF case studies. These include collection of liquid waste sub-streams for further waste management, pre-treatment of sub-streams, treatment of waste gas, wastewater streams and emergency management. The case study companies implement to high extent BATs (STM BREF, 2006) for water and wastewater management due to technical reasons and legal requirements. These include techniques for water use prevention, separation of the wastewater flow types, maximisation of internal recycling and application of adequate treatment for each final flow. The separated wastewater streams are generally pre-treated and then jointly neutralized before discharging to external wastewater systems. The operators also recycle internally the pre-treated wastewater, when possible. The wastewater treatment system often integrates process wastewater, wastewater generated in air treatment (wet scrubbers), spills from storage accidents and wastewater from waste treatment processes e.g. dewatering. The technical, economic and environmental aspects frequently limit the application of more advanced solutions, especially in existing plants with diversified production and those with limitations in space.

Collection of exhaust gases from working baths and their treatment in wet scrubbers is common practice. The wastewater generated in the scrubbers is directed to appropriate wastewater treatment. Demisters are commonly used prior to scrubbers in treatment of waste gases from hard chromium plating.

The organisational schemes of operational monitoring of the treatment processes are important for the case companies. Measurements of quality of particular waste water sub-streams are carried out after pre-treatment and after mixing different sub-streams measurements are being undertaken again before the final discharge to the external waste water system.

The operators of STM installations use closed cleaning systems, biodegradable cleaning agents or pre-treat degreasing and cleaning wastewater in on-site designated wastewater treatment step (e.g. skimmer) or in separate auxiliary waste management installations based on advanced systems (e.g. reverse osmosis, dewatering).

A more detailed overview of BAT implementation according to current STM BREF (2006) in the sector based on HAZBREF case study installations is presented in Annex 4. An example of a waste water treatment process is described more in detail as a BAT-candidate in Annex 1.6.

Industrial waste water discharged to public sewer

The two main mechanisms for controlling industrial waste water discharges into municipal WWTPs include environmental permits for industrial operators and contracts between the industrial operator and the WWTP. Based on analyses of the current situation and good practices already in use, the project BEST has given

recommendations towards the improved management of industrial waste waters at WWTPs in the Baltic Sea Region.⁷⁰

One of the recommendations is that industrial operator immediately must inform the water utility on exceptional emissions into the sewer. Accidental leaks and load peaks must be prevented by risk management planning of STM operators.

Secondly, water utilities and WWTPs should be involved in the permitting process for STM industrial operators that convey waste water to public sewers and WWTPs. The expertise and points of view of water utilities regarding permit conditions should be considered by asking their comments during the permitting process. Environmental permits should include relevant requirements for industrial waste waters. Legislation needs to support setting necessary restrictions and limit values to industrial waste waters.

Another important issue is that the relevant WWTPs are not automatically addressed in the application for an industrial waste water-relevant activity regarding emissions to the sewer for further treatment, although it must be very clear that all stakeholders must be properly informed. Water utilities should be aware of the source, amount and type of industrial waste waters and conclude contracts with industrial customers with the highest loads and risks. This is the case in many countries (e.g. Germany, Finland and Poland) where the receiving WWTP of the pre-treated waste water has to be asked for permission to send a specific amount of waste water in a fixed composition for final treatment. This is not only the case for main pollutants such as nitrogen or sulphate but also the minor compounds like micropollutants. In contract negotiations, the STM operator gets more information about the possible harmful effects of its waste waters and the water utility gets information on what risks the industrial waste waters might have for the sewer network, pumping stations or the WWTP. The fixed amount and composition of industrial waste water in a contract between emitting installation and the WWTP needs amendment as soon as any of the two aspects mentioned above changes.

Furthermore, yearly meetings between water utilities, STM operators and environmental authorities should be set up. Contract negotiations lay the foundations for future cooperation between the water utility and the STM operator. Water utilities and WWTPs should aim for good cooperation with industrial operators by holding annual meetings and exchanging information on planned changes to operations as well as process disturbances. Regular meetings between the water utility, STM operator and the environmental authorities are also strongly recommended.

⁷⁰ BEST 2020. Policy brief – Towards improved management of industrial wastewaters. 2020. Policy brief by Project BEST. BEST_policy_brief_ENGLISH_FOR_WEB.pdf (bestbalticproject.eu); more detailed information in John Nurminen Foundation 2020. Guidelines for the Management of Industrial Wastewaters. 17 August 2020. https://bestbalticproject.eu/wp-content/uploads/2020/09/BEST_Guidelines_for_Management_of_Industrial_Wastewaters.pdf

5. Circular Economy Issues

STM techniques are indirectly supporting the goals of circular economy by creating durable and long-lasting surfaces through which the lifetime of metals and polymers can be extended. On the other hand, the variety of chemicals and metals used in STM processes hinders recycling. The whole sector is a significant user of non-renewable resources (metals) although, recycled materials are used when possible. Already in-line recycling of electrolytes takes place (e.g. chromium-trioxide). Recovery processes are currently widely used for basic metals (such as zinc, copper and nickel) from well-characterised waste streams. Processes are predominantly water-based, so the main waste streams are waste waters from rinsing processes or postprocess spent solutions, sludges from waste water treatment, and wastes from process maintenance. Another significant waste stream is packaging waste contaminated by chemicals.

Depending on the process, liquid emissions may contain cyanides (although the trend is decreasing), as well as surfactants which often have low biodegradability and accumulative effects (e.g. fluorinated surfactants). Hazardous substances, and valuable metals end up in sludge from waste water treatment. Closed water cycles are widely used by modern STM plants. The majority of STM facilities do not recover their process wastes themselves but send them to external treatment. According to the waste processors, examples of external treatment are non-ferrous metal refining, manufacture of metal concentrates or spent etching solutions recovery. Aluminium hydroxide from anodising can be precipitated and recycled as a coagulant for sewage treatment.

General recommendations for improving CE aspects in STM processes

According to BAT and good industrial practices avoiding the generation of waste is a basic principle for CE implementation. However, at present it is not possible to completely avoid waste production due to excessive environmental costs and high energy consumption.

Findings of HAZBREF case studies, which can be identified as CE supporting activities and good practices are the following:

- Common practice is to extract metals from the sludge of the STM waste water treatment.
- Etching liquids containing copper, can be utilized as copper source in e.g. fertilizer production.
- Onsite use of common spent process liquids in the neutralization stage of the waste water treatment system (such as acidic solutions from etching) is becoming more usual as disposal costs rise.
- Rinsing water is usually pretreated onsite prior to discharge to downstream waste water treatment facilities.
- Regeneration and maintenance of technological baths are widely used techniques. All these techniques extend the life of the bath, prevent the formation of waste and are also economically justified.
- Certain waste and waste water streams are collected/stored separately in order to improve recyclability of the waste streams.

- Good practice is to develop a process chart related to chemicals used. It contains a list of all chemicals and their composition used in the installation and helps to determine which waste streams could be put together and which need to be kept separate. This also helps the external recyclers to optimize recycling since they will have better information on the composition of the sludge or liquid waste.

Challenges related to CE issues:

- Due to the use of many hazardous substances, most waste from STM processes is classified as hazardous waste.
- Extraction of metals from rinsing waters is not yet economically viable with some exceptions such as silver and gold due to their value.
- The problem for external waste treatment operators is the irregularity of liquid waste (e.g. used baths) generation, the variable or unknown composition and the unpredictable quantities.
- The quality of chemicals used may vary greatly and may have an influence on product quality and recyclability as well as process waste management.
- The coating of metals and plastics have an influence of the recyclability of metals from post-consumer waste.
- Recycling of packaging in the industry is limited. For example, in one HAZBREF case study installation empty plastic chemical containers must be broken to prevent reuse according to the orders of authority. This current practice generates just the kind of plastic waste that could be avoided if reuse of the containers were allowed.

The supporting tool for transferring the information on substances in the supply chain could be the SCIP-database (Substances of Concern In articles, as such or in complex objects (Products)) currently being developed by ECHA⁷¹. The companies will need to submit information to the database on SVHCs 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. In order for companies to be able to fulfil the obligation of submitting information to the SCIP-database the information flow from users of chemicals in the value-chain is required.

⁷¹ SCIP database will improve transparency on hazardous substances in articles (<https://echa.europa.eu/-/scip-database-will-improve-transparency-on-hazardous-substances-in-articles>).

6. Permitting Process and Management

The case studies and interviews with representatives from permitting authorities in the four countries⁷² indicate significant differences between the respective permitting procedures regarding detail as well as frequency of information on substances to be submitted. For example, some countries apply BREFs and BAT conclusions directly, while others transpose it into national law. Differences in the permitting requirements are also found in internal practices within countries.

6.1. IED permitting and inspection cycle

According to the IED, “installations” are technical units in which one or more industrial activities listed in Annex I or in part 1 of Annex VII of the IED are carried out, also including directly associated activities on the same site which have a technical connection with the activities specified in those annexes and which could have an effect on emissions and pollution.

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 (see: Figure 4). Complaints against permit decisions may be made to the Administrative Court, then to the Supreme Administrative Court.⁷³

⁷² WP3.1 activity final report.

⁷³ https://www.ymparisto.fi/en-US/Forms_permits_and_environmental_impact_assessment/Permits_notifications_and_registration/Environmental_permits

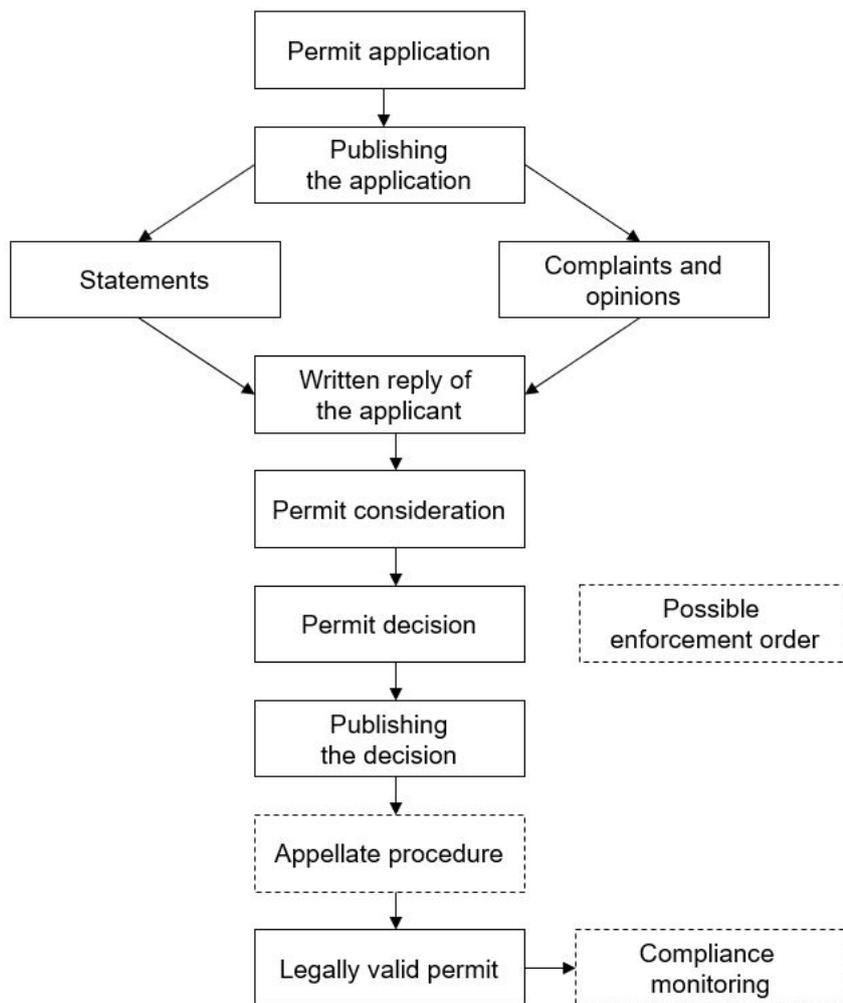


Figure 4. General flow chart of the permitting procedure in Finland.

In the following, the steps of the IED permitting and inspection cycle will be addressed with special consideration of available tools and references as well as common challenges for permit writers, competent permitting authorities and operators. Figure 5 provides an overview of the steps, inputs, links between the steps and how they work together.

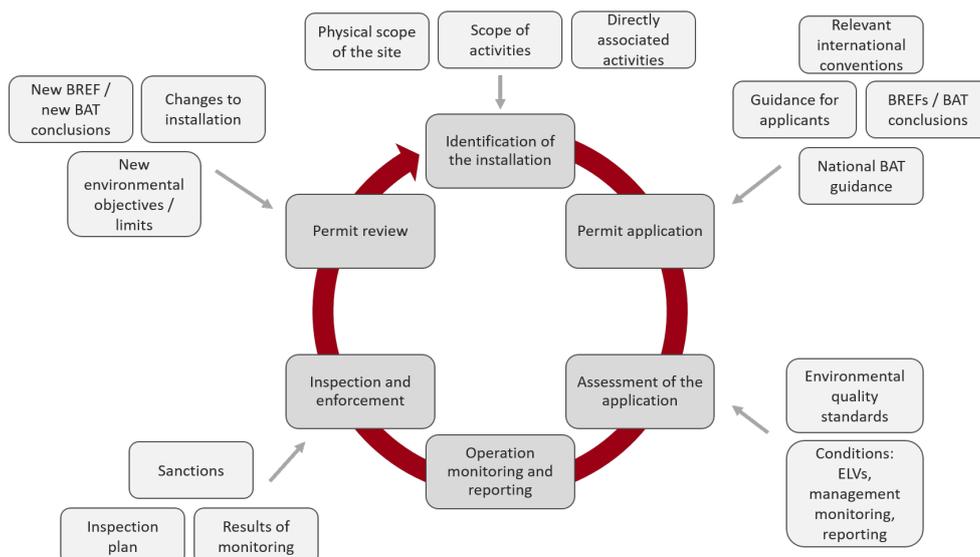


Figure 5. IED permitting and inspection cycle.⁷⁴

6.2. Permit application

Before starting the preparation of 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. According to IED Article 12 the permit application must include descriptions of the following aspects:

- installation and its activities
- raw and auxiliary materials, other substances and the energy used in or generated by the installation
- sources of emissions from the installation
- conditions of the site of the installation
- nature and quantities of foreseeable emissions from the installation into each medium as well as the identification of significant effects of the emissions on the environment
- proposed technology and other techniques for preventing, or where this is not possible – for reducing emissions from the installation
- measures for the prevention, preparation for re-use, recycling and recovery of waste generated
- further measures to comply with the general principles of the basic obligations of the operator as provides for in IED Article 11
- measures planned to monitor emissions into the environment and
- main alternatives to the proposed technology, techniques and measures studied by the applicant in outline (for installations regulated under the EIA Directive).

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

⁷⁴ Based on: IMPEL, Linking the Directive on Industrial Emissions (IED) and the REACH Regulation, 2013).

- 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 Authorisation 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).

Apart from the aforementioned substances operators can use information that is supplied or produced in response to other legislation for their application. This includes for instance information published in the ECHA dissemination portal, information provided in safety data sheets, exposure scenarios or information the operator has generated when complying with REACH obligations. Although the IED does not address the compliance with the duties under REACH as such, several European member states which were questioned in the course of 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).

Good practices:

Electronic tool for submission of applications (ELiA, Germany)

ELIA is an IT solution designed for the application and approval of IED installations under the German Clean Air Act (BImSchG). With this tool, companies or the engineering offices they have commissioned can electronically prepare IED permit applications and send it to the competent permitting authority in encrypted form. The aim is to ensure that even extensive permitting procedures for the construction and operation of installations (or for their substantial modification) are carried out more uniformly, effectively, efficiently and in accordance with the BImSchG. ELiA is currently used by 8 of the 16 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 can see the chemical lists in KemiDigi and use them for their supervision or permitting activities.

Electronic tool for submission of applications (Estonia)

In Estonia all environmental permits are applied and managed in an electronic platform (<https://kotkas.envir.ee/>). The applicants fill in the forms. The system makes preliminary logic tests in checking the consistency of the permit (e.g. if given working hours are equal or less to total working hours of the entire year). Today, application evaluation is mostly done by authority specialists, but in the future, the intention is to automate quality and compliance checks as much as possible. Permits are issued in the same system. Permit owner receives reminders from the system to provide monitoring data. Monitoring data is also entered into the e-system.

In the electronic IED application software (ELiA) REACH duties are especially checked in the Template “Chemical Safety” (the respective template is provided in Annex 5). In other countries REACH duties are not systematically checked in the course of IED-permitting. According to IMPEL the overall awareness of REACH in the framework of IED permitting is, however, not yet very high.

In general, it is not legally binding for authorities to use the REACH data when checking the IED permits. Additionally, it varies whether national authorities use the information gathered by SDSs in the permitting process in the five studied countries. For example, in Finland and Germany it depends on the awareness of the staff granting the permit if SDSs or other REACH information is used as a source of information. Nevertheless, during supervision of STM installations, the compliance with REACH requirements such as the requirement from authorization and restriction process is usually checked. Nevertheless, data gained from the REACH registration dossier or risk reduction measures are rarely used neither in the permitting nor in the supervision procedure. It should also be noted that in some cases the Robust Study Summaries (RSS) submitted to ECHA are either not

available or not sufficiently detailed to allow meaningful conclusions to be drawn from them. Moreover, the actual study data are not available to the authorities and the data submitted under REACH can mainly give an idea of a substance hazard or risk profile. On the other hand, the WFD requirements for priority substances (e.g. environmental quality standards) are a key element considered by permitting authorities when considering setting the emission limit values or other permit conditions for an IED installation in Estonia, Germany, Finland and Sweden (Suhr et al. 2020).

6.3. Assessment of the application documents and permit decision

The competent authority must assess the environmental performance of the installation. For this purpose, compliance with BATs, BAT conclusions (if available) and requirements derived from other sector specific regulations (e.g. Water Framework Directive and occupational safety)⁷⁵ or sector-specific national legislation must be ensured. If certain environmental quality standards impose stricter requirements than those that can be achieved through the application of BATs, additional measures may be required in the permit to comply with given standards. Permit writers are further required to set emission limit values for polluting substances listed in Annex II IED and other polluting substances, which are likely to be emitted from the installation concerned in significant quantities. For this purpose, the authorities shall also consider the nature of the respective substances and their potential to transfer pollution from one medium to another (Art. 14, par 1 IED). Relevant information and inputs concerning the situation and conditions of the respective industrial sites may also be provided by the public, which, according to the IED, has the right to participate in the decision-making process, and to be informed of its consequences. They should therefore be granted access to the permit applications, permits and the results of the monitoring of releases. In case the assessment concludes that all permit requirements are met by the installation, the permit may be issued.

A major challenge for an efficient assessment of chemical-related information in the context of the IED permitting is the lack of systematic evaluation approaches and the lack of comprehensive and accessible information sources. As a result, the competent permitting authorities usually only rely on those information sources that are known and accessible to them. The most important sources of information regarding relevant substances are the SDS (see chapter 3.3.). Other sources include chemical databases such as those made available by ECHA or national organisations (see Annex 2), as well as various checklists or reference tools. The exposure scenarios can serve as an additional source of information when they are available.

To improve the application assessment process regarding chemicals management, it is recommended to provide a comprehensive overview of available tools and references in a clearly arranged and easily accessible way, suitable to facilitate

⁷⁵ If, for example, a priority substance regulated under the WFD (e.g. mercury) is present in the waste water of an installation in a relevant quantity, the operator is required to take measures in order to reduce emissions and to phase out the emissions, discharges and losses of the substance.

their use by plant operators and competent authorities. An exemplary compilation of tools and references relevant for the respective IED permitting steps 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 Authorisation 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 team 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 law (general, implementation of actions, participation in monitoring of BImSchG/IE plants with regard to issues of chemicals law).

6.4. Monitoring, reporting and inspections

To ensure compliance with the emission limit values (ELVs) established for the pollutants listed under Annex II IED (and for other pollutants which may be emitted by the installation concerned) STM installations should be subject to regular monitoring. The monitoring should consider the nature of the pollutants as well as the risk of the pollution shifting from one medium to another as well as the amount and the stability of the load emitted. According to the frequency defined in the permit (at least annually) the operator must submit the emission report for each sample to the competent authority. The permit may also allow the monitoring to be carried out by a certified third party who subsequently transmits the results to the competent authority. As soon as available, BAT conclusions are the reference point for setting the monitoring framework (e.g. parameters to be monitored, test method to be applied and required frequency of reporting).

It is good practice for the competent authority to regularly draw up programs for routine environmental inspections on the basis of an individual inspection plan. The determination of the period between two site visits shall 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. If the inspection revealed non-compliance with the permit conditions, an additional on-site visit should be carried out within 6 months after the first inspection.

In order to investigate serious environmental damage, serious chemical and environmental accidents, incidents and incidents of non-compliance as soon as possible and, where appropriate, before the permit is granted, reviewed or updated, non-routine inspections may be carried out.

6.5. Review of the permit

Under the IED, hazardous substances are defined in Article 3 of the Classification, Labelling and Packaging Regulation [EC1272/2008]. Competent authorities should regularly check whether substances manufactured or used in the relevant installation are included in the candidate list or whether they are subject to authorisation or restrictions. As a minimum, the following also must be checked: CLP Annex VI, Reach Annex XVII and relevant annexes in POPs, Seveso, Water Framework Directive. Changes should be taken into account when evaluating new measures and reviewing the permit, as appropriate. 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 STM installations to submit a chemical inventory 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.

6.6. General challenges and recommendations

In general, the bigger installations usually pose more resources to manage chemicals better than smaller installations for example in Finland (Mehtonen & Knuutila, 2014). This is valid also in other Baltic Sea countries. Thus, from the chemical management and environmental point of view the transition from small STM installations to bigger ones, as seen taken place at least in Germany, can be a beneficial process. It must be stressed that the legal obligations have to be implemented regardless the size of the company operating the installation. For that reason, supportive measures should be implemented on national level to support operators of smaller installations (i.e. operated by SMEs companies) in complying with regulations on chemicals and hazardous substances. These could be easy-to-access databases from the national or local authorities as well as guidance from insurance associations or employers' liability insurance associations, which all have an interest in the safe and compliant operation of installations dealing with hazardous chemicals.

The chemical management of SMEs (as well as larger companies) should be supported and promoted by efficient help of national helpdesk required under the REACH and CLP Regulations⁷⁶ and training provided by authorities and experts. Support for the SME sector will require adequate resources from authorities. This

⁷⁶ <https://echa.europa.eu/en/support/helpdesks>

has been stated as one recommendation for measure in Finnish National Programme on Hazardous Chemicals (Finnish Ministry of Environment, 2017). Other recommendations targeted for SMEs include promoting the use of safety data sheets and exposure scenarios as part of chemical risk management at workplaces. Additionally, materials (model solutions, best practices), training and easy-to-use tools are recommended to be produced for assessing and managing the health and environmental risks of chemicals, especially with SMEs in mind. The concise and clear national guidance's on safe and environmentally sound use of chemicals targeted for STM industry may be significant for the chemical management in STM sector, especially in SMEs. These kind of guidances has been prepared for several industrial sectors such as metal sector at least in Finland by cooperation between Institute of Occupational Health and environmental authorities (Degerth et al., 1999). Furthermore, guidance's also needs to be updated regularly.

A common challenge for both IED installations and competent permitting authorities is the access to and evaluation of information on hazardous substances (e.g. standard hazardous substance reference lists, as indicated in previous chapters). The fact that the current IED requirements regarding the provision of information on used hazardous chemicals by no means are standardised at either international or national levels further underlines this challenge. Although the information requested from plant operators usually includes information on the substances handled, used and generated (including waste water and waste and their material flows) the type and format of the information depends heavily on the respective competent permitting authority. Chapter 3.2 of this report provides an overview of chemical information requirements that should be available during environmental permitting process.

There are first approaches to standardise the environmental application requirements regarding information on chemicals used (e.g. ELiA Germany, see also Annex 5 of this report). Interviews with competent authorities in Germany furthermore show that the information on chemicals usually the part of the application with the largest gaps. This is mainly due to the low level of information available to plant operators which on top are not always easy to access.

Other challenges regarding the evaluation of the data provided in the environmental permit application on the chemicals used include, among others the lack of systematic procedures and database of available references. This is particularly relevant as spot checks of safety data sheets often show significant lapses and inconsistencies of the information contained. A verification of the contained information thus requires well-founded expert knowledge.

A lot of expertise on chemicals is needed among the authorities. One solution could be establishment of chemical units (example from Germany⁷⁷) within the authorities or specific groups among authorities focusing on chemicals. Another solution could be a database where chemical lists and SDS are available primarily for operators in order to enhance chemical management, but also for all relevant

⁷⁷ Schleswig-Holstein example, see chapter 0

authorities, which for example is done in Finland.⁷⁸ One good practice includes holding 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. Exchanging information between Member States authorities would also be good.

One recommendation from a HAZBREF case study is that there should be more discussion between the applicant and chemical and environmental authorities (i.e. improved “trilateral co-operation”) during the whole permitting process. Open communication would clarify issues before the permit is issued and make the whole process more effective and faster.

Availability of staff and expertise on chemicals pose a particular 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. Ideally, the staff composition of relevant authorities would bring together expertise in the areas of chemical and environmental engineering, legal requirements and sectoral process technology.

This is illustrated by findings from a HAZBREF case study. The case study company has many sites around Finland. This means that in total the company’s plants have two chemical and seven environmental supervising authorities. The practices are different in different regions and this is sometimes confusing. Sometimes different authorities disagree among themselves or require information on chemicals in different formats. It is time consuming for the company when information needs to be gathered from various places and the same data must be presented in different ways. This sometimes leads to double work in the installation. Therefore, the personnel of the case study company suggest that supervising authorities could coordinate contradicting issues better among themselves. This could be implemented in practice with common coordinative meetings and inspection visits of both chemical and environmental authorities. Another solution to this issue is the launch of the KemiDigi, an electronic database to store chemical data. When companies start using KemiDigi, the authorities will be able to retrieve the chemical lists from there and the companies do not need to gather different lists anymore. Concerning industrial waste water discharged to public sewer it is recommended that the water utilities should be truly heard in the permitting of industries. Water utilities and WWTP should be involved in the permitting process for STM industrial operators that convey waste water to public sewers and WWTP. The expertise and points of view of water utilities regarding permit conditions should be considered by requesting their comments during the permitting process. Additionally, STM operator should inform the water utility on quantitative or qualitative changes in emissions into the sewer. In case of a process disruption, the STM operator should immediately inform the water utility of exceptional emissions and any other unusual situations affecting the quality or quantity of waste water. Furthermore, yearly meetings between water utilities, STM operators and environmental authorities should be set up. Water utilities and WWTPs should aim for good cooperation with industrial operators by holding

⁷⁸ KemiDigi database example, see chapter 0.

annual meetings and exchanging information on planned changes to operations as well as process disturbances. Regular meetings between the water utility, STM operator and the environmental authorities are also strongly recommended (modified recommendations of BEST project; BEST 2020).

One problem a case study company has faced is that the authorities sometimes lack the knowledge on STM industry. This has often been the case with occupational health authority but similarly sometimes the permit writers do not know where the real risks lie, i.e. what to focus on. The personnel wish that the permit writers would have better knowledge on the industrial sector. According to them the permitting process was also slow, and the application had to be amended several times. If there would be more communication during the permit application process, the process could be streamlined. Efficient chemical management, addressing environmental issues as well as occupational health and safety aspects, is an important challenge for the STM industry, that must and can be solved.

7. Annexes

Annex 1 –Recommendations on BAT candidates

1 Chemical Management System

The purpose of the CMS is to maintain good control of chemicals and hazardous substances at the site, increase the knowledge of the characteristics, risks and impacts 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. A CMS can be part of an Environmental Management System (such as ISO 14001 or EMS according to BAT 1 in CWW), but in a CMS the focus is on the chemicals with the aim to improve management and reduce risks from use of chemicals

A general chemical management system follows the classical PDCA-cycle as does any management system – Plan, Do, Check, Act, See Figure 3 below.

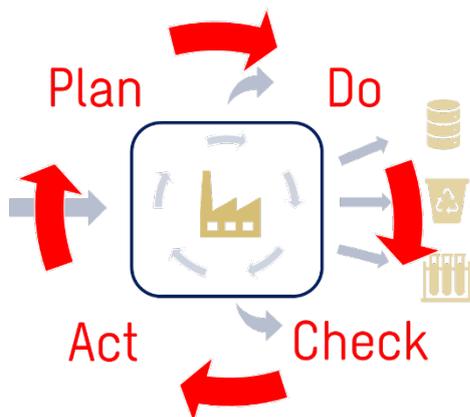


Figure 1 The PDCA-cycle related to chemical management

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. 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 hazardous substances can be substituted

Do

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 to current decision-makers, to be able to go 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.

<i>Name of the technique</i>	Chemical Management System (CMS)
Description of the technique	See the description above. A 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	A CMS is not a technical solution, more an organizational solution that demands leadership, communication, routines and systematic approach.
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 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 STM 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	Customer-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 is working with production of organic chemicals (polymers) used in pharmaceutical industries.
Name of the technique	Chemical Management System (CMS)
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 use of chemicals in the STM sector is very extensive. Therefore, it is important to have a chemical inventory to bring control and a good overview of all chemicals, including process chemicals and maintenance and cleaning products. A structured inventory is a key factor for further actions and work in a successful chemical management system. This type of systems can be built up in different ways and include small or large amount of data that can be used for screening of hazardous substances used on 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 ground information beside the product names are 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 added information along 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

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 of a review.

The quality of the SDS can be a risk factor for false 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 other industry sector NGO's that can help making a high-quality-risk assessment for substances of concern.

For a more expanded 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
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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 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, these systems also provide good support functions such as; access to material 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, PS and SVHC substances
- Identification of national authority databases ex, Swedish Chemical Agency PRIO-list
- Identification of chemical products which are non-biodegradable
- Identification of VOC, and any other environmentally relevant properties, which are not based on CLP hazard classification
- Identification of all combustible/flammable products and those which 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

<i>Name of the technique</i>	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 is up to date. Communication and good routines should be implemented with the suppliers.
	SDS quality and not harmonized information can be an issue. Different suppliers can give contractually data on the same substance.
Cross-media effects	No cross-media effects are expected from this implementation.
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

	<p>searching systems and integrations with other systems. Commercial software is available as plain 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.</p>
Driving force for implementation	<p>Companies may be required by law 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 Biotechnological 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.</p>
Example plants	<p>Example plants from relevant case studies where chemical inventories are described, both from Polymer, STM and Textile sector. Example on 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/</p>
Reference literature	<p>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 https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-1998901-om-verksamhetsutovares_sfs-1998-901 Finnish law on chemical information notification 553/2008 https://www.finlex.fi/fi/laki/alkup/2008/20080553</p>

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An example from a case study from the surface treatment industry about a chemical inventory, named chemical management and safe use of chemicals follows below.

The general management of chemicals is already minimizing the use of hazardous chemicals. Also, release of hazardous substances and continuous development of the management, is one of the key issues in assessing the most suitable BAT applications, which are e.g. chemical inventory and the utilization of the SDS. In the BAT description 'Chemical management and safe use of chemicals', the aim is to provide tools for the chemical inventory. This BAT is general applicable.

<i>Name of the technique</i>	Chemical management and safe use of chemicals
Description of the technique	The chemical products have to be selected not only with respect to their performance but also regarding their intrinsic properties (acute, chronic and sub-chronic human and aquatic toxicity, biodegradability) as well as assessed for specific handling and control requirements.
Technical description	<p>The relevant data for all the products used are entered in an operator's database from which tailored compilation of information can be generated. The main sources of data used for the different chemical products are the SDS and e.g. the Technical Instruction Sheets. The operator should have an SDS for each chemical product used. The SDS's should be up-to-date and include all the relevant parameters. Specific safety info cards could be made based on the info in the SDS.</p> <p>The data base provides information for chemical management needs such as:</p> <ul style="list-style-type: none"> List of all chemical products used (see example in Table 3) Identification of chemical products with high acute aquatic toxicity Identification of all combustible/flammable products and those which can decompose (thermally or by reaction with other chemicals) Compilation of relevant data required for planning and implementing adequate storage and handling of chemicals Assessing compatibility of chemicals and preparing 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 For each hazardous chemical, an estimation on the emissions to the environment should be made.

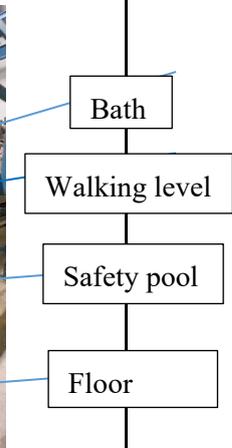
Achieved environmental benefits	The chemical inventory derived from the data base, combined with different filtering and evaluation options allows systematically identifying substances with undesirable environmental and toxicological (adverse) properties. This in turn facilitates the systematic monitoring of relevant hazardous substances. This also helps in selection of chemical products in terms of elimination/avoidance of hazardous substances. Among others, this also helps to streamline the coordination with chemical suppliers asking for products with less hazardous environmental properties.																																
Environmental performance with regard to hazardous substances and operational data	<p>The data from the 8 sections of the respective SDS (as per European CLP/GHS) is inserted into the data base:</p> <ul style="list-style-type: none"> Location information (line and bath number) Identification of the substance/mixture and the manufacturer/importer of the chemical Composition/information on ingredients CAS number Hazards identification Hazard statements Amounts used and stored Chemical categories and maximum amounts in factory based on the classification of the chemical <p>Table 1 shows an exemplary outline of a chemical inventory containing relevant environmental data of chemical products.</p> <p>Table 3. Example for compilation of data extracted from a data base</p> <table border="1" data-bbox="517 1211 1287 1451"> <thead> <tr> <th>Commerci al name</th> <th>Pro duc er</th> <th>Chemical charact erisatio n</th> <th>CA S nu mber</th> <th>Cont . haz. subs tanc es in [weig ht-%] for indiv. subs t.</th> <th>G HS haz ard</th> <th>S DS dat e</th> <th>Annu al consu mptio n</th> <th>Ma x qu anti ty stor ed</th> <th>Biolog. degradatio n/eliminatio n in [%] and test duration [d] and testing method</th> <th>CO D/B OD valu e</th> <th>Tox icity to daph nia</th> <th>Tox icity to bac teria</th> <th>Tox icity to fish</th> <th>Tox icity to alg ae</th> <th>Rel eas ed to air [%]</th> </tr> </thead> <tbody> <tr> <td> </td> </tr> </tbody> </table>	Commerci al name	Pro duc er	Chemical charact erisatio n	CA S nu mber	Cont . haz. subs tanc es in [weig ht-%] for indiv. subs t.	G HS haz ard	S DS dat e	Annu al consu mptio n	Ma x qu anti ty stor ed	Biolog. degradatio n/eliminatio n in [%] and test duration [d] and testing method	CO D/B OD valu e	Tox icity to daph nia	Tox icity to bac teria	Tox icity to fish	Tox icity to alg ae	Rel eas ed to air [%]																
Commerci al name	Pro duc er	Chemical charact erisatio n	CA S nu mber	Cont . haz. subs tanc es in [weig ht-%] for indiv. subs t.	G HS haz ard	S DS dat e	Annu al consu mptio n	Ma x qu anti ty stor ed	Biolog. degradatio n/eliminatio n in [%] and test duration [d] and testing method	CO D/B OD valu e	Tox icity to daph nia	Tox icity to bac teria	Tox icity to fish	Tox icity to alg ae	Rel eas ed to air [%]																		
Cross-media effects	No cross-media effects expected.																																
Technical considerations relevant to applicability	This technique is applicable to any industry as part of chemical Good Housekeeping and basic chemicals management. The necessary software application for the establishment and implementation of such a data base and respective evaluation tools can be either obtained by a range of providers available on the market (as part of an integrated business or stand-alone application) or developed in-house.																																
Economics	The investment and operating costs for a chemical data base depend on the level of sophistication intended. Savings usually arise from being able to streamline stocks, manage surplus chemicals, simplify or automate the procedures/process (e.g. by using chemical inventory software) as well as indirectly from																																

	reducing environmental management costs by gradually eliminating the use of hazardous chemicals.
Driving force for implementation	Elimination of hazardous substances. Companies may be required by law to maintain a chemical inventory, for example a chemical inventory is required in the environmental permit application in Finland. A chemical database allows continuous improvement in the selection of less hazardous chemical products.
Example plants	Many plants in Finland Case Study No.5 provides an example of this from Finnish plants.
Reference literature	GIZ Practical Chemical Management Toolkit, 2017 Supplier Handbook Chemical Management – Section: Documentation (Inventory/MSDS) www.tchibo.com/servlet/cb/1199382/data/-/TrainingshandbuchChemikalienmanagement.pdf KemiDigi https://www.kemidigi.fi/ Substances in Preparation in Nordic Countries SPIN: http://spin2000.net/ Finnish law on chemical information notification 553/2008 https://www.finlex.fi/fi/laki/alkup/2008/20080553

Below is a BAT candidate described from a STM plant in Finland (case study No 5) that describes the handling and storage of chemicals. This is generally applicable to different types of plants.

<i>Name of the technique</i>	Handling and storage of chemicals
Description	Electrolytical coating industries use various chemical products in significant quantities. In order to avoid hazards and accidents, including accidental release of chemicals into the environment, threshold values have been developed which concern the quantities stored and specify respective protective measures to be taken. Chemical products, exceeding these quantitative threshold values are required to be stored properly and handled safely as part of general good chemical management practices.
Technical description	In order to prevent any unintended release (accidental release) of chemicals certain precautionary measures are to be taken. Intermediate bulk containers and drums are to be stored at collection points where the minimum volume of the catchment facility determines the volume of the largest container or drum. When storing chemicals, it is of particular importance to check for their respective storage compatibilities as certain chemicals cannot be stored together utilizing the reaction matrix, figure 1. In order to identify potential storage incompatibilities of

	<p>chemicals, chemical segregation charts are available. Examples for chemicals with special storage requirements are hydrogen peroxide which shall be stored separately in a dedicated catchment facility. Chemical segregation charts should be used together with information gathered from the corresponding Material Safety Data Sheets (SDS).</p> <p>In addition to the measures described above, the following general measures should also be implemented:</p> <ul style="list-style-type: none"> • Any production and storage facility should be tight, bearing, robust and thermally and chemically resistant • Any leakage should be fast and reliably detectable • Catchment facilities should not have any drain • Storage facilities should be equipped with sufficient lighting and ventilation • All chemical products should be clearly and unambiguously labelled • The entire staff should regularly receive competent training <p>Emergency exits and escape routes shall be provided.</p>
<p>Achieved environmental benefits</p>	<p>Proper unloading, storage and handling of chemicals, combined with a general staff awareness of hazards and a high level of precaution, can significantly reduce the likelihood of accidental release of chemical products used in surface treatment of metals and plastics.</p>
<p>Environmental performance with regard to hazardous substances and operational data</p>	<p>The following table outlines exemplary measures (common good chemicals management practices) for the proper discharge, storage and handling of chemical products:</p> <p>Chemical containers are stored in the area with safety pools. Containers have automatic surface level sensors and automatic pumps.</p> 

<p>Chemicals which are harmful to human health are stored in a locked space with only authorized access. Chemicals which react with another are stored separately. All containers have safety pools.</p>		
<p>All tanks are built with materials enduring different chemicals. Pools are supported by steel structures to prevent collapse. All pools have safety pools.</p>		
<p>All IBCs, small tanks and drums are placed on catchment facilities (secondary containments) (secondary containment units should be able contain 10% of the total volume of all containers or 100% of the largest container; holding capacity ideally 110% of the maximum capacity of the largest tank or drum)</p>		

Substance	Zinc (Zn)	Iron (Fe)	Hydrogen chloride (HCl)	Hydrogen peroxide (H ₂ O ₂)	Sodium peroxide (NaOH)	Ammonium chloride (NH ₄ Cl)	Zinc chloride (ZnCl ₂)	Di-ethanolamine ((CH ₂ CH ₂ OH) ₂ NH)	Water (H ₂ O)
Iron (Fe)									
Hydrogen chloride (HCl)	GF	GF							
Hydrogen peroxide (H ₂ O ₂)									
Sodium peroxide (NaOH)	GF	GF		H					
Ammonium chloride (NH ₄ Cl)						H	H		
Zinc chloride (ZnCl ₂)						H	H		
Di-ethanolamine ((CH ₂ CH ₂ OH) ₂ NH)						H	H		
Water (H ₂ O)									

Figure 6. Reaction matrix

Cross-media effects	
Technical considerations relevant to applicability	There are no technical restrictions known for the applicability of the measures described.
Economics	There are no precise figures available for the different measures described. Potential savings arise from reduce risks of uncontrolled reactions and connected costs (losses, damages).
Driving force for implementation	Proper unloading, storage and handling of chemicals is a common compliance requirement for many companies adhering to environmental management systems. In addition, the measures described above facilitate the receipt of insurance benefits and help to meet the necessary requirements of the competent authorities.
Example Plants	Many chemical handlings and storing factories in Europe apply the measures described above, at least part of them.
Reference literature	N/A

3 Closed loop

Establishing a closed cycle in one process or 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.

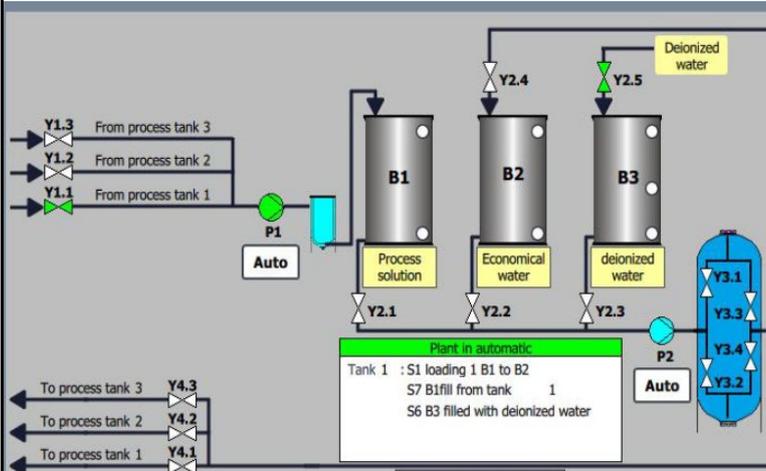
Closed loop is not the same as zero discharge. There may still be small discharges from treatment processes applied to the process solution and process-water circuits (e.g. ion exchange regeneration). A closed loop could still include discharge for maintenance, wastes and exhaust gases/vapours.

The following describes different example on closed systems or recycling.

Retardation plant for recycling of Al-Anodizing process solution reduces the consumption of sulphuric acid considerably. This technique also improves working conditions and occupational health and reduces the amount of waste solutions and aluminum precipitate formation. The technique also cuts down operational costs.

Recirculation of treated waste water back to process reduces the consumption of water and the amount of waste water generated and eventually reduces releases of hazardous substances. This also reduces the operational costs.

<i>Name of the technique</i>	Retardation plant for recycling of Al-Anodizing process solution
Description	Through the retardation-method aluminum, as acidic aluminum sulphate solution, can be separated from the rest of the acid. The regenerated acid is used again in the anodizing process.
Technical description	The retardation method is based on the adsorption effect of special ion-exchange resins. During this process free and non-dissociated acids are tied on cationic, exchange-active groups, while mineral salts pass the ion exchanger. During the first step of this process, the ion exchanger pillar gets coated with an acid including mineral salt. Usually the stream in the ion exchanger is flowing upward and the metal containing solution (including a bit of acid), is flowing downward. If the exchange capacity has been used, de-ionised water is regenerating the pillar shortly before the concentration of the acid is on its highest level. The resulting eluate, which is full of acid, can be reused in the process.
Achieved environmental benefits	With the regenerating method of GS–electrolytes, acid savings of 85 to 90% are possible. Reducing waste solutions reduces waste water treatment costs, waste water discharges and aluminum-precipitate formation.
Environmental performance with regard to hazardous substances and operational data	Dilution of acid is not required which cuts down the use of acids and improves occupational safety. The technique enables the continuous processes. The volume of sulphuric acid has been cut down to 55%.

Cross-media effects	No cross-media effects expected.
Technical considerations relevant to applicability	 <p>Figure 1 shows by example the regeneration plant.</p> <p>A retardation unit can be installed in any existing anodising plant. Space needed for the unit depends on the amount of acid solution to be regenerated.</p> <p>The unit requires deionized water, pressurized air, emergency pools and electricity.</p>
Economics	Investment 33 000 €, operational costs less than 3 200 € annually. Annual savings up to 10 000 € without estimation on the savings in waste water treatment.
Driving force for implementation	Minimization of waste generation (metal sludge) and energy consumption. Economic reasons: savings in chemical costs and better work efficiency. Improvement of occupational safety.
Example Plants	Case Study No 5, Finland
Reference literature	bi.bra Abwassertechnik GmbH, operation manual

<p>Name of the technique</p>	<p>Recirculation of treated waste water back to process</p>
<p>Description</p>	<p>The rinsing water is pre-neutralized and precipitated and flocculated. Cr VI rinsing waters are reduced, and cyanide rinsing waters are oxidized before precipitation. After flocculation the water is lamella filtered and sludge is separated. The lamella filtered water is filtered again through sand. After this the conductivity and turbidity are measured prior to third filtration. If the turbidity is too high, the waters are steered back to the precipitation phase. The third filtration includes membrane or ultra filtration and reverse osmosis. Reject waters are discharged to treatment and the purified water is circulated back to the process.</p>
<p>Technical description</p>	
<p>Achieved environmental benefits</p>	<p>Reduction in raw water consumption and in waste water discharge to the municipal waste water treatment plant. Overall reduction of releases of hazardous substances to the environment.</p>
<p>Environmental performance with regard to hazardous substances and operational data</p>	<p>The consumption of raw water can be significantly reduced in a continuous surface-treatment plant.</p>
<p>Cross-media effects</p>	<p>No cross-media effects expected.</p>
<p>Technical considerations relevant to applicability</p>	<p>This technique is applicable to any industry as part of waste water treatment. Space limitations might restrict applicability of this technique in existing installations. In addition, the residues of the used chemicals (sugars, salt, lime) might affect the possibility to recirculate water. The treatment requirements and concentration of rejects must be taken into account when designing the treatment process. The salinity of the reject waters may limit the recirculation and affect the operation of the downstream waste water treatment plant.</p>

	<p>The system must be equipped with a continuous flow measurement.</p> <p>The used filtration technique must be selected based on the salinity of the water.</p>
Economics	<p>The savings depend on the price of raw water and waste water treatment costs.</p> <p>When the consumption of raw water was cut to half the cost savings were 30% taking into account the operational costs of the purification system.</p>
Driving force for implementation	<p>Significant cost reductions for raw water and waste water treatment.</p>
Example plants	<p>Many plants in Finland</p>
References	<p>Case Study No 5</p>

4 Substitution

Substitution is an important measure to reduce and replace hazardous substances in a process. Several different chemicals are used in the different surface treatment methods. It can be difficult to substitute a single chemical. In order to substitute a chemical, one may need to review the entire treatment process or alternatively switch to another surface treatment method.

Cr(VI) is an example of a hazardous compound that has commonly been used in the STM sector and needs substitution. Surface-treatment methods involving Cr(VI), have in many cases been replaced by other methods. For instance, there are effective chromium-free alternatives for passivation. However, there are still some applications where hard chromium is used while other options are being explored to find suitable alternatives with satisfying results.

The BAT candidate from case study No 6 below gives examples of how to implement substitution and what is important to consider.

<i>Name of the technique</i>	Utilization of installation specific substitution scenarios
Description of the technique	<p>While looking for substitution alternatives in STM, there is often a situation that in need to phase out a single substance (e.g. a substance containing hexavalent chromium), there is a need to substitute the whole system – other chemicals it contains, as well as process parameters and processing conditions. So, the adverse toxic and ecotoxic effects should be compared for a whole system too, and apart from these adverse effects, any adverse impact on the environment should be addressed. e.g. energy consumption, resource consumption.</p> <p>In principle, ideally there is need to consider all life cycle of these systems, starting from resource extraction and finishing with waste management stage / applicability of circular economy principles, i.e. Life Cycle Assessment (LCA) has to be applied, and comparison performed in all the LCA impact categories. LCA modelling requires quite a lot of inputs and outputs, but data are not available in all impact categories. The more there are uncertainties the more unreliable are the results.</p> <p>Thus, there is need for setting boundaries, and also clear decision-making criteria for substitution.</p>
Technical description	<p>The substitution assessment should be done for the hazardous chemicals which are used in the processes: WFD priority substances, SVHC substances. There is need to consider, if substances labelled as hazardous to the environment (GHS hazards H400, H410, H411, H412 and H413) has to be included. There are several LCA models, but they are licensed for use. For the modelling data on inputs and outputs to/from the process are needed.</p>

Achieved environmental benefits	Substitution decisions are based on comparison of properties of all hazardous chemicals involved (ideally all chemicals involved), and other impacts, not only chemical hazards are considered.
Environmental performance with regard to hazardous substances and operational data	See above
Cross-media effects	No cross-media effects identified from the BAT candidate (but LCA considers cross-media effects).
Technical considerations relevant to applicability	Comparison of systems – generally applicable. LCA – applicable by using modelling. Modelling requires quite a lot of monitoring data (inputs and outputs), the more there are uncertainties the more unreliable the result is. Another challenge is that often there are data gaps.
Economics	LCA tools are not freely available. Appropriate modelling needs resources, especially ensuring quality of inputs.
Driving force for implementation	Modelling techniques and measures can be used as supportive tools in identifying appropriate substitution scenarios.
Example plants	–
Reference literature	–

5 Process mapping of hazardous substances

To be able to take actions for reducing emissions of hazardous substances it is necessary to get a good knowledge of the production processes. One 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 4 below.

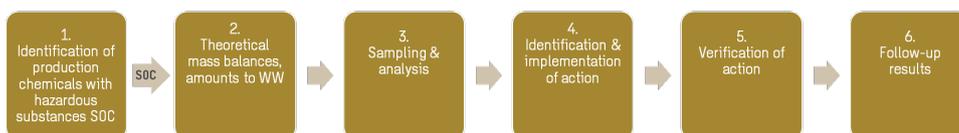


Figure 7. Six steps of process mapping of hazardous substances

1. First step of the process mapping is to go through 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 4 below presents an example of 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). The prioritization can be performed in other ways, depending on the number and types of substances.

Table 4. Example of prioritizing substances of concern (SOC)

SOC/NSOC	Category 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 potentially 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 3, depending of 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 treatment or pre-treatment or changes in the production methods to obtain a higher yield and minimize the emissions, etc.

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

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

<i>Name of the technique</i>	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 run as a projector a part of the normal procedures.
Technical description	Process mapping of hazardous substance sis 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: <ul style="list-style-type: none"> - 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.
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 and 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 solutions 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	N/A

“Utilization of installation specific exposure scenarios” describes how to utilize specific exposure scenarios in the process to assess the relevant emissions to the environment.

<i>Name of the technique</i>	Utilization of installation specific exposure scenarios
Description of the technique	The exposure scenario in the SDS gives the indication 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 lead to “worst case scenarios”. This means that the exposure scenario gives quite 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 installation.
Technical description	The risk ratio calculation should be done for the hazardous chemicals which are used in the processes: WFD priority substances, SVHC substances, substances labelled as hazardous to the environment (GHS hazards H400, H410, H411, H412 and H413). The risk ratio can be estimated 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 on 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.
Technical considerations relevant to applicability	Generally applicable. Modelling requires quite a lot of monitoring data (inputs and outputs), the more there are uncertainties the more unreliable the result is. Another challenge is that often these detailed exposure scenarios are missing from the SDS's. 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 appropriate modelling needs resources, especially ensuring quality of inputs.
Driving force for implementation	Modelling techniques and measures can be used as supportive tools in identifying relevant emissions to the environment.
Example plants	HAZBREF case study
Reference literature	STAN tool http://www.stan2web.net/ EUSES model https://ec.europa.eu/jrc/en/scientific-tool/european-union-system-evaluation-substances

6 Waste water Treatment

Usually the process water is purified in a conventional treatment plant where the purification is carried out by felling and post-adjustment.

In new facilities but also at existing surface treatment plants, it is possible to close the surface treatment process. This is done by installing one or more evaporators.

<i>Name of the technique</i>	Closed process
Description of the technique	Closed surface treatment plant. No discharge to water from the plant.
Technical description	The incoming process water from the surface treatment plant is pH adjusted with sodium hydroxide and sulfuric acid. The process water is then fed to one or more evaporator system. In connection with the purification process, metals and salts are separated from the aqueous phase which is returned to production. The purification may in some cases be supplemented with reverse osmosis and ion exchange.
Achieved environmental benefits	The plant has no discharge into water. The purified water can be returned to the process.
Environmental performance with regards to hazardous substances and operational data	The raw material and chemical consumption can be reduced. The use of chemicals in the waste treatment plant can be significantly reduced up to 80%. Hazardous chemicals end up in the waste by purifying the water with evaporators. No pollution of surface and groundwater contaminants. Recycling of metals (e.g. Ni) in the sludge. This can be done at another facility.
Cross-media effects	Energy consumption is increased compared to conventional plant. Closing the plant so that no process water is released requires more energy than traditional purification technology. Equipment such as evaporators, filters and ion exchangers increase energy consumption.
Technical consideration relevant to applicability	The technology gives higher energy consumption and more transport. No release of hazardous chemicals into water. The technology also requires fewer working hours for the operation of the plant (surface treatment plant).
Economics	Increased energy demand. The cost of process chemicals is significantly reduced. Less need for personnel to operate the plant and costs for analysis. The energy consumption for purifying water with a conventional water treatment plant is between 1-5

	<p>kWh / ton of purified water. For evaporators it is between 8–50 kWh / ton of purified water. Operational costs (including chemicals) and waste disposal costs are high for conventional water-purification technology. This means that the total cost can be lower when using evaporators.</p>
Driving force for implementation	<p>Requirements in permit decisions. Requirements for reduced load on recipient. Reduced use of chemicals and recycling of metals is possible.</p>
Example plant	<p>Several facilities in Sweden. Both new and existing facilities.</p>
Reference literature	<p>DEA – an aid for identification of BAT in the inorganic surface treatment industry, TemaNord 2002:525</p>

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. 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 ⁷⁹
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

⁷⁹ 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 ⁷⁹
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 contains links to hazard and risk analyses and national and regional classifications. Information on exposure and use of the substances is also available.	English		PA, AA

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps ⁷⁹
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	
<i>EUSES European Union System for the Evaluation of Substances</i>	https://ec.europa.eu/jrc/sites/jrcsh/files/EUSES_2.1.2_installation_and_docs.zip https://ec.europa.eu/jrc/en/scientific-tool/european-union-system-evaluation-substances	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.	Various		AA

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps ⁷⁹
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 MSDS 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

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps ⁷⁹
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 Federal states in Germany (GDL):	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 (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.	German		AA, M, R
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

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps ⁷⁹
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		PA, AA

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps ⁷⁹
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 authorisation list, REACH restricted substance list, CLP and possible other regulations like for biocides.	Norwegian		PA, AA, R
<i>OECD Substitution and Alternatives Assessment Tool Selector</i>	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
Other tools					

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps ⁷⁹
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

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps ⁷⁹
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

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps ⁷⁹
Stoffenmanager	https://gestis.stoffenmanager.com	Developed by TNO (Netherlands, ArboUnie 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 and external stakeholders, thus helping them to comply with the regulatory and broader ethical and sustainability requirements.	German, English	General comment: Paid and free version	PA
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

Name of source	Address/location	Description	Languages	Sector specific scope	Relevant Permitting Steps ⁷⁹
PubChem	https://pubchem.ncbi.nlm.nih.gov/	<p>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.</p>	English		

Annex 3 – Safety Data Sheets – Good examples

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 MSDS is provided in the ECHA “[Guide on Safety data sheets and Exposure scenarios](#)”.

MSDS Section	Explanation and Recommendations for Use
Section 1 – Identification	
1.1 Product Identifier Trade Name: [...] Product No: [...]	<p>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.</p> <p>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</p>
1.2 Relevant identified uses of the substance or mixture and uses advised against Use of the substance/mixture: <ul style="list-style-type: none"> • textile auxiliaries • Detergents and cleaning agents 	<p>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.</p> <p>Where applicable the uses which the supplier advises against and the reasons why shall be stated (Example: Do not use for injecting and spraying</p>

	<p>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</p>
<p>Section 2 – Possible Hazards</p>	
<p>2.1 Classification of the substance or mixture: Classification (REGULATION (EC) No 1272/2008): Irritant effect on the skin, category 2</p> <ul style="list-style-type: none"> • H315: Causes skin irritation. <p>Severe eye damage, Category 1</p> <ul style="list-style-type: none"> • H318: Causes severe eye damage. <p>Long-term (chronic) water hazard, category 3</p> <ul style="list-style-type: none"> • H412: Harmful to aquatic organisms, having long term effects. 	<p>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 MSDS.</p> <p>The classification provided here should be consistent with the information provided in the MSDS 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.</p>
<p>2.2 Labelling elements Labelling (Regulation (EC) No 1272/2008): Hazard pictograms</p>  <p>Signal word</p> <ul style="list-style-type: none"> • Danger <p>Hazard Statements</p> <ul style="list-style-type: none"> • H315 Causes skin irritation 	<p>This section of the MSDS should show how the substance or mixture should be labelled. For both substances and mixtures the label elements is to be indicated according to the CLP Regulation.</p> <p>If a substance on its own or in a mixture is subject to REACH authorisation, the authorisation 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 MSDS Section 15.</p> <p>The label elements indicated here need to correspond to those on the product (container, packaging).</p>

<ul style="list-style-type: none"> • H318 Causes severe eye damage • H412 Harmful to aquatic organisms, with long-term effects <p>Safety instructions – Prevention:</p> <ul style="list-style-type: none"> • P264 Wash skin thoroughly after use. • P273 Avoid release into the environment. • P280 Wear protective gloves/ eye/ face protection. <p>Safety instructions – Reaction:</p> <ul style="list-style-type: none"> • 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. <p>Safety instructions – Disposal:</p> <ul style="list-style-type: none"> • P501 Contents/ container to be disposed of in an approved waste disposal facility <p>Hazard-determining component(s) for labelling:</p> <ul style="list-style-type: none"> • Isotridecanoethoxylate • Alcohols, C12-15 branched and linear, ethoxylatedpropoxylated • 2-[2-(2-Butoxyethoxy)ethoxy]ethanol • Acrylic acid polyethylene-polypropylene glycol monoallyl ether copolymer 	
<p>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).</p>	<p>In case the substance is a PBT or vPvB, this needs to be indicated in form of a statement here.</p>
<p>Section 3 – Composition/Information on Components</p>	
<p>3.2 Mixtures Chemical characterization:</p>	<p>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</p>

<ul style="list-style-type: none"> Mixture of fatty alcohol alkoxyates 				<p>the chemical is a mixture, the information is in Section 3.2, usually in form of a table.</p> <p>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</p> <ul style="list-style-type: none"> ○ contribute to the overall hazard classification; or ○ are present at concentrations above certain levels of concern; or ○ have occupational exposure limits. <p>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%.</p> <p>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.</p> <p>Chemical suppliers may like to withhold exact substance name and exact concentration or concentration ranges in this section 3 claiming this confidential business information. In the EU, this requires with prior approval according to CLP, article 4.</p>	
Hazardous components	Substance name	CAS-No. EG-No. Registration number	Classification		Concentration (% w/w)
	Isotridecanoethoxylat	69011-36-5 Polymer	Eye Dam. 1; H318 Aquatic Chronic 3; H412	$\geq 20 - < 25$	
	Alkohole, C12-15-verzweigt und linear, ethoxyliertpropoxyliert	120313-48-6 Polymer	Skin Irrit. 2; H315 Eye Dam. 1; H318 Aquatic Acute 1; H400 Aquatic Chronic 3; H412	$\geq 10 - < 20$	
	2-[2-(2-Butoxyethoxy)ethoxy]ethanol	143-22-6 205-592-6 01- 2119475107- 38	Eye Dam. 1; H318	$\geq 3 - < 10$	
	Isotridecanoethoxylat	69011-36-5 Polymer	Eye Irrit. 2; H319	$\geq 2,5 - < 10$	

Acrylsäure-Polyethylen-Polypropylenglykolmonoallylether Copolymer	205327-92-0 Polymer	Aquatic Chronic 3; H412 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

Section 9 – Physical and chemical properties	
<p>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) Concentration: 100 g/l Melting point / Melting range: No data available</p>	<p>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 MSDS section is relates to further characteristics as described in MSDS section 10 (stability and reactivity). The latter section informs about the stability of the substance or mixture, hazardous reactions that</p>

<p>Boiling point / Boiling range: No data available Ignition point: 100°C Evaporation speed: Not applicable</p> <p>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)</p> <p>Solubility(s)</p> <p>Water solubility: miscible</p> <p>Distribution coefficient: n-octane/water – Not applicable</p> <p>Viscosity</p> <p>Viscosity, dynamic</p> <ul style="list-style-type: none">• 90–150 mPa.s (20°C)• Brookfield LVT• 50 rpm• Spindle 2 <p>Oxidizing properties: Not applicable</p>	<p>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”)</p>
<p>9.2 Other disclosures Conductivity: not determined Spontaneous ignition: not self-igniting</p>	

Section 11 – Toxicological information	
<p><u>11.1 Information on toxicological effects</u></p> <p>Acute toxicity Product:</p> <p>Acute oral toxicity:</p> <ul style="list-style-type: none"> • LD50 (rat): > 2 000 mg/kg • conclusion by analogy <p>Acute inhalative toxicity:</p> <ul style="list-style-type: none"> • On the basis of the available data, the classification criteria are not met. <p>Acute dermal toxicity:</p> <ul style="list-style-type: none"> • On the basis of the available data, the classification criteria are not met. <p>Ingredients:</p> <p>Isotridecanoethoxylate:</p> <p>Acute oral toxicity:</p> <ul style="list-style-type: none"> • LD50 (rat): > 5 000 mg/kg • literature value <p>Acute dermal toxicity:</p> <ul style="list-style-type: none"> • LD50 (rat): > 2 000 mg/kg • Method: OECD test guideline 402 • literature value <p>Alcohols, C12-15 branched and linear, ethoxylatedpropoxylated:</p> <p>Acute oral toxicity:</p> <ul style="list-style-type: none"> • LD50 (rat): > 2 000 mg/kg • conclusion by analogy <p>2-[2-(2-Butoxyethoxy)ethoxy]ethanol:</p> <p>Acute oral toxicity:</p> <ul style="list-style-type: none"> • LD50 (rat): 5 170 mg/kg <p>Acute dermal toxicity:</p>	<p>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.</p> <p>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.</p> <p>Accordingly, this MSDS section should provide following information for the substance and/or components as identified in SMDS section 3.2:</p> <ul style="list-style-type: none"> ○ Relevant health hazards and corresponding toxicological data ○ Likely routes of exposure ○ Potential adverse health effects that may occur upon exposure ○ Delayed and immediate effects, due to both short-term and long-term exposure ○ Numerical measures of toxicity ○ Relevant interactions with other substances ○ Information about other adverse health effects that do not fall into GHS classification <p>With regard to the health hazard references should cover at least</p> <ul style="list-style-type: none"> ○ Acute toxicity ○ Skin corrosion/irritation ○ Serious eye damage/irritation ○ Respiratory and skin sensitization ○ Germ cell mutagenicity ○ Carcinogenicity

<ul style="list-style-type: none">• LD50 (rabbit): 3 480 mg/kg• Isotridecanoethoxylate: <p>Acute oral toxicity:</p> <ul style="list-style-type: none">• LD50 (rat): > 5 000 mg/kg• Method: OECD test guideline 401• literature value <p>Acute dermal toxicity:</p> <ul style="list-style-type: none">• LD50 (rat): > 5 000 mg/kg• literature value <p>2-(2-Butoxyethoxy)ethanol:</p> <p>Acute oral toxicity:</p> <ul style="list-style-type: none">• LD50 (rat): > 2 000 mg/kg• Method: OECD test guideline 401 <p>Acute dermal toxicity:</p> <ul style="list-style-type: none">• LD50 (rabbit): > 2 000 mg/kg• Method: OECD test guideline 402 <p>Etching/irritant effect on the skin</p> <ul style="list-style-type: none">• [...] <p>Eye damage/irritation</p> <ul style="list-style-type: none">• [...] <p>Sensitization of the respiratory tract/skin</p> <ul style="list-style-type: none">• [...] <p>Germ cell mutagenicity</p> <ul style="list-style-type: none">• [...] <p>Carcinogenicity</p> <ul style="list-style-type: none">• [...] <p>Reproductive toxicity</p> <ul style="list-style-type: none">• [...] <p>Specific target organ toxicity at single exposure</p>	<ul style="list-style-type: none">○ Reproductive toxicity○ Single target organ toxicity/single exposure○ Single target organ toxicity/repeated exposure○ Aspiration hazards <p>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.</p> <p>It is important to make sure that results as well as testing guidelines applied are clearly indicated.</p>
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<ul style="list-style-type: none"> • [...] <p>Specific target organ toxicity for repeated exposure</p> <ul style="list-style-type: none"> • [...] <p>Aspiration toxicity</p> <ul style="list-style-type: none"> • [...] 	
<p>Section 12 – Environmental disclosures</p>	
<p>12.1 Toxicity</p> <p><u>Product:</u></p> <p>Toxicity to fish:</p> <ul style="list-style-type: none"> • No data available for the product itself. <p>Toxicity to daphnia and other aquatic invertebrates:</p> <ul style="list-style-type: none"> • EC50 (Daphnia magna (large water flea)): 5,8 mg/l • exposure time: 48 h • Method: OECD test guideline 202 <p>Toxicity to algae:</p> <ul style="list-style-type: none"> • No data available for the product itself. <p>Toxicity to microorganisms:</p> <ul style="list-style-type: none"> • EC50 (activated sludge): > 1 000 mg/l • exposure time: 3 h • Method: OECD test guideline 209 <p><u>Ingredients:</u></p> <p>Isotridecanoethoxylate:</p> <p>Toxicity to fish:</p> <ul style="list-style-type: none"> • LC50 (Oncorhynchus mykiss (rainbow trout)): > 1 – 10 mg/l • exposure time: 96 h 	<p>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?).</p> <p>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.</p> <p>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.</p> <p>This MSDS 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 testresults. 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.</p> <p>The eco-toxicological test data for aquatic organisms used to determine GHS classifications should be provided, such as</p>

<ul style="list-style-type: none">• (Classified according to CESIO recommendations) <p>Toxicity to daphnia and other aquatic invertebrates:</p> <ul style="list-style-type: none">• EC50 (Daphnia magna (Great Water Flea)): > 1 – 10 mg/l• exposure time: 48 h• (Classified according to CESIO recommendations) <p>Toxicity to algae:</p> <ul style="list-style-type: none">• 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) <p>Toxicity to microorganisms:</p> <ul style="list-style-type: none">• EC50 (activated sludge): > 1 000 mg/l• exposure time: 16 h• Method: DIN 38412, part 8• conclusion by analogy <p>Toxicity to daphnia and other aquatic invertebrates (chronic toxicity):</p> <ul style="list-style-type: none">• NOEC: 1 mg/l• Species: Daphnia magna (Great Water Flea)• literature value <p>Assessment of ecotoxicity</p> <p>Long-term (chronic) water endangering:</p> <ul style="list-style-type: none">• Harmful to aquatic organisms with long-term effects (classified according to CESIO recommendations). <p>Alcohols, C12-15 branched and linear, ethoxylatedpropoxylated:</p> <ul style="list-style-type: none">• [...] <p>2-[2-(2-Butoxyethoxy)ethoxy]ethanol:</p>	<ul style="list-style-type: none">○ 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, effect concentration of growth rate concentration (ErC50), chronic No Observed Effect Level (NOEC) or Effective Concentration (ECx) <p>Important details to include throughout this section include species, media, test duration and test conditions.</p> <p>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.</p> <p>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.</p> <p>Any information that indicates possible impact on WWTPs, like degradability and inhibitory effects on microorganisms, should be mentioned.</p>
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<ul style="list-style-type: none"> • [...] <p>Isotridecanoethoxylate:</p> <ul style="list-style-type: none"> • [...] <p><u>2-(2-Butoxyethoxy)ethanol:</u></p> <ul style="list-style-type: none"> • [...] 	
<p>12.2 Persistence and degradability</p> <p><u>Product:</u></p> <p>Biodegradability:</p> <ul style="list-style-type: none"> • Type of test: DOC-CO2 measurement • Biological degradation: 68%. • Method: OECD 302 B with CO2 (mineralisation) <ul style="list-style-type: none"> • 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. <ul style="list-style-type: none"> • 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 	<p>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.</p> <p>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.</p> <p>For example, common methods for determining the biodegradability include OECD 301 A-F (Ready biodegradability), OECD 302 A-C (inherent biodegradability).</p> <p>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).</p>

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:

Isotridecanoethoxylate:

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, ethoxylatedpropoxylated:

Biodegradability:

<ul style="list-style-type: none"> • Type of test: CO2 measurement • Result: Easily biodegradable • Biological degradation: > 60% • exposure time: 28 d • Method: OECD 301 B (mineralisation) • conclusion by analogy <p>2-[2-(2-Butoxyethoxy)ethoxy]ethanol:</p> <ul style="list-style-type: none"> • [...] <p>Isotridecanoethoxylate:</p> <ul style="list-style-type: none"> • [...] <p>2-(2-Butoxyethoxy)ethanol:</p> <ul style="list-style-type: none"> • [...] 	
<p>12.3 Bioaccumulation potential</p> <p><u>Product:</u> Bioaccumulation:</p> <ul style="list-style-type: none"> • There is no data available for the product itself. <p>Distribution coefficient: n-octanol/water:</p> <ul style="list-style-type: none"> • Not applicable <p><u>Ingredients:</u></p> <p>2-(2-Butoxyethoxy)ethanol:</p> <ul style="list-style-type: none"> • Coefficient of partition: n-octane/water: • log Pow: 1 (20°C) • pH value: 7 • Method: OECD 117 	<p>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</p> <p>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.</p> <p>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)).</p> <p>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.</p>

	<p>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).</p> <p>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.</p> <p>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 MSDS.</p>
<p>12.4 Mobility in the ground or soil <u>Product:</u></p> <p>Mobility:</p> <ul style="list-style-type: none"> No data available 	<p>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.</p> <p>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.</p> <p>It is important that the testing guideline (e.g. OECD 106 or OECD 121) is indicate as well.</p>
<p>12.5 Results of the PBT and vPvB assessment <u>Product:</u></p> <p>Rating:</p>	

<ul style="list-style-type: none">• 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).	
<p>12.6 Other adverse effects</p> <p><u>Product:</u></p> <p>Adsorb. org. bound halogen (AOX):</p> <ul style="list-style-type: none">• Due to the fact that it does not contain organically bound halogens, this product cannot contribute to the AOX contamination of waste water. <p>Other ecological information:</p> <ul style="list-style-type: none">• According to our current state of knowledge, the product does not contain any heavy metals or compounds of the EC Directive 2000/60/EC.	

Annex 4 – Level of BAT application in the HAZBREF case studies

1. Introduction

In this annex current practices of implementation of BATs according to STM Reference document (STM BREF, 2006) are presented. The overview of the sector was performed in this regard for selected case studies in Poland, Finland, Germany and Estonia. Moreover, a review of a dozen integrated permits and general overview was carried out for STM sector in Poland. This annex refers to the main BATs related to management of hazardous substances. The outstanding performance of some of the installations was the basis to formulate BAT candidate proposals as presented in Annex 1 and Chapter 4. Considering the current STM BREF document, implementation of generic and process specific BATs in the case study installations are considered.

IED installations in STM sector in the period of the STM BREF (2006) implementation evolved certain technological standards related to management of hazardous substances. These are related to the key issues of hazardous substances management in this sector:

- Chemical management systems
- Accident prevention and control
- Selection of processes and raw materials
- Minimising the use of water and other raw materials
- Minimising and safe management of hazardous wastes
- Emissions to sewer and controlled waters
- Reducing air emissions

The identified in HAZBREF case studies technical and organisational solutions can be promoted as up to date good practices in the management of hazardous substances. They are proved from technical point of view, feasible economically and allows the companies to meet the environmental quality standards imposed by regulations. Nevertheless, there are opportunities for further improvement, especially in the area of chemical management and in some process specific techniques.

2. Generic BATS implemented in the STM companies

In the STM BREF (2006) generic BATs are formulated in the section 5.1. Some of them are related to management of hazardous substances. Overview of their application in the context of the proposed in HAZBREF project Chemical Management System is presented in this chapter.

In particular, with regard to the implementation of advanced techniques, chemical related BATs may require a higher level of operational expertise or changes throughout the process line. In this case they must be considered as an integrated system of techniques.

In addition, the establishment and use of a central database as fundamental tool for systematic chemicals management in each facility is critical to the availability and completeness of the information required for responsible chemical management.

One of the main objectives of chemical-related BAT is the complete substitution of hazardous substances by less hazardous substances. This includes, for example, substitution in favour of chemicals that are easier to abate, have a lower toxicity for workers, are easily biodegradable and are not bio-accumulative. Before substituting chemicals, it is crucial to be aware of what exactly is introduced in the process.

Management of chemicals

BAT to implement and adhere to environmental and other management systems (STM BREF, 2006).

Variations in scale of business activities, production profile, market conditions, clients demand define limitations and opportunities for environmental management. Management systems play important role with regard to hazardous substances, especially in companies in the aviation and automobile sectors operating in complex value chains. These aspects are and had to be considered by the operators.

Management systems

The sector has a significant number of small to medium enterprises (SMEs), with limited technical resources. Hence, management systems are a critical issue, particularly written procedures, training and maintenance. It is recommended (STM BREF Chapter 5.1.1.1 Environmental management) to have an Environmental Management System (EMS) in place, preferably with external certification. Management of the operations must be established with full recognition of the requirements and opportunities in the value chain including vendors delivering of the chemicals clients and auxiliary services such like: cleaning operations, waste collection and treatment and final waste water treatment.

Benchmarking

Benchmarking is one of the BATs (STM BREF Chapter 5.1.1.4 Benchmarking the installation). The operators of the case installations provide information on total area of coated products or as a breakdown to particular processes. The estimations are based usually on expert judgement as there are many factors (thickness of the coated/plated layer, geometry of the elements) and might be perceived as cumbersome. Nevertheless, using these data, efficiency of using of hazardous substances can be estimated as well as impacts on external waste water treatment facility.

Storage of chemicals

For the storage of chemicals, the installations refer to the instructions outlined in the material safety data sheets (MSDS) as well as to the recommendations provided by the chemical suppliers (e.g. storage conditions, storage climate control, placement by storage classes according to compatibility). Furthermore, provisions are made to avoid spillage of chemicals such as use of work instructions, secondary containments and catchment facilities. In addition, provisions for spillage control (spill kits with suitable absorption material) are in place to react to and effectively clean up spillages and leakage.

The surveyed companies record their respective inputs and outputs by documenting the recipes. It was found that, depending on the company, this was carried out either fully electronically or manually.

With regard to chemical related data management, the installations collect and refer to the MSDS as well as technical data sheets as provided by their suppliers. According to representatives of the installations, the MSDS constitute the key source of information and reference, from which relevant data can be extracted when required.

Technical data sheets were mentioned as an additional source of information. Use of extended safety data sheets and/or exposure scenarios were not indicated by any of the case study installations.

The operators have implemented procedures according to legal requirements and quality standards ISO 14000, ISO 9000 and STM BREF (Chapter 5.1.2.1 Storage of chemicals and workpieces/substrates). Chemicals are stored separately in 3 up to 5 different storerooms equipped according to the specifics of the stored chemicals. The cyanide compounds, acid and bases and plating agents with toxic properties like chromium VI are stored separately. Rooms are equipped with drainage and linked to specific waste water treatment lines or are equipped with sump and equipment for pumping of the spills to safe containers. Health protection measures are applied especially in the cases of cyanide and toxic materials. Effective ventilation in the storerooms is secured. According to management standards the operators provide procedures for spills and accidents and occupational safety and health transport procedures. Treatment vats are equipped with drainage connected to appropriate waste water treatment lines (e.g. chromium, cyanide). In certain cases, vats are equipped (chromating process) with double walls.

Handling of chemicals

In the STM sector the operators usually prepare mixtures based on basic substances and own recipes or use ready to use mixtures. In the case of the ready to use mixtures the operator should, according to management standards oblige the requirements for the use put up in the Technical Data Sheets (TDS)⁸⁰. In cases of strict management systems, the in-house recipes and TDS should meet quality defined by the clients. This concerns especially aviation and automobile sectors and specifications ISO 14000, ISO 9000.

Chemicals inventory

The selected installations are maintaining different types of chemical inventory systems. With regard to chemical related data management, the installations collect and refer to the MSDS as well as technical data sheets as provided by their suppliers. According to representatives of the installations, the MSDS constitute the key source of information and reference, from which relevant data is being extracted when required. Technical data sheets were mentioned as an additional source of information. Use of extended safety data sheets and/or exposure scenarios were not indicated by any of the case study installations.

⁸⁰ 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.

The selected installations are maintaining different types of chemical inventory systems. The establishment and use of an enhanced chemical inventory system which could serve as a structured knowledge information system (in line with the format recommended in HAZBREF project BAT recommendation (See BAT 1 “Chemicals Inventorying”) were not commonly found. Making such information available in a more structured format would allow for a better involvement of various in-house parties into an integrated chemical management process. This could be easily done in form of an in-house electronic database, with corresponding search filters (e.g. from waste water, compliance, safety & health, purchasing perspectives)

Systematic selection & use of chemicals

BAT is to test for any possible impact on the waste water treatment system and resolve potential problems (STM BREF, 2006).

The installation operators in Poland indicated that they are frequently seeking support by external service providers or online tools such as those provided by ECHA. According to the contact persons of the installations concerned, however, no STM-specific tools are used. REACH lists were indicated as being of high relevance to them. They are aware of the consequences of using hazardous substances on their technical systems and the quality of products and potential environmental liabilities related to legal requirements imposed by the Integrated Permit and other legal settings. Usually before implementing new substances/mixtures/baths review of the substance characteristics, technical testing is carried out by the operators and the potential impact on the system is assessed (STM BREF 2006, Chapter 5.1.8.2 Testing, identification and separation of problematic flows)

Testing of the new chemicals is required due to quality management reasons (clients requirements). In cases where the operators prefer preparation of baths according to their own recipes, they use Safety Data Sheets, other source of technical information and internal expertise. In case of using ready to use baths the strict requirements specified in TDS are observed.

Management of waste water streams and recovery of chemicals

BAT includes prevention, separation of the waste water flow types, maximising internal recycling and applying adequate treatment for each final flow (STM BREF, 2006).

Separate collection and pretreatment of waste water streams are used in the case companies. It concerns especially companies with a wide portfolio of products and processes offered to clients. In principle the following waste water streams are segregated and separately pretreated: acids and bases, cyanide, chromic, Zinc-Nickel and anodizing waste waters. This allows in the most advanced applications to design closed systems with water recovery and efficient management of post treatment wastes. Moreover, systems collecting air from specific processes are also separated and the waste water from wet air scrubbers is linked to corresponding waste water lines (waste water from chromic air scrubber to chromic waste water treatment). The implementation of enhanced maintenance practices with regard to pipework, valves and pumps can contribute to a reduction of water demand and

chemical wastage. This in turn also reduces the quantity of waste water generated and treatment costs incurred.

In some cases, the rinse flow for a specific process in a production line can be reduced until the materials loop is closed: this is BAT for precious metals, hexavalent chromium and cadmium.

The results of the case studies show that the separate collection and treatment of waste water streams for the systematic recycling and reuse of water and chemicals is not yet widespread and, when applied, is mainly used in the context of water recovery and reuse. Operators pre-treat separately waste water streams from technological processes: cyan water, acid and alkali waters, Zinc plating, chromating and anodising using dedicated pretreatment techniques. Operators to some extent manage separately rinsing waters inflowing in large quantities with relatively low content of contaminants and spent baths utilised in low quantities but of high concentrations. Rinsing waters are neutralised continuously. Spent baths are treated as hazardous liquid wastes or neutralised together with rinsing waters in favourable operational conditions. This gives some flexibility with regard to economy and environmental protection.

More complex separation systems produce more diversified waste materials. One installation has adopted complex waste water treatment solutions allowing for generating liquid wastes in a separated manner with hazardous and non-hazardous wastes. Non-hazardous wastes in this case are reused in other sectors. It is a widespread approach in the installations to treat spent baths in pretreatment units. The common approach is also to use neutralisation unit treating the inflowing pretreated waste waters, where the main waste produced is dewatered waste water sludge. This sludge has to be treated as hazardous waste. The waste water treatment systems are usually operated (monitored and controlled) with application of automatic tools.

Efficiency of raw materials usage

BAT to minimise material losses by retaining raw materials in process vats and at the same time minimise water use (STM BREF, 2006)

All operators apply techniques and strategies to rise the efficiency of materials use through bath maintenance: baths regeneration, application of covers, drag in, drag out reducing techniques, use of recovery and spray rinsing baths and application of control measures (quality of bath, replenishment of water). This can essentially reduce the need for use of hazardous substances.

Efficiency of using of the materials is achieved also by organizing production lines (space and time) with appropriate treatments vats, recovery and rinsing tubs. Regeneration of baths is performed in stationary/automatic units or in mobile systems operated manually. One of the examples of techniques that can be applied is to use of the same chemicals in pretreatment and plating.

Organisation and management of production

BAT is to protect the environment, particularly soil and groundwaters, by using simple risk management to design, construct and operate an installation, together with techniques described in STM BREF (2006)

Operators of the case studies take measures preventing contamination of soil and groundwater. In prevention of spills training of workers is one of the key measures. Toolkits for removal of small spills are provided. For larger accidents appropriate infrastructure is developed. Risk is managed through organisation of infrastructure and technical lines in terms of time and space facilitating proper management of spills and accidents. Appropriate sections of the production hall (containing modular process lines) are connected with relevant waste water treatment lines or to buffer tanks from which the spills can be pumped for disposal. Measures preventing spills and accidents are also applied with regard to storage and handling of chemicals. In best cases the storage facilities are connected to waste water treatment or waste management units. Another important aspect is monitoring of treatment processes and the quality of discharges.

Another important measure observed in the case installations is appropriate designing/organising of technological lines with plating baths lined with rinsing baths, stationery and recovery baths and establishing of control rules (STM BREF, 2006, Chapter 5.1.2 Installation design, construction and operation). If several different processes are planned in one room and each of them has washers, they are positioned in such a way as to be able to use the same rinsing baths for different processes, e.g. one washer for cyanide processes (copper and cyanide cadmium plating), not two to each separately. The same goes for degreasing, etching, activating the surface before electroplating. With respect to STM BREF, 2006; Chapter 5.1.12 Groundwater protection and site decommissioning: the spillages in the installations are directed to an appropriate waste water tank, the floor in the electroplating building is equipped with waste water grates connected to pipelines that will discharge possible spills of the bath to the neutralizer.

Systemic inventory and management of hazardous wastes

Other BAT techniques to aid recycling and recovery are to identify potential waste streams for segregation and treatment (STM BREF, 2006).

STM installations produce high amounts of wastes. Operators are trying to optimise generation, treatment of wastes with respect to materials and processes used and economic opportunities for treatment and recovery of materials from wastes.

In Integrated Permit operators provide characteristics of the waste streams (waste code, amount per year, way of utilisation). Wastes are categorised according to Waste Catalogue. Wastes are rarely characterised with respect to their content, especially if the production profile varies substantially. Classification is done on expert basis, legal definitions and supporting interpretation. The operators in the case studies make trials to seek opportunities to reuse the materials or recover them from wastes internally and externally. Simple examples are neutralising mutually acids and bases and use of spent baths for example in auxiliary processes.

The main stream of wastes generated in the STM installation is related to waste water treatment. In many cases where a simplified approach to waste water treatment is used non-specific dewatered sludges are generated.

3. Process-specific BATs in use in installations

It is a general BAT to use less hazardous substances. Use of chemicals is the essence of surface treatment. Lesser use of hazardous chemicals can be achieved mainly through substitution and improvement of technologies. (STM BREF, 2006, Chapter 5.2.5 Substitution for, and/or control of hazardous substances). This can be also achieved through better management of chemicals and better maintenance of baths (regeneration). Substitution of the substance is connected in many cases with direct changes in the technological processes.

Substitution for, and/or control of, hazardous substances

- replacing of chromium VI with chromium III
- use of fluorinated compounds other than PFOS
- use of non-hazardous surfactants instead of nonylphenol

It is BAT to substitute for EDTA by biodegradable alternatives or to use alternative techniques. Where EDTA has to be used, it is BAT to minimise its loss and treat any remaining amount in waste waters. In the case installations EDTA is either substituted or used in closed systems. For substitution ethylenodiamine and other amine compounds are used. EDTA is used in certain applications but in one of the cases a closed waste water system is applied.

For PFOS, it is BAT to minimise its use by controlling additions, minimising fumes which has to be controlled by techniques including floating surface insulation sections. However, occupational health may be an important factor. It can be phased out in anodising and there are also alternative processes to hexavalent chromium and alkali cyanide-free zinc plating. PFOS is not used in the cases studies.

Examples of process substitution related BATs in case installations

- Replacing of cyanide cadmium plating with zinc/nickel plating
- Replacement of anodizing in chromic acid with zinc-nickel coatings
- Anodizing of steel in sulphuric tartaric acid
- Passivation based on chromium (VI) and bathing in chromates replaced with other, more environmentally friendly processes such as passivation in hot water or in chromates (III)
- Replacement of cyanide cadmium plating with zinc and nickel plating in tartaric acid
- Chromium plating can be replaced with PVD (Physical Vapor Deposition) to some extent – PVD is outside of the STM BREF

It is not possible to replace cyanide in all applications, but cyanide degreasing is not BAT according to STM BREF (2006). The BAT substitutes for zinc cyanide are acid or alkali cyanide free zinc, and for cyanide copper, acid or pyrophosphate options, with some exceptions. Cyanide is still used in the cases studies but according to the operators their use is in decline.

Hexavalent chromium cannot be replaced in hard chromium plating in certain applications. BAT for decorative plating is trivalent chromium or alternative processes such as tin-cobalt, however, at an installation level there may be

specification reasons such as wear resistance or colour that require hexavalent chromium processing.

Where hexavalent chromium plating is used, it is BAT to reduce air emissions by techniques including covering the solution or vat, achieving closed loop for hexavalent chromium, and in new or rebuilt lines in certain situations, by enclosing the line. For hexavalent chromium in all case study installations there are applied sealed process baths with extraction of the fumes and separate waste water, air and waste collection and pre-treatment lines as integrated system containing and preventing releases of the substance.

Examples of good practices of BATs related to efficiency of material use in case installations

- Use of recovery rinsing baths in some processes, especially in those in which the hazardous substances of concern (hexavalent chromium, lead) are used
- Use of spray rinsing and cascade systems: 2–3 rinsing stationary scrubbers, in combination with final rinsing in a flow scrubber
- Proper drag out and drag in reduction methods such as: suspension system ensuring good contact of the workpieces with the galvanizing baths and efficient and fast drainage, coating of small workpieces in drums of appropriate design and perforation
- Proper construction and condition of hangers
- Use of plastic gutters between the edges of the process baths and the first washers
- Controlling of waste water discharge with flow meters
- Proper maintenance of jig lines – drag-out reduction

The analysis of the case studies shows that there are not many new specific compounds requiring special attention from general point of view. Specific problems might arise on installation level.

It is not currently possible to formulate a BAT for chromium passivation, although it is BAT to replace hexavalent chromium systems in phospho-chromium finishes with non-hexavalent chromium systems. There is a chance that passivation and rinsing in chromates will be replaced with other, more environmentally friendly processes, but it depends on customer requirements. Some of them are conducting research on changes and if safer alternatives work then they will change processes and eliminate chromium.

For degreasing, it is BAT to liaise with customers to minimise the grease or oil applied, and/or to remove excess oil by physical techniques.

Examples of BATs related to degreasing and cleaning in case installations

- Closed system for trichloroethylene and mineral oils and management of waste materials
- Use of organic surfactants derived from natural raw materials
- In-house treatment of degreasing and cleaning waste water

It is BAT to replace solvent degreasing by other techniques, usually water-based, except where these techniques can damage the substrate. If the chlorinated organic compounds are used for degreasing, they are used in closed systems (solvent vapour degreasing). According to the case studies the spent baths are treated as hazardous wastes by external companies or special units are implemented within the premises of the company plants subjected to integrated permitting for waste treatment installations.

In a case example the plant uses solvent degreasing with PER in a closed system and soaked alkaline baths.

In aqueous degreasing systems, it is BAT to reduce the amount of chemicals and energy used by using long-life systems with solution maintenance or regeneration.

Regeneration of the degreasing and cleaning baths is not used in the case installations which have diversified profile of production. In the best cases water is recovered from the water-based baths in liquid waste processing units. The companies in these cases try to minimise the environmental impacts by using benign agents, for example based on natural components. In some of the cases, operators, the process water from cleaning and degreasing treat in auxiliary units, dedicated to liquid wastes in waste water treatment installations.

It is BAT to increase process solution life, as well as preserving quality, by monitoring and maintaining solutions within established limits. Operators use a variety of techniques for regeneration of baths.

Good examples identified in the case studies important for efficient use of hazardous chemicals:

- The cyanide baths are subjected to activated carbon treatment and electrochemical treatment at low current densities using insoluble anodes
- Cyanide regeneration through freezing of carbonates
- Cadmium and nickel plating regeneration through filtration on material and activated carbon filters, carbonates freezing, electrochemical treatment at low current densities using insoluble anodes
- Nickel plating is regenerated through filtration on materials and activated carbon and on metal sheet work out
- Regeneration of acidic metal etching solutions
- Zinc-Nickel bath regeneration by freezing
- Phosphatizing baths are cleaned and regenerated with removal of carbonates and sulfates by crystallization from the solution
- Chromium plating baths are regenerated by electrochemical cleaning at low current densities using insoluble anode to remove impurities and removing sludge from the bottom
- Anodizing in sulfuric acid regeneration through filtration on fabric and activated carbon filters

For pickling on a large scale, it is BAT to extend the life of the acid by techniques including electrolysis. The acids may also be recovered externally.

It is also BAT to recover caustic etch where there is high consumption, there are no interfering additives and the surface can meet specifications.

It is not BAT to close rinse-water cycles using deionised water, because of the cross-media impacts of the regenerations. In the most advanced examples complex closed water cycles are applied. In most of the cases appropriate waste water pretreatment for separated streams is in place.

Examples of BAT and of pipe techniques in the case installations

- Separation of waste water streams depending on the installation production profile i.e. 4 separate lines: automatic or manually controlled linked to dedicated specific pretreatment processes
- Applied methods of waste water minimization, using neutralizer with pretreatment processes of separate waste water streams (three, four depending on technical processes).
- Neutralisation of spent baths in the waste water treatment, in case that there is no opportunity for recovery of metals or bath regeneration and with respect to neutralization process (high level of process maintenance)
- Integration of waste water streams with waste water from air emission wet scrubbers and from bath stands and storage areas
- Systemic control of waste water treatment processes, use of double tanks of each of the separate streams to abate risks of failure
- Technology of closing water cycle implementation in case there are appropriate conditions

Air emission reduction BATs comprise collection of the vapours from above the working baths and their treatment in abatement installations. The applied measures reduce emissions of metals and organic compounds. Currently, applied air emission abatement system reduces essentially emissions of hazardous substances to a level at least of recommended values (STM BREF, 2006).

Air emission reduction related BATs in the case installations

- Agitation of process solutions based on low pressure with compressed air system
- Energy and water: application of bathtub covers to reduce evaporation from baths in some processes, using of energy saving utilities like-pressure blowers, operation of baths in the lower limits of the recommended temperature ranges, maintain of temperature of the process solutions in some of the baths by the use of electric heaters.
- Air emissions, use of wet scrubbers for reducing the emissions

Waste management

Wastes are produced in the sector in high quantities including waste from waste water treatment, spent baths and waste from auxiliary processes (i.e. degreasing). They contain hazardous substances: metals and organic compounds, and depending on the content, are classified as hazardous and non-hazardous. The opportunity for waste recycling/recovery of metals depends highly on an installation production profile. Higher specialisation and large-scale favour the option of internal or external recovery of metals from spent baths versus diversified process on smaller scale.

Waste management related BATs in the case installations

- Waste stream separation as far as possible for technical and economic reasons, appropriate coding and external utilisation by specialized companies
- Implementation of internal techniques for neutralisation and recycling of wastes (acids and bases mutual neutralization)
- Techniques for internal recovery of metals/raw materials
- Dewatering of wastes

Monitoring

Monitoring is essential part of chemical management. The operators apply monitoring practices focused on the quality control of the processes including waste water treatment.

BATs related to hazardous substances in the case installations

- Controlling the discharge parameters (external WWTP)
- Controlling of parameters of pretreated waste water i.e. chromium 6+

Annex 5 – Examples of Information concerning substances in the permit applications⁸¹

Template 3.5

3.5 Information about substances including waste water and waste material their flows

Name of chemical substance / mixture / article	total amount (t)	Composition, content (weight %)				Calorific value (MJ/kg)	EWC code	input material reactant raw material
		Name of component	CAS-no	content (weight %)				
				Min.	Max.			
1	2	3	4	5	6	7	8	9

Name of chemical substance / mixture / article	Inter-mediate	Product / article	byproduct	waste	Waste water	Relevant concerning emissions to air	Regulated under Seveso	Hazardous substance	REACH relevant	climate impact / ozone layer depleting	hazardous to waters	ordinance on industrial safety and health	comment
1	10	11	12	13	14	15	16	17	18	19	20	21	22

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

The table below is an annex for the environmental permit application to be filled in by the applicant in Finland.⁸² 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)

Chemical list	VOCs	Chemical fate
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⁸¹ As described in [Phase 1](#) of the IMPEL Project on Linking the Directive on Industrial Emissions (IED) and the REACH Regulation. These template have been adopted in a modified form into the electronic IED-application tool [EiA](#)

⁸² https://www.ymparisto.fi/fi-fi/asiointi_luvat_ja_ymparistovaikutusten_arviointi/luvat_ilmoitukset_ja_rekisterointi/ymparistolupa/Miten_ymparistolupa_haetaan__ohjeet_ja_lomakkeet

Annex 6 – Substances of Very High Concern and Water Framework Priority Substances used in the STM sector

REACH substances of very high concern (SVHC) and WFD priority substances (PS) / priority hazardous substances (PHS) which have registered uses in STM industry in the ECHA chemical database (ECHA CHEM) and Nordic SPIN 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 CHEM separately from the REACH registration information.

Substance (SVHC / WFD substance)	CAS	Already addressed in existing BREF	Use in STM sector (ECHA CHEM /SPIN)	Found from HAZB REF case study plants	Total imported or manufactured for all uses in EU (ECHA CHEM) or for STM in Nordic countries (SPIN) ¹	“Fate” in waste water treatment plant ²	Other information
1,2-Benzenedicarboxylic acid, di-C6-10-alkyl esters SVHC	68515-51-5	No	ECHA: coating products, manufacture of plastic products Annex XV: coatings, manufacture of plastic products SPIN: adhesives, binding agents	No	ECHA: no data* SPIN (2017): 0 tons/a	not evaluated in HAZBREF	Manufacture ceased in 2018. Included in the Annex XIV of REACH (Authorisation list). This substance may still be used because there is still time to apply for

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							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-diethoxyethane SVHC	629-14-1	No	ECHA: no data Annex XV: 1,2-diethoxyethane belongs to the glyme family (polyglycol ethers) of chemicals. Glymes are powerful solvents for many polymer systems and find a role in many coating applications, including one- and two-part polyurethanes and epoxies.	No	ECHA: no data SPIN: no data	not evaluated in HAZBREF	

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			SPIN: no data				
1,2-dimethoxyethane, ethylene glycol dimethyl ether (EGDME) SVHC	110-71-4	No	ECHA: no STM related uses Annex XV: surface treatment of aluminum in order to ensure that surfaces are less reactive SPIN: surface treatment	No	ECHA: 100 – 1 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	
1,3,5-tris(oxiran-2-ylmethyl)-1,3,5-triazinane-2,4,6-trione (TGIC) SVHC	2451-62-9	No	ECHA: coating products, manufacture of machinery and vehicles Annex XV: used as a hardener in resins and coatings, in polyester powder coatings for metal finishing SPIN: paints, lacquers, manufacture of fabricated metal products	No	ECHA: 100 – 1 000 tons/a SPIN (2013): 0 tons/a, no STM related uses after 2013	not evaluated in HAZBREF	
1,3,5-tris[(2S and 2R)-2,3-epoxypropyl]-1,3,5-triazine-2,4,6-(1H,3H,5H)-trione (β -TGIC) SVHC	59653-74-6	No	ECHA: no public registered data Annex XV: β -TGIC is not used or produced as separated substance, it exists and is used only as a part of TGIC (mixture of isomers, 90% α and 10% β isomer). SPIN: no data	No	ECHA: confidential SPIN: no data	not evaluated in HAZBREF	
1,6,7,8,9,14,15,16,17,17,18,18-Dodecachloropenta	13560-89-9	No	ECHA: manufacture of plastic products, adhesives, sealants	No	ECHA: 100 – 1 000 tons/a	not evaluated in HAZBREF	May be used in metal surface

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<p>cyclo[12.2.1.16,9.0 2,13.05,10]octadeca-7,15-diene ("Dechlorane Plus"TM)</p> <p>SVHC</p>			<p>Annex XV: metal surface treatment products including galvanic and electroplating products (formulated products)</p> <p>SPIN: adhesives, binding agents</p>		<p>SPIN (2010): 0 tons/a, no use after 2010</p>		<p>treatment. Annex XV: "A broad range of uses and applications are indicated, but it is not clear how many are currently relevant."</p>
<p>1-bromopropane (n-propyl bromide)</p> <p>SVHC</p>	<p>106-94-5</p>	<p>No</p>	<p>ECHA: manufacture of plastic products, fabricated metal products</p> <p>Annex XV: no information on use*</p> <p>SPIN: surface treatment, manufacture of fabricated metal products</p>	<p>No</p>	<p>ECHA: 1 000 – 10 000 tons/a</p> <p>SPIN (2017): 0 tons/a</p>	<p>not evaluated in HAZBREF</p>	<p>*The available use and exposure information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.</p> <p>Included in the Annex XIV of</p>

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							REACH (Authorisation list).
1-methyl-2-pyrrolidone (NMP) SVHC	872-50-4	No	ECHA: coating products, metal surface treatment products, non-metal-surface treatment products Annex XV: high temperature coating, acrylic and styrene latexes, metal coatings SPIN: manufacture of rubber and plastic products, manufacture of fabricated metal products, surface treatment and coating of metals	No	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 45.6 tons/a	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	No	ECHA: coating products, manufacture of plastic products Annex XV: UV-stabilisers, coatings and paints SPIN: paints, lacquers and varnishes, manufacture of rubber and plastic products, industry for plastic products	No	ECHA: 100 – 1 000 tons/a SPIN (2017): 0.2 tons/a	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorisation list).
2,2'-dichloro-4,4'-methylenedianiline (MOCA) SVHC	101-14-4	No	ECHA: polymers and metal surface treatment products, manufacture of plastic products and machinery and vehicles	No	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 1.5 tons/a	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorisation list).

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			Annex XV: used in polyurethane coatings SPIN: manufacture of rubber and plastic products				
2-benzotriazol-2-yl-4,6-di-tert-butylphenol (UV-320) SVHC	3846-71-7	No	ECHA: no data Annex XV: UV-protection agents in coatings SPIN: manufacture of rubber and plastic products	No	ECHA: no data SPIN (2009): 0 tons/a, no use after 2009	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorisation list).
2-benzyl-2-dimethylamino-4'-morpholinobutyronone SVHC	119313-12-1	No	ECHA: coating products, manufacture of plastic products and fabricated metal products Annex XV: coatings and paints, manufacture of fabricated metal products SPIN: paints, lacquers and varnishes	No	ECHA: 100+ tons/a SPIN (2017): 9.4 tons/a	not evaluated in HAZBREF	
2-methoxyethanol (ethylene glycol monomethyl ether; EGME) SVHC	109-86-4	No	ECHA: intermediate Annex XV: wide application as a solvent, chemical intermediate and industrial processing aid in different areas, surface coating in aeronautics SPIN: surface treatment	No	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	

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2-methyl-1-(4-methylthiophenyl)-2-morpholinopropan-1-one SVHC	71868-10-5	No	ECHA: coating products, manufacturing of plastic products and fabricated metal products Annex XV: coatings and paints, thinners, manufacturing of plastic products and fabricated metal products SPIN: no STM related uses	No	ECHA: 1000+ tons/a No STM related uses in SPIN.	not evaluated in HAZBREF	
4-(1,1,3,3-tetramethylbutyl)phenol SVHC, WFD PS	140-66-9	No	ECHA: coating products Annex XV: component in coatings, paints and printing inks SPIN: adhesives, binding agents, paints, lacquers and varnishes, vulcanizing agents, manufacture of rubber and plastic products	No	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 0.2 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	No	ECHA: polymers, plastic products Annex XV: coating of plastic products SPIN: manufacturing of chemicals and chemical products, colouring agents	No	ECHA: no data* SPIN (2017): 0 tons/a	not evaluated in HAZBREF	Manufacture ceased in 2020. This substance may still be used in STM sector.

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4,4'-isopropylidenediphenol (bisphenol A; BPA) SVHC	80-05-7	No	ECHA: polymers, manufacture of plastic products Annex XV: manufacture of polymers, coatings SPIN: manufacture of fabricated metal products, basic metals, rubber and plastic products, surface treatment and coating of metals	No	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 32.9 tons/a	7.5% to surface water 6.4% to sludge 86.1% biodegradation 0% volatilization	
4,4'-oxydianiline and its salts SVHC	Not presented in ECHA database. 101-80-4 (4,4'-oxydianiline)	No	ECHA: metal surface treatment products, manufacture of plastic products and fabricated metal products Annex XV: no information on use* SPIN: no data	No	ECHA: 10 – 100 tons/a (4,4'-oxydianiline) SPIN: no data	not evaluated in HAZBREF	*The available use and exposure 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,	Not presented in ECHA database.	Nonyl and other alkyl phenyl ethoxylates	ECHA: coating products (4-nonylphenol, branched) Annex XV: metal care products, surface treatment (4-nonylphenol, ethoxylated)	No	ECHA: 1 – 10 tons/a (4-nonylphenol, ethoxylated)	p-nonylphenol (NP): 3.4% to surface water 62% to sludge	NP formed due the degradation of NPE

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WFD PHS	84852-15-3 (branched), 26027-38-3 (ethoxylated), 127087-87-0 (branched, ethoxylated)	(NP/NPEs) included in the STM BREF 2006.	SPIN: paints, lacquers and varnishes manufacture of rubber and plastic products, fabricated metal products, surface treatment		SPIN (2017): 0 tons/a	34.3% biodegradation 0.3% volatilization	Some use of the substances restricted (textiles)
4-tert-butylphenol SVHC	98-54-4	No	ECHA: coating products Annex XV: industrial application of coatings or inks, hardener (e. g. in coatings and paints, fillers, putties, thinners) SPIN: surface treatment, paints, lacquers and varnishes, manufacture of rubber and plastic products, fabricated metal products	No	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 0.4 tons/a	not evaluated in HAZBREF	
Acetic acid, lead salt, basic SVHC,	51404-69-4	Lead and acetic acids included	ECHA: coating products Annex XV: no data on use*	No	ECHA: 1 – 10 tons/a SPIN: no data	not evaluated in HAZBREF	*The available use and exposure information is

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WFD PS		in the STM BREF 2006.	SPIN: no data				provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.
Acrylamide SVHC	79-06-1	No	ECHA: manufacture of chemicals Annex XV: intermediate in the production of polyacrylamides, coatings SPIN: surface treatment, manufacture of fabricated metal products and chemicals	No	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 40 tons/a	not evaluated in HAZBREF	
Arsenic acid SVHC	7778-39-4	No	ECHA: metal surface treatment products, manufacture of metals and fabricated metal products Annex XV: production of copper foil for printed circuit boards SPIN: manufacture of basic metals	No	ECHA: 100 – 1 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	Included in the Annex XIV of REACH (Authorisation list).
Benzyl butyl phthalate (BBP)	85-68-7	No	ECHA: no data available Annex XV: dossier not found	No	ECHA: 1 – 10 tons/a	8% to surface water 42% to sludge	Annex XV dossier is not

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SVHC			SPIN: paints, lacquers and varnishes, manufacture of basic metals and fabricated metal products, treatment and coating of metals		SPIN (2017): 0.9 tons/a	50% biodegradation 0% volatilization (Simple Treat – model, ECB 2007)	available for some reason. Included in the Annex XIV of REACH (Authorisation list).
Bis (2-ethylhexyl) phthalate (DEHP) SVHC, WFD PHS	117-81-7	No	ECHA: manufacture of chemicals and plastic products Annex XV: used for paints, adhesives and pigments, to help the formation of coating of vinyl acetate emulsion paints SPIN: paints, laquers and varnishes, surface treatment and coating of metals, manufacture of plastic and rubber products	No	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 125.5 tons/a	2.6% to surface water 78.6% to sludge 18.8% biodegradation 0% volatilization	Included in the Annex XIV of REACH (Authorisation list).
Bis(pentabromophenyl ether (decabromodiphenyl ether) (DecaBDE) SVHC	1163-19-5	No	ECHA: coating products, manufacture of plastic products, rubber products and fabricated metal products Annex XV: protective coatings – used as an additive flame retardant in plastics/polymers SPIN: no STM related uses	No	ECHA: 1 000 – 10 000 tons/a SPIN: no STM related uses	6% to surface water 93% to sludge 1% biodegradation 0% volatilization (EPI model, ECB 2002)	Some uses banned, but some uses still allowed in EU. STM use is not allowed anymore.

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Boric acid SVHC	10043-35-3	No	ECHA: no STM related uses Annex XV: non-electrolytic metal coatings, metal surface treatment agents, corrosion inhibitors, rust preventive agents SPIN: surface treatment, electroplating agents, corrosion inhibitors, manufacture of fabricated metal products, basic metals, machinery and equipment, rubber and plastic products	Yes	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 180 tons/a	Not evaluated in HAZBREF	
Cadmium SVHC, WFD PHS	7440-43-9	Cadmium included in the STM BREF 2006.	ECHA: metals, metal surface treatment products, manufacture of fabricated metal products and metals Annex XV: production of battery electrodes, alloys and metal coatings in electrical, electronic, aerospace, mining, offshore, automotive and defence industries SPIN: manufacture of fabricated metal products and basic metals, surface treatment and coating of metals	Yes	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0 tons/a	19% to surface water 81% to sludge 0% biodegradation 0% volatilization (modelling + measured data; Vieno 2014)	
Cadmium chloride SVHC, WFD PHS	10108-64-2	Cadmium included in the STM	ECHA: metals, metal surface treatment products, manufacture of fabricated metal products Annex XV: not found	No	ECHA: 1 – 10 tons/a SPIN: no data	Cadmium: 19% to surface water 81% to sludge	Annex XV dossier is not available for some reason.

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		BREF 2006.	SPIN: no data			0% biodegradation 0% volatilization (modelling + measured data; Vieno 2014)	
Cadmium oxide SVHC, WFD PHS	1306-19-0	Cadmium included in the STM BREF 2006.	ECHA: metals and metal surface treatment products Annex XV: not found SPIN: manufacture of rubber and plastic products, surface treatment	Yes	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0 tons/a	Cadmium: 19% to surface water 81% to sludge 0% biodegradation 0% volatilization (modelling + measured data; Vieno 2014)	Annex XV dossier is not available for some reason.
Chromium trioxide SVHC	1333-82-0	Chromium included in the STM BREF 2006.	ECHA: metal surface treatment products and non-metal surface treatment products, manufacture of fabricated metal products and plastic products Annex XV: metal finishing (for electroplating e.g. passivation of zinc, aluminum, cadmium and brass, pickling), non-electrolytic metal coatings, surface treatment products for non-metal	Yes	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 122.6 tons/a	not evaluated in HAZBREF	Substance is included in the REACH Annex XIV (Authorisation list) which means that the use of substance is allowed only if

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			SPIN: manufacture of fabricated metal products and of basic metals, surface treatment and coating of metals, treatment and coating of metals, electroplating agents, conductive agents, corrosion inhibitors				authorisation is granted
Cobalt dichloride SVHC	7646-79-9	No	ECHA: metal surface treatment products, manufacture of chemicals and fabricated metal products Annex XV: as a metal drier in air-drying coatings, as drying agent in paints, lacquers and varnishes, electroplating processes (galvanoplasty) SPIN: manufacture of fabricated metal products, electroplating agents, corrosion inhibitors, surface treatment	No	ECHA: 1 000 – 10 000 tons/a SPIN (2012): 0 tons/a, no STM related uses after 2012	not evaluated in HAZBREF	
Cobalt (II) carbonate SVHC	513-79-1	No	ECHA: metal surface treatment products, manufacture of fabricated metal products Annex XV: production of pigments for decorating porcelains, adhesion: ground coat frit, production of other chemicals (intermediate) SPIN: surface treatment	No	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	

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Cobalt (II) diacetate SVHC	71-48-7	No	ECHA: metal surface treatment products, polymers, manufacture of fabricated metal products and plastic products Annex XV: surface treatment of metals, rubber adhesion SPIN: manufacture of fabricated metal products, surface treatment	Yes	ECHA: 100 – 1 000 tons/a SPIN (2017): 0.1 tons/a	not evaluated in HAZBREF	
Cobalt (II) dinitrate SVHC	10141-05-6	No	ECHA: metal surface treatment products, manufacture of fabricated metal products Annex XV: surface treatment (incl. formulation, passivation and plating) SPIN: manufacture of fabricated metal products, surface treatment and coating of metals, electroplating agents, corrosion inhibitors	Yes	ECHA: 100 – 1 000 tons/a SPIN (2017): 2 tons/a	not evaluated in HAZBREF	
Cobalt (II) sulphate SVHC	10124-43-3	No	ECHA: metal surface treatment products, manufacture of fabricated metal products Annex XV: surface treatments: anodizing, electrodeposition, non-electro deposition, corrosion prevention	Yes	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 1.1 tons/a	not evaluated in HAZBREF	

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			SPIN: manufacture of fabricated metal products, surface treatment and coating of metals, electroplating agents				
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)	No	ECHA: coating products, polymers, manufacture of chemicals, machinery and vehicles Annex XV: manufacture of alkyd resins, plasticizers, insect repellents, rust inhibitors and as hardener in epoxy resins SPIN: manufacture of fabricated metal products, paint and varnish, decorative protection	No	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 0.4 tons/a (HHPA)	not evaluated in HAZBREF	
Decamethylcyclotrisiloxane (D5) SVHC	541-02-6	No	ECHA: no STM related uses Annex XV: coatings, non-metal surface treatment SPIN: manufacture of rubber, plastic and fabricated metal products, treatment and coating of metals, surface treatment	No	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 4 tons/a	2.0% to surface water 74.9% to sludge 0% biodegradation 23.1% volatilization	
Diarsenic trioxide SVHC	1327-53-3	No	ECHA: metals and semiconductors, manufacture of metals Annex XV: decolorizing agent for glass and enamels, refining and oxidizing agent for manufacturing	No	ECHA: 100 – 1 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)

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			<p>special glass and lead crystal formulations and as a hydrogen recombination poison for metallurgical studies</p> <p>SPIN: manufacture of fabricated metal products, manufacture of basic metals, rubber and plastic products</p>				
<p>Diboron trioxide</p> <p>SVHC</p>	1303-86-2	No	<p>ECHA: manufacture of metals and machinery and vehicles</p> <p>Annex XV: flame retardants, fire resistant additive for paints and electronics</p> <p>SPIN: flame retardants, manufacture of basic metals and fabricated metal products</p>	No	<p>ECHA: 1 000 – 10 000 tons/a</p> <p>SPIN (2017): 242.3 tons/a</p>	not evaluated in HAZBREF	
<p>Dibutyl phthalate (DBP)</p> <p>SVHC</p>	84-74-2	No	<p>ECHA: polymers, manufacture of plastic products and fabricated metal products</p> <p>Annex XV: softener (plasticizer in PVC), softener/solvent (e.g. sealants, nitrocellulose paints, film coatings, glass fibres and cosmetics)</p> <p>SPIN: manufacture of fabricated metal products, surface treatment</p>	No	<p>ECHA: 1 000 – 10 000 tons/a</p> <p>SPIN (2017): 0.1 tons/a</p>	<p>9% to surface water 33% to sludge 58% biodegradation 0% volatilization (Simple Treat model, ECB 2003)</p>	Included in the REACH Annex XIV (Authorisation list)

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Dichromiumtris (chromate) SVHC	24613-89-6	Chromium included in the STM BREF 2006.	ECHA: metal surface treatment product Annex XV: formulation of metal treatment products, industrial surface treatment of metals- reactive anti-corrosion primer for steel and aluminum SPIN: paints, lacquers and varnishes, manufacture of fabricated metal products, surface treatment	No	ECHA: 10 – 100 tons/a SPIN: 2010: 0 tons/a, no STM related use after 2010	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)
Diisobutyl phthalate (DIBP) SVHC	84-69-5	No	ECHA: coating products, manufacture of plastic products Annex XV: e.g. plasticizer for cellulose & vinyl plastics SPIN: manufacture of rubber and plastic products, treatment and coating of metals	No	ECHA: 1 – 10 tons/a SPIN (2017): 1,9 tons/a	5.3% to surface water 9.2% to sludge 70.1% biodegradation 15.4% volatilization	Included in the REACH Annex XIV (Authorisation list)
Dinoseb (6-sec-butyl-2,4-dinitrophenol) SVHC	88-85-7	No	ECHA: coating products, manufacture of plastic products Annex XV: no data on use* SPIN: no data	No	ECHA: 1 000 – 10 000 tons/a SPIN: no data	not evaluated in HAZBREF	Also used as herbicide. *The available use and exposure information is provided in the registration

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							dossiers (authorities with access rights only) or on ECHA's dissemination website.
Disodium octaborate SVHC	12008-41-2	No	ECHA: coating products, metal surface treatment products, manufacture of fabricated metal products and metals Annex XV: paints and coatings SPIN: manufacture of fabricated metal products	No	ECHA: 1 000 – 10 000 tons/a SPIN (2001): 0 tons/a, no use after 2001	not evaluated in HAZBREF	
Disodium tetraborate, anhydrous SVHC	1330-43-4, 1303-96-4 (Borax), 12179-04-3 (pentahydrate)	No	ECHA: coating products, manufacture of fabricated metal products and metals Annex XV: metal production, metal surface refining (pentahydrate) SPIN: manufacture of fabricated metal products, rubber and plastic products, surface treatment surface treatment and coating of metals, electroplating agents (Borax)	Yes (CAS 1303-96-4 and 1330-43-4)	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 0 tons/a 23.9 tons/a (Borax) 5.6 tons/a (pentahydrate)	7.9% to surface water 0% to sludge 91.6% biodegradation 0.5% volatilization	

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			manufacture of fabricated metal products (pentahydrate)				
Dodecamethylcyclohexasiloxane (D6) SVHC	540-97-6	No	ECHA: polishes and waxes, manufacture of chemicals Annex XV: polymer production SPIN: manufacture of chemicals and chemical products, fabricated metal products, surface treatment, treatment and coating of metals	No	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 9.1 tons/a	1.9% to surface water 89.4% to sludge 0% biodegradation 8.7% volatilization	
Ethyldiamine (EDA) SVHC	107-15-3	No	ECHA: coating products Annex XV: polymers, coatings SPIN: surface treatment and coating of metals, paints, lacquers and varnishes, electroplating agents, corrosion inhibitors, manufacture of fabricated metal products, basic metals, plastic and rubber products	Yes	ECHA: 10 000+ tons/a SPIN (2017): 4.6 tons/a	not evaluated in HAZBREF	
Formaldehyde, oligomeric reaction products with aniline SVHC	25214-70-4	No	ECHA: coating products Annex XV: production of chemically resistant pipes, production of rolls with composite cover SPIN: manufacture of rubber and plastic products, surface treatment	No	ECHA: 100 – 1 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)

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Imidazolidine-2-thione (2-imidazoline-2-thiol) SVHC	96-45-7	No	ECHA: manufacture of rubber products Annex XV: dossier not found SPIN: manufacture of fabricated metal products, basic metals and rubber and plastic products, surface treatment and coating of metals	No	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0 tons/a	99.9% to surface water 0% to sludge 0% biodegradation 0.1% volatilization	Annex XV dossier is not available for some reason.
Lead SVHC, WFD PS	7439-92-1	Lead included in the STM BREF 2006.	ECHA: metals, metal surface treatment products, polymers, manufacture of fabricated metal products Annex XV: in production of: batteries, lead sheets, leaded steels, hot-dip galvanized steel, lead powder, a range of lead articles SPIN: manufacture of basic metals, fabricated metal products, rubber and plastic products, surface treatment and coating of metals, electroplating agents	Yes	ECHA: 1 000 000 – 10 000 000 tons/a SPIN (2017): 16 476 tons/a	11% to surface water 89% to sludge 0% biodegradation 0% volatilization (modelling + measured data; Vieno 2014)	
Lead bis (tetrafluoroborate) SVHC, WFD PS	13814-96-5	Lead included in the STM BREF 2006.	ECHA: metal surface treatment products, non-metal-surface treatment products, manufacture of fabricated metal products Annex XV: no data on use* SPIN: electroplating agents (2005)	No	ECHA: 10 – 100 tons/a SPIN: no STM related data	not evaluated in HAZBREF	*The available use and exposure information is provided in the registration dossiers

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							(authorities with access rights only) or on ECHA's dissemination website.
Lead chromate SVHC, WFD PS	7758-97-6	Lead included in the STM BREF 2006.	ECHA: no data Annex XV: pigment in paint and varnishes, primary coating SPIN: treatment and coating of metals, surface treatment, manufacture of fabricated metal products, rubber and plastic products	No	ECHA: no data SPIN (2015): 0 tons/a, no use after 2015	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)
Lead chromate molybdate sulphate red (C.I. Pigment Red 104) SVHC, WFD PS	12656-85-8	Lead included in the STM BREF 2006.	ECHA: coating products, manufacture of plastic products, fabricated metal products and machinery and vehicles Annex XV: coatings SPIN: surface treatment, manufacture of rubber and plastic products	No	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)
Lead di(acetate) SVHC, WFD PS	301-04-2	Lead included in the STM BREF 2006.	ECHA: coating products, manufacture of metals Annex XV: coatings and paints SPIN: manufacture of fabricated metal products, surface treatment	No	ECHA: 1 – 10 tons/a SPIN: 2003: 0 tons/a, no STM related use after 2003	not evaluated in HAZBREF	

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Lead dinitrate SVHC, WFD PS	10099-74-8	Lead included in the STM BREF 2006.	ECHA: coating products, manufacture of machinery and vehicles Annex XV: no data on use* SPIN: surface treatment	No	ECHA: 1 000 – 10 000 tons/a SPIN: 2007: 0 tons/a, no use after 2012	Lead: 11% to surface water 89% to sludge 0% biodegradation 0% volatilization (modelling + measured data; Vieno 2014)	*The available use and exposure information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.
Lead monoxide (lead oxide) SVHC, WFD PS	1317-36-8	Lead included in the STM BREF 2006.	ECHA: coating products, manufacture of plastic and rubber products Annex XV: no data on use SPIN: corrosion inhibitors, surface treatment, manufacture of fabricated metal products, rubber and plastic products	No	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 and exposure information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.

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Lead oxide sulfate SVHC, WFD PS	12036-76-9	Lead included in the STM BREF 2006.	ECHA: coating products Annex XV: no data on use* SPIN: no data	No	ECHA: 1 – 10 tons/a SPIN: no data	Lead: 11% to surface water 89% to sludge 0% biodegradation 0% volatilization (modelling + measured data; Vieno 2014)	*The available use and exposure information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.
Lead sulfochromate yellow (C.I. Pigment Yellow 34) SVHC, WFD PS	1344-37-2	Lead included in the STM BREF 2006.	ECHA: manufacture of plastic products, coating products Annex XV: coating of plastic material SPIN: surface treatment, manufacture of plastic and rubber products	No	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0.1 tons/a	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)
Lead (II) bis (methanesulfonate) SVHC, WFD PS	17570-76-2	Lead included in the STM BREF 2006.	ECHA: no public data Annex XV: electrolytic and electroless plating SPIN: surface treatment, electroplating agents, manufacture of fabricated metal products	No	ECHA: confidential SPIN: 2012: 0 tons/a, no use after 2012	not evaluated in HAZBREF	

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Methyloxirane (Propylene oxide) SVHC	75-56-9	No	ECHA: polymers, coating products, metal surface treatment products Annex XV: not found SPIN: manufacture of fabricated metal products, rubber and plastic products, treatment and coating of metals, surface treatment, corrosion inhibitors	No	ECHA: 1 000 000 – 10 000 000 tons/a SPIN (2017): 0.1 tons/a	4.0% to surface water 0% to sludge 16.7% biodegradation 79.3% volatilization	Annex XV dossier is not available for some reason.
N,N- dimethylacetamide (DMAC) SVHC	127-19-5	No	ECHA: manufacture of chemicals, machinery and vehicles Annex XV: coatings SPIN: manufacture of chemicals and chemical products, paints, laquers, varnishes	No	ECHA: 1 000+ tons/a SPIN (2017): 0 tons/a	22.5% to surface water 0.1% to sludge 77.4% biodegradation 0% volatilization	
N,N- dimethylformamide SVHC	68-12-2	No	ECHA: manufacture of chemicals, machinery and vehicles Annex XV: polymers, coatings SPIN: manufacture of chemicals and chemical products	No	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	
Octamethylcyclasil oxane (D4) SVHC	556-67-2	No	ECHA: non-metal-surface treatment products, manufacture of plastic and rubber products	No	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 2.7 tons/a	2.6% to surface water 48.4% to sludge 0% biodegradation	

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			Annex XV: non-metal surface treatment products, manufacture of rubber and plastic products SPIN: manufacture of fabricated metal products, rubber and plastic products, treatment and coating of metals, surface treatment			49% volatilization	
Orange lead (lead tetroxide) SVHC, WFD PS	1314-41-6	Lead included in the STM BREF 2006.	ECHA: coating products, manufacture of chemicals and plastic products Annex XV: no information on use* SPIN: manufacture of basic metals, paints, laquers and varnishes, active corrosion inhibitor	No	ECHA: 10 000 – 100 000 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 and exposure information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.
Pentazinc chromate octahydroxide SVHC	49663-84-5	Zinc included in the STM BREF 2006.	ECHA: coating products, manufacture of machinery and vehicles Annex XV: coatings, industrial use of mixtures in the vehicle coating sector	No	ECHA: 100 – 1 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)

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			SPIN: paints, lacquers and varnishes, repair of motor vehicles and motorcycles				
Perfluorobutane sulfonic acid (PFBS) and its salts SVHC	Not presented in ECHA database. 25628-08-4 (Tetraethylammonium perfluorobutane sulfonate)	No	ECHA: no data Annex XV: Tetraethylammoniumperfluorobutane sulfonate is used in metal (chromium) plating. PFBS-related substances, including polymers, are used as surface treatment for porous hard surfaces, like concrete, grout, unglazed tile, granite, clay, slate, limestone, marble and terracotta. SPIN: no data	No	ECHA: no data SPIN: no data	not evaluated in HAZBREF	PFBS related substances are widely used in STM, but they are not SVHCs
Perfluorononanoic acid (PFNA) and its sodium and ammonium salts SVHC	375-95-1 (PFNA), 21049-39-8 (PFN-S), 4149-60-4 (PFN-A)	No	ECHA: no data Annex XV: PFNA is used as a processing aid for the fluoropolymer manufacture, as surfactant for fire extinguishers and as polishing surfactant SPIN: no data	No	ECHA: no data SPIN: no data	not evaluated in HAZBREF	
Potassium chromate SVHC	7789-00-6	No	ECHA: metal surface treatment products Annex XV: not found	No	ECHA: 1 – 10 tons/a	not evaluated in HAZBREF	Annex XV dossier is not available for some reason.

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			SPIN: no STM related uses		SPIN: no STM related uses		Included in the REACH Annex XIV (Authorisation list)
Potassium dichromate SVHC	7778-50-9	No	ECHA: metal surface treatment products, manufacture of metals and fabricated metal products Annex XV: treatment and coating of metals SPIN: manufacture of fabricated metal products, electroplating agents	Yes	ECHA: 100 – 1 000 tons/a SPIN (2015): 0 tons/a, no STM related use after 2015	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)
Potassium hydroxyoctaoxidizincatedichromate SVHC	11103-86-9	Zinc included in the STM BREF 2006.	ECHA: coating products, manufacture of machinery and vehicles Annex XV: coating of metal products (wash primers, shop primers, tie coats, coating powders) SPIN: manufacture of fabricated metal products, surface treatment	No	ECHA: 100 – 1 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)
Pyrochlore, antimony lead yellow SVHC, WFD PS	8012-00-8	Lead included in the STM BREF 2006.	ECHA: coating products Annex XV: no data on use* SPIN: paints, lacquers and varnishes	No	ECHA: 10 – 100 tons/a SPIN (20017): 0 tons/a	not evaluated in HAZBREF	*The available use and exposure information is provided in the registration

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							dossiers (authorities with access rights only) or on ECHA's dissemination website.
Silicic acid (H ₂ Si ₂ O ₅), barium salt (1:1), lead-doped SVHC, WFD PS	68784-75-8	Lead included in the STM BREF 2006.	ECHA: coating products Annex XV: no data on use* SPIN: no data	No	ECHA: 10 – 100 tons/a SPIN: no data	not evaluated in HAZBREF	*The available use and exposure information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.
Sodium chromate SVHC	7775-11-3	No	ECHA: metal surface treatment products Annex XV: corrosion inhibitor, electroplating (chrome plating), conversion coatings (passivating and anodising) and in brightening)	Yes	ECHA: 1 – 10 tons/a SPIN (2011): 0 tons/a, no STM related use after 2011	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)

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			SPIN: manufacture of fabricated metal products, electroplating agents, surface treatment				
Sodium dichromate SVHC	10588-01-9, 7789-12-0	No	ECHA: metal surface treatment products, non-metal-surface treatment products, manufacture of fabricated metal products and plastic products Annex XV: metal finishing, corrosion resistance, chrome plating, electroplating, conversion coatings (passivating, anodising and brightening) SPIN: surface treatment and coating of metals, corrosion inhibitor, manufacture of fabricated metal products	Yes (CAS 10588-01-9)	ECHA: 100 – 1 000 tons/a SPIN (2015): 0 tons/a, no STM related use after 2015	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)
Strontium chromate SVHC	7789-06-2	No	ECHA: coating products, manufacture of machinery and vehicles Annex XV: protective (primer) coatings, paint production mainly as corrosion inhibitor and as pigments SPIN: manufacture of fabricated metal products (2017), corrosion inhibitors (2017), surface treatment and coating of metals (2014)	No	ECHA: 1 000 – 10 000 tons/a SPIN (2017): 0 tons/a SPIN (2014): 89 tons/a	not evaluated in HAZBREF	Included in the REACH Annex XIV (Authorisation list)

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Terphenyl hydrogenated SVHC	61788-32-7	No	ECHA: coating products, manufacture of chemicals and plastic products Annex XV: industrial coatings SPIN: manufacture of rubber and plastic products	No	ECHA: 10 000 – 100 000 tons/a SPIN: 0 tons/a	not evaluated in HAZBREF	
Tetralead trioxide sulphate SVHC, WFD PS	12202-17-4	Lead included in the STM BREF 2006.	ECHA: coating products, manufacture of plastic products, machinery and vehicles and metals Annex XV: no data on use* SPIN: manufacture of rubber and plastic products	No	ECHA: 100 000 – 1 000 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	*The available use and exposure information is provided in the registration dossiers (authorities with access rights only) or on ECHA's dissemination website.
Trilead dioxide phosphonate SVHC, WFD PS	12141-20-7	Lead included in the STM BREF 2006.	ECHA: used in coating products, manufacture of plastic and rubber products Annex XV: no data on use* SPIN: manufacture of fabricated metal products, paints, lacquers and varnishes	No	ECHA: 10 000 – 100 000 tons/a SPIN (2017): 0 tons/a	not evaluated in HAZBREF	*The available use and exposure information is provided in the registration dossiers (authorities

							with access rights only) or on ECHA's dissemination website.
Tris(4-nonylphenyl, branched and linear) phosphite (TNPP) with = 0.1% w/w of 4-nonylphenol, branched and linear (4-NP) SVHC, WFD PHS	Not presented in ECHA database. 26523-78-4 (Tris(nonylphenyl) phosphite) 3050-88-2 (4-nonylphenol phosphite)	Nonyl and other alkyl phenyl ethoxylates (NP/NPEs) included in the STM BREF 2006.	ECHA: coatings (TNPP) Annex XV: The information provided relates to the registered substance tris(4-nonylphenyl, branched) phosphite (TNPP). TNPP is primarily used as an antioxidant to stabilise polymers. Use of formulated polymer in manufacturing, coatings and adhesives. SPIN: no data	No	ECHA: 10 000 – 100 000 tons/a (TNPP) SPIN: no data	not evaluated in HAZBREF	

¹⁾ Information taken from ECHA chemical database (<https://echa.europa.eu/fi/information-on-chemicals>) 20.3.2020, indicates total imported/manufactured amount in EU (tons per year) in all uses, no information on use specifically in STM sector. The years of the information which the data are based on is unknown. Information taken from SPIN database (<http://spin2000.net/>) 24.3.2020, indicates total imported/produced volume in STM sector in the Nordic Countries in one particular year (tons per year).

²⁾ GoA2.2 mini-report

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- Annex XV dossier 1-Methyl-2-pyrrolidone
- Annex XV dossier 1,2-dimethoxyethane, ethylene glycol dimethyl ether (EGDME)
- Annex XV dossier 1,3,5-Tris(oxiran-2-ylmethyl)-1,3,5-triazinane-2,4,6-trione
- Annex XV dossier 2,2'-dichloro-4,4'-methylenedianiline
- Annex XV dossier 2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol (UV-328)
- Annex XV dossier 4-(1,1,3,3-tetramethylbutyl) phenol
- Annex XV dossier 4,4'-oxydianiline
- Annex XV dossier Acetic acid, lead salt, basic
- Annex XV dossier Arsenic acid
- Annex XV dossier Bis(2-ethylhexyl)phthalate
- Annex XV dossier Bis(pentabromophenyl)ether (decabromodiphenyl ether; decaBDE)
- Annex XV dossier Boric acid
- Annex XV dossier Cadmium
- Annex XV dossier Calcium arsenate
- Annex XV dossier Chromium trioxide
- Annex XV dossier Cobalt (II) carbonate
- Annex XV dossier Cobalt (II) diacetate
- Annex XV dossier Cobalt dichloride
- Annex XV dossier Cobalt (II) dinitrate
- Annex XV dossier Cobalt (II) sulphate
- Annex XV dossier Decamethylcyclopentasiloxane (D5)
- Annex XV dossier Diarsenic trioxide
- Annex XV dossier Diboron trioxide
- Annex XV dossier Dibutylphthalate (DBP)
- Annex XV dossier Dichromiumtris (chromate)
- Annex XV dossier Diisobutyl phthalate
- Annex XV dossier Dinoseb(ISO); 6-sec-butyl-2,4-dinitrophenol
- Annex XV dossier Disodium tetraborate, anhydrous
- Annex XV dossier Formaldehyde, oligomeric reaction products with aniline
- Annex XV dossier Lead

- Annex XV dossier Lead bis(tetrafluoroborate)
- Annex XV dossier Lead(II) bis(methanesulfonate)
- Annex XV dossier Lead di(acetate)
- Annex XV dossier Lead dinitrate
- Annex XV dossier Lead monoxide [Lead oxide]
- Annex XV dossier Lead oxide sulfate
- Annex XV dossier Methoxyacetic acid (MAA)
- Annex XV dossier Octamethylcyclsiloxane (D4)
- Annex XV dossier Orange lead [Lead tetroxide]
- Annex XV dossier Pentazinc chromate octahydroxide
- Annex XV dossier Potassium dichromate
- Annex XV dossier Potassium hydroxyoctaoxidizincatedichromate
- Annex XV dossier Pyrochlore, antimony lead yellow
- Annex XV dossier Silicic acid (H₂Si₂O₅), barium salt (1:1), lead-doped [Silicic acid, barium salt, lead-doped]
- Annex XV dossier Sodium chromate
- Annex XV dossier Sodium dichromate
- Annex XV dossier Strontium chromate
- Annex XV dossier Sulfurous acid, lead salt, dibasic
- Annex XV dossier Tetralead trioxide sulphate
- Annex XV dossier Trileadiarsenate
- Annex XV dossier Trilead dioxide phosphonate
- Annex XV report 1,2-Benzenedicarboxylic acid, di-C₆-10-alkyl esters; 1,2-Benzenedicarboxylic acid, mixed decyl and hexyl and octyldiesters
- Annex XV report 2-benzyl-2-dimethylamino-4'-morpholinobutyrophenone
- Annex XV report 2-methyl-1-(4-methylthiophenyl)-2-morpholinopropan-1-one
- Annex XV report 4-tert-butylphenol
- Annex XV report 4,4'-isopropylidenediphenol (Bisphenol A)
- Annex XV report Disodium octaborate
- Annex XV report Ethylenediamine (ethane-1,2-diamine)
- Annex XV report Perfluorobutane sulfonic acid (PFBS) and its salts
- Annex XV report Perfluorohexane-1-sulphonic acid and its salts
- Annex XV report Tris(4-nonylphenyl, branched and linear) phosphite (TNPP) with $\geq 0.1\%$ w/w of 4-nonylphenol, branched and linear (4-NP)1

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Sectoral Guidance for Chemicals Management in the Surface treatment of metals and plastics Industry

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HAZBREF-project Activity 4.1 report

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The authors assume sole responsibility for the contents of this report, which therefore cannot be cited as representing the views of the Swedish EPA.

This sectoral guidance contains information on uses of hazardous chemicals, the best practices in chemical management and recommendations on enhancing the permitting process in the STM sector. This document sums up the findings from HAZBREF project and is based on industrial case studies, interviews with authorities and expert judgment. The aim is to describe good practices in chemical management to be utilized by STM installations as well as environmental and chemical authorities. These include technical, organisational and management aspects and concrete tools supporting chemical management.

The report addresses the STM sector as a whole in Europe, although the main part of the findings is generated from HAZBREF case installation and other experiences in the Baltic Sea Region. The document provides also general descriptions of BAT proposals related to management of hazardous chemicals and substances. These findings of the guidance will feed into in the forthcoming revision of the STM BREF. They are also to be used for HELCOM recommendations on how to reduce the discharge of hazardous substances into the Baltic Sea.

Moreover, the document provides an overview of applicable legal requirements, procedures and other obligations of installation operators regarding use of chemicals and releases of hazardous substances. This includes guidance for tools to identify and assess relevant hazardous substances used and released from the STM installations.



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