National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Potential measures for emission reduction within the European Water Framework Directive

Illustrated by fact sheets for Cd, Hg, PAHs and TBT

RIVM report 607648001/2012

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Colophon

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Abstract

Potential measures for emission reduction within the European Water Framework Directive
Illustrated by fact sheets for Cd, Hg, PAHs and TBT

Member States of the European Union can apply various measures to fulfil the obligations of the Water Framework Directive (WFD). The WFD stipulates that Member States must comply with the standards for priority substances in surface water and ultimately eliminate emission of priority hazardous substances. Exactly who will apply the measures needed to fulfil these obligations – the Member States or the European Commission – is a point of continuing discussion. The outcome will depend on the scale of the problems and the legal options for tackling them.

The Dutch National Institute for Public Health and the Environment (RIVM) has identified measures taken within the Europe Union in order to fulfil the requirements of the WFD. The research (in the form of an inventory) was commissioned by the Dutch Ministry of Infrastructure and the Environment (IenM) to support a European ad hoc Drafting Group. The study was carried out for four substances: cadmium, mercury, polyclyclic aromatic hydrocarbons (PAHs) and tributyltin (TBT).

The ad hoc Drafting Group has defined the preconditions for the inventory in a number of sessions. Based on these preconditions, a summary was made of the measures that have been taken or can be taken in order to comply with the WFD. Examples of measures already taken by one or more Member States and/or the European Commission are tax on batteries containing cadmium, a limitation on PAHs in tyres and the prohibition of mercury in thermometers.

Keywords:
Water Framework Directive, measures, diffuse sources

Rapport in het kort

Potentiële maatregelen voor emissiereductie binnen de Europese Kaderrichtlijn Water
Geïllustreerd met factsheets voor Cd, Hg, PAK's en TBT

Landen van de Europese Unie zetten verschillende middelen in om te voldoen aan de verplichtingen van de Kaderrichtlijn Water (KRW). Volgens de KRW moeten lidstaten onder andere voldoen aan de normen voor chemische stoffen in oppervlaktewater en van zeer gevaarlijke stoffen moeten de emissies tot nul worden teruggebracht. Wie de maatregelen gaat nemen om te voldoen aan de verplichtingen – de lidstaten of de Europese Commissie – is een punt van voortdurende discussie. Wie dat gaat doen, hangt af van de schaal van de problemen en de (juridische) mogelijkheden om die aan te pakken.

In het kader van die discussie is door het RIVM een inventarisatie gemaakt van de maatregelen die de landen in de EU en de Europese Commissie nemen om te voldoen aan de KRW. Het onderzoek is in opdracht van het ministerie van Infrastructuur en Milieu uitgevoerd ten behoeve van een Europese ad hoc werkgroep. De inventarisatie gebeurde aan de hand van vier stoffen: cadmium, kwik, polycyclische aromatische koolwaterstoffen (PAK's) en de organische tinverbinding tributyltin (TBT).

De werkgroep heeft in een aantal sessies de randvoorwaarden van de inventarisatie bepaald. Op basis daarvan is een overzicht gemaakt van de maatregelen die de Commissie en de lidstaten al hebben genomen of nog kunnen nemen. Voorbeelden van maatregelen die al zijn ingevoerd zijn belasting heffen op cadmiumhoudende batterijen, PAK's in autobanden beperken, en het gebruik van kwik in thermometers verbieden.

Trefwoorden:
Kaderrichtlijn Water, maatregelen, diffuse bronnen

Contents

Summary

The European Water Framework Directive aims at protecting and improving the aquatic environment. Therefore it requests for specific measures for the reduction of emissions of hazardous substances and for the cessation of emissions of the priority hazardous substances.

The tasks of defining and implementing measures for priority and priority hazardous substances are divided between the European Commission and the Member States. However, it is not always clear at what level measures should be developed and implemented. To discuss this topic, to identify potential measures at national and/or EU level, and to identify gaps, an ad hoc Drafting Group was installed. This ad hoc Drafting Group consisted of representatives of the European Commission, the Member States and stakeholders. The Drafting Group gathered information on existing legislation from the European Union and the Member States for four substances, which were identified as being relevant for a large part of the European Union: cadmium, mercury, PAHs and TBT. Background information was gathered and filed by the RIVM and laid down in a draft report.

The draft report was used to reflect the input at various stages and to streamline the discussion within the Drafting Group. The background information and the discussions showed that the different Member States have their own approach to tackle problems with phasing out a substance or complying with the environmental quality standards. These approaches may vary per substance.

The present report reflects the exchange of ideas and decisions made within the Drafting Group and provides insight in the potential and existing measures within the European Union, as delivered by the various participants. It therefore provides a general, but not an extensive overview of measures for these four substances. For some legislative texts on emission reduction or restrictions on production and use background information has been provided on the policy process.

After the last session of the Drafting Group, in January 2010, discussions on measures have proceeded and will further proceed as they are part of the River Basin Management Plans. The report may provide input for further discussions within the European Union on measures that can be developed for reducing or phasing out emissions.

1 Introduction

The European Water Framework Directive (WFD) aims at enhanced protection and improvement of the aquatic environment. It tries to accomplish this through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing out of discharges, emissions and losses of the priority hazardous substances. Member States contribute to this aim by developing a programme of measures which should include so called basic measures and which may include so called supplementary measures, where necessary. Basic measures and supplementary measures are listed in non-exclusive lists in parts A and B of Annex VI of the Water Framework Directive. Besides legislative instruments, the supplementary measures also include, among others, economic or fiscal instruments, negotiated environmental agreements and codes of good practice.

The tasks of defining and implementing the measures for priority and priority hazardous substances are divided between the European Commission (e.g. article 16) and the Member States (e.g. articles 4 and 11). It is clear that the relevance of such measures on a European level, proposed by the European Commission on the basis of article 16, should be without any doubt in terms of proportionality and subsidiarity. Problems on a smaller geographic scale are the competence of the individual Member States. The definition of European and smaller geographical scale and the solution of problems on both levels require a kind of tango between the Member States and the Commission as is made clear in article 12 which states that 'Where a Member State identifies an issue which has an impact on the management of its water but cannot be resolved by that Member State, it may report the issue to the Commission and any other Member State concerned and may make recommendations for the resolution of it.' Such a tango is also needed in the cases where substances are causing problems in the surface water, but are still allowed by other legislation (e.g. Regulation concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency (REACH, or the biocide and pesticide regulations). Although several cross links exist, e.g. in articles 2(4), 61(5) and 62(5) in REACH and in articles 16(2) and 16(5) of the Water Framework Directive, such problems need to be addressed in these frameworks to result in the necessary measures leading to compliance. Besides the competence problems discussed above, analysis indicate that not all sources of pollution are covered by existing EU legislation. The European Commission indicate in their WFD Impact assessment that there may still be regulatory gaps where certain sources of emissions are not adequately and effectively addressed (European Commission, 2006a). Examples provided were lead ammunition, mercury in thermometers, and point source pollution from small- and medium-sized enterprises not covered by the IPPC Directive. This observation challenges both the Commission and the Member States to come up with proposals for measures.

A first meeting to discuss these findings was organised in Amsterdam by the Dutch Ministry of Housing, Spatial Planning and the Environment, in collaboration with the Dutch Ministry of Transport, Public Works and Water Management in May 2008 and was entitled 'Workshop on Diffuse Sources of Water Pollution'. After the Amsterdam workshop, the European Commission and the Member States agreed to install an ad hoc Drafting Group to focus on measures for diffuse sources. The Drafting Group consisted of participants from the European Commission, the Member States and stakeholders and held its kick-off meeting in Brussels on 24 and 25 February 2009. The main objective of

the Drafting Group, as described in the mandate, was to identify sources of priority substances that are not sufficiently addressed by existing measures and that significantly contribute to water bodies not reaching a good status, and to identify potential measures to tackle these sources.

To facilitate the work of the ad hoc Drafting Group the RIVM was asked to supply fact sheets with information on sources and measures of a number of selected substances, to make the minutes of the meetings of the ad hoc Drafting Group and to adapt the fact sheets conform the information supplied by the participants and the discussions within the Drafting Group. This report reflects the discussions in the Drafting Group and the decisions made on the approach. The appendices to the report contain the fact sheets of the selected substances. The fact sheets are based on the research work carried out by the RIVM to facilitate the process, the input by the various Member States through a questionnaire on national measures, the information supplied by the participants of the Drafting Group meetings and the adaptations made during this process.

2 Approach and limitations

The mandate of the ad hoc Drafting Group on Emissions identified the following steps to streamline the process:

A. Identify priority substances for which diffuse sources prevent reaching WFD goals.
B. Among these substances identify potential measures at national and/or EU level based on substance specific studies on existing legislation and gaps.
C. Discuss effectiveness of measures and feasibility.
D. Prepare a technical report integrating the findings of activities A to C of the substances concerned.
E. Prepare a technical report with potential measures, both at Member State level and at EU level, in order to contribute to the cessation or phasing out of discharges, emissions and losses of priority hazardous substances.

It was also described in the mandate that a number of documents on sources and measures were already available as a starting point. Based on the available material and the discussions within the Drafting Group chapters were drafted on general European legislation that could be applied for emission reduction or phasing out of priority hazardous substances. Fact sheets containing information on production and use, emission sources and national and European measures on each of the four selected substances were used as a starting point for the discussions. Written text proposals and/or results from the questionnaire to the Member States alternated with discussions on certain topics within the Drafting Group on Emissions. The steps made within the ad hoc Drafting Group on Emissions comprised:

- selection of the relevant substances;
- which kind of sources to be considered: diffuse or point sources, historical pollution;
- selection of relevant data sources;
- selection of relevant emission sources;
- selection of potential measures.

This process finally resulted in a chapter on generic EU legislation and fact sheets on four priority hazardous substances. The fact sheets provide an introduction in existing and potential measures and do not provide a complete overview. As an example of the extensive area of legislation Vos and Janssen (2005) indicated that for mercury 277 European legislative texts could be retrieved of which 98 were dedicated to measures whereas for cadmium the total number was 158 with 52 dedicated to measures. Documents used and produced during the Drafting Group sessions can be found on the CIRCA website "Implementing the Water Framework Directive/ Working groups and Expert Advisory Forum/Working Group E priority substances/drafting group on emissions" (CIRCA, 2012).

2.1 Substance selection

According to the mandate of the Drafting Group the key activity was to develop an overview of existing and potential legislative measures for the priority hazardous substances (PHS) to support decisions on how these substances could be best dealt with in the framework of the WFD, where a further cease or phase out of the discharges, emissions and losses of this type of substances is strived for. Based on an inquiry among the various Member States (see Appendix 5), the Drafting Group concluded that

tributyltin (TBT), Polycyclic Aromatic Hydrocarbons (PAH), cadmium and mercury appear to represent a problem for many Member States and therefore it might also be 'problematic' at the European level. These substances were therefore selected for this case study. The Drafting Group also recognised that there might also be other 'problematic' substances. Fact sheets of these priority hazardous substances (PHS) were used as a starting point for discussions within the Drafting Group. The first versions of the fact sheets were prepared by the RIVM, based on the layout defined during the first meeting and were adapted due to input of the participants and various Member States. They are provided in Appendices 1-4.

2.2 Considerations on point and diffuse sources

Based on the general considerations of the Workshop on Diffuse sources of water pollution in Amsterdam it was expected that the focus of the activity of the ad hoc Drafting Group would be on diffuse sources, but that point sources would be addressed as necessary. Within the Drafting Group there was considerable discussion on the definition of diffuse sources and which sources to include and which not. There was also a request to provide examples.

Diffuse sources are mentioned in the WFD Impact assessment (European Commission, 2006a): *'While we have made particular progress with direct and easily identifiable emission sources (point sources), there is a lot more to be done on diffuse sources (e.g. pesticides and fertilisers from agriculture and pollution from households).'* The E-PRTR Regulation, EC/166/2006, gives the following definition of diffuse sources: *'"Diffuse sources" means the many smaller or scattered sources from which pollutants may be released to land, air or water, whose combined impact on those media may be significant and for which it is impractical to collect reports from each individual source'* and the Environmental Liability Directive, 2004/35/CE, recognises that in the case of diffuse pollution it is often difficult to find a causal between damage and (an) identified polluter(s). The directive states that *'Liability is therefore not a suitable instrument for dealing with pollution of a widespread, diffuse character, where it is impossible to link the negative environmental effects with acts or failure to act of certain individual actors.'* Finally the European Environmental Agency describes diffuse pollution as: *'Diffuse pollution can be caused by a variety of activities that have no specific point of discharge. Agriculture is a key source of diffuse pollution, but urban land, forestry, atmospheric deposition and rural dwellings can also be important sources. By its very nature, the management of diffuse pollution is complex and requires the careful analysis and understanding of various natural and anthropogenic processes*.' (European Environmental Agency, 2010). It is important to note that a point source at a local scale, may act as a diffuse source at a larger geographical scale.

The Drafting Group discussed the position of wastewater treatment plants (WWTPs). The Drafting Group decided that a WWTP is a discharge point that should be dealt with as a point source in accordance with the principle as set out in second sentence of Article 174(2) of the Treaty (European Union, 2006) that source-oriented measures go before effect-oriented measures. It should be emphasized that discharges by WWTPs, as well as storm water discharges, are not the primary sources of PAHs, Cd, Hg and TBT. To be able to tackle the problem of emissions from urban areas to surrounding waters the solution preferably has to start upstream the WWTP. The WFD Impact assessment (European Commission, 2006a) dedicates the following sentences to this problem: *'It is currently not possible to determine at EU level whether and to what extent discharges from wastewater treatment plants would lead to exceeding of the proposed EQS. However, if an exceeding is identified, the aim is to identify the products or processes*

the substance might have come from. According to the WFD, the most cost-effective measures are to be applied. In most cases, it can be demonstrated that 'end-of-pipe' measures are not cost-effective. It will be important to improve knowledge and data on the sources and pathways of priority substances into municipal wastewater in order to identify targeted and efficient control options.'

Another important aspect tackled by the Drafting Group was historical pollution. The main outcome of the discussion was that this issue is important to address at River Basin Management Plan level (RBMP). The Drafting Group decided that this subject was beyond its scope. For some substances historical pollution can be an important source. In some river basins contaminated sediment may represent a considerable component of the overall source apportionment and should not be overlooked even though resolution of such problems may be difficult to achieve. The Drafting Group advised Member States to include historical pollution into the mass balances of emissions. However, accounting for historical pollution is not as easy to deliver in mass-balances as this suggests. Even when quantification is possible it is up to the regulator to decide whether additional action to compensate for historical inputs is possible and necessary. Diffuse polluted areas on a large scale are in this respect different from areas that are polluted on a smaller scale where perhaps measures at a point source are less problematic. This does not mean that operators should never be asked to deliver more than their proportionate share – this might be the result of imposing BAT-conditions. However, it is up to national and regional authorities to decide on remediation and disposal of contaminated sludge/soil. Historical pollution is a local and site-specific problem and therefore the Drafting Group decided not to develop guidance on this issue. Member States were asked to inform the Drafting Group about national guidance documents and best practises. This information will be made available on CIRCA, as examples how the problem of historical pollution can be tackled.

The discussions in the ad hoc Drafting Group showed that it is not always easy to distinguish between diffuse and point sources. Therefore some definitions from European legislative texts have been provided. It was recognised that waste water treatment plants are not the primary sources of pollutants, and that Member States have to improve their knowledge to identify targeted and efficient control options more upstream. The Drafting Group agreed that historical pollution should not be solved on EU level, but national.

2.3 Selection of relevant data sources

Basically five different information sources were distinguished for identification of the most relevant emissions: the risk assessments and the harmonised classification and labelling requirements, the reporting obligations of the Member States on environmental quality, the European project on Source Control of Priority Substances in Europe (SOCOPSE), EPER and E-PRTR reporting obligations of the Member States and the WFD source screening and measures fact sheets.

For each of the four substances information is gathered on the risks to the environment based on risk assessments carried out under the Existing Substances Regulation 793/93/EEC and the potential hazards based on the existing harmonised classification and labelling requirements for these substances in line with Annex VI to Regulation (EC) No 1272/2008. In addition, the production and use of the substances are identified. This information could reveal the potential discharge from point and diffuse sources of the substances considered.

At present, there is not a complete overview of the sources and emissions of PHS to the aquatic environment based on regular reporting from the Member States. Evaluation of a recent state-of-the-environment (SOE) reporting to the European Environment Agency (EEA) is in progress and also more information is expected to become available after WFD reporting of River Basin Management Plans as per spring 2010. Some data are available, though, from the literature, e.g. in the context of making normalisations in Life Cycle Assessments (LCA).

In the sixth framework programme of the EU, several European research organisations have carried out a project under the title Source Control of Priority Substances in Europe (SOCOPSE). The main aim of the project was to provide guidelines and decision support system tools for the implementation of the WFD with regard to certain priority substances including the selected PHS. One of the deliveries within the SOCOPSE project was to prepare the Material Flow Analysis (MFA) diagrams for all priority substances selected within the project. MFA is a systems thinking approach, usually applied to achieve quantitative information on how the flow (mass per time) of materials or substances behave within a well defined system. This constitutes a broad source of information on PHS that is considered very useful in the development of the fact sheets. There are also other sources for emission data available such as the data from EPER and E-PRTR and the source screening and measures fact sheets for each priority substance (available on CIRCA WFD: 'Implementing the Water Framework Directive'/F - Working Groups and Expert Advisory Forum/e - WG E Priority Substances/Drafting Group on Emissions).

The Drafting Group decided that basic information on the four substances should be taken from the reports of the SOCOPSE project because this project provides quantitative data and comprises the most complete dataset on point and diffuse sources.

2.4 Selection of relevant emission sources

The potential sources of production and use are considered in relation with releases of substances to the relevant environmental compartments. Based on this information, a selection of the entry routes into the environment of more than 10% was made (as agreed by the Drafting Group on Emissions). The emphasis of this analysis would be on sources contributing for more than 10% to the total load. It is expected that this category would provide the main areas where the highest gain in the potential discharge reducing activities could be realised. The layout of the table on sources and measures was developed based on the discussions made during the meeting of February 2009 of the Drafting Group. Two important points should be realised in selecting the most relevant sources based on the 10% rule. Firstly, a relevant source locally or regionally is not necessarily relevant on a European level. Secondly, effectiveness does not depend on the relative contribution of a source. Thus, it might be more cost-efficient to tackle a small source, than to tackle a large source and relevance can be counteracted by cost-efficiency.

In the last meeting of the Drafting Group it was stated that the report will reflect that the Drafting Group has studied the most important sources identified in the SOCOPSE project on a EU level, but that it can not be excluded that important sources at a local or national or even European level are neglected, because there are still some important gaps in the knowledge of PHS sources and fluxes in the environment. This study was not intended to identify such sources, but to identify potential lacks in measures. Although the study focussed on sources contributing for more than 10%, measures for minor

sources have been incorporated in the text, as they might provide examples for potential measures for larger sources.

2.5 Potential measures

The mandate of the Drafting Group request to identify potential measures at national and/or EU level on existing legislation and gaps based on substance specific studies. Basic measures and supplementary measures are listed in non-exclusive lists in the parts A and B of Annex VI of the Water Framework Directive. Other valuable information sources are the WFD Impact assessment (European Commission, 2006a), the informal background document related to the Commission documents on priority substances and the source screening and measures fact sheets for each priority substance (latter two available on CIRCA WFD: 'Implementing the Water Framework Directive'/F - Working Groups and Expert Advisory Forum/e - WG E Priority Substances/Drafting Group on Emissions). SOCOPSE does not only deliver information on the sources, but also on potential measures. However, it focuses mainly on the identification of possible measures from a technical perspective. The same accounts for the Source Control Options for Reducing Emissions of Priority Pollutants (SCOREPP) projects. Other valuable sources of information are the national measures applied by Member States. In the tables of measures a distinction is made between existing and potential measures. The last category also includes the measures in preparation. For each category, national and EU measures are indicated.
Basic measures have not been studied in depth and have not been repeated/translated into category national measures in the fact sheets. Basic measures are the minimum requirements to be complied with and consist, among others, of measures required to implement community legislation for the protection of water, including measures required under the legislation specified in article 10 and in part A of Annex VI (see box). For this exercise it is assumed that Member States have implemented these requirements[1].
However, practice showed to be different. The WFD Impact assessment (European Commission, 2006a) indicated that there was a serious implementation deficit concerning Directive 76/464/EEC, since measures agreed some time before had still not been applied. This has resulted in quite a number of infringement procedures. However, focus here will be on legislative gaps and not on non-compliance.

> WFD Annex VI LISTS OF MEASURES TO BE INCLUDED WITHIN THE PROGRAMMES OF MEASURES
>
> PART A
>
> Measures required under the following directives:
>
> (i) The Bathing Water Directive (76/160/EEC);
>
> (ii) The Birds Directive (79/409/EEC) (1);
>
> (iii) The Drinking Water Directive (80/778/EEC) as amended by Directive (98/83/EC);
>
> (iv) The Major Accidents (Seveso) Directive (96/82/EC) (2);

[1] This assumption, stated on the Diffuse Sources workshop of May 2008 in Amsterdam, has been confirmed by the Drafting Group and WG E. Please note that when reading the tables of measures, anyone should be aware of the fact that it is assumed that MSs fully implemented existing Community legislation and obligations.

(v) The Environmental Impact Assessment Directive (85/337/EEC) (3);

(vi) The Sewage Sludge Directive (86/278/EEC) (4);

(vii) The Urban Waste-water Treatment Directive (91/271/EEC);

(viii) The Plant Protection Products Directive (91/414/EEC);

(ix) The Nitrates Directive (91/676/EEC);

(x) The Habitats Directive (92/43/EEC) (5);

(xi) The Integrated Pollution Prevention Control Directive (96/61/EC).

WFD, Article 10

The combined approach for point and diffuse sources

1. Member States shall ensure that all discharges referred to in section 2 into surface waters are controlled according to the combined approach set out in this Article.

2. Member States shall ensure the establishment and/or implementation of:

(a) the emission controls based on best available techniques, or

(b) the relevant emission limit values, or

(c) in the case of diffuse impacts the controls including, as appropriate, best environmental practices

set out in:

- Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (19),

- Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (20),

- Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (21),

- the directives adopted pursuant to Article 16 of this directive,

- the directives listed in Annex IX of the WFD,

- any other relevant community legislation

at the latest 12 years after the date of entry into force of this directive, unless otherwise specified in the legislation concerned.

3. Where a quality objective or quality standard, whether established pursuant to this directive, in the directives listed in Annex IX, or pursuant to any other community legislation, requires stricter conditions than those which would result from the application of section 2, more stringent emission controls shall be set accordingly.

During the September 2009 meeting, the Drafting Group concluded that pollution sources should be dealt with at national level as far as reasonable. Overall, what is reasonably expected from Member States to do at national level to solve water quality problems within limits of the internal market/level playing field is to fully implement basic measures, to apply supplementary measures where possible, and making use of exemptions if necessary. Basically, this is the level of regulation that is demanded by the relevant EU directives in the field of water policies. The text of the WFD Impact assessment (European Commission, 2006a) provides two reflections on this subject. Firstly, it indicates that the interpretation of cessation allows certain exemptions, for example where cessation is technically unfeasible or disproportionately expensive. And secondly, that cases of non-compliance that give rise to social or economic difficulties can be addressed within the framework of the exemptions allowed under the WFD in terms of the most cost-effective combination of measures.

3 Outcome

The report integrates the findings of activities A to C and contains potential and existing measures at Member State and EU level. The results of both the discussions within the Drafting Group and the research work are incorporated in chapter 4 and the appendices. Chapter 4 provides an overview of generic European legislation, applicable to all substances, which may be used in drafting measures for specific substances or specific circumstances. In the appendices 1, 2, 3 and 4, the draft fact sheets for the four example substances, cadmium, mercury, PAHs and TBT are presented. The draft fact sheets have been revised by the rapporteur reflecting the comments made by the Working Group-E (WG-E) and the ad hoc Drafting Group. Received information has been evaluated and incorporated when applicable for this research. If possible, cross links between chapter 4 and the fact sheets have been provided.

The ad hoc Drafting Group decided in the kick off meeting of February 2009 to leave the question of effectiveness and feasibility on the table. It was concluded that it is difficult to draw conclusions about effectiveness other than those on global terms of measures because there is no direct relation between diffuse sources and measures. Definitive answers can only be given on the basis of monitoring data.

The report and the fact sheets should be considered as an introduction to measures already taken or potential measures to be taken for these four priority hazardous substances. It provides rather a selection of possible solutions than a comprehensive overview of all measures possible or already taken. Such a comprehensive overview would only be possible with significant input from all 27 Member States. It was realised during the discussions and during the research that the different Member States have their own approach to tackle problems with phasing out a substance or complying to the environmental quality standards. These approaches may vary per substance.

The last session of the ad hoc Drafting Group was held in January 2010. The draft report has been discussed extensively during that session and has been revised as a result of these discussions. The report reflects the exchange of ideas and the decisions made in the ad hoc Drafting Group, and provides insight in the potential and existing measures within the European Union, as delivered by the various participants.
After the last session of the ad hoc Drafting Group, in January 2010, discussions on measures have proceeded and will further proceed as they are part of the River Basin Management Plans. The report may provide input for the discussions on the measures that can be developed for reducing or phasing out emissions.

4 Legislation concerning all four substances with possibilities for emission reduction, cessation or phasing out measures

In this chapter an overview is given of directives and regulations, which are thought to have the potential to reduce risks of chemicals, **as generic measures**. As these directives and regulations set the generic principles, either the European Commission or the Member States have to take action in order to formulate source specific or substance specific measures. Examples are the restriction of cadmium through REACH, the non-inclusion of TBT on Annex I of the Directive on Plant Protection Products, 91/414/EEC, and discussions on creosote within the framework of the Biocidal Products Directive, 98/8/EC.
The information in this section is based on RIVM report (Vos and Janssen, 2005), which has been updated with new information on the EU legislation, and the outcome of tabulated measures in the fact sheets for cadmium, mercury, PAHs and TBT (see Appendices to this report). The selected directives and regulations to be discussed are:

- The Directive for Integrated Pollution Prevention Control (IPPC, 2008/1/EC, previously 96/61/EC);
- The National Emission Ceilings (NEC) Directive (2001/81/EC) and the Air Quality Directives (2008/50/EC and 2004/107/EC);
- The REACH Regulation (EC/1907/2006));
- The Regulation on Persistent Organic Pollutants (POPs) (EC/850/2004);
- The Plant protection products (91/414/EEC) and Biocidal Products Directives (98/8/EC); and
- The Waste Framework Directive (2008/98/EC).

Generally, these directives were mentioned as potentially strong legislation by the other consulted sources (WFD and daughter directives; NordRiskRed, 2001; Expert Advisory Forum, 2004; European Commission, 2004a; Führ, 2004, and Vos and Janssen, 2005). For further reading the latter reference is recommended.
Besides the generic legislative text listed above, there is a large range of directives, regulations and decisions dedicated to one or more of the selected substances. Examples are the Restriction of Hazardous Substances (RoHS) Directive, 2002/95/EC, the End of Life Vehicles (ELV) Directive, 2000/53/EC, and the decision establishing the conditions for a derogation for plastic crates and plastic pallets, which contain regulations on the content of lead, cadmium, mercury and hexavalent chromium allowed. Although such legislative texts are relevant, they are not discussed in detail because of the amount of documents and the limited scope of each of them.

The Water Framework Directive (WFD) requires the European Commission to establish environmental quality standards (EQS) for the priority substances (PS) and the priority hazardous substances (PHS) and to come forward with community-wide control measures to reduce pollution from the PS, or to phase out emissions, discharges and losses of the PHS. The WFD and the related Directive on Priority Substances (2008/105/EC) contain no specific measures but refer to basic measures as established in existing community legislation and principles as combined approach, the polluter pays principle, the precautionary principle and emission registration (articles 10, 11, 13, and 15 to 17). The WFD and the Directive on Priority Substances contain no product related measures which are necessary to control measures at the source. The Directive on

Priority Substances, 2008/105/EC, contains article 5.5 which indicates that the Commission shall verify that the aims of the Water Framework Directive are met, i.e. that emissions, discharges and losses are making progress towards compliance with the reduction or cessation objectives. This is also reflected in considerations 6 and 20 of the same directive. The considerations also indicate that causes of pollution should be identified and emissions should be dealt with at source, in the most economically and environmentally effective manner.

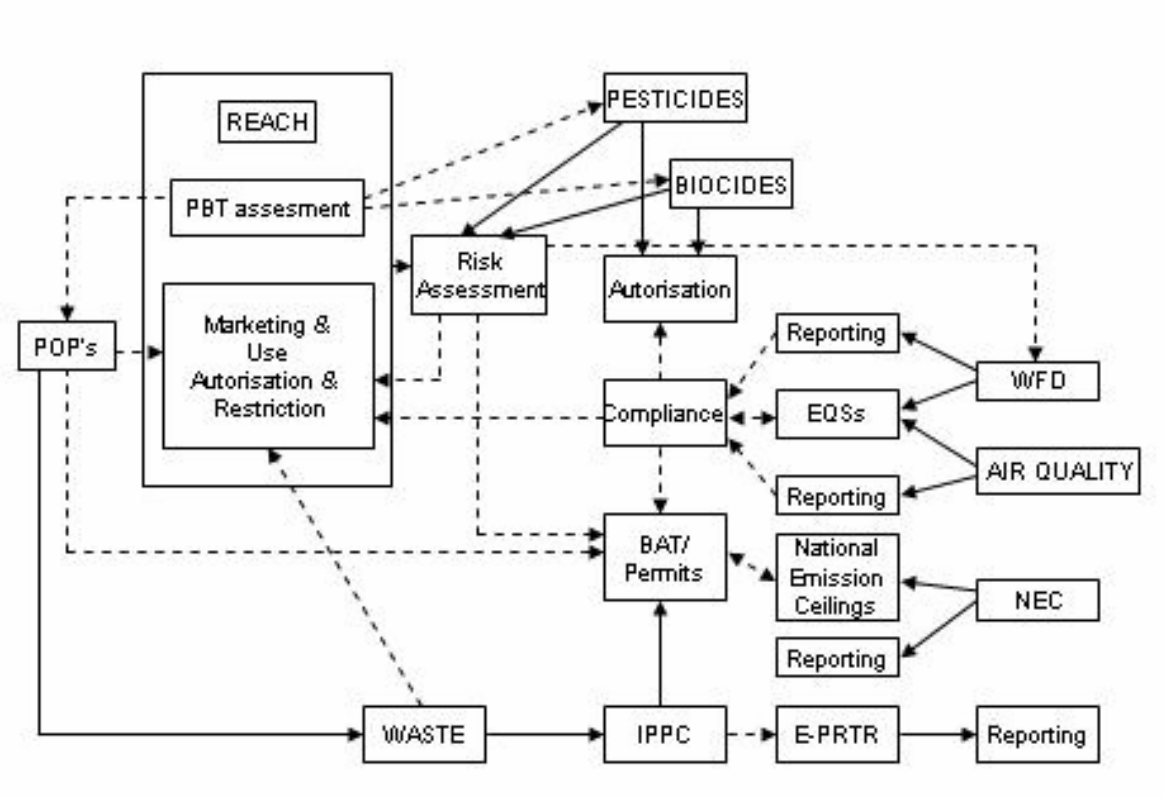

Figure 1 Coherence of the legislation considered to be most relevant for emission reduction of cadmium, mercury, PAHs and TBT and discussed in this report
Directives and regulations are given in capitals, deliverables from the various legislative texts are provided in normal style. These may be or risk assessments or assessments of the Persistent, Bioaccumulative and Toxic character of the substance (PBT), authorisations or restrictions, BAT Reference documents (BREFs), EQSs or reports on yearly emissions or environmental quality. Arrows indicate relationships between the various legislative texts, arrows in broken lines relationships between legislative text and their products.
IPPC = IPPC Directive 2008/1/EC, NEC and Air Quality Directives = 2001/81/EC, 2004/107/EC and 2008/50/EC, REACH = REACH Regulation EC/1907/2006, POPs = POPs Directive 850/2004/EC, Pesticides = Plant Protection Products Directive 91/414/EEC, Biocides = Biocidal Products Directive 98/8/EC, and Waste = Waste Framework Directive 2008/98/EC. The Dangerous Substances Directive (2006/11/EC), which replaces directive 76/464/EEC and daughter directives has not been included in the figure. The directive will be repealed by the Water Framework Directive in 2013.

In the Communication published in 2006 together with a draft of the daughter directive on Priority Substances (European Commission, 2006b), the European Commission has indicated that a wide range of instruments is already available and that numerous legislative proposals and decisions have been made since the publication of the WFD.

Instruments to comply with the EQS mentioned in the Communication are for instance Directive 91/414/EEC concerning the authorisation and assessment of plant protection products and Directive 96/61/EC on integrated pollution prevention control for industries.
In addition, the Member States are obliged to take into account 'any other relevant community legislation' when formulating measures. The Communication also states that although marketing and use restrictions are regulated at European level, 'Member States may also, under certain strict conditions laid down in the Treaty, introduce national provisions to restrict marketing and use because of risk to the aquatic environment'. An example is the Dutch derogation on creosoted wood, which resulted in Commission decision 1999/832/EC which lays down measures that are stricter than the European measures on creosote.

Demands of the WFD and other legislative texts may result in measures considering marketing and use of a substance or considering emissions as regulated by the IPPC. Risk assessment results performed under the REACH Regulation are taken into account during the formulation of measures considering marketing and use of a substance. The results of risk assessment under the Plant Protection Products and Biocidal products Directives and the REACH Regulation are used for the selection of the priority substances and for the formulation of measures. The basic principles of the IPPC are implemented in the WFD. Figure 1 gives a simplified overview of the relations between the generic European legislation which was considered to be most relevant for the reduction of cadmium, mercury, PAHs and TBT and which is discussed in this report.

The European Commission communicated in 2006 that it believes that the current body of community legislation should enable achievement of the WFD objectives in most cases, and that the impact assessment demonstrated that the most cost-effective and proportionate approach for priority substances is to set clear and harmonized standards and allow Member States a maximum of flexibility on how to achieve them (European Commission, 2006b). Consideration 8 of the Directive on Priority Substances (2008/105/EC) reflect on that topic stating: '*As regards emission controls of priority substances from point and diffuse sources it seems more cost-effective and proportionate for Member States to include, where necessary, in addition to the implementation of other existing community legislation, appropriate control measures in the programme of measures to be developed for each river basin district*.' So the assignment is to find the most appropriate measures, c.q. directives and regulations to support the implementation of the required pollution reduction measures and to find out which is the most appropriate level to implement them.

4.1 Directive 2008/1/EC concerning integrated pollution prevention and control (the IPPC Directive)

In essence, the IPPC Directive aims to reduce emissions to air, water and land from the certain activities, including measures concerning waste, in order to achieve a high level of protection of the environment. The activities covered by the IPPC Directive are mentioned in Annex I of the directive. Operators of industrial installations covered by Annex I of the IPPC Directive are required to obtain an authorisation (environmental permit) from the authorities in the Member States.

IPPC (keywords; permits, BAT and emission limit values)
The aim of the directive is to achieve integrated prevention and control of pollution. Pollution is defined broadly, as 'direct or indirect introduction as a result of human activity, of substances, vibrations, heat or noise into the air, water or land which may be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment' (article 2 of IPPC).

The IPPC integrates provisions and measures dealing with emissions to air, water and land, including measures concerning waste. To achieve this, 'intervention at the source' and the 'polluter pays' principles are leading. Waste production is avoided in accordance with the principles laid down in the Waste Framework Directive (75/442/EEC, now replaced by 2008/98/EC).

Sources covered by the directive are medium-sized and large industrial installations, waste management installations and installations for the intensive rearing of poultry and pigs (Annex I of IPPC). For some of the industrial branches, installations with low production capacity are left out of the scope of the directive (e.g., iron and steel mills with capacity less than 2.5 tonnes per day or paper and board mills with capacity less than 20 tonnes per day).

The Member States have to take the necessary measures to ensure that the competent authorities grant permits in accordance with IPPC (articles 4, 5 and 6 of IPPC) and to ensure that the conditions of the permit are complied with by the operator (article 14 of IPPC). Member States shall also determine at what stage decisions, acts or omissions may be challenged (article 15a of IPPC). Permit conditions including emission limit values (ELVs) must be based on Best Available Techniques (BAT). To assist the licensing authorities and companies to determine BAT, the Commission organises an exchange of information between experts from the EU Member States, industry and environmental organisations. This work is co-ordinated by the European IPPC Bureau of the Institute for Prospective Technology Studies at EU Joint Research Centre in Seville (Spain). This results in the adoption and publication by the Commission of the BAT Reference Documents (the so-called BREFs). Executive summaries of the BREFs are also translated into the official EU languages. The ability to combat pollution through the IPPC depend on the age and quality of the BREF documents and the negotiations between (local) authorities and the entity requesting the permit. The argument that the mercury-cell process was not considered the BAT for the chlor-alkali industry was used by the European Commission to negotiate with the chlor-alkali industry to phase out the use of mercury (see chapter 'Sources and measures mercury').

The IPPC requires that the results of monitoring of releases, as required under the permit conditions, are made publicly available (article 15). Member States also have to report the results to the Commission who organises an exchange of information between Member States and the industries (article 16). Previously, the data on emissions were stored in a database known as the 'European Pollutant Emissions Register' (EPER). In Annex A1 to the EPER Decision (2000/479/EC), 50 pollutants and their threshold values (kg/yr), selected for reporting, are listed for both air and water. EPER has been replaced by the Pollutant Release and Transfer Registers (E-PRTR Regulation (EC/166/2006). The E-PRTR Regulation includes more pollutants, more activities, releases to land, and releases from diffuse sources and off-site transfers. As described in consideration 20 of

the regulation E-PRTR aims at informing the public about important pollutant emissions due to activities covered by Directive 96/61/EC.
Article 3 of the Regulation requests the register to include information on releases of pollutants from diffuse sources, where available. Data collecting on diffuse sources is a shared responsibility between the European Commission, the European Environment Agency and the Member States. It has been recognised by the legislator that the collection of data from diffuse sources is not an easy task. Consideration 11 of the E-PRTR Regulation states that: 'Where appropriate, reporting on releases from diffuse sources should be improved in order to enable decision-makers to better put into context those releases and to choose the most effective solution for pollution reduction'.

A priority substance within the WFD is automatically a substance of concern for the IPPC (article 22(5) of the WFD). Given the obligation of the WFD to phase out or cease emissions of cadmium, TBT, PAHs and mercury the application of principles of the IPPC Directive, in particular the application of Best Available Techniques (BAT) could be considered for installations that are not covered by the IPPC Directive on case-by-case basis. This has also been suggested in the WFD Impact Assessment (European Commission, 2006a). Furthermore, the IPPC Directive and WFD allow for conditions tighter than those implied by BAT to be imposed in order to meet a statutory EQS. This remains an option, although the UK Environment Agency has advised operators that they would not impose more stringent conditions unless there was clear evidence linking their activity/discharge to an EQS failure. This is also the policy in the Netherlands, where after an extensive study on the effects of air emissions on human health more stringent measures were negotiated between the authorities and the industry considered (Schols, 2009).

4.2 National Emission Ceilings Directive (2001/81/EC) and Air Quality Directives (2004/107/EC and 2008/50/EC)

The National Emission Ceilings Directive (2001/81/EC) sets upper limits for sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia for each European Member State to be reached in 2010. The ceilings are laid down in Annex I to the directive and are designed to meet the interim objectives for acidification. The decisions on the measures to comply with the directive are left to the Member States. The directive refers in the consideration to the Fifth Environmental Action Programme, to WHO guidelines and to the Gothenburg Protocol to the UNECE LRTAP Convention. The emission ceilings in the directive are in most cases equal and in some cases more stringent than those in the Gothenburg Protocol.

There is a close correspondence between EU legislation on emission reduction and the UNECE LRTAP Convention. For the substances discussed within the ad hoc Drafting Group on Emissions the Protocols on Heavy Metals and POPs to the UNECE LRTAP Convention are most relevant. The Heavy Metal Protocol aims at a reduction of the total emission of heavy metals into the atmosphere for each party to the protocol by taking effective measures, appropriate to its particular circumstances. It does not contain national emission ceilings, but aims to reduce the emissions of these substances by applying BAT and limit values for stationary sources. Main focus is on the metals cadmium, lead and mercury. The POP Protocol aims at a reduction of emissions and prohibition of substances which have been identified as a POP. Poly aromatic hydrocarbons (PAH's) are listed in Annex III of the POP Protocol. Parties are obliged to take effective measures, appropriate in its particular circumstances in order to reduce its total annual emissions. Both protocols oblige parties to report the national emissions every year with the aim of a further emission reduction. The trend tables provide

information on the trends of various substances under the UNECE LRTAP Convention for each party since 1990, for instance for cadmium, mercury and PAHs. (see: Centre on Emission Inventories and Projections, 2012).
Since 1996 the European Commission has produced several directives that aim to regulate air pollution by setting limits for the allowable concentration of pollutants in ambient air. These directives cover the concentrations of sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter, lead, benzene, carbon monoxide, ozone, arsenic, cadmium, mercury, nickel and poly aromatic hydrocarbons (PAHs) in ambient air. At present, the first substances are covered by the Directive on Ambient Air Quality (2008/50/EC), and the latter five by the so called 4th Daughter Directive on Air Quality (2004/107/EC). The limits in the directives are expressed either as limit values that have to be achieved by a certain date, or as target values for which the standards should be achieved wherever possible. Limit values are set for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter, lead, benzene and carbon monoxide, whereas the limits for ozone, arsenic, cadmium, nickel and benzo(a)pyrene are expressed as target values. Member States should take action in order to comply with the limit values, and where possible, to attain the target values and long-term objectives. For mercury there is only a requirement to monitor the pollutant. The Mercury Strategy (European Commission, 2005a) states on this issue: '*The recently agreed 4th Air Quality Daughter Directive does not set a target value or quality standard for mercury – levels observed in ambient air are below those believed to have adverse health effects – but concentrations and deposition are to be measured to show geographical and temporal trends*.'

The scope and limitations of the Air Quality Directives in reducing emissions are reflected by the considerations provided in Directive 2004/107/EC: '*The target values would not require any measures entailing disproportionate costs. Regarding industrial installations, they would not involve measures beyond the application of best available techniques (BAT) as required by Council Directive 96/61/EC concerning integrated pollution prevention and control and in particular would not lead to the closure of installations. However, they would require Member States to take all cost-effective abatement measures in the relevant sectors.*' This indicates that reductions should be reached through applying BAT and to a further search for sources beyond those listed in the IPPC Directive. Further information on legislation to be found on the Ambient Air Quality website of the European Commission (European Commission, 2012a).

In 2006 the European Commission reported to the United Nations Commission on Sustainable Development (CSD) that considerable reductions in the emissions of the 'classical' air pollutants had been realised in the last decades, but that for areas where a specific air pollution policy was not yet developed the emissions have remained essentially unchanged. The paper concluded that it would be a challenge to find the most effective way of implementing measures, to find the right balance between community and national programmes and that in many cases community action might be needed to achieve the objectives. It was further concluded that in order to reach the objectives in a cost-effective way, all sectors should contribute to emission reductions, including those where only few measures have been taken such as in agriculture, international shipping, aviation and on domestic heating (European Commission, 2006c).

4.3 REACH Regulation (EC/1907/2006)

The REACH Regulation (EC/1907/2006), concerning the Registration, Evaluation, Authorisation and restriction of Chemicals creates a single regulatory system for dealing

with new and existing chemical substances. Authorisation and Restriction are relevant for emission reduction and are discussed below individually.

4.3.1 Authorisation (REACH Annex XIV)

Authorisation is required for uses of chemicals that cause cancer, mutations or problems with reproduction, or that accumulate in our bodies and the environment and that are listed in Annex XIV of the Regulation. Authorisation to use these chemicals, or chemicals raising an equivalent concern, will be granted only to companies that can show that the risks are adequately controlled or if the social and economic benefits outweigh the risks where no suitable alternative substances or technologies exists. The aim is to encourage progressive substitution – the replacement of the most dangerous chemicals with safer alternatives.

The authorisation mechanism consists of an in-depth assessment. Its outcome is then thoroughly discussed before appropriate decisions are taken (see box below). The authorisation process starts with a procedure to nominate substances of very high concern as set out in articles 57 and 58 of the Regulation. Substances of very high concern will be gradually included in Annex XIV of the REACH Regulation. Once included in that annex, they cannot be placed on the market or used after a date to be set (the so-called 'sunset date') unless the company is granted an authorisation. The procedure to include substances in Annex XIV can also be found at the ECHA website (ECHA, 2012a).
Substances of very high concern include substances which are:

- Carcinogenic, Mutagenic or toxic to Reproduction (CMR) classified in category 1 or 2;
- Persistent, Bioaccumulative and Toxic (PBT) or very Persistent and very Bioaccumulative (vPvB) according to the criteria in Annex XIII of the REACH Regulation, and/or
- identified, on a case-by-case basis, from scientific evidence as causing probable serious effects to humans or the environment of an equivalent level of concern as those above e.g. endocrine disrupters.

The authorisation process

The authorisation process consists of four steps. Industry has obligations in the third step. However, all interested parties have the opportunity to provide input in steps 1 and 2.

Step 1: Identification of substances of very high concern (by authorities)
Substances of very high concern can be identified on the basis of the criteria previously described. This will be done by Member State Competent Authorities or the Agency (on behalf of the European Commission) by preparing a dossier in accordance with Annex XV. Interested parties can comment on substances for which a dossier has been prepared. The outcome of this identification process is a list of identified substances, which are candidates for prioritisation (the 'candidate list'). The list will be published and periodically updated by the Agency.

Step 2: Prioritisation process (by authorities)
The substances on the candidate list are then prioritised to determine which ones should be subject to authorisation. Interested parties are invited to submit comments during this process. At the end of the prioritization process, the following decisions are taken:

- whether or not the substance will be subject to authorisation;

- which uses of the included substances will not need authorisation (e.g. because sufficient controls established by other legislation are already in place);
- the 'sunset date' by when a substance can no more be used without authorisation.

Step 3: Applications for authorisation (by industry)
Applications for authorisation need to be made within the set deadlines for each use that is not exempted from the authorisation requirement. They must include among others:
- a chemical safety report covering risks related to those properties that caused the substance to be included in authorisation system (unless already submitted as part of the registration);
- an analysis of possible alternative substances or technologies including, where appropriate, information on research and development foreseen or already in progress to develop such alternatives.

If the analysis of alternatives reveals that a there is a suitable alternative, the applicant must submit a substitution plan, explaining how he intends to replace the substance by the alternative. The suitability of available alternatives is assessed taking into account all relevant aspects, including whether the alternative results in reduction of overall risks and is technically and economically feasible.
An applicant can include a socio-economic analysis in his application, but in cases where he is not able to demonstrate adequate control of risks and where no suitable alternative exists, he needs to include one in his application.
A fee has to be paid for each application.
For all applications, the Agency will provide expert opinions. The applicant can comment on these opinions.

Step 4: Granting of authorisations (by the European Commission)
Authorisations will be granted if the applicant can demonstrate that the risk from the use of the substance is adequately controlled. The 'adequate control route' does not apply for substances for which it is not possible to determine thresholds and substances which are persistent, bioaccumulative and toxic or very persistent and very bioaccumulative, so called PBT or vPvB substances.
If the risk is not adequately controlled, an authorisation may still be granted if it is proven that the socio-economic benefits outweigh the risks and there are no suitable alternative substances or technologies.
Downstream users may only use such substances for uses which have been authorised.

For this they must either:
- obtain the substance from a company that was granted an authorisation for that use. They must stay within the conditions of that authorisation. Such downstream users must notify the Agency that they are using an authorised substance.
- apply themselves for authorisations for their own uses.

Reviews
All authorisations will be reviewed after a certain time-limit which will be set on a case-by-case basis.

4.3.2 Restriction (REACH Annex XVII)

REACH foresees a restriction process to regulate the manufacture, placing on the market or use of certain substances within the EU territory if they pose an unacceptable risk to health or the environment. Such activities may be limited or even banned, if necessary. The restriction is designed as a 'safety net' to manage risks that are not addressed by the other REACH processes.

Any substance on its own, in a preparation or in an article may be subject to restrictions if it is demonstrated that risks need to be addressed on a community-wide basis. Restrictions of a substance can apply to all uses or to specific uses. All uses of a restricted substance which are not specifically restricted are allowed under REACH unless they are subject to authorisation, or other community or national legislation regulating their use. There is no tonnage threshold for a substance to be subject to restriction. Proposals for restrictions will be prepared by Member States or by the Agency on request of the Commission in the form of an Annex XV dossier. The Annex XV dossier should demonstrate that there is a risk to human health or the environment that needs to be addressed at community level and should identify the most appropriate set of risk reduction measures. Annex XVII contains restrictions on the manufacture, placing on the market and use of certain dangerous substances, preparations and articles.

In combination with the obligations of the WFD to phase out or cease emissions of cadmium, mercury, PAHs and TBT, further restriction for these substances under REACH could be considered. Within the ad hoc Drafting Group on Emissions it was remarked that it will not be an easy task to prepare a restriction dossier. Further remarks made were that there are certain criteria to start such dossiers, that there should be emissions and that probably more specific legislation can be used in diminishing emissions as well. These specific pieces of legislation may also lead to a result faster. Some participants of the ad hoc Drafting Group indicated that the links between the various pieces of legislation should automatically lead to actions when priority substances are identified. It was stated that an official working procedure with a link between the identification of priority substance and the procedure of putting a substance on the REACH candidate list is pure logic and that an identified priority substance has in the long run to be restricted in its use and marketing by REACH. By other participants it was also questioned if REACH is the right tool for measures as the scope is much broader than only the water compartment and not all uses of a specific substance affect the water compartment.

All four substances or substance groups fulfil the criteria for SVHC:

- Cadmium is classified as carcinogenic category 1B.
- Mercury is classified repro-toxic category 1B.
- Anthracene fulfils the PBT criteria, and benzo(a)pyrene has been classified as carcinogenic category 1B, mutagenic category 1B and repro-toxic category 1B.
- Bis(tributyltin)oxide (TBTO) also fulfils the PBT criteria, whereas from tetrabutyltin it is denoted as PBT forming substance.

All four substances of concern meet the criteria for authorisation. At present anthracene, various anthracene oil constituents and TBTO are mentioned in the candidate list for Annex XIV.

All four substances (cadmium, mercury, PAHs and TBT) are included with restrictions in Annex XVII, as it was decided to incorporate all restrictions under Directive 76/769/EEC into Annex XVII without following the full restrictions procedure laid down in article 68. At present, there are three proposals to amend Annex XVII, not considering the substances subject to this report (ECHA, 2012b).

At present a restriction dossier for mercury in measuring devices is being discussed. A communication on this topic has already been published by the Commission in 2007 (European Commission, 2007a). Other examples of restriction dossiers are PAHs in tyres and cadmium in PVC and ornaments.

4.4 Regulation (EC/850/2004) on Persistent Organic Pollutants (POPs)

The POP Regulation is developed to prohibit or restrict the production, placing on the market and use of substances which are very persistent, very bioaccumulative, toxic and which are transported over long distances. Thus, the regulation embraces a limited range of substances, but does not apply to specific emission routes.
The regulation is the European implementation of the UNEP Stockholm Convention on POPs and the UNECE-LRTAP POP Protocol. Substances which are produced and used intentionally can be listed in either Annex I, which prohibits production and use, or Annex II, which restrict production, placing on the market and use. For the substances listed in Annex III, which contain unintentionally released substances Member States must draw up release inventories into air, water and land. The Member States have to develop an action plan including measures to minimise releases and with the final aim to eliminate these where feasible. Also, priority consideration should be given to alternative processes, techniques or practices that have similar usefulness but which avoid formation and release of Annex III substances (article 6 of 850/2004/EC, see also UNECE, 1998 and UNEP, 2001).
Substances can be added to the annexes of the POPs Regulation if the substances are listed in the Convention or the Protocol. To add a substance to the Convention or the Protocol, a substance dossier has to be created and judged by the Persistent Organic Pollutants Review Committee (UNEP) or the Task Force POP under the Working Group on Strategies and Review (UNECE). After the review has been finalised, the Conference of Parties (UNEP) or the Executive Body (UNECE) decides on amendment of the Convention or the Protocol (Vos and Janssen, 2005).

The European POP Regulation, 850/2004/EC, is the European implementation of the Stockholm Convention on Persistent Organic Pollutants (POPs) (UNEP, 2001) and the Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants (LRTAP) (UNECE, 1998).
The Regulation entered into force on 20 May 2004 and is developed to implement the remaining provisions of the Convention and the Protocol which are not covered by existing Community legislation.
At first the REACH Regulation was considered to be an appropriate instrument to implement the necessary control measures on POPs and a special annex was dedicated to the POPs. Later, the POPs Regulation was developed and entered into force in order to implement the control measures on POPs as soon as possible. Consideration 8 of the Regulation states: *'In the future, the proposed REACH Regulation could be an appropriate instrument by which to implement the necessary control measures on production, placing on the market and use of the listed substances and the control measures on existing and new chemicals and pesticides exhibiting persistent organic pollutants' characteristics. However, without prejudice to the future REACH Regulation and since it is important to implement these control measures on the listed substances of the Protocol and the Convention as soon as possible, this Regulation should for now implement those measures.'* The objective of the Regulation is the protection of human health and the environment by prohibiting, phasing out or restricting the production, placing on the market and use of substances subject to the Convention or the Protocol. In addition, it establishes provisions regarding waste containing any of these substances (article 1 of POPS Regulation 850/2004/EC).
If a use of a substance is subsequently prohibited or otherwise restricted in Regulation EC/850/2004 the Commission shall withdraw the authorisation for that use from the REACH Regulation (REACH article 61).

Of the four selected substances, only PAHs are covered by the POP Regulation. The PAHs are listed in Annex III and are thus subject to release reduction measures.

4.5 Biocidal Products Directive (98/8/EC) and Plant Protection Products Directive (91/141/EEC)

The Water Framework Directive refers to the Plant Protection Products Directive and the Biocidal Products Directive in article 16 and in Annex II. In article 16 it refers to the selection of priority substances on basis of the risks identified through the risk assessments carried out under these directives and product controls including relevant authorisations under these directives. In Annex II it refers to information on potentially harmful effects and control measures gathered under the relevant articles of directives 91/414/EEC and 98/8/EC.

Plant protection products

The Plant Protection Products Directive (91/414/EEC) concerning the placing of plant protection products on the market lays down rules and procedures for approval of the active ingredients at EU level and for the authorisation at Member State level of plant protection products (PPPs) containing these active ingredients. Active ingredients can only be used in plant protection products if they are included in a positive EU list provided in Annex I of the directive. Once an active ingredient is included Member States may authorise the use of products containing these active ingredients. Before inclusion in Annex I of the directive new active ingredients have to be evaluated concerning the harmful effects on human health and the environment and on the effectiveness against pests. Plant protection products on the market before 1991 were not extensively screened against these criteria. Therefore the European Commission started a 10-year review programme in which the existing pesticides were evaluated in accordance with European-wide criteria. Before the review was carried out, authorisation was based on national rules and level of protection could vary widely. More information on the Plant Protection Products directive can be found on the Plant Protection website of the European Commission (European Commission, 2012b). A list of active ingredients of plant protection products is available in the EU pesticide database at (European Commission, 2012c). This database contains approved active ingredients, active ingredients that are not included in the positive list and banned substances.

Biocides

The Biocidal Product Directive (98/8/EC) aims to harmonise the authorisation and placing on the European market of biocidal products and to ensure a high level of protection for humans, animals and the environment. Active ingredients have to be assessed and the decision on their inclusion into a list of authorised active ingredients (Annex I or IA of the directive) is taken at community level. If there are less harmful, suitable alternatives, the inclusion may be denied. The authorised active ingredients can be found on the biocides website of the European Commission (European Commission, 2012d). Products can only be placed on the market when the active ingredients are authorised. Once a biocidal product is authorised in one Member State it shall be authorised upon application also in other Member States unless there are specific grounds to derogate from the principle of mutual recognition.

Many Member States did not have a full legislative regime for biocidal products before the Biocidal Products Directive came into force in 2000. Active substances that were present on the market before 2000 are being examined in a 10-year working programme. Active ingredients that are of marginal use, or that have unfavourable effects on men and/or the environment will not be included in the list in Annex I

(European Commission, 2008a) and have to be phased out within 12 months after the decision of non-inclusion.
In 2009 the European Commission proposed a new regulation on biocides which is expected to replace the Biocidal Products Directive in 2013. The objective of the new regulation is to improve the functioning of the internal market in biocidal products while maintaining a high level of protection of human health and the environment. Similar to the directive the Regulation will work through a two-tier authorisation process: firstly, the inclusion of the active substance in an annex and secondly, the authorisation of the biocidal product by the Member States. More information on the Biocidal Products Directive can be found on the biocides website of the European Commission (European Commission, 2012d).

Of the four substances discussed within the ad hoc Drafting Group on Emissions, cadmium can not be found on Annex I of directive 91/414/EEC, which suggests that it has never been used as an active ingredient within the scope of this directive. Various mercury compounds have been banned as a pesticide by means of the directive prohibiting the placing on the market and use of plant protection products containing certain active substances (97/117/EC). The organic tin compounds fentin acetate, fentin hydroxide and bis(tributyltin) oxide have not been included in the positive list by means of decisions 02/478/EC, 02/479/EC and 2002/2076/EC, whereas fenbutatin oxide has been voluntarily withdrawn, but has been resubmitted since than. Cyhexatin has not been included in Annex I due to withdrawal of the sole notifiers from the re-evaluation process (Decision 2008/296/EC). Of the PAHs only anthracene oil and 1-4 Dimethylnaphtalene could be found on the list of active ingredients. By means of regulation EC/2076/2002 anthracene oil was not included in Annex I, whereas inclusion of 1-4 Dimethylnaphtalene is still pending.

None of the four substances discussed within the ad hoc Drafting Group on Emissions can be found on the list of authorised substances in Annex I of the Biocidal Products Directive. Bis(tributyltin)oxide (CAS 56-35-9) can be found on the list of substances for which a decision of non-inclusion in Annex I or IA has been adopted, whereas creosote is under review. The Commission has started a consultation procedure and invited stakeholders to comment on the possible consequences of the inclusion or non-inclusion of creosote in Annex I. Information on the re-evaluation of creosote can be found on the biocides website of the European Commission (European Commission, 2012e).

4.6 Directive 2008/98/EC on waste (Waste Framework Directive)

The Water Framework Directive does not refer to the Waste Directive. However, Annex VI of the WFD does refer to the Sewage Sludge Directive (86/278/EEC). The WFD also refers to the Urban Waste Water Treatment Directive (91/271/EEC) in article 10(1), Annex II and Annex VI. The Waste Framework Directive lays down general rules applying to waste management, in order to protect human health and the environment. It is explicitly mentioned that risk to water, air, soil, plants and animals should be minimised, that nuisance through noise or odours should be prevented and that the countryside or places of special interests should not be adversely affected by waste (article 4 of 2006/12/EC).

The EU approach to waste management is based on following principles:
- waste prevention;
- recycling and reuse;
- improving final disposal and monitoring.

A more extensive explanation is given on the waste website of the European Commission (European Commission, 2012f).

The Waste Framework Directive (2008/98/EC) provides an overall structure for waste management within the EU. This directive replaces the previous codified Waste Framework Directive (2006/12/EC), with which the original Waste Framework Directive (75/442/EEC) was repealed. In comparison to the old Waste Framework Directive (75/442/EC) directive 2008/98/EC focuses more on recycling and re-use, contains the obligation to set minimum standards for treatment activities where there is evidence that a benefit in terms of the protection of human health and the environment would be gained from such minimum standards and includes an obligation for EU Member States to develop national waste prevention programmes. Directive 2008/98/EC also merges, streamlines and clarifies legislation, sets the basic concepts and definitions related to waste management and lays down waste management principles such as the 'polluter pays principle' or the 'waste hierarchy'. Besides the Waste Framework Directive there are quite some legislative European documents on waste. An overview is given on the waste website of the European Commission (European Commission, 2012f).

Furthermore, the Commission's Communication on the Thematic Strategy in the prevention and recycling of waste (European Commission, 2005b), as well as some Commission staff working papers on waste may be a relevant sources of information. The Commission staff working document (European Commission 2008b) provides insight in the European legislative framework for waste and the priorities. The impact assessment of the Directive on Waste Electrical and Electronic Equipment (WEEE) (European Commission, 2008c) provides insight in the implementation of the WEEE Directive and the future priorities. The impact assessment indicates that there are economic reasons why sound management of WEEE is not yet to be fulfilled. Some of the main reasons include:

- hazardous substances are often the cheapest technical solutions in the short term;
- environmental recycling or disposal of WEEE brings extra financial costs with the benefits accruing to society;
- low prices for raw materials in previous decades discouraged investment in collection and recycling infrastructure and development of recycling technology.

There are also several daughter directives of the Waste Directive. These daughter directives lay down specific rules for categories of waste management. Because these daughter directives generally are directed to specific categories of waste or waste management, most of the daughter directives are not general, powerful tools for pollution risk reduction (NordRiskRed, 2001). However, specific daughter directives address specific categories of waste management or specific waste and define specific measures and emission limits and therefore may be of use to reduce emission in specific cases.

Although the various generic waste directives set the basic rules, they generally do not provide measures for specific substances. In quite a number of EU documents measures for specific substances are mentioned, including the four substances discussed within the ad hoc Drafting Group on Emissions. EU regulations and directives may provide binding rules for the substances mentioned, whereas the other EU documents may provide less binding decisions and recommendations. Most of the directives retrieved focus on both the application of the substance during use (restriction) as on recycling and re-use after the equipment becomes waste. Examples of both are given below for the four substances.

With the WEEE Directive (2002/96/EC) the EU aims to reduce the quantity of electrical and electronic waste by promoting reuse, recycling and other forms of recovery. The EU is also taking measures to restrict the use of hazardous substances, such as lead, mercury and cadmium, in this type of equipment. As it is not always possible to abandon these substances completely, the Commission provides tolerance levels for these substances and specifies exempted uses. Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators prohibits the placing on the market of most batteries and accumulators with a certain amount of mercury or cadmium and establishes rules for the collection, recycling, treatment and disposal of batteries and accumulators. A number of applications, such as the use in emergency and alarm systems, the use in medical devices and the use in cordless power tools, are exempted from the prohibition of cadmium. Interestingly article 4.4 mentions: '*The Commission shall review the exemption referred to in section 3(c), the use in cordless power tools, and submit a report to the European Parliament and to the Council by 26 September 2010, together, if appropriate, with relevant proposals, with a view to the prohibition of cadmium in batteries and accumulators*.' At present, the directive is being revised (COM/2008/0211 final). The relationship with other European documents is reflected by Galligan and Morose (2004) stating: '*The impetus for changing the legislation addressing the way batteries are handled came from the EU Sixth Community Environment Action Programme (6EAP), which outlined environmental objectives and priorities for the decade starting in July 2002*.'

Directive 2000/53/EC on the end-of life vehicles aims to prevent the release of hazardous substances into the environment, to facilitate recycling and to avoid the disposal of hazardous waste. In particular the use of lead, mercury, cadmium and hexavalent chromium should be prohibited. The use of these heavy metals is restricted to certain applications according to a list in Annex II of the directive.

During the last years the Commission decided to establish criteria for the award of the Community Eco label to a number of products such as wooden floor coverings (C(2009) 9427), wooden furniture (C(2009) 9522), hard coverings (C(2009) 5613), bed mattresses (C(2009) 4597), footwear (C(2009) 5612), and outdoor paints and varnishes (C(2008) 4452). In order to be awarded, products within each product group must comply with the criteria set out in the annex to these decisions. In most cases these criteria also comprise regulations on hazardous substances such as cadmium, mercury and organic tin compounds in order to prevent these substances to end up in the waste stream.

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Appendix 2 Fact sheet cadmium (Cd, CAS: 7440-43-9)

Substance specific information cadmium
Cadmium is a naturally occurring element with ubiquitous distribution. Although cadmium ores also exist (greenockite) these are not commercially important. Cadmium is a Water Framework Directive (WFD) Priority Hazardous Substance, meaning that all emissions, discharges and losses to water need to be phased out or eliminated. Under Regulation (EC) No 1272/2008 cadmium is classified as carcinogenic category 2; R45 (may cause cancer), mutagenic category 3; R68 (possible risk of irreversible effects), toxic to reproduction category 3; R62 (possible risk of impaired fertility) and R63 (possible risk of harm to the unborn child), T+; R26 (very toxic by inhalation), T; R48/23/25 (toxic: danger of serious damage to health by prolonged exposure through inhalation and if swallowed), and N; R50/53 (very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment).

Production of cadmium
The information in this section is mainly based on the EU Risk Assessment Report (EU-RAR) and the SOCOPSE report (ECB, 2007; Zielonka et al., 2009a).
Zinc (sulphide) ores are the primary source for cadmium production. Smaller amounts of cadmium are produced during the production of other non-ferrous metals such as lead. In the refining of these ores cadmium is obtained as a by-product (Cadmium Association, 1991).
In the EU-RAR it is stated that the European primary cadmium production is estimated at approximately 5,000 t/y (1994) to 5,800 t/y (1996), produced at 12 sites all over the EU territorial surface. The EU-RAR states: '*An update provided by Industry (2003) reveals that there are now only three, possibly four sites: Budel (now known as Pasminco, Budel) in the Netherlands, Norzink (now known as Norzinc Outokumpu) in Norway, Enirisorse (now known as Porto Vesme, owned by Glencore) in Italy and possibly Metaleurop Weser Zink (recently taken over by Glencore) in Germany*.'
According to the World Metal Statistic of July 2009 (World Bureau of Metal Statistics, 2009), the refined production of cadmium in the European Union amounted in 2005 to 1,943.7 tonnes, in 2006 to 1,917.7 tonnes, in 2007 to 2,048.7 tonnes and in 2008 to 2,106.7 tonnes. According to these statistics, the production takes place in Bulgaria, France, Germany, the Netherlands and Poland. Between 153 tonnes (2005) and 178 tonnes (2008) are produced in addition in Norway. The amount imported in Europe in the same period is estimated at 1,500 tonnes/year to 960 tonnes/year (figure is representative for January-July 1996) (Eurostat, 1997 in ECB, 2007). Export out of Europe is estimated at 2,200 t/y (1996). This latter figure is obtained by subtracting the total EU consumption from the total EU production. According to the data published in the interim review of the scientific information on cadmium, published at the UNEP website (UNEP, 2008) and based on information provided by the International Cadmium Association's report of 2007, the total consumption of cadmium in the European Union amounted in 2006 to 5,713 tonnes.

Use of cadmium
Metallic cadmium is commercialised in different forms: powder, balls (3-5 cm diameter), plates (10-200-200 to 1,000mm) or sticks (200 to 240-10 to12 mm) (ECB, 2000). Metallic cadmium and cadmium oxide are mainly used in the production of nickel-cadmium batteries. Further, cadmium is used in coatings, alloys, pigments and other miscellaneous uses. The two types of 'main categories' for cadmium are characterised as non-dispersive use and use resulting into or onto a matrix.

A list of about 40 selected applications of cadmium is provided in Butterman and Plachy (2002). These applications can be divided into 5 main categories: batteries, pigments, stabilizers, plating and other uses. Butterman and Plachy (2002) also provide the distribution among these categories in 1960, 1980 and 2000, showing a reduction in use and a shift from cadmium mainly applied in plating to cadmium mainly applied in batteries. The US Geological survey Mineral Commodity Summaries of 1996 (USGS, 1996) indicated a large share of cadmium use for batteries and predicted an even greater share if the sales of electric vehicles would accelerate. The report also indicates that the US market for cadmium containing pigments was reduced until 1/8th of its 1988 size due to stricter environmental regulations and increased availability of alternatives. The 2010 report (USGS, 2010) foresees a stable application of NiCd batteries world wide, with a large percentage of the global NiCd market being concentrated in Asia. It further foresees a decrease of the application of NiCd batteries in the consumer market, but a higher demand for industrial applications. US statistics and other information on cadmium can be found on the website of the United States Geological Service (USGS, 2012).

Emission sources cadmium

The information on cadmium emission is mainly based on the material flow analysis (MFA) in the SOCOPSE report (Zielonka et al., 2009a) in which estimates have been made on total emission balances for the Netherlands, Denmark, and the EU as a whole. The total emissions of cadmium mentioned in the SOCOPSE report are much higher than the emissions reported in EPER which is caused by the information sources used. EPER covers only large and medium-sized industrial plants, listed in Annex I of the IPPC Directive, while SOCOPSE uses a number of databases and reports in addition to the EPER database (Pacyna, 2009). Therefore, it was decided to use the SOCOPSE report to identify the emission sources and the possible measures.

Table A.1 and Figure A.1 present emissions of cadmium to the aquatic environment air, land and water expressed in tonnes/year as a so-called material flow analysis (MFA) (Pacyna, 2009, Zielonka et al. 2009a) The interactions between the media are not clarified in the SOCOPSE document. The importance of the sources is indicated in Table A.2.

The total releases of cadmium to the aquatic environment in Europe were estimated to be about 590 tonnes/year for air and 500 tonnes/year for water. Estimated releases to the terrestrial environment were three times higher than the releases to the aquatic environment, possibly up 1,500 tonnes per year[2]. The emissions in Europe for 2000 as reported in the European risk assessment and attributed only to the use of cadmium as a commercial product and releases from point sources were as follows: to the atmosphere 124 tonnes, to water approximately 39 tonnes, and to the terrestrial ecosystem about 245 tonnes (ECB, 2007).

[2] estimations according to WP2 SOCOPSE

Table A.1 MFA table for cadmium in Europe at the beginning of the 2000's based on the MFA diagram for cadmium in Europe in 2000 in (Zielonka et al., 2009a)

	Air [tonnes/year]	**Land [tonnes/year]**	**Water [tonnes/year]**
Non-ferrous metal[1]	-		100
Agriculture and phosphate fertilizer production[1]	Low	165	Low
Iron and steel production[1]	45.60		
Combustion installations[1]	366		Low
Manufacturing processes[1]	52	75	125
Cement production[1]	64.5		
Road transport and other mobile sources[1]	Low		
Waste treatment and disposal	9.2	825	100
Atmospheric deposition	?	195	125
Cadmium stabilizers[2]			
Cadmium electroplating[2]			
Batteries[2]			
Cadmium pigments[2]			
Other Sources		75	Low
Sub-TOTAL	*± 537*	*1335*	*±450*
not further specified above	*53*	*165*	*50*
TOTAL	*590*	*1500*	*500*

[1] cadmium as by-product.

[2] cadmium as product.

The following part has been taken from the SOCOPSE report 2007 (Pacyna, 2007): '*The estimated emissions into the atmospheric compartment are about 590 tonnes cadmium per year and are mainly resulting from combustion installations together with refuse incineration. These emission sources contribute alone to about 63% and 17% of the total emission to air respectively. For fuel combustion, the main part of the emissions are emerging from oil boilers (26% of total emissions to air) and coal boilers (17% of total emissions to air) as well as coal fuel combustion (17% of total emissions to air). Fuel combustion of oil contributes for less than 3% to the total emissions to air. Large quantities are also related to cement production, non-ferrous metal industry and iron and steel production being responsible for 11%, 9% and 9% of the total emissions to air. Contributions from agriculture and road transport are assumed to be very low. Large parts of the atmospheric deposition are deposited into the aquatic and terrestrial surfaces in Europe.*

Cadmium emissions to the aquatic environment is for Europe estimated to be about 500 tonnes per year where 1/3rd of the discharge is caused by manufacturing processes (including metals, chemicals and petroleum products) and atmospheric deposition, contributing with 25% of the total emissions to water each. Both primary non-ferrous metal production and domestic waste treatment plants are counting for about 20% of the total emissions to water.[3]
The soil compartment is the largest receiver of cadmium and is assumed to receive about 1,500 tonnes per year. The source of emissions is first and foremost occurring from waste treatment and disposal with a quantity of about 30% of the total emissions

[3] The primary cadmium sources are indicated in MFA diagram in Figure A.1

to the compartment. These emissions are related to disposal of fly ash and bottom ash from power plants and waste incineration. Land filling of urban refuse is responsible for about 25% and wastage of commercial products are responsible for about 5% of the emissions to the compartment. Next, the atmospheric deposition to terrestrial ecosystems is responsible for about 13% while filling of various foods and agriculture waste counts for about 11% of the total emissions received by the compartment for soil. Except food, the disposal of waste from various manufacturing processes and wastage of commercial products on land both are responsible for about 5% of the total. Municipal sewage sludge application is expected to give low contributions to the total" (Pacyna, 2007).

Jensen and Bro-Rasmussen,(1992, in Zielonka et al., 2009a) indicated that that 70-90% of all cadmium circulating within the community is disposed of as waste in solid waste deposits. This is reflected in the large share of waste treatment and disposal in the MFA diagram in Figure A.1.

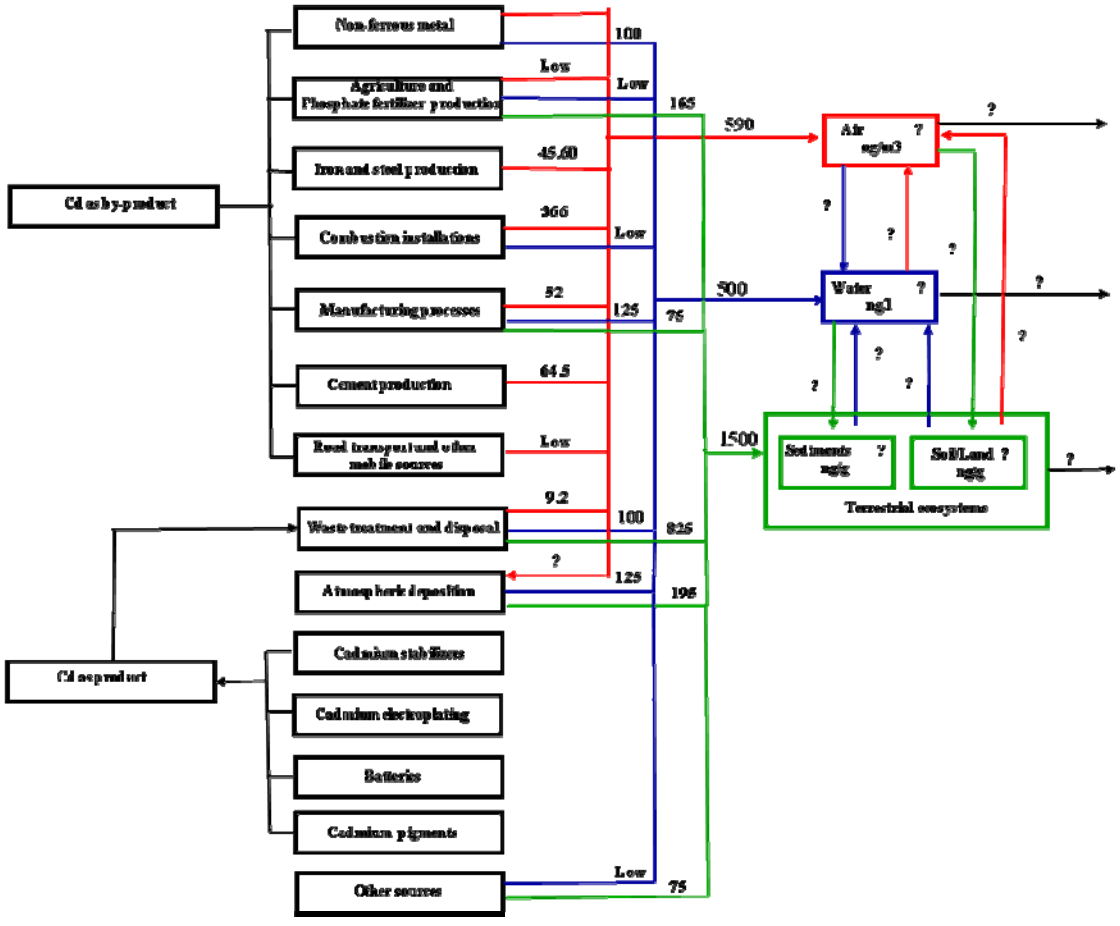


Figure A.1 MFA diagram for cadmium in Europe in 2000 (numbers in tonnes/year, unless indicated otherwise) Zielonka et al., 2009a

Table A.2 Cadmium emissions to air, land, and water in 2000, Zielonka et al., 2009a

Medium	Sources	DS/PS [a]	Importance per medium [%]	Importance for total[b] [%]
Air	Combustion of fossil fuels (coal/oil/gas for the production of electricity and heat)	PS	44.3	10.1
	Cement production	PS	Low emissions	
	Primary (smelters) non-ferrous metal production pyrometallurgical zinc production, pyrometallurgical copper production, pyromettalurgical lead production	PS	19.3	4.4
	Secondary non-ferrous metal production	PS	Low emissions	
	Iron and steel production, including coke production pig iron production, steel production (various technologies), coke production	PS	13.7	3.1
	Major uses of cadmium in production and consumption	PS/DS	Low emissions	
	Waste disposal: incineration of municipal waste, incineration of hazardous waste	PS	3.4	0.8
	Road transport and other mobile sources and machinery	DS	Very low emissions	
	Phosphate fertilizer production	DS	Low emissions	
Land	Land-filling of various food and agriculture waste	PS	11	6.4
	Land-filling of urban refuse	PS	25	14.5
	Municipal sewage sludge agricultural application	PS	Low emissions	
	Disposal of waste from various manufacturing processes except food	PS	5	2.9
	Disposal of fly ash and bottom ash from power plants and waste incineration	DS	30	17.4
	Wastage of commercial products on land	DS	5	2.9
	Atmospheric deposition to terrestrial ecosystems	DS	13	7.5
	Fertiliser use	DS	10	5.8
Water	Domestic waste disposal – waste treatment plants central WWTP non-central WWPT	PS	20	3.9
	Cooling tower waters in the combustion of fossil fuels	PS	Low contribution to emissions	
	Base metal mining	PS	Low	
	Primary non-ferrous metal production – hydrometallurgical technology	PS	20	3.9
	Iron and steel production	PS	Low emissions	

Medium	Sources	DS/PS [a]	Importance per medium [%]	Importance for total[b] [%]
Water	Manufacturing processes metals, chemicals, petroleum products Major uses of cadmium	PS PS/DS	25 Low emissions	4.8
	Road transport and other mobile sources and machinery	DS	Very low emissions	
	Agriculture related sources	DS	Very low emissions	
	Atmospheric deposition to European seas and their catchments	DS	25	4.8
	Sediment re-suspension	DS	Probably low emissions	

[a] DS = Diffuse Source, PS = Point Source

[b]Total emissions are estimated 2590 tonnes/year in 2000. 6.9% of total emissions is attributed an importance of "low" or "very low".

Sources and measures cadmium

An introduction into this subject has been provided by Vos et al. (2008). Cadmium is heavily regulated and this has not been without effects on the global cadmium market. The US Geological Survey (USGS) Mineral Commodity Summaries of 1996 (USGS, 1996) indicated that the reduction in the use of cadmium containing pigments between 1988 and 1996 could be attributed to stricter environmental regulations and the availability of alternative pigments. The report mentions that both recyclability and potential liability were important for both consumers and suppliers, but that further substitution would become increasingly difficult. The 2001 report of the USGS (USGS, 2001) mentions the increasing regulatory pressure to reduce or eliminate of cadmium in many developed countries and specifically note the listing of cadmium in the US Environmental Protection Agency list of persistent and bioaccumulative toxic pollutants and the aim to reduce the use of cadmium by 50% by 2005. The listing has been objected by the International Cadmium Association because no distinction was made between various cadmium compounds and cadmium metal (USGS, 2001).

Europe published a Council Resolution on a Community action programme to combat environmental pollution by cadmium (88/C 30/01) in 1988. Although the action programme does not contain concrete measures, it has set the scope for the development of measures.

Cadmium was also identified as a priority substances under the Existing Substances Regulation (EEC/793/93). The risk evaluation for cadmium and cadmium oxide resulted in a strategy for limiting the risks of these substances. The recommendations were published by means of Communication 2008/C149/03 and the obligatory socio-economic analysis of potential measures, focussing on cadmium in brazing alloys, cadmium in jewellery and cadmium in PVC waste, has been published in 2010 (RPA, 2010). The latter report will be used in proposals for amendments of the cadmium entries under Annex XVII of the REACH Regulation.

The largest use of cadmium, the use in batteries, has been dealt with in EU Directive 2006/66/EC. It reflects two items mentioned in the action programme: limitation of the uses of cadmium to cases where suitable alternatives do not exist; and collection and recycling of products containing cadmium, for example batteries. The directive prohibits the use of portable batteries and accumulators that contain more than 0.002% of cadmium by weight except for the use in emergency and alarm systems, including

emergency lighting, medical equipment, and cordless power tools. Article 9 of the directive allows Member States to use economic instruments to promote the collection of waste batteries and accumulators or to promote the use of batteries and accumulators containing less polluting substances, for instance by adopting differential tax rates. In that case the Member State has to notify the measures to the Commission. Furthermore the directive oblige the Commission to review the exemption for cordless power tools and report it to the European Parliament and to the Council together with relevant proposals on the prohibition of cadmium in batteries and accumulators, if appropriate.
The International Cadmium Association provided information on production, applications and trends and pleads for an increased recycling rather than a ban on cadmium in batteries. It provides various examples of recycling programmes and advocates that improved collection of all chemistries would be more important than only focussing on batteries (Morrow, 2005).
Recycling programmes are mentioned in a information sheet by Residua (2000), which mentions a mandatory collection in Germany, and voluntary collections in Belgium and Denmark. The information sheet raises the question who should pay the recycling operation and pinpoints the fact that in most cases the cost of recycling exceeds the revenues to be obtained (Residua, 2000).
The US Geological Survey Mineral Commodity Summaries of 2010 (USGS, 2010) remarks: '*Concern over cadmium's toxicity has spurred various recent legislative efforts, especially in the European Union, to restrict the use of cadmium in most of its end-use applications. The final effect of this legislation on global cadmium consumption has yet to be seen. If recent legislation involving cadmium dramatically reduces long-term demand, a situation could arise, such as has been recently seen with mercury, where an accumulating oversupply of by-product cadmium will need to be permanently stockpiled.*'

Cadmium in fertilisers have long been identified as an important source of cadmium in the European environment. The development of measures related to cadmium content in phosphate rock for the production of fertilisers was first mentioned in the action programme (88/C30/01). In a study 'Cadmium in the European Community: A policy-orientated analysis' Van der Voet (1996) identified the loading of agricultural soil by cadmium containing fertilisers as an important problem.
Sweden, Finland, and Austria had strict national rules on cadmium in fertiliser at the time of accession to the EU in 1995 and derogated successfully for exemptions to Directive 76/116/EEC, which did not contain limitations concerning the cadmium content. These exemptions were amended by means of Directive 98/97/EC which also indicated that the Commission should, in consultation with Member States and interested parties, review by 31 December 2001 the need for establishing provisions at Community level concerning the cadmium content of fertilisers. The review of the Commission has lead to a draft proposal relating to cadmium in fertilisers, for which an internet consultation have been launched early 2010. The draft proposal foresees the stepwise introduction of upper limits for cadmium in phosphate fertilisers over a transitory period of several years. This will allow the suppliers of phosphate the necessary time to adapt and ensure continuity of supply to the EU farmer. The aim is that the accumulation of cadmium in agricultural soils will be diminished. In the consideration of the draft directive it is stated that besides Austria, Finland an Sweden 'several other Member States have equally taken measures aimed at reducing the cadmium content in fertilizers. As a result, the EU fertilizer market is highly fragmented. Action aimed at remedying this situation is therefore needed'. The EU consultation and other information on the EU fertiliser regulations can be found on the DG Enterprise website of the European Commission (European Commission, 2012g).

The most recent decisions on the derogations by Austria, Finland and Sweden ((2006/349/EC, 2006/348/EC and (2006/347/EC) resulted in an amendment of Regulation EC/2003/2003. These derogations prohibit the placing on the Austrian market of phosphorous mineral fertilisers (containing 5% P_2O^5 or more) with a cadmium content exceeding 75 mg/kg P_2O^5, on the Finnish market of phosphorous mineral fertilisers with a cadmium content exceeding 50 mg for each kilogram of phosphorous, and on the Swedish market of fertilisers containing in excess of 100 grams of cadmium per tonne of phosphorous. Furthermore, Sweden has put a national tax on fertilisers with cadmium concentrations over 5 g/tonne phosphorus (Oosterhuis et al., 2000; Månsson et al., 2008; Söderholm and Christiernsson, 2008). Other Member States aim for a cadmium reduction by applying other policy means. In 2000 the European Commission has commissioned a study on a European wide taxation on cadmium in fertilisers (Oosterhuis et al., 2000). Söderholm and Christiernsson (2008) remark that the use of fertilizer taxes would profit from the implementation of an EU-wide tax, but that the probability for such a EU-wide tax is small. '*The requirements on unanimity makes the adoption of horizontal measures difficult in the Union, not the least since the ambition of member states' environmental policies differ.'* Söderholm and Christiernsson (2008) focus on taxes on nitrogen and phosphate. More information on the Swedish fertiliser tax and on other economic instruments on environmental policy can be found on the website of the University College Dublin (2012).

The ad hoc Drafting Group on Emissions was informed by the Commission on a new opinion on cadmium in fertilisers by the Impact Assessment Board to be published in 2010. A previous impact assessment was published on the consultation webpage in 2003. The Commission also informed the ad hoc Drafting Group on the EFSA opinion of 2009 which concluded that although the risks for adverse effects are low the current exposure to cadmium at the population level should be reduced. Within the ad hoc Drafting Group best farming practices and agricultural and rural land management best practice to reduce the cadmium load and mentioning the cadmium concentration on the product were put forward as possible voluntary measures.

Both Van der Voet (1996) and Hawkins et al. (2006) indicate the importance to look at related substance cycles in order to formulate an effective policy for the control of cadmium. Hawkins et al. (2006) mention the zinc cycle, Van der Voet (1996) the zinc and organic phosphate cycle. Hawkins et al. (2006) recommend restriction on products with short lifetimes, while allowing products with long lifetimes, low risk of exposure during use and high recycling rates. Candidates mentioned by Hawkins et al. (2006) are industrial NiCd batteries and thin film photovoltaics.

The existing and possible measures at Member State and EU level, as provided by the participants of the ad hoc Drafting Group meetings, are given in Table A.3.

Table A.3 Sources and measures cadmium

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	**EU/international**	**National**	**EU/international**
General	Flanders: restrictions in use and in bringing on to the market : this is a federal matter; more information can be obtained from *FOD Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu DG Leefmilieu, Afdeling Risicobeheersing* (FOD, 2012)	Directive on Priority Substances (Directive 2008/105/EC).	REACH: national authorities can propose candidate substances for authorisation according to Annex XV. Substances in Annex XIV are not allowed to be used in production and products.	
	For cadmium there is also an 'action plan', which has the objective of mapping out the cadmium problems in Flanders and giving an overview of the measures (LNE, 2012)			

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	**EU/international**	**National**	**EU/international**
Cadmium in fertilisers	In derogation from Regulation No 2003/2003, the Austrian, Finnish and Swedish derogations concerning the cadmium content in phosphorous mineral fertilisers shall apply until harmonised measures on cadmium in fertilisers are applicable at community level – NL Decree on the execution of the Dutch act on fertilizers 'Uitvoeringsbesluit Meststoffenwet' sets limits on cadmium in fertilizers such as sewage sludge and compost. The limits for cadmium in sewage sludge are more stringent than those required in the Directive 86/278/EEC on sewage sludge. The act also sets limits to cadmium levels in anorganic fertilizer which is not arranged in Directive 76/116/EEC.	Regulation (EC) No 2003/2003 relating to fertilisers. Does not lay down cadmium limits.	UK: - Adoption of best farming practice to reduce pollution from fertilisers (Cd is a contaminant). The Environment Agency will: • enforce REACH Annex 17 restrictions; • provide advice to small and medium sized businesses on obligations in relation to priority substances, priority hazardous substances and specific pollutants through NetRegs website. Possible options that could be explored in this or subsequent cycles for Agriculture and Rural Land Management: Improved/ best practice storage and handling for fertilisers.	The Commission services have launched an internet consultation on a draft proposal relating to cadmium in fertilisers. The draft proposal foresees the stepwise introduction of upper limits for cadmium in phosphate fertilisers over a transitory period of several years. This will allow the suppliers of phosphate the necessary time to adapt and ensure continuity of supply to the EU farmer. The result will be that the accumulation of cadmium in agricultural soils will be diminished.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
Domestic waste disposal – waste treatment plants central WWTP versus non-central WWTP		REACH Regulation 1907/2006, Annex XVII		Consider appointing cadmium as a SVHC substance.
		Cadmium Directive 83/513/EEC on limit values and quality objectives for cadmium discharges requires Member States to set up an (prior) authorisation system for discharges of cadmium. Contains emission limits and monitoring requirements for effluent. Will be repealed by Directive 2008/105/EC per 2/12/2012.	UK: Investigate emissions from WWTPs and confirm whether further investigation into sources discharging to sewer is required.	Consider the possibility of lowering the limits and the discharges.
	Sweden: tax on cadmium containing batteries. DK: introduced a tax on NiCd batteries in 1996 which has resulted in increased recycling rates. Source: OECD, 2001.	Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators.		Consider water quality in the revision of Directive 2006/66/EC. Consider replacement of NiCd batteries in cordless power tools if there are feasible alternatives.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
		Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs. Sets limit values for metals in composted or fermented household waste: 0.7 mg Cd/kg dw, for soft ground rock phosphate and aluminium calcium phosphate: 90 mg Cd/kg $P_2O^{5.}$		
Primary non-ferrous metal production – hydrometal lurgical technology	The Dutch government initiated several programmes that offer financial support to participants in the innovation chain to stimulate the development and use of environmental friendly equipment and machinery. These tax-relief programmes (MIA/Vamil) give a direct fiscal advantage to companies that invest in environmental friendly machinery.	REACH Regulation 1907/2006, Annex XVII	UK EA: Local pollution prevention[4] campaign (including, where appropriate, campaigns to raise awareness of existing Marketing and Use Restrictions).	Consider appointing cadmium as a SVHC substance.

[4] The term pollution prevention refers to any action which reduces the chance of causing environmental pollution. This could include improvements to site drainage, e.g. to minimise risks from contaminated surface water, grey water and sewage, better waste storage and disposal, improved facilities for storage of chemicals, oil and other materials, and the development of contingency plans in case of spillages or other pollution incidents. Pollution prevention actions may be delivered through advice, or enforcement (e.g. anti-pollution works notices), or a combination of both. Advice to industry and the public on pollution prevention is available at: http://www.environment-agency.gov.uk/business/topics/pollution/39083.aspx.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
	NL: For the Dutch priority substances, reduction or elimination of emission is aimed for. Emissions of a number of these substances need to be reported in the so-called annual environmental report (Milieujaarverslag) by all installations, also the ones not covered by the IPPC. Application of BAT for all installations on case-by-case approach. Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: a (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation; • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).	Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC). Regulation (EC) No 166/2006	Consider application of BAT for all installations on a case-by-case approach. UK: Investigate emissions from installations and appraise options (to reduce at source or treat, up to BATNEEC) to meet EQS and reduce/cease emissions in this or subsequent rounds.	Consider setting more stringent measures in the revision of BREF documents under Directive 2008/1/EC concerning IPPC.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	**EU/international**	**National**	**EU/international**
Manufacturing processes metals, chemicals, petroleum products	The Dutch government initiated several programmes that offer financial support to participants in the innovation chain to stimulate the development and use of environmental friendly equipment and machinery. These tax-relief programmes (MIA/Vamil) give a direct fiscal advantage to companies that invest in environmental friendly machinery. Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits Flanders: a (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation; • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tried to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).	Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC). Regulation (EC) No 166/2006	Consider application of BAT for all installations on a case-by-case approach. UK: Investigate emissions from installations and appraise options (to reduce at source or treat, up to BATNEEC) to meet EQS and reduce/cease emissions in this or subsequent rounds.	Consider setting more stringent measures in the revision of BREF documents under Directive 2008/1/EC concerning IPPC.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
	For the Dutch priority substances, reduction or elimination of emission is aimed for. Emissions of a number of these substances need to be reported in the so-called annual environmental report (Milieujaarverslag) by all installations, also the ones not covered by the IPPC. Application of BAT for all installations on case-by-case approach. Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: a (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation; • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).			

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
Atmospheric deposition to European seas and their catchments	The NeR, the Netherlands Emission Guidelines for Air, is a national guideline, aimed at reducing emissions to air and harmonize the environmental permits in the Netherlands with respect to abatement of emissions to the air.	Directive 84/360/EEC on the combating of air pollution from industrial plants.		
		Directive 96/62/EC on ambient air quality. The 4th Daughter Directive of Directive 96/62/EC established a target value of 5 ng/m^3 air.		
		Directive 2000/76/EC on the incineration of waste, sets emission limit values to air of exhaust gases. For cadmium, 0.5 mg/l in waste water of cleaning exhaust gases and in air together with thallium an average of 0.05 mg/m^3 should be reached.		Consider the possibility of lowering the limits and the discharges.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	**EU/international**	**National**	**EU/international**
	NL: Consider application of BAT for all installations on a case-by-case approach. Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation; • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).	Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC). Regulation (EC) No 166/2006	Consider application of BAT for all installations on a case-by-case approach	Consider setting more stringent measures in the revision of BREF documents under Directive 2008/1/EC concerning IPPC.

Relevant legislation cadmium

There is a considerable amount of European legislation which refers/contains references to cadmium. Vos and Janssen (2005) indicated that 158 legislative texts referred to cadmium, whereas 52 of these contained measures relevant for the water compartment. Vos and De Poorter (2007) identified 174 legislative texts in force which referred to cadmium. This source also provides a summary of all relevant Eurlex entries in Appendix I. Further information is provided in Vos et al. (2008). The legislative texts can be of different scope, different size and different strength. The documents range from REACH restricting the production and use of cadmium for certain applications, to texts dedicated to a specific application and texts with a policy perspective, rather than a legislative content such as the Council Resolution 88/C 30/01 of 25 January 1988 on a Community action programme to combat environmental pollution by cadmium, the decisions on eco-label mentioned in section 4.5 and the communication on the risk assessment. The impact of such policy documents should not be underestimated.
Below the most important entries are provided, some relevant entries are provided in earlier sections such as 4.5 on the Waste Framework Directive. For a more complete overview the appendix in Vos and De Poorter (2007) is recommended. A good overview of current cadmium restrictions in the EU is also provided by RPA (2010).

Cadmium under REACH

Currently, cadmium is placed on Annex XVII of REACH. This annex concerns restrictions.
Entry 23 of Annex XVII to Regulation (EC) No 1907/2006 (REACH) as amended: Cadmium (CAS No 7440-43-9, EINECS No 231-152-8) and its compounds.
For the purpose of this entry, the codes and chapters indicated in square brackets are the codes and chapters of the tariff and statistical nomenclature of Common Customs Tariff as established by Council Regulation (EEC) No 2658/87.
1. Shall not be used to give colour to articles manufactured from the following substances and mixtures:

(a) polyvinyl chloride (PVC) [390410] [390421][390422]:
- polyurethane (PUR) [390950];
- low-density polyethylene (ld PE), with the exception of low-density polyethylene used for the production of coloured masterbatch [390110];
- cellulose acetate (CA) [391211] [391212];
- cellulose acetate butyrate (CAB) [391211][391212];
- epoxy resins [390730];
- melamine — formaldehyde (MF)[390920];
- urea — formaldehyde (UF) [390910];
- unsaturated polyesters (UP) [390791];
- polyethylene terephthalate (PET)[390760];
- polybutylene terephthalate (PBT);
- transparent/general-purpose polystyrene [390311] [390319];
- acrylonitrile methylmethacrylate (AMMA);
- cross-linked polyethylene (VPE);
- high-impact polystyrene;
- polypropylene (PP) [390210].

(b) paints [3208] [3209]

However, if the paints have a high zinc content, their residual concentration of cadmium shall be as low as possible and shall in any event be less than 0.1 % by weight.

In any case, whatever their use or intended final purpose, articles or components of articles manufactured from the substances and mixtures listed above coloured with cadmium shall not be placed on the market if their cadmium content (expressed as Cd metal) is greater than 0.01 % by weight of the plastic material.

2. However, paragraph 1 shall not apply to articles to be coloured for safety reasons.

3. Shall not be used to stabilize the following mixtures or articles manufactured from polymers or copolymers of vinyl chloride:
- packaging materials (bags, containers, bottles, lids) [3923 29 10];
- office or school supplies [392610];
- fittings for furniture, coachwork or the like [392630];
- articles of apparel and clothing accessories (including gloves) [392620];
- floor and wall coverings [391810];
- impregnated, coated, covered or laminated textile fabrics [590310];
- imitation leather [4202];
- gramophone records;
- tubes and pipes and their fittings [391723];
- swing doors;
- vehicles for road transport (interior, exterior, underbody);
- coating of steel sheet used in construction or in industry;
- insulation for electrical wiring.

In any case, whatever their use or intended final purpose, the placing on the market of the above mixtures, articles or components of articles manufactured from polymers or copolymers of vinyl chloride, stabilised by substances containing cadmium is prohibited, if their cadmium content (expressed as Cd metal) exceeds 0.01 % by mass of the polymer.

4. However, paragraph 3 does not apply to mixtures and articles using cadmium-based stabilisers for safety reasons.

5. For the purpose of this entry, 'cadmium plating' means any deposit or coating of metallic cadmium on a metallic surface.

Shall not be used for cadmium plating metallic articles or components of the articles used in the following sectors/applications:
(a) equipment and machinery for:
- food production: [8210] [841720] [841981] [842111] [842122] [8422][8435] [8437] [8438] [847611];
- agriculture [841931] [842481] [8432] [8433] [8434] [8436];
- cooling and freezing [8418];
- printing and book-binding [8440] [8442] [8443].

(b) equipment and machinery for the production of:
- household goods [7321] [842112] [8450] [8509] [8516];
- furniture [8465] [8466] [9401] [9402] [9403] [9404];
- sanitary ware [7324];
- central heating and air conditioning plants [7322] [8403] [8404] [8415].

In any case, whatever their use or intended final purpose, the placing on the market of cadmium plated articles or components of such articles used in the sectors/applications listed in points (a) and (b) above and of articles manufactured in the sectors listed in point (b) above is prohibited.

6. The provisions referred to in paragraph 5 shall also applicable to cadmium-plated articles or components of such articles when used in the sectors/applications listed in points (a) and (b) below and to articles manufactured in the sectors listed in (b) below:
(a) equipment and machinery for the production of:
- paper and board [841932] [8439] [8441];
- textiles and clothing [8444] (1) [8445] [8447] [8448] [8449] [8451] [8452].

(b) equipment and machinery for the production of:
- industrial handling equipment and machinery [8425] [8426] [8427] [8428] [8429] [8430] [8431];
- road and agricultural vehicles [chapter 87];
- rolling stock [chapter 86];
- vessels [chapter 89].

7. However, the restrictions in paragraphs 5 and 6 shall not apply to:
- articles and components of the articles used in the aeronautical, aerospace, mining, offshore and nuclear sectors whose applications require high safety standards and in safety devices in road and agricultural vehicles, rolling stock and vessels;
- electrical contacts in any sector of use, on account of the reliability required of the apparatus on which they are installed.

In addition, cadmium as such and all mixtures containing it at a concentration equal to or greater than 0.1% cannot be placed on the market or used for supply to the general public because cadmium is classified as a carcinogen category 2.

Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC)
The following plants require authorisation (among others): 'Plants for the production and melting of non-ferrous metals having installations with a total capacity of over 1 tonne for heavy metals or 0.5 tonne for light metals'. Heavy metals and their compounds are in the list of most important polluting substances:

2.5. Installations:
(a) for the production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes;
(b) for the smelting, including the alloyage, of non-ferrous metals, including recovered products, (refining, foundry casting, etc.) with a melting capacity exceeding 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals.

Council Directive 83/513/EEC on limit values and quality objectives for cadmium discharges (Cadmium Daughter Directive to DSD, to be repealed by Directive 2008/105/EC with effect from 22 December 2012)

ANNEX I

Limit values, time limits fixed for compliance with these values and monitoring procedures to be applied to discharges

1. *Limit values and time limits*

Industrial sector (1)	Unit of measurement	Limit values which must be complied with as from	
		1.1.1986	1.1.1989 (2)
1. Zinc mining, lead and zinc refining, cadmium metal and non-ferrous metal industry	Milligrams of cadmium per litre of discharge	0,3 (3)	0,2 (3)
2. Manufacture of cadmium compounds	Milligrams of cadmium per litre of discharge	0,5 (3)	0,2 (3)
	Grams of cadmium discharged per kilogram of cadmium handled	0,5 (4)	(5)
3. Manufacture of pigments	Milligrams of cadmium per litre of discharge	0,5 (3)	0,2 (3)
	Grams of cadmium discharged per kilogram of cadmium handled	0,3 (4)	(5)
4. Manufacture of stabilizers	Milligrams of cadmium per litre of discharge	0,5 (3)	0,2 (3)
	Grams of cadmium discharged per kilogram of cadmium handled	0,5 (4)	(5)
5. Manufacture of primary and secondary batteries	Milligrams of cadmium per litre of discharge	0,5 (3)	0,2 (3)
	Grams of cadmium discharged per kilogram of cadmium handled	1,5 (4)	(5)
6. Electroplating (6)	Milligrams of cadmium per litre of discharge	0,5 (3)	0,2 (3)
	Grams of cadmium discharged per kilogram of cadmium handled	0,3 (4)	(5)
7. Manufacture of phosphoric acid and/or phosphatic fertilizer from phosphatic rock (7)		—	—

(1) Limit values for industrial sectors not mentioned in this table will, if necessary, be fixed by the Council at a later stage. In the meantime the Member States will fix emission standards for cadmium discharges autonomously in accordance with Directive 76/464/EEC. Such standards must take into account the best technical means available and must not be less stringent than the most nearly comparable limit value in this Annex.

(2) On the basis of experience gained in implementing this Directive, the Commission will, pursuant to Article 5 (3), submit in due course to the Council proposals for fixing more restrictive limit values with a view to their coming into force by 1992.

(3) Monthly flow-weighted average concentration of total cadmium.

(4) Monthly average.

(5) It is impossible for the moment to fix limit values expressed as load. If need be, these values will be fixed by the Council in accordance with Article 5 (3) of this Directive. If the Council does not fix any limit values, the values expressed as load given in column '1.1.1986' will be kept.

(6) Member States may suspend application of the limit values until 1 January 1989 in the case of plants which discharge less than 10 kg of cadmium a year and in which the total volume of the electroplating tanks is less than 1,5 m^3, if technical or administrative considerations make such a step absolutely necessary.

(7) At present there are no economically feasible technical methods for systematically extracting cadmium from discharges arising from the production of phosphoric acid and/or phosphatic fertilizers from phosphatic rock. No limit values have therefore been fixed for such discharges. The absence of such limit values does not release the Member States from their obligation under Directive 76/464/EEC to fix emission standards for these discharges.

Council directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy

In consideration (6) it is described that '*In accordance with Article 4 of Directive 2000/60/EC, and in particular paragraph 1(a), Member States should implement the necessary measures in accordance with Article 16(1) and (8) of that Directive, with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances'*. and in consideration 20) that '*It is necessary to check compliance with the objectives for cessation or phase-out, and reduction, as specified in Article 4(1)(a) of Directive 2000/60/EC, and to make the assessment of compliance with these obligations transparent, in particular as regards the consideration of significant emissions, discharges and losses as a result of human activities*'.

According to article 5.5., the Commission shall verify that emissions, discharges and losses progress towards compliance with the reduction or cessation objectives.

ANNEX I

ENVIRONMENTAL QUALITY STANDARDS FOR PRIORITY SUBSTANCES AND CERTAIN OTHER POLLUTANTS

PART A: ENVIRONMENTAL QUALITY STANDARDS (EQS)

AA: annual average;

MAC: maximum allowable concentration.

Unit: [µg/l]

(1)	(2)	(3)	(4)	(5)	(6)	(7)
No	Name of substance	CAS number (1)	AA-EQS (2) Inland surface waters (3)	AA-EQS (2) Other surface waters	MAC-EQS (4) Inland surface waters (3)	MAC-EQS (4) Other surface waters
(1)	Alachlor	15972-60-8	0,3	0,3	0,7	0,7
(2)	Anthracene	120-12-7	0,1	0,1	0,4	0,4
(3)	Atrazine	1912-24-9	0,6	0,6	2,0	2,0
(4)	Benzene	71-43-2	10	8	50	50
(5)	Brominated diphenylether (5)	32534-81-9	0,0005	0,0002	not applicable	not applicable
(6)	Cadmium and its compounds (depending on water hardness classes) (6)	7440-43-9	≤ 0,08 (Class 1) 0,08 (Class 2) 0,09 (Class 3) 0,15 (Class 4) 0,25 (Class 5)	0,2	≤ 0,45 (Class 1) 0,45 (Class 2) 0,6 (Class 3) 0,9 (Class 4) 1,5 (Class 5)	≤ 0,45 (Class 1) 0,45 (Class 2) 0,6 (Class 3) 0,9 (Class 4) 1,5 (Class 5)
(6a)	Carbon-tetrachloride (7)	56-23-5	12	12	not applicable	not applicable
(7)	C10-13 Chloroalkanes	85535-84-8	0,4	0,4	1,4	1,4
(8)	Chlorfenvinphos	470-90-6	0,1	0,1	0,3	0,3
(9)	Chlorpyrifos (Chlorpyrifos-ethyl)	2921-88-2	0,03	0,03	0,1	0,1
(9a)	Cyclodiene pesticides: Aldrin (7) Dieldrin (7) Endrin (7) Isodrin (7)	 309-00-2 60-57-1 72-20-8 465-73-6	Σ = 0,01	Σ = 0,005	not applicable	not applicable
(9b)	DDT total (7) (8)	not applicable	0,025	0,025	not applicable	not applicable
	para-para-DDT (7)	50-29-3	0,01	0,01	not applicable	not applicable
(10)	1,2-Dichloroethane	107-06-2	10	10	not applicable	not applicable
(11)	Dichloromethane	75-09-2	20	20	not applicable	not applicable
(12)	Di(2-ethylhexyl)-phthalate (DEHP)	117-81-7	1,3	1,3	not applicable	not applicable
(13)	Diuron	330-54-1	0,2	0,2	1,8	1,8
(14)	Endosulfan	115-29-7	0,005	0,0005	0,01	0,004
(15)	Fluoranthene	206-44-0	0,1	0,1	1	1
(16)	Hexachloro-benzene	118-74-1	0,01 (9)	0,01 (9)	0,05	0,05
(17)	Hexachloro-butadiene	87-68-3	0,1 (9)	0,1 (9)	0,6	0,6
(18)	Hexachloro-cyclohexane	608-73-1	0,02	0,002	0,04	0,02

(1)	(2)	(3)	(4)	(5)	(6)	(7)
No	Name of substance	CAS number (1)	AA-EQS (2) Inland surface waters (3)	AA-EQS (2) Other surface waters	MAC-EQS (4) Inland surface waters (3)	MAC-EQS (4) Other surface waters
(19)	Isoproturon	34123-59-6	0,3	0,3	1,0	1,0
(20)	Lead and its compounds	7439-92-1	7,2	7,2	not applicable	not applicable
(21)	Mercury and its compounds	7439-97-6	0,05 (5)	0,05 (5)	0,07	0,07
(22)	Naphthalene	91-20-3	2,4	1,2	not applicable	not applicable
(23)	Nickel and its compounds	7440-02-0	20	20	not applicable	not applicable
(24)	Nonylphenol (4-Nonylphenol)	104-40-5	0,3	0,3	2,0	2,0
(25)	Octylphenol ((4-(1,1',3,3'-tetramethylbutyl)-phenol))	140-66-9	0,1	0,01	not applicable	not applicable
(26)	Pentachloro-benzene	608-93-5	0,007	0,0007	not applicable	not applicable
(27)	Pentachloro-phenol	87-86-5	0,4	0,4	1	1
(28)	Polyaromatic hydrocarbons (PAH) (10)	not applicable	not applicable	not applicable	not applicable	not applicable
	Benzo(a)pyrene	50-32-8	0,05	0,05	0,1	0,1
	Benzo(b)fluor-anthene	205-99-2	Σ = 0,03	Σ = 0,03	not applicable	not applicable
	Benzo(k)fluor-anthene	207-08-9				
	Benzo(g,h,i)-perylene	191-24-2	Σ = 0,002	Σ = 0,002	not applicable	not applicable
	Indeno(1,2,3-cd)-pyrene	193-39-5				
(29)	Simazine	122-34-9	1	1	4	4
(29a)	Tetrachloro-ethylene (7)	127-18-4	10	10	not applicable	not applicable
(29b)	Trichloro-ethylene (7)	79-01-6	10	10	not applicable	not applicable
(30)	Tributyltin compounds (Tributhyltin-cation)	36643-28-4	0,0002	0,0002	0,0015	0,0015
(31)	Trichloro-benzenes	12002-48-1	0,4	0,4	not applicable	not applicable
(32)	Trichloro-methane	67-66-3	2,5	2,5	not applicable	not applicable
(33)	Trifluralin	1582-09-8	0,03	0,03	not applicable	not applicable

(1) CAS: Chemical Abstracts Service.
(2) This parameter is the EQS expressed as an annual average value (AA-EQS). Unless otherwise specified, it applies to the total concentration of all isomers.
(3) Inland surface waters encompass rivers and lakes and related artificial or heavily modified water bodies.
(4) This parameter is the EQS expressed as a maximum allowable concentration (MAC-EQS). Where the MAC-EQS are marked as 'not applicable', the AA-EQS values are considered protective against short-term pollution peaks in continuous discharges since they are significantly lower than the values derived on the basis of acute toxicity.
(5) For the group of priority substances covered by brominated diphenylethers (No 5) listed in Decision No 2455/2001/EC, an EQS is established only for congener numbers 28, 47, 99, 100, 153 and 154.
(6) For cadmium and its compounds (No 6) the EQS values vary depending on the hardness of the water as specified in five class categories (Class 1: < 40 mg $CaCO_3$/l, Class 2: 40 to < 50 mg $CaCO_3$/l, Class 3: 50 to < 100 mg $CaCO_3$/l, Class 4: 100 to < 200 mg $CaCO_3$/l and Class 5: ≥ 200 mg $CaCO_3$/l).
(7) This substance is not a priority substance but one of the other pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009.
(8) DDT total comprises the sum of the isomers 1,1,1-trichloro-2,2 bis (p-chlorophenyl) ethane (CAS number 50-29-3; EU number 200-024-3); 1,1,1-trichloro-2 (o-chlorophenyl)-2(p-chlorophenyl) ethane (CAS number 789-02-6; EU number 212-332-5); 1,1-dichloro-2,2 bis (p-chlorophenyl) ethylene (CAS number 72-55-9; EU number 200-784-6); and 1,1-dichloro-2,2 bis (p-chlorophenyl) ethane (CAS number 72-54-8; EU number 200-783-0).
(9) If Member States do not apply EQS for biota they shall introduce stricter EQS for water in order to achieve the same level of protection as the EQS for biota set out in Article 3(2) of this Directive. They shall notify the Commission and other Member States, through the Committee referred to in Article 21 of Directive 2000/60/EC, of the reasons and basis for using this approach, the alternative EQS for water established, including the data and the methodology by which the alternative EQS were derived, and the categories of surface water to which they would apply.
(10) For the group of priority substances of polyaromatic hydrocarbons (PAH) (No 28), each individual EQS is applicable, i.e. the EQS for Benzo(a)pyrene, the EQS for the sum of Benzo(b)fluoranthene and Benzo(k)fluoranthene and the EQS for the sum of Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene must be met.

Regulation 166/2006 concerning the establishment of a European Pollutant Release and Transfer Register

A facility has to report data under E-PRTR for releases to water if it fulfils the following criteria:

- the facility falls under at least one of the 65 E-PRTR economic activities listed in Annex I of the E-PRTR Regulation and exceeds at least one of the E-PRTR capacity thresholds;
- the facility releases (transfers) pollutants which exceed specific thresholds specified for water – in Annex II(of the E-PRTR Regulation;
- an indicative list of activities which might have releases to water of specific pollutants can be found in the E-PRTR Guidance Document in Appendix 5.

The presented tables are not the full Annexes I and II. They can be found in the Regulation itself.

ANNEX I

Activities

No	Activity	Capacity threshold
1.	Energy sector	
(a)	Mineral oil and gas refineries	* (1)
(b)	Installations for gasification and liquefaction	*
(c)	Thermal power stations and other combustion installations	With a heat input of 50 megawatts (MW)
(d)	Coke ovens	*
(e)	Coal rolling mills	With a capacity of 1 tonne per hour
(f)	Installations for the manufacture of coal products and solid smokeless fuel	*
2.	Production and processing of metals	
(a)	Metal ore (including sulphide ore) roasting or sintering installations	*
(b)	Installations for the production of pig iron or steel (primary or secondary melting) including continuous casting	With a capacity of 2,5 tonnes per hour
(c)	Installations for the processing of ferrous metals:	
	(i) Hot-rolling mills	With a capacity of 20 tonnes of crude steel per hour
	(ii) Smitheries with hammers	With an energy of 50 kilojoules per hammer, where the calorific power used exceeds 20 MW
	(iii) Application of protective fused metal coats	With an input of 2 tonnes of crude steel per hour
(d)	Ferrous metal foundries	With a production capacity of 20 tonnes per day
(e)	Installations:	
	(i) For the production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes	*
	(ii) For the smelting, including the alloying, of non-ferrous metals, including recovered products (refining, foundry casting, etc.)	With a melting capacity of 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals
(f)	Installations for surface treatment of metals and plastic materials using an electrolytic or chemical process	Where the volume of the treatment vats equals 30 m^3
3.	Mineral industry	
(a)	Underground mining and related operations	*
(b)	Opencast mining and quarrying	Where the surface of the area effectively under extractive operation equals 25 hectares
(c)	Installations for the production of:	
	(i) Cement clinker in rotary kilns	With a production capacity of 500 tonnes per day
	(ii) Lime in rotary kilns	With a production capacity of 50 tonnes per day
	(iii) Cement clinker or lime in other furnaces	With a production capacity of 50 tonnes per day
(d)	Installations for the production of asbestos and the manufacture of asbestos-based products	*

ANNEX II

Pollutants (*)

No	CAS number	Pollutant (1)	Threshold for releases (column 1)		
			to air (column 1a) kg/year	to water (column 1b) kg/year	to land (column 1c) kg/year
1	74-82-8	Methane (CH_4)	100 000	— (2)	—
2	630-08-0	Carbon monoxide (CO)	500 000	—	—
3	124-38-9	Carbon dioxide (CO_2)	100 million	—	—
4		Hydro-fluorocarbons (HFCs) (3)	100	—	—
5	10024-97-2	Nitrous oxide (N_2O)	10 000	—	—
6	7664-41-7	Ammonia (NH_3)	10 000	—	—
7		Non-methane volatile organic compounds (NMVOC)	100 000	—	—
8		Nitrogen oxides (NO_x/NO_2)	100 000	—	—
9		Perfluorocarbons (PFCs) (4)	100	—	—
10	2551-62-4	Sulphur hexafluoride (SF_6)	50	—	—
11		Sulphur oxides (SO_x/SO_2)	150 000	—	—
12		Total nitrogen	—	50 000	50 000
13		Total phosphorus	—	5 000	5 000
14		Hydrochlorofluorocarbons (HCFCs) (5)	1	—	—
15		Chlorofluorocarbons (CFCs) (6)	1	—	—
16		Halons (7)	1	—	—
17		Arsenic and compounds (as As) (8)	20	5	5
18		Cadmium and compounds (as Cd) (8)	10	5	5
19		Chromium and compounds (as Cr) (8)	100	50	50
20		Copper and compounds (as Cu) (8)	100	50	50
21		Mercury and compounds (as Hg) (8)	10	1	1
22		Nickel and compounds (as Ni) (8)	50	20	20
23		Lead and compounds (as Pb) (8)	200	20	20
24		Zinc and compounds (as Zn) (8)	200	100	100
25	15972-60-8	Alachlor	—	1	1
26	309-00-2	Aldrin	1	1	1
27	1912-24-9	Atrazine	—	1	1
28	57-74-9	Chlordane	1	1	1

Directive 96/62/EC on ambient air quality assessment and management

ANNEX I

LIST OF ATMOSPHERIC POLLUTANTS TO BE TAKEN INTO CONSIDERATION IN THE ASSESSMENT AND MANAGEMENT OF AMBIENT AIR QUALITY

I. **Pollutants to be studied at an initial stage, including pollutants governed by existing ambient air quality directives**

1. Sulphur dioxide
2. Nitrogen dioxide
3. Fine particulate matter such as soot (including mw 10)
4. Suspended particulate matter
5. Lead
6. Ozone

II. **Other air pollutants**

7. Benzene
8. Carbon monoxide
9. Poly-aromatic hydrocarbons
10. Cadmium
11. Arsenic
12. Nickel
13. Mercury

Directive 2000/76/EC on the incineration of waste

ANNEX IV

Emission limit values for discharges of waste water from the cleaning of exhaust gases

Polluting substances	Emission limit values expressed in mass concentrations for unfiltered samples	
1. Total suspended solids as defined by Directive 91/271/EEC	95 % / 30 mg/l	100 % / 45 mg/l
2. Mercury and its compounds, expressed as mercury (Hg)	0,03 mg/l	
3. Cadmium and its compounds, expressed as cadmium (Cd)	0,05 mg/l	
4. Thallium and its compounds, expressed as thallium (Tl)	0,05 mg/l	
5. Arsenic and its compounds, expressed as arsenic (As)	0,15 mg/l	
6. Lead and its compounds, expressed as lead (Pb)	0,2 mg/l	
7. Chromium and its compounds, expressed as chromium (Cr)	0,5 mg/l	
8. Copper and its compounds, expressed as copper (Cu)	0,5 mg/l	
9. Nickel and its compounds, expressed as nickel (Ni)	0,5 mg/l	
10. Zinc and its compounds, expressed as zinc (Zn)	1,5 mg/l	
11. Dioxins and furans, defined as the sum of the individual dioxins and furans evaluated in accordance with Annex I	0,3 mg/l	

Until 1 January 2008, exemptions for total suspended solids may be authorised by the competent authority for existing incineration plants provided the permit foresees that 80 % of the measured values do not exceed 30 mg/l and none of them exceed 45 mg/l.

National measures beyond EU legislation

Information on national measures was found by a few Member States. National measures may therefore not be considered to be broadly applied among all EU Member States. National measures were only listed in Table A.3 if these deviated from the EU measures. Local and national initiatives are also mentioned in Månsson et al. (2008) who studied the efforts to the phase out cadmium, lead and mercury within the Stockholm region. Local initiatives concerning cadmium focussed on cadmium in artist paint and the cleaning of floors of small metal-working enterprises. The Stockholm Environmental Authority has controlled the retail of artist paint containing cadmium in order to reduce the input of cadmium. Within the ad hoc Drafting Group questions were raised on a EU prohibition of cadmium in artist paint through Annex XVII of REACH. At the meeting in January 2010 the Commission clarified that at the time of listing cadmium in paints in the REACH entry (then Existing Substance Regulation), there was an intensive debate on artist paints and some European Member States opposed the restriction of these types of paints. By using the combined customs nomenclature [3208 and 3209] artists paints have been excluded from the restriction (see also European Commission, 2010). Wickman et al. (2009) report on the Stockholm artist paint initiative in the SCOREPP report D4.4: 'Identification of voluntary initiatives for reducing the use of products containing Priority Pollutants'. In this report also other voluntary initiatives are reported. Månsson et al. (2008) made a comparison of substance flow analyses for Stockholm conducted in 1995 and 2002-2003

and observed a considerable reduction in the cadmium balance. The various measures also showed to have resulted in a considerable decrease in cadmium concentration in the sewage sludge from the Stockholm waste water treatment plant. The changes found can be related to regulations, initiatives by industries and organisations, and the proactive attitude of the local environmental authorities and of the water company.

Appendix 3 Fact sheet mercury (Hg, CAS: 7439-97-6)

Substance specific information mercury

The information in this section is mainly based on the SOCOPSE report (Zielonka et al., 2009b). Elemental mercury (Hg(0)) is the only metal in liquid form at room temperature. In contrast with the other heavy metals, mercury and many of its compounds behave exceptionally in the environment due to their volatility and capability for methylation. Under the 67/548/EEC mercury compounds are classified as presented in Table A.4 below (ECB ESIS database). Mercury and its compounds are Water Framework Directive (WFD) priority hazardous substances, meaning that all emissions and discharges to water need to be phased out or eliminated.

Table A.4 Classification and labelling of mercury and mercury compounds

Index number	Substance Name	EC number	CAS number	Classification
080-001-00-0	mercury	231-106-7	7439-97-6	Repr. Cat. 2; R61 T+; R26 T; R48/23 N; R50-53
080-003-00-1	dimercury dichloride, mercurous chloride, calomel	233-307-5	10112-91-1	Xn; R22 Xi; R36/37/38 N; R50-53
080-004-00-7	organic compounds of mercury with the exception of those specified elsewhere in this appendix			T+; R26/27/28 R33 N; R50-53
080-005-00-2	mercury difulminate, mercuric fulminate, fulminate of mercury	211-057-8	628-86-4	E; R3 T; R23/24/25 R33 N; R50-53
080-006-00-8	dimercury dicyanide oxide, mercuric oxycyanide	215-629-8	1335-31-5	E; R2 T; R23/24/25 R33 N; R50-53
080-007-00-3	dimethylmercury [1] diethylmercury [2]	209-805-3 [1] 211-000-7 [2]	593-74-8 [1] 627-44-1 [2]	T+; R26/27/28 R33 N; R50-53
080-008-00-9	phenylmercury nitrate [1] phenylmercury hydroxide [2] basic phenylmercury nitrate [3]	200-242-9 [1] 202-866-7 [2] [3]	55-68-5 [1] 100-57-2 [2] 8003-05-2 [3]	T; R25-48/24/25 C; R34 N; R50-53
080-009-00-4	2-methoxyethyl mercury chloride	204-659-7	123-88-6	T; R25-48/25 C; R34 N; R50-53
080-010-00-X	mercury dichloride, mercuric chloride	231-299-8	7487-94-7	Muta. Cat. 3; R68 Repr. Cat. 3; R62 T+; R28 T; R48/24/25 C; R34 N; R50-53
080-011-00-5	phenylmercury acetate	200-532-5	62-38-4	T; R25-48/24/25 C; R34 N; R50-53

Production of mercury

This section is mainly based on the SOCOPSE report (Zielonka et al., 2009b) and Lassen et al. (2008). According to SOCOPSE (Zielonka et al., 2009b), the two main routes of mercury production are primary production and recycling. Primary production of mercury is generally achieved by extracting, crushing, and heating cinnabar (HgS). In Europe, the mercury ore was extracted in three important cinnabar mines: Idrija in Slovenia (closed), Mt. Amiata in Italy (closed in 1982), and Almadén in Spain (mining activities closed, only recycling activities). Other primary production comes from other metal processing including gold, silver, and zinc, where mercury represents a by-product. Secondary production consists in recycling products containing mercury such as batteries, fluorescent lamps, and industrial waste.

Nowadays, most of the mercury produced in Europe comes from recycling. Europe is currently the largest exporter of metallic mercury. According to the Lassen et al. (2008) the estimated export figure for the 27 EU countries and Norway and Switzerland was 151 tonnes in 2007.

The use of mercury

This section is based on the SOCOPSE report (Zielonka et al., 2009b) and Lassen et al. (2008). After manufacturing, mercury is used as commercial product and raw material for production of various mercury compounds (e.g. mercury dichloride, mercury dinitrate, mercury sulphate and organic compounds).

An extensive overview of use, products and import and export data in the EU is given in the report of Lassen et al. (2008). Lassen et al (2008) reported a total EU consumption of 320-530 tonnes per year for 2007. The main identified uses were chlor-alkali production (41.2%), dental amalgam (23.5%) and miscellaneous uses (15.2%) as main uses. Miscellaneous uses reported are the use in porosimetry and pycnometry, mercury slip rings and maintenance of lighthouses. Smaller uses mentioned are for batteries (3.8%), measuring equipment (2.8%), switches (0.1%) and chemicals (10.2%).

QSC (2003) reported that US demand peaked during the mid-1960s at 2,500 tonnes per year and decreased until 200 tonnes per year in 2000. The uses for 2000 included thermostats and electrical switches (66 tonnes), dental fillings (48), electric lights (30), chlor-alkali (30) and instruments (24) (to measure temperature, pressure, or flow, e.g., thermostats, manometers). The chlor-alkali industry was a major consumer of mercury on a global basis. US and European plants, representing about 60% of world mercury cell plant capacity, have made major advances in reducing losses, and therefore in reducing demand, over the past ten years. The USGS indicated the chlorine-caustic soda industry as the leading domestic end user of mercury (USGS, 2010). Lassen et al. (2008) indicate that for some uses (chlor-alkali production and dental amalgam) the EU market has been relatively stable, whereas for other uses consumption has decreased considerably.

Emission sources of mercury

The natural global bio-geochemical cycling of mercury is characterized by degassing of the element from soils and surface waters, followed by atmospheric transport, deposition of mercury back to land and surface waters and sorption of the compound to soil or sediment particulates. Mercury deposited on land and open water is in part revolatilised back into the atmosphere. Particulate-bound mercury can be converted to insoluble mercury sulphide and precipitated or bioconverted into more volatile or soluble forms that re-enter the atmosphere or are bioaccumulated in aquatic and terrestrial food chains.

Mercury emitted to the environment usually stays on the surface of sediments or soil and does not move through the soil to groundwater. Mercury and its inorganic compounds may be converted into organic mercury compounds. Mercury associated with soils can be directly washed into surface waters during rain events. Surface runoff is an important mechanism for transporting mercury from soil into surface waters, particularly for soils

with high humic content (Zielonka et al., 2009b). Table A.5 and Figure A.2 present the main emission sources of mercury to air, land, and water, including the direct and indirect routes for water as reported in SOCOPSE 2009 (Zielonka et al., 2009b).

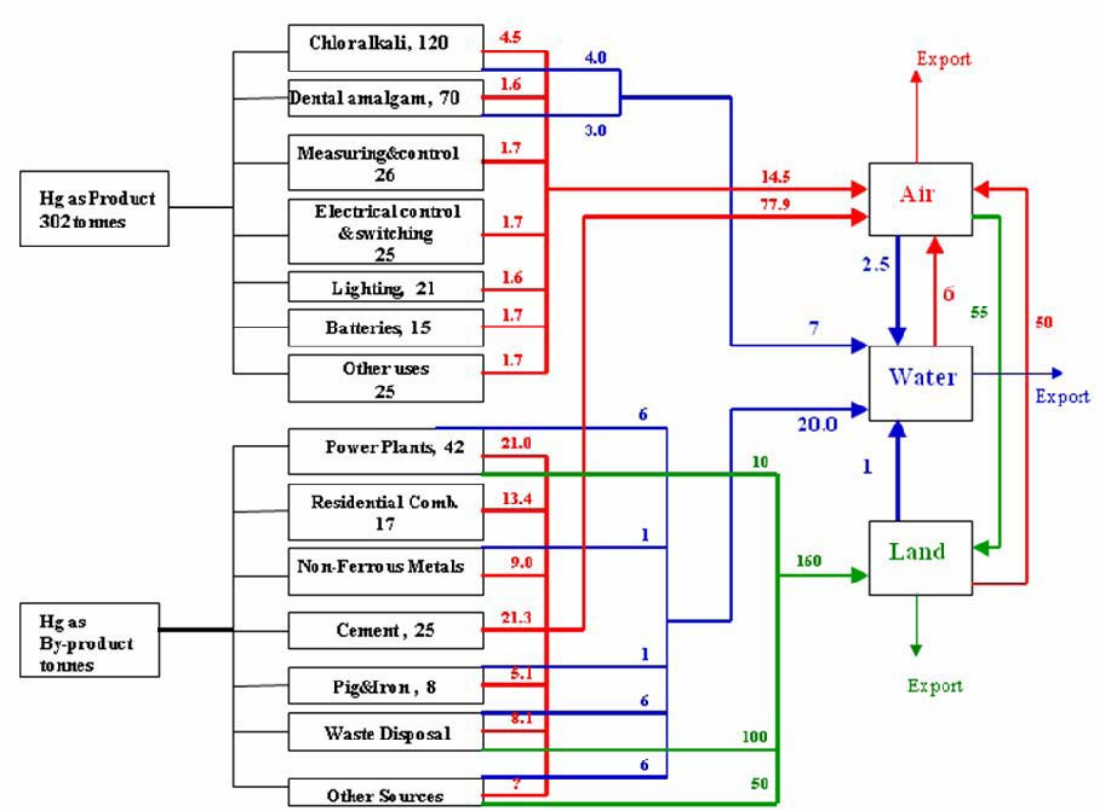


Figure A.2 Material Flow Analysis (MFA) diagram for Hg in Europe in 2000 (numbers in tonnes/year) (Zielonka et al., 2009b)

Table A.4 Mercury and its compounds emissions to air, land, and water.(Zielonka et al., 2009b)[5]

Medium	**Sources**	**DS/PS**[a]	**Importance** [% of total Hg emissions to the atmosphere in Europe for the year 2000 and per medium]
Air	Combustion of fossil fuels	PS	47.6
	Cement production	PS	12.6
	Primary (smelters) non-ferrous metal production	PS	6.5
	Secondary non-ferrous metal production	PS	Very low emissions
	Iron and steel production, including coke production	PS	5.2
	Major uses of mercury	PS/DS?	About 17
	Waste disposal – incineration	PS	4.8
	Crematories	PS	Very low
	Road transport and other mobile sources and machinery	DS	Very low
Land	Land-filling of various food and agriculture waste	PS	10
	Land-filling of urban refuse	PS	Low
	Municipal sewage sludge application	??	5
	Disposal of waste from various manufacturing processes except food	PS	10
	Disposal of fly ash and bottom ash from power plants and waste incineration	DS	30
	Wastage of commercial products on land	DS??	10
	Atmospheric deposition to terrestrial ecosystems	DS	30
Water	***Direct emissions***		
	Domestic waste disposal – waste treatment plants central WWTP, non-central WWTP[6]	PS	8
	Combustion of fossil fuels, incl. cooling tower waters	DS??	35
	Base metal mining and dressing	PS	Low contribution
	Primary non-ferrous metal production – hydrological technology	PS	Low
	Iron and steel production	PS	Low
	Manufacturing processes: metals, chemicals, petroleum products	PS	25

[5] estimations according to WP2 SOCOPSE
[6] primary Hg sources include dental amalgam and minor sources

Medium	Sources	DS/PS[a]	Importance [% of total Hg emissions to the atmosphere in Europe for the year 2000 and per medium]
	Major uses of mercury: dentistry, chlor-alkali production	PS	Low
	Road transport and other mobile sources and machinery	DS	Very low
	Agriculture related sources	DS	Very low
	Atmospheric deposition to European seas and their catchments	DS	25
	Sediment re-suspension	DS	Probably low

[a] DS = Diffuse Source, PS = Point Source

As shown in Table A.5 major sources of mercury to water are combustion of fuels to produce electricity and heat and disposal of waste. Impact of these sources on aquatic environment is indirect through air deposition and leaching from landfills, according to (Zielonka et al., 2009b).
From the table and figure above the major sources were selected for further review (see chapter 2). For load to water (same as direct emissions to water) sources were selected contributing more than 10% to total water load. These sources are 'combustion of fossil fuels, including cooling tower water' (35% of total load to water), 'manufacturing processes: metals, chemicals, petroleum products' (25%) and 'atmospheric deposition to European seas and their catchments' (25%). The major emission sources to the atmosphere is 'combustion of fossil fuels' (48% of total emission to air), which will be taken into account in the policy assessment below.
National measures were only listed in the table with sources and measures (Table A.6) when these deviate from the EU measures. This fact sheet is primarily confined to legislative tools. For technical controls is referred to the SOCOPSE and SCOREPP projects.

Sources and measures mercury
Mercury is heavily regulated worldwide. UNEP has a special mercury strategy with '*the goal to protect human health and the global environment from the release of mercury and its compounds by minimizing and, where feasible, ultimately eliminating global, anthropogenic mercury releases to air, water and land'.* (UNEP, 2010) The United States has a special roadmap for addressing mercury uses and releases and outlines priority activities for addressing remaining mercury risks. An overview of the US strategy is provided at the US-EPA website on EPA's Roadmap for Mercury (US-EPA, 2012). An overview of various regional and global initiatives relating to mercury is provided in the Consultation document Development of an EU Mercury Strategy Invitation to comment issued in March 2004 and European Commission's website on mercury (European Commission, 2012h).
QSC (2003) analysed the global mercury market and predicted a market oversupply considering the large stocks and the economic conditions. They concluded that stocks, recycling and new supplies are larger than the demand. QSC (2003) also note a west to east shift in demand. Their conclusion was based on the fact that non-mercury alternatives for important applications such as dental care, instruments, chlor-alkali plants, and lighting, became increasingly available in developed countries and that mercury may flow to countries having weaker regulatory controls and less awareness of mercury's toxicity. USGS (2001) concluded that domestic mercury consumption was continue to decline as

mercury would be eliminated in many products. They identified the availability of alternatives and stringent environmental regulations as main drivers of this process.

There is a large amount of existing EU and national legislation tackling various aspects of the mercury problem. Most of these focus on use and emissions of mercury (see for more details chapter 4 on legislation). As a result of these measures and of other factors, such as a shift from coal to cleaner fuels, European emissions of mercury have decreased with about 60% between 1990 and 2000.
One of the larger uses of mercury in the European Union was the application in the chlor-alkali plants. In 1998 Eurochlor (Eurochlor, 1998a) launched a report on the topic and concluded that a compulsory phase out of the plants would harm the competitiveness because of the reinvestments costs of the European chlor-alkali industry and would only have marginal benefits to the environment. Eurochlor anticipated on the European developments to reduce mercury use and emissions and made a voluntary commitment which was presented to OSPAR POINT 1999 as implementation of PARCOM Decision 90/3 for mercury cells in the chlor-alkali industry (OSPAR, 2008). In short the commitment contained the following items:

- no new mercury chlor-alkali plants;
- mercury cells not to be shipped to third parties;
- a challenging and quantified mercury emissions reduction programme;
- reporting and auditing of individual plant emissions;
- end of existing mercury plants by 2020;
- safe disposal of metallic mercury from shutdown cells.

The voluntary commitment was renewed soon after 2000 (Eurochlor, 1998b, Eurochlor 2002). The commitment required the industry to achieve a voluntary emissions target of 1g/t chlorine capacity on a national basis by 2007 with no individual plant exceeding 1.5 g/t chlorine capacity. Results of the implementation of PARCOM Decision 90/3 considering emission reductions and plant closures can be found in various OSPAR reports (OSPAR, 2004, 2008).
In 2002 the European Commission presented a report to the Council concerning mercury from the chlor-alkali industry (European Commission, 2002). The report refers to the IPPC directive, but focuses mainly on waste and the consequences of phase out. The Commissions saw three basic options for the fate of mercury after phase out, namely re-use, intermediate storage and definitive storage. Maxson (2004) indicated that the impact of the phase out depended for a large part on the speed of closure and the rate at which mercury would be released to the world market. The voluntary commitment of the European chlor-alkali industry is not mentioned in the report, but an agreement between the chlor-alkali industry and the Minas de Almadén for buying the surplus of mercury is. The agreement between the chlor-alkali industry and the Minas de Almadén is also mentioned in a Eurochlor document drafted in order to contribute to the development of the EU Mercury Strategy (Eurochlor, 2004). In preparation of the Mercury Strategy Eurochlor promotes the voluntary phase out of the mercury cell plants until 2020 and provides an alternative storage for decommissioned mercury by means of storage of liquid mercury by Minas de Almadén. In 2008 the Commission published a regulation (EC/1102/2008) to ban all export from mercury to prevent it to enter the world market. In a press release the European Commission stated: '*The European Commission welcomes a voluntary agreement to ensure the safe storage of surplus mercury from the European chlor-alkali industry, once a ban on exports of the highly toxic metal from the European Union takes effect. The legislation requires that mercury that is no longer used, be stored in a way preventing its release*.' (European Commission, 2008e).

An interesting remark in the report from the Commission (European Commission, 2002) concerns mercury cells and BAT. '*The legal situation governing the mercury based chlor-alkali industry has revealed that – The IPPC Directive is the only legally binding instrument that governs the phase out of mercury cells. The mercury cell process is not considered to be BAT for the chlor-alkali sector and it will be for the local competent authority to decide on BAT-based permit conditions for individual installations on a plant-by-plant basis. All existing installations should meet permit conditions based on BAT and operate in accordance with the requirements of the Directive by 30 October 2007.*' The same document refers that according to the Reference Document on Best Available Techniques in the Chlor-Alkali Manufacturing Industry of October 2000, which was adopted by the European Commission in December 2001, considered the mercury cell process not to be BAT for the chlor-alkali sector (European Commission, 2002).

The European Union has made considerable progress in addressing the global challenges of mercury since it launched the EU Mercury Strategy in 2005 (European Commission, 2005a). This has resulted in restrictions on the sale of measuring devices containing mercury, a ban on exports of mercury from the EU that will come into force in 2011 and new rules on safe storage. The EU's Mercury Strategy is a comprehensive plan addressing mercury pollution both in the EU and globally. It contains 20 measures to reduce mercury emissions, cut supply and demand and protect against exposure, especially to methylmercury found in fish, under which:

- banning mercury exports by 2011 (Regulation (EC) No 1102/2008);
- global action – input to international activities and cooperation with other countries, e.g. to control mercury trade, emissions, and use in activities like gold mining;
- reducing EU demand – restricting the marketing of measuring devices containing mercury (e.g. thermometers), and further investigation of remaining uses (e.g. dental amalgam);
- addressing EU surpluses – safe storage of mercury decommissioned by industry, and further study of mercury already circulating in society (e.g. in old products still in use);
- reducing EU emissions – review of the effects of current EU law, provision of information to support further emission cuts in Member States, and study of additional control of releases from coal burning;
- protecting against EU exposure – further investigation of dietary exposure for women of child-bearing age and children, and provision of additional advice on mercury in food;
- improving understanding – research to fill key gaps in mercury knowledge.
-

The EU Mercury Strategy to be found on the mercury site of the European Commission (European Commission, 2012h).

Emissions of mercury from major industrial sources are now subject to the EU Directive (96/61/EC) on Integrated Pollution Prevention and Control (IPPC), which had to be implemented in Member States by October 1999. Existing installations had until October 2007 to comply. The IPPC Directive also covers the EU's chlor-alkali industry, which is phasing out the use of mercury in its production process. Mercury emissions have also been reduced by the application of sector-specific EU directives dealing with large combustion plants and waste incineration. Some EU Member States have introduced further emission controls, for instance on cremation.

EU legislation also prohibits, or severely restricts, the use of mercury in the following applications: batteries; electrical and electronic equipment; pesticides and biocides;

cosmetics; wood preservatives; textile treatment agents; anti-fouling agents for boat hulls and switches in vehicles. Some Member States have introduced further controls, for example to restrict the use of mercury in dental amalgam.
Other areas of EU legislation set requirements for the management of waste that contains mercury and for the protection or monitoring of the quality of the environment in respect of mercury (air, water and groundwater). EU legislation also sets limits for the mercury content in drinking water and fishery products.
Since the adoption of the Community Strategy concerning Mercury in January 2005, EU legislators have adopted a directive (2007/51/EC) relating to the restrictions on the marketing of certain measuring devices containing mercury (thermometers, barometers). In September 2008, legislation was adopted banning mercury exports from the European Union and requiring the safe storage of metallic mercury when the ban takes effect in March 2011.
On the basis of an analysis of inputs of mercury to society and the management of mercury waste, four applications of mercury were selected by Lassen et al. (2008). These four applications were expected in the sense of taking legislative measures:

- dental amalgams (including mercury input and waste management);
- measuring devices for professional uses (including a detailed assessment of thermometers, barometers and sphygmomanometers);
- mercury catalysts for polyurethane elastomers;
- mercury porosimetry.

Lassen et al. (2008) remarked that further measures concerning mercury-containing light sources, as well as mercury-containing components in electrical and electronic medical devices and monitoring and control instruments were already under evaluation in the context of the RoHS Directive. This was taken into consideration in the selection of policy options for these product groups.

Measuring devices and porosimetry
Measuring devices for industrial and professional uses containing mercury are at present subject of a Annex XV report under the REACH regulation. The measuring devices include the devices mentioned by Lassen et al. (2008) as well as porosimeters. Placing on the market for mercury containing devices for the general public is already restricted by an existing entry in Annex XVII in REACH.

Dental amalgam
Mercury in dental amalgam has been on the European agenda for about two decades. In 1995 an ad hoc working group on dental amalgam was installed, which reported in 1998. The working group concluded that no systematic dose-dependent toxic effect had been shown in relation to the release of mercury from dental fillings (Dental Amalgam, 1998). In the EU Mercury Strategy (European Commission 2005a) the Commission stated: '*As the chlor-alkali industry phases out mercury cells, dental amalgam will become the EU's major mercury use. It is therefore appropriate to re-examine the scope for substitution. This is especially important as Member States can encourage substitution, but the coverage of dental amalgam under the medical devices Directive limits the scope for restrictive national measures.*' Dental amalgam, including the route through dental surgeries and cremation, are seen as a significant source of mercury entering into the environment by some Member States.
To identify the risks of mercury in dental amalgam and the possibilities for substitution the European Commission commissioned opinions by the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR, 2008) and by the Scientific Committee on Health and Environmental Risks (SCHER, 2008). The SCHER (2008) concluded that a potential environmental risk associated to dental amalgams could not be excluded. A firm

conclusion could not be drawn as too limited data were available. However, SCHER (2008) remarked: '*At present amalgam fillings are considered less expensive than the alternative. However, this is debated since the cost of treatment does not cover the cost of releasing mercury in the environment.*' SCHER (2008) provided recommendations to solve the data gap. SCENIHR (2008) concluded that both mercury amalgam and their substitutes were safe for dental health and that there were very low rates of local adverse effects with no evidence of systemic disease. About the applications SCENIHR concluded: '*There is, obviously, a greater level of aesthetic appeal with those alternatives that are tooth coloured compared to the metallic amalgam. Furthermore, these alternatives allow the use of minimally interventional adhesive techniques. These clinical trends themselves ensure that there will continue to be a sustained reduction in the use of dental amalgams in clinical practice across the European Union.*'
Since the release of the opinions there were no further European developments, such as proposals, to restrict the marketing and use of mercury in dental amalgam. However, the Council of European Dentists published a resolution in favour of continued use of amalgam. '*The worldwide consensus of the dental profession is that amalgam should remain part of the dentist's armoury in order to best meet the needs of patients. It is important that patients must not be denied freedom of choice in respect of how to be treated. Dental amalgam continues to be the most appropriate filling material for many restorations, due to its ease of use, durability and cost-effectiveness. Dentists are best placed to identify patients' oral health needs. Restrictions on the use of amalgam would damage the financial stability of health systems as well as impact on individual patients' ability to afford dental care.*' (Council of European Dentists, 2009). A workshop organised in 2012 still showed different opinions from the various stakeholders (Bio Intelligence Services, 2012).
Dental amalgam is an important source of Hg to WWTPs and thus to surface water (See Figure A.2). The sources are dental clinics and wide spread daily erosion of amalgam from teeth.
Both Norway and Sweden have national legislation severely restricting the marketing and use of mercury in products, including dental amalgam. In Norway the ban became effective in January 2008, in Sweden per June 2009. The Swedes published two extensive reports on a general ban (KEMI, 2004) and specifically on mercury in dental amalgam (KEMI, 2005). In 2007 the Nordic Council of Ministers published their Mercury substitution priority working list. Concerning global reductions it was concluded that '*a long phase out time is expected to be realistic'* Nordic Council of Ministers. (2007).
Sweden not only banned marketing and use of dental amalgam, but also tried to prohibit the exportation of mercury containing dental amalgam. In 2009 the European Court concluded that '*Article 4(1) of Council Directive 93/42/EEC must be interpreted as precluding legislation of a Member State, such as the legislation at issue in the main proceedings, under which the commercial exportation of dental amalgams containing mercury and bearing the 'CE' marking provided for in Article 17 of that directive is prohibited on grounds relating to protection of the environment and of health*'. The European Court of Justice stated that directive 93/42/EEC constitutes a harmonisation measure and is intended to promote the free movement of medical devices (InfoCuria, 2012).

Light sources
Certain energy-saving light bulbs, namely the compact fluorescent lamps (CFLs), are widely available on the European market and contain a certain amount of mercury. Both OSPAR (2007) and HELCOM (2002) already did recommendations to reduce the risk of mercury in light sources and other products. OSPAR listed a number of actions per contracting party, resulting in a letter from the OSPAR Chair to the European Commission asking for a review of relevant EC marketing and use directives on a number of products,

including lighting. HELCOM (2002), with a special decision on light sources recommended the contracting parties the following:

- mercury-containing light sources should be substituted by energy-efficient mercury-free light sources as soon as technically and economically feasible;
- where energy-efficient mercury-free alternatives are not available:
    - light sources should be replaced as soon as possible with low-mercury-containing alternatives complying to following limit values;
    - measures should be taken to minimize the use of mercury in such applications.
- mercury-containing electrical equipment should be substituted by mercury-free-equipment;
- where alternative mercury-free equipment is not available measures should be taken to minimize the use of mercury in such applications;
- measures should be taken to facilitate the organization of an effective collection and recovery system;
- development of mercury-free alternatives should be supported by ECO-labelling.

The EU directive 2002/95/EC (RoHS Directive) restricted the mercury content in compact fluorescent lamps to a maximum of 5 mg per lamp. Directive 2002/95/EC also list a number of other exemptions in the accompanying annex. A much lower indicative benchmark of 1.23 mg of mercury (BAT) in CFLs is provided in the Eco-design Regulation EC/244/2009.
The amount of 5 mg per lamp as laid down in the RoHS Directive is reviewed every four years. In 2010 the SCHER published an opinion on mercury in certain energy-saving light bulbs and concluded that mercury in CFLs is unlikely to pose a health risk to adults (SCHER, 2010). The limited data did not allow to draw a conclusion considering the exposure and risk for children. In an earlier report commissioned by the EC it was concluded that the elimination of mercury in CFLs was still technically and scientifically impracticable (Öko-Institut and Fraunhofer IZM, 2009). Environmental organisations opt for a reduction of mercury to 2 mg per lamp.

In the US the National Electrical Manufacturers Association (NEMA) initiated a voluntary commitment programme after discussion with the US Environmental Protection Agency (EPA), the US Department of Energy (DOE), and the Natural Resources Defense Council (NRDC) which lead to a voluntary commitment effective since April 2007: '*Participating manufacturers will cap the total mercury content in CFLs at less than 25 watts at 5 milligrams (mg) per unit. CFLs that use 25 to 40 watts of electricity will have total mercury content capped at 6 mg per unit*.' (NEMA, 2010).

The existing and possible measures at Member State and EU level, as provided by the participants of the ad hoc Drafting Group meetings, are given in Table A.6.

Table A.5 Sources and measures mercury. Numbers behind countries refer to the relevant tables in the paragraph on national measures

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	**EU/international**	**National**	**EU/international**
General	Flanders: Restrictions in use and in bringing on to the market: this is a federal matter; more information can be obtained from *FOD Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu DG Leefmilieu, Afdeling Risicobeheersing* (FOD, 2012)	Directive on Priority Substances (Directive 2008/105/EC)	REACH: national authorities can bring up candidate substances for authorisation according to Annex XV. Substances in Annex XV are not allowed to be used in production and products. UK Environment Agency: • Enforce REACH Annex 17 restrictions[7]; Provide advice to small and medium sized businesses on obligations in relation to priority substances, priority hazardous substances and specific pollutants through NetRegs website.	
	EUREAU: A comparison of substance flow analyses conducted in 1995 and 2002-2003, concerning the accumulation of metals in the Stockholm technospere. The changes found can be related to regulations, initiatives by industries and organisations, and the proactive attitude of the local environmental authorities and of the water company.			
	SE: Developed an action programme for a more effective and comprehensive collection of used products and goods containing mercury.			
Waste water	SE, DK, DE, FR, AT:			

[7] For example UK EA currently looking at the use of mercury amalgam traps in dental practices as failure to install and/or maintain these traps could result in a significant source of mercury to sewer.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	**EU/international**	**National**	**EU/international**
	In most dental clinics amalgam traps are installed.			
	Sweden: In 1998 a project was started with the purpose of removing mercury from different sewer systems in Stockholm.			
Combustion of fossil fuels (direct discharge to water or indirect via atmospheric deposition)	Norway[4] Denmark[5] The Netherlands[6] Sweden[7] UK[8] Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation; • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out,	Integrated Pollution Prevention and Control (IPPC)[3] 2008/1/EC, European Pollutant Emission Register (E-PRTR), Best Available Techniques (BAT) reference documents[2]. Mercury falls under the 'metals' for which emission limits should be fixed when relevant (Annex III of IPPC). For mercury and compounds emission limits for reporting are established in E-PRTR. Directive 2001/80 (no specific mercury controls in Directive 2001/80 but some mercury removed alongside other pollutants). LRTAP	Consider application of BAT for all installations on a case-by-case approach. Sweden[9]	Consider setting more stringent measures in the revision of BREF documents under Directive 2008/1/EC concerning IPPC.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
	Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).			
Manufacturing processes: - metal industry (zinc, copper and lead refineries)	Norway[4] Denmark[5] The Netherlands[6] Sweden[7] UK[8] Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation: • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out,	IPPC[1], E-PRTR, BAT reference documents[2]. Mercury falls under the 'metals' for which emission limits should be fixed when relevant (Annex III of IPPC). All installations of the metal industry fall under the IPPC. For mercury and compounds emission limits for reporting are established in E-PRTR.	Consider application of BAT for all installations on a case-by-case approach. Sweden[9] UK: Possible options for industry and manufacturing that could be explored in this or subsequent cycles: • Investigate emissions from installations and appraise options (to reduce at source or treat) to meet EQS and for priority substances and priority hazardous substances, reduce/cease emissions in this or subsequent rounds.	Consider setting more stringent measures in the revision of BREF documents under Directive 2008/1/EC concerning IPPC.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
	Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).			
		REACH Regulation 1907/2006, Annex XVII		Consider appointing mercury as a SVHC substance.
Manufacturing processes: - Chemical industry (chlor-alkali industry)	Norway[4] Denmark[5] The Netherlands[6] Sweden[7] UK[8] Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation: • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations);	IPPC[1], E-PRTR, BAT reference documents[2]. Mercury falls under the 'metals' for which emission limits should be fixed when relevant (Annex III of IPPC). For mercury and compounds emission limits for reporting are established in E-PRTR. For the chemical industry, capacity thresholds are set below which the installations do not fall under the requirements of the IPPC. Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) recommendation 90/3 to eliminate mercury cell production.	Consider application of BAT for all installations on a case-by-case approach Sweden[9].	Consider setting more stringent measures in the revision of BREF documents under Directive 2008/1/EC concerning IPPC.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
	• for priority hazardous substances, which are required to be phased out, Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).			
		REACH Regulation 1907/2006, Annex XVII		Consider appointing mercury as a SVHC substance.
Manufacturing processes: - Petroleum production	Norway[4] Denmark[5] The Netherlands[6] Sweden[7] UK[8] Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation: • in these authorisations BAT always need to be applied (for all	IPPC[3], E-PRTR, BAT reference documents[2]. Mercury falls under the 'metals' for which emission limits should be fixed when relevant Annex III of IPPC). For mercury and compounds emission limits for reporting are established in E-PRTR.	Consider application of BAT for all installations on a case-by-case approach. Sweden[9]	Consider setting more stringent measures in the revision of BREF documents under Directive 2008/1/EC concerning IPPC.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
	installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).			
		REACH Regulation 1907/2006, Annex XVII		Consider appointing mercury as a SVHC substance.

[1] Mercury is listed in the IPPC. This annex is an 'indicative list of the main polluting substances to be taken into account if they are relevant for fixing emission limit values'.For metal industry, paper and board production and food processing, capacity thresholds are set below which the installations do not fall under the requirements of the IPPC.

[2] Up to now there is no best available technique (BAT) dedicated specifically for mercury in the BREF documents under the IPPC Directive [Directive 96/61/EC]. There are some BAT related to mercury in many BREFs; for instance in BREF for: waste treatments industries, waste incineration, common waste water and waste gas treatment/management systems in the chemical sector, large combustion plants, chlor-alkali manufacturing industry, or production of iron and steel. The mercury cell process is not BAT under the IPPC Directive. Mercury cell plants are being phased out due to BREF requirements (Zielonka et al., 2009b).

[3] Annex I of the Annex I of the IPPC, containing the installations regulated by this directive:

1. Energy industries

1.1 Combustion installations with a rated thermal input exceeding 50 MW

1.2 Mineral oil and gas refineries

1.3 Coke ovens

1.4 Coal gasification and liquefaction plants

[4] *Table A.7a National restrictions of Norway (taken from Lassen et al., 2008)*

Scope of legislation	Country	General exemptions	Name of instrument
General prohibition on production, import, export, sale and use of mercury and mercury compounds in concentrations above 0.001 percent by weight. (=10 mg/kg) The prohibition do not apply to products regulated by EC Directives on packaging, batteries, components in vehicles and electrical and electronic equipment The prohibitions do not apply to mercury that occurs naturally in coal, ore and ore concentrate	NO	Until 31 December 2010 for substances and preparations: - thiomersal in vaccines - Amalgam for dental treatment of patients who must be treated under general anaesthesia or who are allergic to ingredients in other dental fillings - Contact material in welding equipment Until 31 December 2010 for articles: - Polarographs	Amendment of regulations of 1 June 2004 no 922 relating to restrictions on the use of chemicals and other products hazardous to health and the environment (Product regulations). Entered into force 1 January 2008

[5] *Table A.7b National restrictions of Denmark (taken from Lassen et al., 2008)*

Scope of legislation	Country	General exemptions	Name of instrument
General prohibition on import, export and sale of mercury and mercury-containing products in concentrations above 100 mg/kg in their homogeneous components The prohibition do not apply to: - natural impurities in coal - used products which fulfilled Danish requirements at the time they were first offered for sale - products regulated by other legislation, unless they are stated in the Annex.	DK	Mercury-containing products for which import, sale and export are permitted: 1. Dental products for filling permanent molar teeth, where the filling is worn 2. Mercury-wetted film switches and relays which meet EN 119000, for specified applications in businesses: - data and telecommunication - process control - PLC remote control of energy supply - electrical test systems 3. Thermometers for special applications: - calibration of other thermometers - analysis equipment 4. Special light sources: - discharge lamps, including energy-saving bulbs - for analysis operations - for graphic operations 5. Flash units for safety installations on railway lines 6. Manometers for calibration of other pressure gauges 7. Barometers for calibration of other barometers 8. Electrodes for special applications: - polarographic analysis - potentiometric analysis - calomel reference 9. Mercury-containing chemicals for special applications: - raw materials for analysis reagents - analysis reagents - standards - preservation of starch for laboratory use - isotope dilution testing - catalysts 10. Products for research, including odontological research 11. Products for teaching 12. Products for vital applications in aircraft 13. Products for the repair of existing mercury-containing equipment	Statutory Order no 627 of 01.07.2003 on prohibition of import, sale and export of mercury and mercury-containing products

[6] *Table A.7c National restrictions of the Netherlands (taken from Lassen et al., 2008)*

Scope of legislation	Country	General exemptions	Name of instrument
General prohibition of manufacture and import of products (effective as of 1 Jan 2000)	NL	a heating thermostat as well as a mercury switch which is exclusively meant for use in a heating thermostat; and b. an activity meter for animals, as well as a mercury switch which is exclusively meant for use in an activity meter for animals. 2. until 1 January 2005, a barometer containing mercury;	Bulletin of Acts and Decrees of the Kingdom of the Netherlands No. 553: Decree of 9 September 1998, comprising regulations regarding products containing mercury
General prohibition of possessing or use for trading or production if the product has been taken into use for the first time after 1 January 2003 (1 January 2006 for barometers)	NL	a. a pycnometer or porosimeter for measuring the air space volume of soil or other porous solids; b. sampling equipment designed to measure particles in liquids; c. a calibration instrument meant for low flow-rate flow meters; d. a cuvette, meant for determining the chemical oxygen demand; e. a McLeod compression manometer, meant for measuring absolute pressures lower than 20 kPa; f. a submersible pump; g. a roll-spot welding head, meant for seam welding; h. a slip ring; i. a semiconductor test system, as well as a mercury relay of which the maximum mercury content per component does not exceed 0.15 gram and which is exclusively meant for use in semiconductor test systems; j. a mercury thermometer exclusively intended to perform specific analytical tests according to established standards; k. equipment for the calibration of platinum resistance thermometers using the triple point of mercury; l. a gas discharge lamp, with the exception of: 1.a fluorescent lamp for purposes of lighting with an integrated means of starting when it contains more than 10 mg of mercury; 2. a non-circular fluorescent lamp for purposes of lighting with a single lamp-cap terminal connection when it contains more than 10 mg of mercury; 3. a straight fluorescent lamp for purposes of lighting with two lamp-cap terminal connections when it contains more than 20 mg of mercury; m. a product for use in shipping in which	Bulletin of Acts and Decrees of the Kingdom of the Netherlands No. 553: Decree of 9 September 1998, comprising regulations regarding products containing mercury

Scope of legislation	Coun-try	General exemptions	Name of instrument
		the use of mercury is prescribed by or under law, equipment directly related to shipping in which the use of mercury is deemed to be necessary by the Minister of Transport and Public Works and ships' equipment to which Directive no. 96/98/EC of the Council of the European Union of 20 December 1996 on marine equipment (OJEC 1997 L 46) applies; n. a product for use in aviation for which the use of mercury is prescribed by or under the Aviation Act, and equally any product directly related to aviation purposes in which the use of mercury is deemed to be essential by the Minister of Transport and Public Works; o. equipment in use by the Armed Forces, in which the use of mercury is prescribed by or under law, or equipment necessary to the operational responsibilities of the Armed Forces in which the use of mercury is deemed to be essential by the Minister of Defence; p. a photographic film, a photographic plate and photographic paper, in as far as the film, plate or paper do not contain more than 0.3 mg of mercury per kg of product. Electrotechnical components which serve as spare parts for equipment used for the first time before 1 January 2003	

[7] *Table A.7d National restrictions of Sweden (taken from Lassen et al., 2008)*

General prohibition of sale, use and commercial export of mercury and chemical compounds and preparations containing mercury. General prohibition of sale and commercial export of goods containing mercury.	Certain uses for which harmonised EC provisions apply are exempted. Light sources and other electrical and electronic articles, batteries and vehicles, for example. The Swedish Chemicals Agency's (KEMI) regulations specify certain time-limited exemptions for analysis chemicals, certain instruments and equipment and certain amalgam use. KEMI may also grant exemption in particular cases.	Ordinance (1998:944) Concerning Prohibitions etc. in Certain Cases in Connection with the Handling, Import and Export of Chemical Products

[8]*Table A.7e National restrictions of UK (taken from Lassen et al., 2008)*

Mercury and its Compounds – Potential Measures to Reduce Releases								
			Description of the Action			**Means of Delivery**	**Lead Organisation**	**Driver for Measures**
Sector	**M1-M4**	**Scenario**	**What will happen**	**Where it will happen**	**When it will happen by**			
Environment Agency	M3b	B	Investigate emissions from WWTPs and confirm whether further investigation into sources discharging to sewer is required	Risk WWTP non PR09	2010	Internal communication	EA	WFD
Environment Agency	M4	C	Pollution prevention	Where contributing to potential EQS failures	Ongoing	Local action including use of anti-pollution works notices under WRA91 Section 161, 161A to D as detailed in the Anti-Pollution Works Regulations 1999, and enforcing prohibition under WRA91 Sections 85, 91A, 91B, 92 and 93	EA	WFD
Environment Agency	M4	C	Local pollution prevention campaigns including campaigns to raise awareness of marketing and use restrictions	Where contributing to potential EQS failures	Ongoing	Requires local funding / resource – EA working in partnership with others to target specific sector or issue.	EA	WFD
Industry, Manufacturing and other Business	M3b	B	Conversion to a mercury free manufacturing process	PI sites	Will be partially in place by 2015, fully in	PPC Regs 2000	Industry	WFD

					place by 2020			
Industry, Manufacturing and other Business	M3b	B	Investigate leachate from landfill sites and appraise options for site specific measures to meet EQSs and reduce/cease emissions in this or subsequent rounds	Landfill sites	2015	Environmental Permitting Regs	Landfill operators	WFD
Industry, Manufacturing and other Business	M3b	A	Ensure amalgam traps are installed and properly maintained at dental surgeries	Applies across the whole of the UK	Ongoing	Local Voluntary Agreements	EA	Dangerous Substances Directive
Industry, Manufacturing and other Business	M3b	B	Investigate emissions from installations and appraise options (to reduce at source or treat, up to BATNEEC) to meet EQS and reduce/cease emissions in this or subsequent rounds	PI sites	2015	PPC Regs 2000	Industry	WFD
Industry, Manufacturing and other Business	M3b	B	Investigate emissions from installations and appraise options (to reduce at source or treat) to meet EQS and reduce/cease emissions in this or subsequent rounds	Sites contributing to potential EQS failures	2015	WRA91 s88 (discharge consent) or WRA 91 s90B (enforcement notices)	Industry	WFD

Water Industry	M3 b	B	Investigate emissions from WWTPs and appraise options (to reduce at source or treat at WWTP) to meet EQS and reduce/cease emissions in this or subsequent rounds	Risk WWTP PR09	2015	WRA91 s88 (discharge consent) or WRA 91 s90B (enforcement notices) as part of PR09	Wate r plc	WFD

Types of Measures:

M1 Measures that will happen – Actions already agreed and funded which may contribute to meet the objectives of the Water Framework Directive. This includes the National Environment Programme for PR04, the current Catchment Sensitive Farming delivery initiative, the Coal Authority mine water restoration programme, ongoing local initiatives and partnerships etc.

M2 New measures that will happen – Actions that will happen irrespective of Water Framework Directive (usually under other directives) but which may contribute to meeting the objectives of the Water Framework Directive. This covers mainly new action for directives on freshwater fish, urban waste water treatment, habitats, nitrates, current and revised bathing water, and shellfish waters.

M3a New measures that may happen – national – Measures for the Water Framework Directive that require only national decisions. For example, controls on chemicals, fertilisers, and the formulation of other products (e.g. detergents) and, national general binding rules and codes of practice that apply to specific activities.

M3b New measures that may happen – national, RBD targeted – Measures led nationally that require targeting at the water body or catchment scale. For example, bespoke calculations of permit conditions, targeted use of uniform emission limits, targeted use of diffuse pollution measures e.g. Catchment Sensitive Farming new catchments, catchment scale water protection zones.

Relevant legislation mercury

Vos and Janssen (2005) indicated that for mercury 277 European legislative texts could be retrieved from Eur-Lex of which 98 were dedicated to measures. The extended impact assessment (European Commission 2005a) mentions about 35 legal instruments dealing with mercury in Annex 4, where also a number of strategy documents, such as Thematic Strategy being developed pursuant to the EU's 6th Environment Action Programme, are listed. An update is provided in Mudgal et al. (2010). The European Mercury Strategy itself mentions 17 relevant policy and legislative texts.

Among the first documents regulating mercury are Directive 79/117/EEC prohibiting the placing on the market and use of plant protection products containing certain active substances and various amendments to the Dangerous Substances Directive 76/769/EEC. In 1989 (89/677/EEC) the use of mercury as a fouling agent was prohibited as well as the use in the preservation of wood; the impregnation of heavy-duty industrial textiles and for the treatment of industrial waters, in 1991 (91/157/EEC) marketing of batteries and accumulators containing mercury was restricted, which amendment was replaced in 1998 when marketing of batteries and accumulators, containing more than 0.0005 % of mercury by weight was prohibited (98/101/EC). In 2007 placing on the market of mercury in fever thermometers and in other measuring devices intended for sale to the general public (e.g. manometers, barometers, sphygmomanometers, thermometers other than fever thermometers) was forbidden (2007/51/EC).

The directives and regulation mentioned in the EU Mercury Strategy are listed below. Proposals mentioned in the Strategy have here been replaced by the final documents.

- Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations, OJ L 262, 27.9.76.
- Council Directive 91/157/EEC of 18 March 1991 on batteries and accumulators containing certain dangerous substances, OJ L 078, 26.3.91.
- Council Directive 93/42/EEC of 14 June 1993 concerning medical devices, OJ L 169, 12.7.93.
- Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control, OJ L 257, 10.10.96. 5 Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants, OJ L 309, 27.11.2001.
- Council Directive 98/83/EEC of 3 November 1998 on the quality of water intended for human consumption, OJ L 330, 5.12.98.
- 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, as amended by Decision 2001/2455/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, OJ L 331, 15.12.2001.
- Commission Decision 2000/479/EC of 17 July 2000 on the implementation of a European pollutant emission register (EPER) according to Article 15 of Council Directive 96/61 concerning integrated pollution prevention and control, OJ L192, 28.7.2000.
- Commission Decision (2000/532/EC) of 3 May 2000 replacing Decision 94/3/EC establishing a list of waste pursuant to Article 1(a) of Directive 75/442 on waste and Council Decision 94/904 establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689EEC on hazardous waste, OJ L226/3, 6.9.2000 (as amended).
- Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants, OJ L 309, 27.11.2001.
- Commission Regulation (EC) No 466/2001 of 8 March 2001 setting maximum levels for certain contaminants in foodstuffs, OJ L 77, 16.3.2001.
- Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restrictions of the use of certain hazardous substances in electrical and electronic equipment (RoHS), OJ L 37, 13.2.2003.
- Regulation (EC) No. 304/2003 of the European Parliament and of the Council of 28 January 2003 concerning the export and import of dangerous chemicals, OJ L 63, 6.3.2003.
- Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.
- Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air.
- COM(2002) 489 final, Report to the Council concerning mercury from the chlor-alkali industry (European Commission, 2002).
- SEC(2005) 101, Extended Impact Assessment. (European Commission, 2005c)
- COM(2004) 416 final, European Environment and Health Action Plan 2004-2010. (European Commission, 2004b)

After publication of the European Mercury Strategy the following relevant directives and regulations have been published:

- Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directives 91/157/EEC.
- Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC.
- Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs.
- Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.
- Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives.
- Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council.
- Regulation (EC) No 689/2008 of the European Parliament and of the Council of 17 June 2008 concerning the export and import of dangerous chemicals.
- Regulation (EC) No 1102/2008 of the European Parliament and of the Council of 22 October 2008 on the banning of exports of metallic mercury and certain mercury compounds and mixtures and the safe storage of metallic mercury.
- Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.
- Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 on the safety of toys 2009/161/EC.

Of the mentioned documents Regulation No 1102/2008 on the banning of exports of metallic mercury and certain mercury compounds and mixtures and the safe storage of metallic mercury is entirely dedicated to mercury. It was adopted after extensive discussions between Member States and stakeholders. The regulation prohibits the export of metallic mercury, certain mercury compounds and mixtures/alloys from the community from 15th March 2011 and sets out the requirement to store these materials in ways safe for human health and the environment; companies in certain industry sectors are also required to pass information to the relevant competent authority on use/gains, storage and import and export of mercury. The regulation was followed by a Commission recommendation on safe storage addressed to Eurochlor (2009/39/EC). An UK impact assessment on the implementation of regulation EC/1102/2008 can be found on DEFRA (2010).

Council directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy

In consideration (6) it is described that *'in accordance with Article 4 of Directive 2000/60/EC, and in particular paragraph 1(a), Member States should implement the necessary measures in accordance with Article 16(1) and (8) of that Directive, with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances*' and in consideration 20) that *'it is necessary to check compliance with the objectives for cessation or phase out, and reduction, as specified in Article 4(1)(a) of Directive*

2000/60/EC, and to make the assessment of compliance with these obligations transparent, in particular as regards the consideration of significant emissions, discharges and losses as a result of human activities'.
According to Article 5.5., the Commission shall verify that emissions, discharges and losses progress towards compliance with the reduction or cessation objectives.
Annex I of Directive 2008/105/EC with the environmental quality standards is provided in the Appendix 2.

National measures beyond EU legislation
Lassen et al. (2008) reported that only three European Member States and Norway had reported having broad national legislation on the use of mercury that exceeds the current EU legislation. They mention examples of national legislation for Denmark, the Netherlands, Norway and Sweden in chapter 5 and 6.5 and most of these consider marketing and use of mercury containing products. In most cases certain uses are exempted from the national legislation. The tables provided in Lassen et al. (2008) are copied in this report as Tables A.7a-e.
The national bans in Norway and Sweden were implemented in 2008 and 2009 respectively (see chapter 2 on sources and measures). The situation in 1998 is reflected in the report on dental amalgam (Dental Amalgam, 1998), which states that legally binding restrictions on the use of dental amalgam are rare. Denmark, Finland, Norway and Sweden have recommendations instead to restrict the use of dental amalgam for environmental concerns, whereas restrictions because of reducing human exposure could be found in Austria and Germany. The report does not indicate if the latter are legally binding.

The OECD reported on instrument mixes for environmental policy and highlights some instruments for the case mercury indicating what kind of instruments can be applied (OECD, 2007). Sweden for instance strictly regulates the sale of mercury containing products '*by not reimbursing medical expenses if dental amalgam is used, etc. Further, significant subsidies have been applied to promote the collection of mercury from a broad range of historical sources*'. The authors conclude that '*it would not be possible to address all the relevant aspects of the mercury problem properly (only) with a single instrument, like for example a single tax or trading system'*.

In Table A.8 a brief overview is presented on legislation pertaining to waste from mercury in products to the extent that national legislation surpasses community legislation. In general, Sweden is recognised to have the most far-reaching approach to mercury waste management, banning the export and requiring temporary storage of all waste containing more than 0.1% mercury until such time as appropriate permanent bedrock disposal is available, but no later than 2015.

Table A.8 National mercury waste requirements beyond EU legislation (taken from Lassen et al., 2008)

Country	Brief description or scope of legislation or other requirements
Austria	The Abfallbehandlungspflichtenverordnung (BGBl. II Nr. 459/2004 idF BGBl. II Nr. 363/2006), among other stipulations, states specifically how mercury lamps, mercury-containing equipment and amalgam residues are to be treated.
	According to Altölverordnung 2002 (BGBl. II Nr. 389/2002), engine oils may not contain mercury.
	The Kompostverordnung (BGBl. II Nr. 292/2001) limits the mercury contents of material for compost production to 5 mg/kg dry matter.
	Restriction on landfilling of waste containing mercury: Austria has no underground waste disposal. There are different landfills in Austria (for excavated soil, for construction and demolition waste, for residual waste, for mass waste), the mercury limit value there is given between 1 – 20 mg/kg TS. (Exception: mercury as sulphide: 3000 mg/kg

	TS - provided the waste is solidified). Any other mercury-containing waste has to be de-contaminated or land filled in an underground storage.
	Restriction on incineration of waste containing mercury: In waste incineration plants mercury emissions are limited according to the Austrian waste incineration ordinance to 0.05 mg/m^3 (half-hour mean value and daily mean value, dry, 11% or 3% O_2). This value applies also to plants where waste is co-incinerated, to cement plants and combustion plants.
	Mercury-containing appliances (thermometers, electrical equipment, batteries, fluorescent tubes, etc.) are defined as hazardous waste, requiring separate collection with a notification form. For such waste arising from households there is a special charge-free collection system ('Problemstoffsammlung') provided by the municipalities.
	For dentists an amalgam recovery system is mandatory. The amalgam is recycled in Austria (recovery of Ag and Hg) by a specialised company.
Belgium (Flanders)	In Flanders there is a landfill ban on waste containing toxic substances. The decision of the Flemish government of June 1st 1995 concerning general and sectoral provisions with regard to environmental hygiene contains the following provisions. The following waste may not be accepted at a landfill site: – Waste containing more than 0.1% toxic organic substances, characterised by the symbol T+ or T, with reference to dry waste. – Waste containing toxic inorganic substances in concentrations exceeding the thresholds for classifying preparations of these substances as T+ or T on the basis of the toxicological properties of the substances (R-sentences 23, 24, 25, 26, 27, 28, 39, and 48) (Directive 88/379/EEG of June 7th 1988 as modified), with reference to dry waste. Summarized, this means that waste containing more than 0.5% of organic mercury compounds or 0.5% of inorganic mercury compounds (except Hg-sulphide), may not be landfilled in Flanders. In practice a threshold of 100 mg/kg is applied since this was the limit for toxic waste in Belgium.
	Flemish legislation doesn't contain restrictions on the input of mercury to waste incineration installations. All environmental conditions are being enforced by imposing strict emission limits. The European directive on the incineration of waste excludes the incineration of wood waste with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood-preservatives or coating, and which includes in particular such wood waste originating from construction and demolition waste. Flemish legislation, however also imposes emission limits for mercury when 'non-contaminated treated wood waste' is (co-)incinerated. 'Non-contaminated treated wood waste' is defined as treated wood waste with the exception of wood waste which may contain halogenated organic compounds, PAHs or heavy metals as a result of treatment with wood-preservatives or coating, and which includes in particular such wood waste originating from construction and demolition waste. For installations < 5 MW there is no emission limit for mercury. For installations between 5 and 50 MW the emission limit for mercury is 0.1 mg/Nm^3. For installations > 50 MW the emission limit for mercury is 0.05 mg/Nm^3.
	For the incineration of other waste the emission limits for mercury are the same as the limits from the Waste Incineration Directive.
	Landfilling of mercury is prohibited in Flanders for the reasons quoted under the restrictions for landfilling of waste containing mercury. This prohibition goes further than the European directive on landfills.

	Chapter 5.58 of the decision of the Flemish government of June 1st 1995 concerning general and sectoral provisions with regard to environmental hygiene contains the environmental conditions for crematoria. Summarized, this means that emission limits for dust, mercury (compounds), SO_2, NO_x and dioxins are imposed. The emission limit for mercury and mercury compounds (expressed as mercury) is 0.2 mg/Nm^3.
	Chapter 5.43 of the decision of the Flemish government of June 1st 1995 concerning general and sectoral provisions with regard to environmental hygiene contains the environmental conditions for discharges to water for dentists. Summarized, this means that a certified amalgam separator must be installed. The emission limit for total mercury in the discharged water is 0.3 mg/l. Furthermore these provisions contain technical specifications of the amalgam separator and require that the mercury-containing waste removed from the amalgam separator must be handed over to an authorised or registered transporter of waste.
Finland	Disposal requirements for landfill deposition of mercury waste: • Waste with <40 ppm mercury can be deposited in industrial waste deposit area. • Waste with >40 ppm mercury must be deposited in special/hazardous waste deposit area. With special permission, certain types of waste with mercury content are admissible for deposition in hazardous waste landfills.
	All mercury-containing waste is neutralised or treated in a well-controlled sulphidation reactor before deposition in special landfills to minimise emissions. There are supplementary requirements for solubility of mercury from waste in landfills.
France	The regulation on rejections restricts the amount of mercury waste going into the incinerating process.
	Stabilization using hydraulic binders is required on the leachable fraction for storage in Technical Landfilling Center (TLC), in respect of regulation limits.
	Solidification is required for storage in a salt mine.
Norway	There is one zinc production site in Norway. The mercury residue is considered as waste. The residue is cemented in a sarcophagus and placed in bedrock at the production site. There are no emissions of mercury reported from this activity.
The Netherlands	Landfilling of measuring and control equipment containing mercury (e.g. thermometers) and separately collected batteries are not allowed under Dutch legislation. Landfilling of other mercury-containing waste and 'by-products' are not allowed in the Netherlands by legislation, and export to deep underground storage is only allowed if one has gone to all lengths to prevent the generation of mercury-containing waste, or to treat the waste.
	The national waste management plan sets standards for the method of treatment of waste. For mercury-containing waste the 'lowest' standard is separating the mercury and recovering the other fractions like metals, glass etc. This 'minimum standard' is used in permitting waste treatment installations.
	Mixing of mercury-containing waste (> 10 ppm) with other waste for preparation of a mix principally used as a fuel or other means to generate energy, is not allowed.
Sweden	Restrictions on landfilling of waste containing mercury: Waste containing at least 0.1% by weight mercury must be disposed of in permanent underground storage no later than 1st January 2015. Before 1st January 2015 it is not allowed to dispose waste containing mercury in such a way that prevents permanent underground storage. The Swedish

	EPA may, on a case-by-case basis, grant exemptions from this provision if there are exceptional reasons or if the amount of waste is so small that the permanent underground disposal is unreasonable. (Waste Ordinance 2001:1063)
UK	In terms of exports of waste containing mercury, the Waste Shipments Regulation (WSR) bans the export of any waste for disposal from the EU (except to EFTA). The WSR also allows Member States to go further than this and ban exports of any waste for disposal from their territory. The UK has banned such movements. Therefore, if mercury-containing waste has to be disposed of (as opposed to recovered or recycled) then the UK ban on export would apply.
	In terms of the domestic hazardous waste controls, dental amalgam is classified as a hazardous waste (when discarded). As a result of the application of the Hazardous Waste Regulations to dentists, the UK expects more amalgam to be collected separately, and possibly more dentists will use alternatives to amalgam.

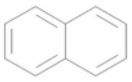
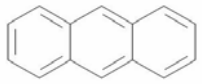
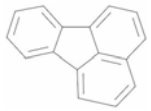
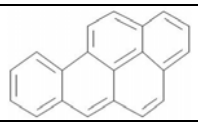
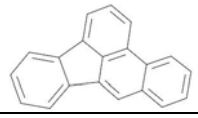
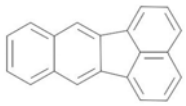
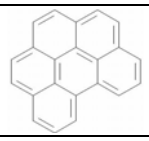
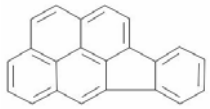
Appendix 4 Fact sheet PAHs

Substance specific information PAHs

The information in the sections below is mainly taken from the SOCOPSE report (Ullrich et al., 2009). Poly aromatic hydrocarbons (PAHs) are a group of organic chemicals comprising two or more fused benzene rings. They are ubiquitous environmental contaminants formed mainly by the incomplete combustion of carbon-containing fuels such as wood, coal, diesel and oil. PAHs are substances of high concern due to their toxicity and persistence in the environment. Many PAHs and/or their metabolites are known or suspected carcinogens.

The physical and chemical properties of PAHs are largely determined by their size and the ring linkage pattern. Most are solid at room temperature and have relatively high melting and boiling points. They are relatively insoluble in water, but have good lipid solubility. Table A.9 gives the chemical identity of some environmentally significant PAHs that have been included on the EU Water Framework Directive (WFD) priority list.

Table A.9 Chemical identity of selected polycyclic aromatic hydrocarbons

CAS[1]#	EINECS[2]#	Substance name	Short name	Formula	Structure
91-20-3	202-049-5	Naphthalene	–	$C_{10}H_8$	
120-12-7	204-371-1	Anthracene	–	$C_{14}H_{10}$	
206-44-0	205-912-4	Fluoranthene	–	$C_{16}H_{10}$	
50-32-8	200-028-5	Benzo(a)pyrene	B(a)P	$C_{20}H_{12}$	
205-99-2	205-911-9	Benzo(b)fluoranthene	B(b)F	$C_{20}H_{12}$	
207-08-9	205-916-6	Benzo(k)fluoranthene	B(k)F	$C_{20}H_{12}$	
191-24-2	205-883-8	Benzo(g,h,i)perylene	B(g,h,i)P	$C_{22}H_{12}$	
193-39-5	205-893-2	Indeno(1,2,3-cd)pyrene	I(1,2,3-cd)P	$C_{22}H_{12}$	

[1] CAS: Chemical Abstract Services

[2] EINECS: European Inventory of Existing Commercial Chemical Substances

The 2001 Decision (2455/2001 (EC)) lists five typical representatives as indicative parameters for this substance group (benzo-a-pyrene, benzo-b-fluoranthene, benzo-k-fluoranthene, benzo-g,h,i-perylene, and indeno(1,2,3-cd)pyrene). In addition, three other PAHs were identified as priority substances in their own right: naphthalene, anthracene and fluoranthene. The first two were provisionally identified as priority substances (PS)

subject to a review for their identification as possible priority hazardous substances (PHS), and fluoranthene was included in the list of priority substances as an indicator of other, more dangerous PAHs. In Directive 2008/105/EC the group PAHs and anthracene are identified as priority hazardous substances, and the other PAHs (fluoranthene and naphthalene) as priority substances. The intention of the Water Framework Directive is that all emissions and discharges of priority hazardous substances to water need to be phased out or eliminated.

Production of PAHs

Also for the information in this section the literature source has mainly been the SOCOPSE report (Ullrich et al., 2009). PAHs are formed predominantly as products of incomplete combustion of carbon-containing materials like oil, wood, garbage or coal. Many useful products such as blacktop and creosote wood preservatives contain PAHs. They are also found at low concentrations in some special-purpose skin creams and anti-dandruff shampoos that contain coal tars.

Automobile exhaust, industrial emissions and smoke from burning wood, charcoal and tobacco contain high levels of PAHs, with PAHs associated with small particles. Low molecular weight PAHs are formed at high temperatures (e.g. in cooking operations). Complex PAHs occur at moderate temperatures. PAHs can also be formed over time even at low temperatures, such as in wood fires or cigarettes.

Only anthracene and naphthalene are intentionally produced and are registered in the EINECS database (European INventory of Existing Commercial chemical Substances). Fluoranthene is also commercially produced, but it is not clear if it is produced and used within Europe in significant quantities; it is not registered in EINECS. According to information from the internet it can be used as an intermediate for dyes, pharmaceuticals and agrochemicals (Toxipedia, 2012). Some products contain a mixture of PAHs.

Naphthalene

Naphthalene is obtained by crystallisation from naphthalene oils. There are two sources for the manufacture of naphthalene in the EU. These are coal tar (which accounts for the majority of production) and petroleum. The total annual production of naphthalene in the EU has been estimated to be in the order of 200,000 t/y, including 20,000 t/y of naphthalene oil being at least 90% pure, and excluding lower grade naphthalene which has a separate Chemical Abstracts System (CAS) number. Companies producing naphthalene are located on 17 sites in the UK, Belgium, France, Italy, the Netherlands, Denmark, Germany, Austria and Spain. Production figures from individual producers range from 4,000 to 70,000 tonnes annually.

Anthracene

Anthracene is produced from light anthracene oil by crystallisation and distillation. Anthracene oil is a semisolid, greenish brown crystalline material and is obtained in two fractions from the primary distillation of coal tars. The lower-boiling fraction (light anthracene oil) has a high content of phenanthrene, anthracene and carbazole. The higher-boiling fraction (heavy anthracene oil) has a high content of fluoranthene and pyrene. Light anthracene oil, the starting material for the production of pure anthracene, makes up about 20% of coal tar and usually has an anthracene content of 6-7%.

There is only one European manufacturer of anthracene, operating in Germany. In recent years the production of pure anthracene is thought to have dropped to around 1,000 tonnes annually. Approximately 99% of the 1999 production was exported to outside the EU. No importation of anthracene into the EU appears to take place.

Other PAHs

Products containing anthracene and other PAHs as part of complex mixtures are coal tar and coal-tar containing products (paints, waterproof membranes, etc.), and creosote. Coal tars and creosote contain mainly volatile, but also heavier PAHs.

Coal tars are by-products of the destructive distillation of coal, also called carbonisation or coking. They are complex mixtures of hydrocarbons, phenols and heterocyclic compounds. Two main classes of coal tars are distinguished, depending on the temperature of carbonisation. The anthracene content of high-temperature coal tars is about 1.5%, whereas low-temperature coal tars contain only negligible amounts. Coal tar distillation is conducted at 10 distillation plants in Europe (one each in Germany, Belgium, France, the Netherlands, Italy, Denmark, and two each in the UK and Spain). The amounts of coal tar produced and distilled in the EU during 1997-1999 were between 1 million and 1.8 million tonnes.

Creosote is made up of a blend of several coal-tar distillation fractions. It is a dark oily liquid of variable composition, containing about 160-200 compounds of which only about 30 have so far been identified. PAHs (including anthracene, naphthalene and phenanthrene derivatives) generally account for 75-85% of creosote. In the EU, creosote is manufactured according to grades specified by the West European Institute for Wood Preservation (WEI). The maximum B(a)P content of WEI Grade A creosote is 500 mg/kg and that of WEI Grades B and C 50 mg/kg. Anthracene concentrations in creosote are at maximum 1.5%.

There is no known commercial production of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, or fluoranthene within the EU.

Use of PAHs

Naphthalene

Naphthalene is largely manufactured for use as a chemical intermediate (e.g. phthalic anhydride), which accounts for approximately 70% of its use. It is used in the manufacture of a wide range of products, including dyestuffs, alpha and beta-naphthols, tetralin, decalin, chlorinated naphthalenes, naphthalene sulphonates, phenol, propylene oxide, superplasticisers for concrete additives, non-agricultural pesticides, celluloids, solvents, lubricants, cutting fluids, synthetic tanning products, wood preservatives (e.g. creosote), emulsion breakers, asphalt, detergents, resins, antiseptics, air fresheners and lacquers. The use of naphthalene as a moth repellent and insecticide has decreased since the introduction of chlorinated compounds such as p-dichlorobenzene. Figures for the amount of naphthalene used within the EU vary, but have been estimated at approximately 140,000 t/y, with the remaining tonnage being exported. Table A.10 shows some typical use categories for naphthalene and approximate annual tonnages (Ullrich et al., 2009).

Table A.10 Principal uses of naphthalene in Europe (Ullrich et al., 2009)

Process	**Amount (t/y)**
Phthalic anhydride production	40,000
Manufacture of dyestuffs	46,000
Naphthalene sulphonic acid manufacture	24,000
Alkylated naphthalene solvent production	15,000
2-naphthol production	12,000
Pyrotechnics manufacture	15
Mothballs manufacture	1,000
Grinding wheels manufacture	350

Anthracene

Until recently, the main uses of anthracene which could give rise to releases were two specific types of chemical synthesis (production of anthraquinone and anthracene-9-aldehyde). These processes have now ceased and the only known remaining uses of anthracene in the EU relate to the production of carbon black and to the use of small

amounts of anthracene in the manufacture of pyrotechnics (approximately 0.2 t/y) and in scientific research laboratories. Therefore, practically all consumption of anthracene in the EU, which until recently was carried out by two main industrial users, has now stopped and almost all anthracene produced in Europe is exported.

Uses of products containing anthracene and/or other PAHs:

- Creosote is used almost exclusively in wood impregnation. Recent estimates put the amount of creosote used in the EU at approximately 107,000 t/y. There are 9 bulk wood impregnation plants in the EU. The marketing and use of creosote in the EU are strictly regulated by Directive 2001/90/EC, now Annex XVII REACH (see section 4).
- Coal-tar containing products: coal tar and its distillates are used in some specialist paints, damp-proofing materials, waterproof membranes, coal tar epoxy paints and coal tar polyurethane sealers. Tar paints are no longer used in Germany, and Scandinavian countries are moving away from them. Coal tar paints usually contain 0.5% anthracene, while the anthracene content of other products seems to be below 0.5%. No information on the number of plants or the production volumes of these products in Europe is available. Historic uses of anthracene oil and coal tar in cosmetics are now prohibited.
- Petroleum pitch and coal-tar pitch are used as a binder material in the production of carbon and graphite. Coke or carbon is usually bound with pitch (14 – 18% by weight) to produce a green paste which then undergoes a number of shaping, baking, impregnation and graphitising stages to produce the final product. Green paste is also used directly for Søderberg electrodes or paste. Table A.11 gives annual production figures for various carbon and graphite products in Europe. The aluminium industry is the largest user of pre-bake anodes, Søderberg paste and cathode blocks.

Table A.11 Annual production of carbon and graphite in the EU and Norway together

Product type	**Production (t/y)**
Green mix for Søderberg electrodes or paste	410,000
Anodes for primary Al	1380,000
Electrodes	420,000
Specialty carbon and graphite	25,000

There is no known commercial use of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, and fluoranthene within the EU.

Emission sources of PAHs

Releases of PAHs to the environment occur from a multitude of point and diffuse sources. Major sources of PAH emissions include fossil fuel combustion in residential and industrial units, road transport (mainly petrol but also diesel engines), wood burning and a variety of industrial processes (e.g. coke ovens, coal tar distillation, aluminium production, iron and steel production, anode baking, wood impregnation). Other sources include accidental discharges during the use, transport and disposal of petroleum products, waste incineration and disposal, run-off from roads, and natural sources such as forest fires and geothermal activity. For those PAHs which are manufactured intentionally, there may also be inputs associated with their production, storage and use. These inputs are considered to be of minor importance compared to the unintentional sources. Table A.12 and Figure A.3 present the main emission sources of PAHs to air, land and water.

Table A.13 presents emissions to the aquatic environment via air, land, waste water and the direct route (adjusted copy of Ullrich et al. (2009) of a so-called material flow analysis (MFA). If Table A.10 and Table A.11 are compared the relation between the emissions to air, land and water and the emission from these compartments to water should be noted. Total estimated emissions to air are 2,500 tonnes in 2003. For land, the emission is

estimated at 6,000 t/y (3,000 tonnes from engineering and 3,000 tonnes from atmospheric deposition).

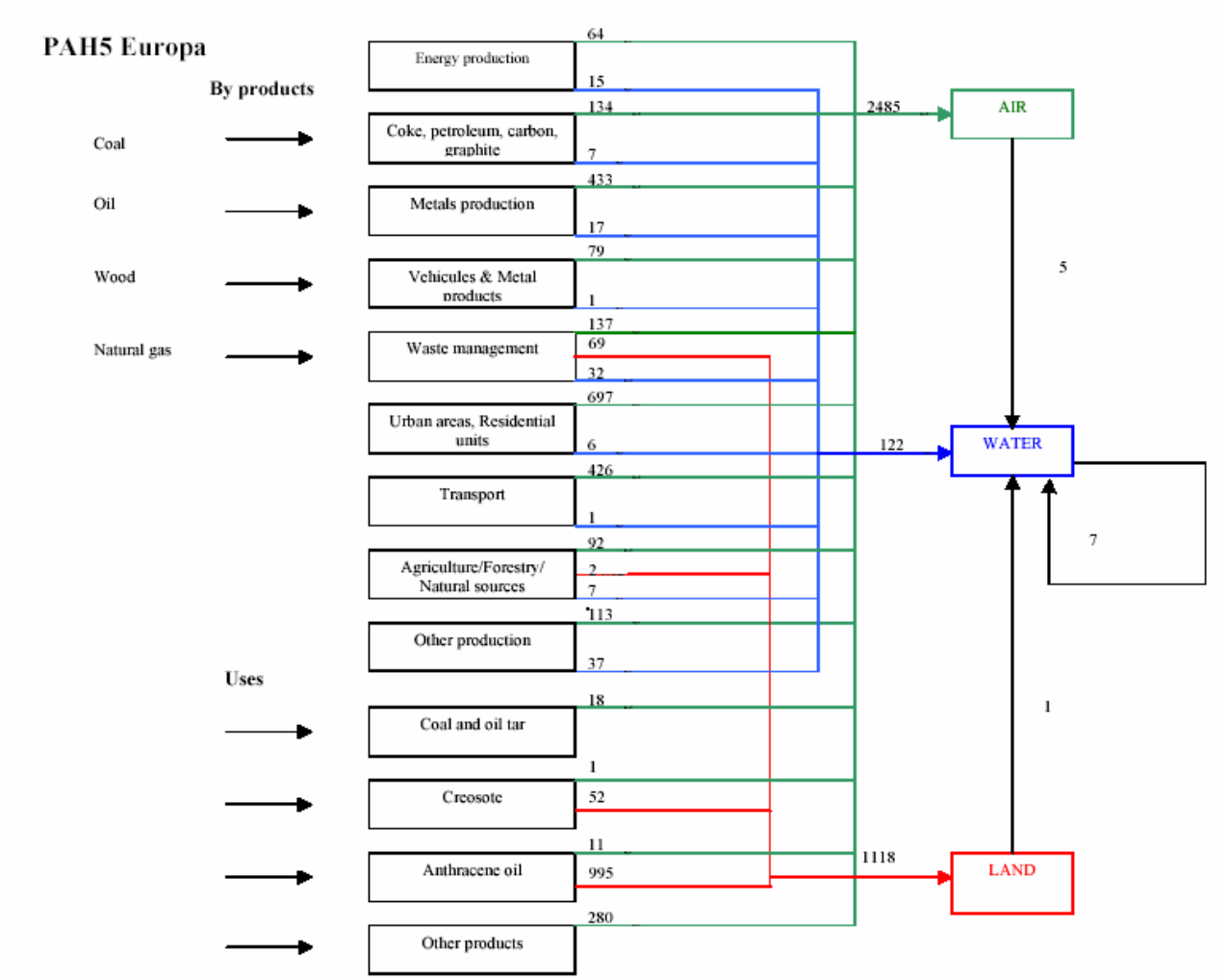


Figure A.3 MFA diagram for 5 PAHs[8] in Europe at the beginning of the 2000's (numbers in tonnes/year) (Ullrich et al., 2009)

As the vast majority of PAH emissions occur initially to air, atmospheric deposition is a significant pathway of soil and surface water contamination. Direct contamination of the aquatic environment is most frequently associated with discharges from the chemical and petroleum industries and accidental spillages or leakages of petroleum products to land or water. Small amounts of PAHs may be released to soils and surface water from wood products treated with creosote.

Run-off from industrially contaminated sites can be a source of secondary surface water pollution by PAH. Industrially contaminated sites may include e.g. coal gasification and coking plants, gasworks, waste dumps, coal tar refineries, pine tar factories and wood treatment plants. Groundwater contamination may also occur, for example as a result of seepage from underground petrol storage facilities, from uncontrolled landfill leachates and from disused industrial sites such as coal gasification plants.

[8] Benzo(a)pyrene, Benzo(k)fluoranthene, Benzo(b)fluoranthene, Indeno(1,2,3-cd)pyrene, and Benzo(a)pyrene

Table A.12 PAH emissions to air, land and water. Adjusted copy of Ullrich et al. (2009)

Medium	Sources	DS/PS[a]	Importance[1] (%)
Air[2]	Combustion of fuels (39.9%): - Residential plants - coal combustion in residential units - Energy Industries - coal combustion in utility boilers (power plants) - coal combustion central heating plants - residual oil combustion - Industry - Primary (smelters) non-ferrous metal production - Other (plaster and other furnaces, cement, lime, glass, mineral wool, bricks and tiles) - coal combustion in industrial boilers and technological processes, Agriculture/Forestry/Fishing	DS PS PS PS PS DS DS	39.9 - 28.01 - 1.18 - 6 - 2.9 - 1.19 - 2.27
	Road transport and other mobile sources and machinery	DS	15.9
	Metal production (13.83%) and coke production (2.1%): - cast iron and steel processes - aluminium production - electric steel production - graphite electrode production	PS	15.93
	Major uses of PAH: - various applications	DS	11.72
	Various industries: - cement production - petrochemical and related industries - bitumen and asphalt industries - rubber tyre manufacturing - creosote and wood preservatives	PS	10.9
	Waste disposal – incineration: - incineration of municipal / hazardous / hospital waste	PS	2.9
	Agriculture - field burning of agricultural waste	PS	1.54
Land[3]	Disposal of waste from various manufacturing processes except food	DS	30
	Agricultural waste	DS	20
	Mining and quarrying waste	PS	10
	Disposal of fly ash and bottom ash from power plants and waste incineration	PS	10
	Land-filling of urban refuse and municipal sewage sludge	PS	10
	Municipal sewage sludge agricultural application	PS	5
	Atmospheric deposition to terrestrial ecosystems (Institut Ekologii Terenów Uprzemysłowionych (IETU) estimate 3000 t/a)		significant
Water[4]	Combustion of fossil fuels - Power plants and industrial	PS	35
	Metal industry	PS	35
	Mineral oil and gas refineries	PS	12
	Plants for pre-treatment of fibres or textiles	PS	13
	Basic organic chemicals	DS	2
	Municipal Wastewater treatment plants	PS	Low
	Major uses of PAHs – creosote	PS	Low
	Sediment re-suspension	DS	significant
	Erosion	DS	significant

Medium	Sources	DS/PS[a]	Importance[1] (%)
	Atmospheric deposition to European seas and surface waters (IETU estimate 400 t PAH in Europe in 2003[5])	DS	significant

[a] DS = diffuse source, PS = point source

[1] Percent of total PAH emissions to compartment (air/land/water) in Europe.

[2] Atmospheric emissions 2500 tonnes in Europe in 2003 (based on European Monitoring and Evaluation Programme (EMEP) data).

For B(a)P, B(b)F, B(k)F and I(1,2,3-cd)P the sector split (15 countries in Europe in 2003) is as follows: residential 58%, metal production 17%, public electricity and heat production 3%, manufacturing industries and construction 5%, road transportation 5% and other 11%.

[3] Engineering guess IETU team 3000 t/y.

[4] Around 40 t/y for Integrated Pollution Prevention and Control (IPPC) installations (based on EPER data, excluding atmospheric deposition).

[5] Calculated only for surface water areas and potentially impacted sea areas (BaP: 30 t; sum of BaP, B(k)F, B(b)F, and I(1,2,3-cd)P: 80 t).

Table A.13 MFA table for the sum of 5 PAHs in Europe at the beginning of the 2000's (numbers in t/y) (Ullrich et al., 2009)*

	Pathways to the aquatic environment			
	Air	**Land**	**Waste Water**	**Direct**
Energy production	64			15
Coke, petroleum, carbon graphite	134			7
Metal production	433			17
Vehicles and metal products	79			1
Waste management	137	69		2
Urban areas	697			6
Transport	426			1
Agriculture forestry	92	2		7
Other productions	113			37
Coal and oil tar	18			
Creosote	1	52		
Anthracene oil	11	995		
Other products	280			
TOTAL	*2485*	*1118*		*93 + 7 (sediment)[1]*

*(Benzo(a)pyrene, Benzo(k)fluoranthene, Benzo(b)fluoranthene, Indeno(1,2,3-cd)pyrene, and Benzo(a)pyrene).

[1] In the water/sediment system an estimated amount of 7 t/y is according for sedimentation and resuspension.

Since atmospheric deposition is a significant pathway of surface water contamination by PAH, the management options discussed in the following section will also include some information on how atmospheric emissions of PAH from selected industrial sectors could be curbed, as well as information on wastewater treatment techniques.

Sources and measures PAHs

The data presented in Table A.14 are taken from the SOCOPSE report (Ullrich et al., 2009) and are referring to potential detailed measures taken in industry in the area of reduction of point sources.

Information on national measures was mostly based on information provided by the United Kingdom and the Netherlands. National measures may therefore not be considered to be broadly applied among EU Member States, since information about measures of individual Member States was not available at the time this fact sheet was assembled. National

measures were only listed if these deviated from the EU measures. This fact sheet is primarily confined to legislative tools. For technical controls is referred to the SOCOPSE and SCOREPP projects.

Table A.14 Emission sources and possible emission abatement measures (Ullrich et al., 2009)

Measures	**Sources**										
	Primary aluminium production	Production of carbon and graphite	Coke oven plants	Bitumen production / refineries	Waste incinerators	Power stations	Residential combustion	Wood treatment plants	Waste water	Urban runoff	Sewage sludge
Source control											
Use of pre-bake anodes[1]	O										
Use of inert anodes[2]	O										
Point feeders technology for Søderberg plants with dry paste	O										
Improved transport and storage at wood impregnation plants								X			
Process modification at wood impregnation plants								X			
Use of wood preservation products with a lower PAH content								X			
Alternative wood preserving techniques[3]								O			
Use of alternative construction materials								X			
Combustion optimisation						X	X				
Fuel replacement							X				
End-of-pipe											
Wastewater pre-treatment: tar removal[4]			X								
Biological wastewater treatment			X						X		
Gas-tight operation of the gas treatment plant			X								
Wastewater pre-treatment: sour water stripping (SWS)[5]				X							
Flue gas incineration[6]	X	O		X							
Wet flue gas scrubbing[7]	X			X	X O	X					
Dry flue gas scrubbing	X	X			X	X					
Use of condensation and electrostatic precipitators		X				X					
Biofilters[8]										O	
Ozonisation and anaerobic digestion[9]											O
Community level measures							X				
Enhancing user awareness											

Measures	Sources										
	Primary aluminium production	Production of carbon and graphite	Coke oven plants	Bitumen production / refineries	Waste incinerators	Power stations	Residential combustion	Wood treatment plants	Waste water	Urban runoff	Sewage sludge
Regulatory measures											
Application of product standards							X				
Ozone oxidation?											
Activated carbon?											
Nanofiltration?											
Reverse osmosis?											

Note: X = available measure; O = emerging measure

[1] Applicable to new plants only.

[2] Technology still at pilot stage and not yet proved at industrial scale. Not expected to be available before 2020.

[3] Techniques still under development.

[4] Recommended for pre-treatment of coal water prior to biological wastewater treatment.

[5] Recommended for pre-treatment of waste water from bitumen blowing.

[6] A novel regenerative afterburner has been used in a number of applications.

[7] A novel oil scrubber could be employed at waste incinerators.

[8] Potentially applicable to urban runoff.

[9] Potentially applicable as a pre-treatment for sewage sludge prior to its use on agricultural land.

The primary source of PAHs is incomplete combustion of wood and other fuel. Some PAHs are produced and used intentionally, but it is often considered that commercial production is of minor significance in terms of exposure and effects. Most measures therefore focus on end-of-pipe control as illustrated by Table A.14. There are various developments to control the emissions from industries, from domestic heating and from traffic and these have been described in Janssen et al. (2012).
Risk assessments under the Existing Substances Directive have been carried out for anthracene, naphthalene and coal tar pitch and for creosote a competent authority report under the Biocidal Products Directive (98/8/EC) has been published.
Coal tar pitch is still under study. Considering authorisation or restriction of coal tar pitch under REACH Beekman et al. (2008) concluded: *'A restriction or authorisation within the European legislation REACH is not the most appropriate option to reduce the risks of the emission of PAHs. These emissions, primary caused during production and combustion processes, are not adequately controlled by this legislation.'*
Within the process to control the risks of coal tar pitch it has been forwarded for classification and labelling and some of the constituents of coal tar pitch have been noted as SVHC substance. Conform the recommendations above no measures have been proposed to incorporate within Annex XVII of REACH.

Creosote already has the attention of the European Commission and the Member States since the end of the 90's. In 2001 creosote was added to the Existing Substances Directive and a number of Member States already had or came up with national provisions (see Janssen et al., 2012). In 2007 a competent authority report under the Biocidal Products Directive was submitted by Sweden and concluded: *'Based on the hazard assessment and risk characterisation for human health, an inclusion in Annex I of Directive 98/8/EC cannot be recommended at present for creosote as an active substance in wood preservatives, product type 8.'* However, Sweden recommended to perform a analysis of the benefits before taking a final decision and new data on dermal exposure, submitted by the

applicant, suggested possibilities for safe use. Therefore the competent authority meeting decided that there was 'the need to perform an overall risk/benefit analysis before taking a final decision and the European Commission invited stakeholders to comment on the possible consequences of an inclusion or non-inclusion in Annex I of the Biocidal Products Directive and to provide additional data. This has resulted in about 60 contributions. The outcome of the consultation was communicated at the 30th meeting of the competent authorities, which can be found together with other information on creosote at a specific website dedicated to creosote European Commission. (2012e). Until now, no further steps have been communicated.

Germany has been active in restricting the presence of PAHs in a number of products. The reduction of PAHs in tyres can partly be attributed to Germany and the TÜV Rheinland has developed a certification for PAHs in a number of products (see Janssen et al., 2012). In June 2010 the German Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAUA) has asked the European Commission to propose restrictions on PAHs in consumer products. Restriction through REACH article 68 is considered to be the preferred risk management option by BAUA (BAUA, 2010). An overview of measures on PAHs is provided in Janssen et al. (2012).

There are various initiatives which decrease the emissions of PAHs through exhaust gases of traffic, shipping and domestic heating. The policy leading to more energy-efficient cars, less exhaust gases from shipping by increased legislation and research on exhaust gasses from domestic heating commissioned by the European Commission are such initiatives. Some of these initiatives are not directly focussed on PAHs, but on emissions of for instance dioxins or CO_2 and NO_x, or on increasing the energy-efficiency. The 'Climate change and shipping. ECSA position paper' describes a number of technical, operational and legislative options for a higher energy-efficiency of which PAH emissions may profit as well (ECSA, 2008). The Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) agreed in 2009 on a package of voluntary technical and operational measures to reduce greenhouse gas emissions from shipping (MEPC, 2009). More information on emission reduction of PAHs through these sources are described in Janssen et al., 2012.

The existing and possible measures at Member State and EU level, as provided by the participants of the ad hoc Drafting Group meetings, are given in Table A.15.

Table A.15 Sources and measures PAHs

Source/ pathway	**Legislative and non-legislative tools**			
	Existing measures		**Possible measures / measures in preparation**	
	National	**EU/international**	**National**	**EU/international**
General		Directive on Priority Substances (Directive 2008/105/EC).	REACH: national authorities can bring up candidate substances for authorisation according to Annex XV. Substances in Annex XV are not allowed to be used in production and products UK Environment Agency: • enforce REACH Annex 17 restrictions; • provide advice to small and medium sized businesses on obligations in relation to priority substances, priority hazardous substances and specific pollutants through NetRegs website.	

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
Combustion of fossil fuels - Power plants and industrial	NL: Environmental permits related to the IPPC set more strict demands on installations. Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation: • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit and substitution are preferable to end-of-pipe-measures). NL: National cooperation programme on air quality (NSL).[7] NeR, the Netherlands Emission Guidelines for Air, is a national guideline, aimed at reducing emissions to air and harmonizing the environmental permits in the Netherlands with respect to abatement of emissions to the air.	Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants[1] IPPC (2008/1/EC) and E-PRTR (166/2006 (EC))[2] REACH Regulation 1907/2006, Annex XVII	Consider the possibilities of further reduction of the emission and stricter regulation under IPPC (use of BAT/BREF on smaller installations). In this case additional promotion of alternative sources of energy that are more sustainable could be considered. UK: Investigate emissions from installations and appraise options (to reduce at source or treat, up to BATNEEC) to meet EQS and reduce/cease emissions in this or subsequent rounds. UK: Local pollution prevention campaigns including campaigns to raise awareness of marketing and use restrictions.	Consider the possibilities of further reduction of the emission and stricter regulation under IPPC. In this case additional promotion of alternative sources of energy that are more sustainable could be considered.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
Metal industry	NL: environmental permits related to the IPPC set more strict demands on installations. Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. NL: National cooperation programme on air quality (NSL)[7]. NeR, the Netherlands Emission Guidelines for Air, is a national guideline, aimed at reducing emissions to air and harmonizing the environmental permits in the Netherlands with respect to abatement of emissions to the air.	IPPC (96/61/EC) and E-PRTR (166/2006 (EC))[2]	UK: Investigate emissions from installations and appraise options (to reduce at source or treat, up to BATNEEC) to meet EQS and reduce/cease emissions in this or subsequent rounds.	Consider the possibilities of further reduction of the emission and stricter regulation under IPPC (use of BAT/BREF on smaller installations).
	Flanders restrictions in use and in bringing on to the market : this is a federal matter; more information can be obtained from *FOD Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu DG Leefmilieu, Afdeling Risicobeheersing* (FOD, 2012).	REACH Regulation 1907/2006, Annex XVII	UK: Local pollution prevention campaigns including campaigns to raise awareness of marketing and use restrictions.	

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
Mineral oil and gas refineries	NL: Environmental permits related to the IPPC set more strict demands on installations. Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. NL: National cooperation programme on air quality (NSL)[7]. NeR, the Netherlands Emission Guidelines for Air, is a national guideline, aimed at reducing emissions to air and harmonizing the environmental permits in the Netherlands with respect to abatement of emissions to the air.	IPPC (2008/1/EC) and E-PRTR (166/2006 (EC))[2]	UK: Investigate emissions from installations and appraise options (to reduce at source or treat, up to BATNEEC) to meet EQS and reduce/cease emissions in this or subsequent rounds.	Consider the possibilities of further reduction of the emission and stricter regulation under IPPC (use of BAT/BREF on smaller installations).
	Flanders: Restrictions in use and in bringing on to the market : this is a federal matter; more information can be obtained from *FOD Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu DG Leefmilieu, Afdeling Risicobeheersing* (FOD, 2012)(	REACH Regulation 1907/2006, Annex XVII	UK: Local pollution prevention campaigns including campaigns to raise awareness of marketing and use restrictions.	

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
Plants for pre-treatment of fibres or textiles	NL: Environmental permits related to the IPPC set more strict demands on installations. Estonia: According to IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents and measures of reduction or avoidance of emissions have to be performed by enterprises. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation: • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tried to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit and substitution are preferable to end-of-pipe-measures) NL: National cooperation programme on air quality (NSL)[7]. NeR, the Netherlands Emission Guidelines for Air, is a national guideline, aimed at reducing emissions to air and harmonizing the environmental permits in the Netherlands with respect to abatement of emissions to the air.	IPPC (2008/1/EC) and E-PRTR (166/2006 (EC))	UK: Investigate emissions from installations and appraise options (to reduce at source or treat, up to BATNEEC) to meet EQS and reduce/cease emissions in this or subsequent rounds.	Consider the possibilities of further reduction of the emission and stricter regulation under IPPC (use of BAT/BREF on smaller installations).

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		**Possible measures / measures in preparation**	
	National	**EU/international**	**National**	**EU/international**
	Flanders: Restrictions in use and in bringing on to the market : this is a federal matter; more information can be obtained from *FOD Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu DG Leefmilieu, Afdeling Risicobeheersing* (FOD, 2012).	REACH Regulation 1907/2006, Annex XVII	UK: Local pollution prevention campaigns including campaigns to raise awareness of marketing and use restrictions.	
Preserved Wood	NL: The use of preserved wood is regulated by environmental permits. Besluit PAK-houdende coatings en producten milieubeheer[4].	REACH Regulation 1907/2006, Annex XVII	Removal of creosoted wood in waterways	Consider the use of alternatives for creosote-treated wood.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
Traffic /Transport	NL: *Road* • Besluit lozen buiteninrichtingen 3 (drain off rainwater); • subsidise of soot filters. *Waterway* • prohibition/restriction of the use of PAH as coating on vessels; • offer financial support to participants for technical innovation to reduce the use of PAK in lubricant via tax-relief programmes (MIA/Vamil); • -reduction of PAHs emission to air by technical innovation clean engines.	98/70/EC: quality of petrol and diesel fuels and amending Council Directive 93/12/EEC Several directives concerning exhaust emissions of inland waterway vessels.	NL: Besluit PAK-houdende coatings en producten milieubeheer[5] UK: Urban and Transport • ban domestic waste burning, construction and demolition waste burning; • encourage enhanced use of SUDs (Sustainable Urban Drainage Systems); • evaluate options to further reduce domestic waste burning, construction and demolition waste burning; • improved design or improved codes of practice for runoff, e.g. from highways and other transport; • improved street and green space cleaning; • initiatives to reduce vehicle emission limits.	European Commission (2007b) Proposal for a Directive of the European Parliament and of the Council amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions from the use of road transport fuels and amending Council Directive 1999/32/EC, as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC. Brussels, 31.1.2007. This directive is still under consultation. (European Commission, 2007b) Consider stricter requirements on the emission of PAHs from combustion fuels.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
				2005/69/EC: restricts the placing on the market and the use of PAH rich extender oils and blends used as extender oils for the production of tyres. All tyres retreaded after 1 January 2010 should be retreaded with new tread containing new PAH-low extender oils.
				Directive 2003/44/EC: regulates exhaust emissions relating to recreational craft.
		.		REACH Annex XVII sets limits for concentrations of PAHs in extender oils from January 1st, 2010.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		Possible measures / measures in preparation	
	National	EU/international	National	EU/international
Domestic fireplaces	NL: Public information; domestic waste burning prohibited.		Consider raising of public awareness. UK: Ban or investigate further reduction of domestic waste burning, construction and demolition waste burning.	Consider the adaptation of present environmental legislation (certification of stoves). Consider the introduction of standardised test procedures for wood stoves. Consider the stimulation of innovative improvement through emission limiting equipment. Consider raising of public awareness. Consider a ban on fuel additives. Consider discussing at an international level whether fireplaces are a EU-wide problem (and to what extent).

[1] This directive applies to combustion plants, the rated thermal input of which is equal to or greater than 50 MW, irrespective of the type of fuel used (solid, liquid or gaseous). Member States are demanded to draw up a license system. Emission limits for dust are reported in Annex VII to Directive 2001/80/EC. Reduction of dust emission will also reduce emission of PAHs. For Annex VII to 2001/80/EC see next pages on relevant legislation.

[2] For the IPPC directive (2008/1/EC) see next pages on relevant legislation.

[3] When discharging groundwater deriving from pumping up spring water during a clean-up operation or from soil sanitation the amount of PAH's in any of the samples is not allowed to exceed 1 µg/L.

[4] Prohibits the use of wood treated with coal distillate containing benzo(a)pyrene ≥ 0,005 % weight by weight.

[5] Refers to PAHs in tyres (article concerning this subject is not yet into force): tyres containing more than 1 mg/kg benzo[a]pyreen or more than 10 mg/kg PAHs in total are prohibited.

[6] An overview is presented of substances of concern and sectors responsible for environmental contamination. Measures to solve the problems and achieving the goals set by the WFD are described.

[7] National Air Quality Cooperation Programme (NSL) will cut air quality excesses in the short term and contains a comprehensive package of measures for accomplishing this.

Relevant legislation PAHs

Quite some European legislation focus on PAHs in food, such as regulation EC/1881/2006 and regulation EC/333/2007. These will not further be discussed because of their limited relevance to regulate the amount of PAHs in the environment in general. A number of relevant European documents related to measures are summarised in Janssen et al. (2012). These are given here and updated where necessary.

- Marketing and Use Directive 76/769/EEC and Daughter Directives 2005/69/EC on extender oils and tyres and 2001/90/EC on creosote, now in REACH Annex XVII.
- 2002/884/EC: Commission Decision of 31 October 2002 concerning national provisions on restrictions on the marketing and use of creosote-treated wood notified by the Netherlands under Article 95(4) and (5) of the EC Treaty, now in REACH Annex XVII.
- REACH 1907/2006 (EC) and specifically entries in Annex XVII.
- POPs Regulation 850/2004. This Regulation implements the Protocol to the 1979 Convention on Long Range Transboundary Air Pollution on Persistent Organic Pollutants.
- Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants.
- Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air, daughter of the Air Quality Framework Directive (96/62/EC).
- Directive 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air, first daughter of the Air Quality Framework Directive (96/62/EC), now Directive 2008/50/EC.
- Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC, now amended by Directive 2009/30/EC.
- Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC (IPPC).
- EU-JRC PAHs fact sheet (Lerda, 2010).

Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion

This directive applies to combustion plants, the rated thermal input of which is equal to or greater than 50 MW, irrespective of the type of fuel used (solid, liquid or gaseous). Member States are demanded to draw up a license system. Emission limits for dust are reported in Annex VII to directive 2001/80/EC. Reduction of dust emission will also reduce emission of PAHs. The emission limits in Annex VII to 2001/80/EC is provided on the next page.

ANNEX VII

EMISSION LIMIT VALUES FOR DUST

A. Dust emission limit values expressed in mg/Nm³ (O_2 content 6 % for solid fuels, 3 % for liquid and gaseous fuels) to be applied by new and existing plants pursuant to Article 4(1) and 4(3), respectively:

Type of fuel	Rated thermal input (MW)	Emission limit values (mg/Nm³)
Solid	≥ 500 < 500	50 (²) 100
Liquid (¹)	all plants	50
Gaseous	all plants	5 as a rule 10 for blast furnace gas 50 for gases produced by the steel industry which can be used elsewhere

(¹) A limit value of 100 mg/Nm³ may be applied to plants with a rated thermal input of less than 500 MWth burning liquid fuel with an ash content of more than 0,06 %.
(²) A limit value of 100 mg/Nm³ may be applied to plants licensed pursuant to Article 4(3) with a rated thermal input greater than or equal to 500 MWth burning solid fuel with a heat content of less than 5 800 kJ/kg (net calorific value), a moisture content greater than 45 % by weight, a combined moisture and ash content greater than 60 % by weight and a calcium oxide content greater than 10 %.

B. Dust emission limit values expressed in mg/Nm³ to be applied by new plants, pursuant to Article 4(2) with the exception of gas turbines:

Solid fuels (O_2 content 6 %)

50 to 100 MWth	> 100 MWth
50	30

Liquid fuels (O_2 content 3 %)

50 to 100 MWth	> 100 MWth
50	30

In the case of two installations with a rated thermal input of 250 MWth on Crete and Rhodos to be licensed before 31 December 2007 the emission limit value of 50 mg/Nm³ shall apply.

Gaseous fuels (O_2 content 3 %)

As a rule	5
For blast furnace gas	10
For gases produced by the steel industry which can be used elsewhere	30

Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC)

In Annex I of the IPPC, categories of industrial activities that need to have a permit are listed. For some of the industrial branches, installations with low production capacity are left out of the scope of the directive (e.g., thermal power stations and other combustion installations with a heat input less than 50 megawatts or paper and board mills with capacity less than 20 t/d and installations for the disposal of non-hazardous waste with a capacity of 50 t/d). For the different categories of metal production and processing several capacity thresholds apply. For coke ovens, mineral oil and gas refineries no capacity limit apply.

Annex III of the IPPC includes an indicative list of main polluting substances to be taken into account when considering emission limits. The list includes some specific substances, such as dioxins, but also large groups of substances, such as 'persistent and bioaccumulative organic toxic substances'.

Annex II of the E-PRTR holds the emission threshold values for the reporting of specific PAH-substances. These are summarised in Table A.16.

Table A.16 Threshold values for releases of PAHs as reported in Annex II of the E-PRTR. Below these threshold values, the releases do not need to be reported

Substance name	**CAS-number**	**Threshold for releases [kg/y]**		
		To air	To water	To land
Anthracene	120-12-7	50	1	1
Naphthalene	91-20-3	100	10	10
Fluoranthene	206-44-0	-	1	-
Benzo(g,h,i)perylene	191-24-2	-	1	1
Polycyclic aromatic carbons[1]		50	5	5

[1] Polycyclic aromatic hydrocarbons (PAHs) are to be measured for reporting of releases to air as benzo(a)pyrene (50-32-8), benzo(b)fluoranthene (205-99-2), benzo(k)fluoranthene (207-08-9), indeno(1,2,3-cd)pyrene (193-39-5).

Council directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy

In consideration (6) it is described that: '*In accordance with Article 4 of Directive 2000/60/EC, and in particular paragraph 1(a), Member States should implement the necessary measures in accordance with article 16(1) and (8) of that Directive, with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances*' and in consideration (20) that: '*It is necessary to check compliance with the objectives for cessation or phase out, and reduction, as specified in Article 4(1)(a) of Directive 2000/60/EC, and to make the assessment of compliance with these obligations transparent, in particular as regards the consideration of significant emissions, discharges and losses as a result of human activities*'.

According to article 5.5. the Commission shall verify that emissions, discharges and losses are making progress towards compliance with the reduction or cessation objectives.

Annex I of Directive 2008/105/EC with the environmental quality standards is provided in Appendix 2.

National measures beyond EU legislation

Table A.15 summarises a number of national measures beyond EU legislation. An overview of derogations beyond EU legislations was given at the website of DG Enterprise and Industry (European Commission, 2012i). Not all derogations are provided there anymore.

There are seven derogations on creosote or creosote treated wood:

- Commission Decision 2002/884/EC of 31 October 2002 concerning national provisions on restrictions on the marketing and use of creosote-treated wood notified by the Netherlands under Article 95 (4) and (5) of the EC Treaty.
- Commission Decision 2002/59/EC of 23 January 2002 concerning draft national provisions notified by the Kingdom of the Netherlands on limitations on the marketing and use of creosote-treated wood.
- Commission Decision 2001/599/EC of 13 July 2001 concerning draft national provisions notified by the Kingdom of the Netherlands on limitations on the marketing and use of creosote.
- Commission Decision 1999/835/EC of 26 October 1999 on the national provisions notified by the Kingdom of Denmark concerning the limitation to the placing on the market and use of creosote.
- Commission Decision 1999/834/EC of 26 October 1999 on the national provisions notified by the Kingdom of Sweden concerning the limitation to the placing on the market and use of creosote.
- Commission Decision 1999/833/EC of 26 October 1999 on the national provisions notified by the Federal Republic of Germany concerning the limitations of the marketing and use of creosote.
- Commission Decision 1999/832/EC of 26 October 1999 concerning the national provisions notified by the Kingdom of the Netherlands concerning the limitations of the marketing and use of creosote.

All these derogations were approved.
REACH (EC/1907/2006) article 67 describes that Member States may maintain existing and more stringent restrictions until June 2013 provided that these restrictions are notified to the Commission.

Appendix 5 Fact sheet tributyltin (TBT, CAS No. 688-73-3)

Substance specific information TBT

The information is this section is mainly based on SOCOPSE (Feenstra et al., 2009).
There are several tributyltin compounds, such as tributyltin oxide (bis(tributyltin)oxide), tributyltin chloride, tributyltin fluoride, tributyltin methacrylate, tributyltin benzoate, tributyltin linoleate and tributyltin naphthenate. Most commonly applied was bis(tributyltin)oxide.
Under EU Directive 2006/11/EC organotin compounds are classified as R25 (toxic if swallowed), R48/23/25 (danger of serious damage to health by prolonged exposure through inhalation and if swallowed), R21 (harmful in contact with skin), R36/38 (irritating to eyes and skin) and R50/53 (very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment). Bis(tributyltin)oxide is classified as a persistent bioaccumulative and toxic substance (PBT-substance). Tributyltin compounds are Water Framework Directive (WFD) priority hazardous substances, meaning that all emissions and discharges to water need to be phased out or eliminated. In water, tributyltin degrades into less toxic dibutyltin and monobutyltin compounds. In sediment this degradation process takes place far more slowly, creating a source of tributyltin.

Use of organotins

Unless stated differently, the information is based on SOCOPSE (Feenstra et al., 2009).
In the past, mono and di-substituted organotins (generally considered together) were used as PVC stabilisers, as catalysts and in glass coating. Tri-substituted organotins were used as biocides, pesticides and as intermediates in the production of other chemicals. Tetra-substituted organotin compounds are not used commercially, except in synthesis of other chemicals.
Table A.17 outlines the key uses for organotins in the EU and the quantities sold to the EU market in 2002. More recent production and use have not been submitted.

Table A.17 Organotin Uses and Quantities Sold in the EU (estimates for 2002, RPA 2005)

	Applications	Quantity (t/yr)
Tetra-substituted	Intermediate in synthesis	N/A
Tri-substituted	Biocide	< 100
	Biocide in anti-fouling paints[2]	1,250
	Pesticide	100
	Synthesis[3]	< 150
Mono/di-substituted	PVC stabilisers	15,000
	Catalysts	1,300 to 1,650
	Glass coating	760 to 800
Total (maximum)	***All uses (except tetra-subs)***	***approx 19,000***

Notes:
1) Data from ORTEPA (2002) (biocides, pesticides, synthesis and glass coating), ESPA (2002) (stabilisers) and ETICA (2002) (catalysts) as updated by ETINSA in 2003.
2) As discussed below, use of tributyltins for this application are now prohibited (within the EU).
3) ETINSA has advised that the total quantity of tri-substituted tins for use as an intermediate in 2004 was substantially higher than the estimate for 2002. Although not clarified, this could perhaps be because the quantities present in the tetra-substituted tins were excluded.

Within a commercial organotin product, there will always be some quantity of related substances, in addition to the substance itself. In some cases, the performance of these products relies upon the presence of more than one related substance (e.g. mono and disubstituted octyltin stabilisers), whereas in others, the related substances are present as an inevitable impurity. For example, tributyltin chloride will contain impurities of mono, di and tetra-butyl tins, as well as tin tetrachloride.

The use and production of tributyltin
Uses of tributyltin were as a biocide in anti-fouling paints, wood preservatives, other applications and in a wide range of industrial applications including cooling water, pulp and paper mills, breweries, leather processing and textile mills (RPA,2005). Tributyltin compounds have also been used as preservatives in paper, leather, glass and textile, as antioxidants, corrosion inhibitor and in flame resistant polyester. Tributyltin ethacrylate was used as stabiliser in PVC. RPA (2007) reported that tributyltin compounds are currently only used as biocides (including anti-foulants), pesticides; and intermediates in the production of other chemicals. The use as biocide and pesticide is prohibited within the EU as TBT has not been notified (see chapter 2 on legislation).

In 2001, organotin compounds were produced by seven companies at seven sites in the EU and one additional site in the European Economic Area (EEA) (RPA 2005, Table 2). In RPA (2005) it was reported that the (only) company which produces tri-substituted tins for use in wood preservatives has informed the European Commission that it will be withdrawing these products from the market. RPA (2007) remarks: *'According to ETINSA (2007), the production of TBT for this application has strongly decreased (although it is still above 30 tonnes per year for one manufacturer (ETICA, 2007)) and the sales in the EU have stopped and, as such, the tonnages indicated in the RAR are unlikely to be representative of the situation today'*. From the information available at the time of writing the present fact sheet, no information was available if this company indeed has withdrawn its tri-substituted tins from the market. The production as provided in Table A.18 is taken from RPA (2005).

Table A.18 Production of organotins in the EU and EEA in 2001, Table 2.1 in RPA (2005)

Production site	Tetra-substituted (intermediate)	Tri-substituted[1] (biocides/pesticides)	Mono/di- (stabilisers, catalysts)
Akcros - Germany			Yes
Atofina - Holland		Yes	Yes
Baerlocher - Italy			Yes
BNT - Germany	Yes	Yes	Yes
Crompton - Germany[2]	Yes	Yes	
Crompton - Germany			Yes
Reagens - Italy			Yes
Rohm & Haas - Switzerland		Yes	Yes

Source: ORTEPA (2002b).
Notes:
1) ETINSA has advised that as of 2004, only two of the four sites identified in 2001 still produce tri-substituted tins for use in biocidal products. However, the tetra-substituted tins used as an intermediate contain significant amounts of tri-substituted tins. Furthermore, small amounts of tri-substituted tins will still be present as impurities in mono- and di-substituted compounds.
2) On 1st July 2005, Crompton merged with Great Lakes to form Chemtura (www.chemtura.org).

In 2001, the production sites listed in the table used a total of 12,779 tonnes of inorganic tin for the production of the various organotin compounds, as well as for production of inorganic tin compounds. It should further be noted that the data given above apply only to butyltin and octyltin compounds. Methyltin compounds, whilst used in the EU, are only produced outside the EU and are imported.

Emission sources
Many years of use of TBT as an antifoulant has resulted in the contamination of marine and to a lesser extent freshwater sediments. TBT readily binds to sediment where it is extremely persistent. Half-lives in aerobic surface sediments are in the order of 1-2 years

and in anaerobic sediments 10 times longer. Bioaccumulation occurs in most aquatic organisms (Feenstra et al., 2009).
Although there is an abundancy of data on TBT in general, it is difficult to get a clear picture of the mass flows of TBT due to the varying 'stocks' around and the variable half life times. Feenstra et al (2009) report: '*Data on emission of TBT are scarce, and often they are included in "organotin compounds", i.e. it is not possible to identify TBT as such from other organostanic compounds. In Sweden, the use of TBT corresponds to 0.2% of the total use of organotin compounds (KEMI, 2004). Therefore, reported emissions of organotin compounds may be significantly higher than the actual emissions of TBT.*'
Table A.19 and Figure A.4 present the main emission sources of TBT to air, land and water as provided within the SOCOPSE project (Feenstra et al., 2009).

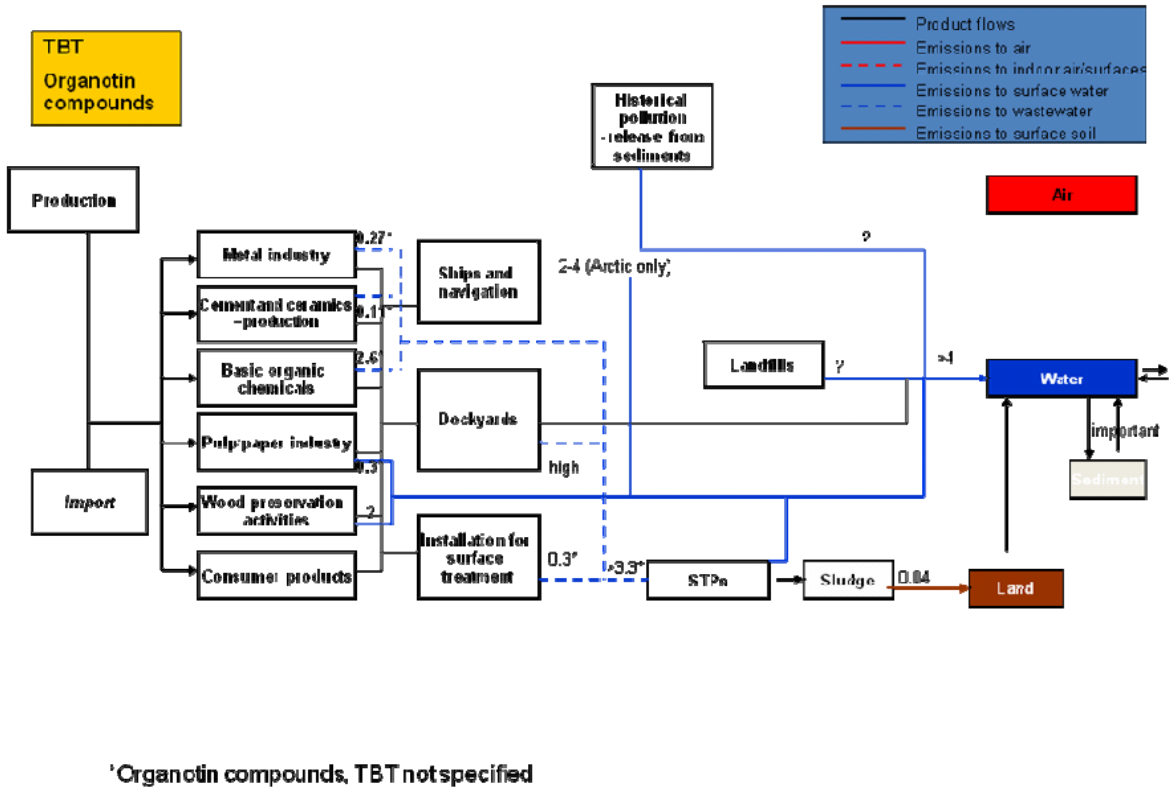


Figure A.4 Material flow analysis (MFA) diagram for TBT in Europe in 2000 (numbers in tonnes/year) (Feenstra et al., 2009)

Table A.19 Tributyltin emissions to air, land and water in 2005 (Feenstra et al., 2009)

Medium	Source	DS/PS[a]	Amount (t/y)
Air	Emission of organotin production plants in EU and EEA to air (units are not correct)	PS	0.0155
Water	Emission of organotin production plants in EU and EEA to waste water	PS	0.018
	Emission of organotin production plants in EU and EEA to surface water	PS	0.054
	Metal industry and metal ore roasting or sintering installations, installations for the production of ferrous and non-ferrous metals, release of organotin compounds (TBT not specified) to Waste Water Treatment Plants (WWTP)	PS	0.274

	Production of cement clinker, lime, glass, ceramic products release of organotin compounds (TBT not specified) to WWTPs	PS	0.106
	Basic organic chemicals, release of organotin compounds (TBT not specified) to WWTP	DS	2.56
	Industrial plants for pulp from timer or other fibrous materials and paper or board production, release of organotin compounds (TBT not specified) to water	PS	0.333
	Construction and demolition of preserved wood, additives in paints and stain	PS	?
	Dockyards, emissions of TBT to runoff water and waste water (may be very high concentrations, more than 3 mg TBT/L have been measured)	DS	?
	Historical pollution (contaminated harbour sediments, old dockyards) has accounted for the most significant local releases of TBTO. Many of the 'hot spot areas' of TBT contamination are associated with the releases from dockyards	DS	?
	Shipyards and navigation- emissions to surface water, release from antifouling coatings	DS	2-4
	Consumer products – TBT as impurity in products such as textiles, materials in contact with food, PVC products using DBT as stabiliser	DS	0.12
	Installation for surface treatment or products using organic solvents, release of organotin compounds (TBT not specified) to WWTP	DS	0.285
Waste	Leaching from landfills is possible (not quantified)	PS/DS	?
Terrestrial environment	Municipal sewage sludge application, amount based on Swedish levels in sludge, 2005 and EU data on sludge application	DS	0.041

[a] DS = diffuse source, PS = point source

Sources and measures TBT

Data on emissions of TBT are scarce and Figure A.4 and Table A.19 indicate that a lot on the material flow from TBT is still unclear. However, it appears from the data presented in Table A.19 that the main identified sources are basic organic chemicals, release of organotin compounds (TBT not specified) to WWTP and shipyards and navigation emissions to surface water, release from antifouling coatings. Emissions from dockyards and historical pollution are unknown, but from the literature it is clear that these can be potential important sources as well (e.g. Eklund et al., 2008; Santillo et al., 2001).

Tributyltin has been mentioned 'the best example of endocrine disruption in invertebrates that is causally linked to an environmental pollutant' and it is among the best examples where awareness of it effects has lead to international measures (Santillo et al., 2001). However, these measures do not indicate that all problems have been solved.
Tributyltin was introduced as an anti-fouling agent in the 1960s and sales increased rapidly in the 1970s. First adverse effects of tributyltin were observed in the 1970s in France and the UK, but at the end of the 70s failure of the oyster stocks in Southwest France and the observed relationship with the use of TBT lead to swift action of the French government. In 1982 TBT paints were forbidden for ships smaller than 25 meters in France. Actions in other countries followed. A good description of the phasing out of TBT can be found in Santillo et al. (2001), which also focus on the process of global phase out and the roles of IMO and OSPAR. In a number of cases the restriction led to recovery of the ecosystem, but in others such recoveries were much slower than expected. Santillo et al. (2001) indicated that the restrictions on retail had undoubtly lead to a shift from TBT containing paints on smaller ships, resulting in a substantial reduction in input. However, they also observed continued inputs due to isolated but significant illegal use and releases from historical

pollution. An additional cause of the slow recovery could be the high larval sensitivities and long life histories of the species.
First international initiatives were taken in 1987 by PARCOM, which soon realised that it could not achieve restrictions within the commercial shipping sector. Therefore focus was redirected to input from docking activities (Santillo et al., 2001). In 1990 the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) adopted a resolution in which the MEPC recommended that governments adopt and promote effective measures to control the effects associated with tributyltin within their jurisdiction. In the next decade a lot of research was carried out, and negotiations finally led to a draft of the International Convention on the Control of Harmful Anti-Fouling Systems on Ships, which was adopted by IMO in 2001. The Convention entered into force on 17 September 2008, is at present signed by 47 parties and covers 75% of the world tonnage (IMO, 2012). A thorough description of the process, as well as the perceived obstacles in banning organotin compounds, such as the absence of acceptable alternatives, unknown environmental risks of the alternatives and losses of business and possible closures of European yards in case of unilateral European action, is provided in IMO (2002).
According to the Convention ships should not have TBT based systems applied or re-applied from January 2003 onwards. Existing TBT systems had to be replaced, or over-coated by January 2008. Industries view on the Treaty as well as the development of alternatives is reflected in a paper 'Industry way ahead of antifouling treaty', available on Tankeroperator (2003)

In 2001 Germany tried to ban organostannic compounds from a number of products such as heavy industry textiles and consumer products by means of a derogation of the Marketing and Use Directive (76/769/EC). The request was rejected. However, in 2009, the European Commission decided to ban the use of specific organostannic compounds in consumer products (2009/425/EC). This decision has been implemented through an amendment of REACH Annex XVII (EC/276/2010) after studies by RPA in 2004, 2005 and 2007 and a recommendation by the SCHER in 2006 (RPA, 2005, 2007; SCHER 2006). RPA (2007) mentions the application of TBT in non-allergenic pillows used in the UK, insoles for shoes in the UK, use in the padding of cycling shorts in Germany and use in a spray for the treatment of athlete's foot in Germany. RPA (2007) concluded that these applications were no longer allowed because they were not notified under the Biocidal Products Directive and proposed to restrict the use of tri-substituted organotins (TBT and TPT), in order to '*address any concerns relating to borderline products (e.g. those relating to medicinal products) and the importation for sale in the EU of consumer articles treated outside of the EU with organotins (for biocidal purposes)'*. It was also stated that the actual benefits were unclear, but that the restriction at least ensures that this use does not re-occur in the future. RPA (2007) summarises national measures, measures at an international level and lists some voluntary initiatives to address the risks of organotins.
The European Commission concluded in their impact assessment (European Commission, 2009) that there would be no impact on the EU budget and that the proposal would also be notified to the WTO under the TBT agreement, which will give third countries the possibility to comment. In the WTO meeting of December 2009 Japanese delegations expressed their concerns on the restrictions of marketing and use of organostannic compounds, but mainly focussed this on the dibutyltin compounds. No remarks were made on the prohibition of the tributyltin compounds in the regulation proposal.

Besides the efforts to prohibit the application of TBT as antifouling and the more general non-inclusion of TBT on Annex I of the Biocidal Products Directive and inclusion in Annex XVII of REACH, various voluntary measures have been proposed to limit the input from cleaning and other docking activities in various ports throughout the globe. Input from hull maintenance have long been recognised, but the effectiveness of measures to limit these inputs are difficult to evaluate (Santillo et al., 2001). The MEPC has considered a 'draft guidance on best management practices for removal of anti-fouling coatings from ships, including TBT hull paints', developed by scientific groups under the London Convention and the London Protocol, which has been adopted by IMO in 2009 (IMO,

2009). The guidance provided basic facility requirements, as well as a chapter on anti-fouling waste chain. Various initiatives and guidelines from local ports, available on the internet, have already been implemented before 2009. Eklund et al. (2008) observed high TBT concentrations in Swedish ports and attributed this to hull cleaning without collecting the scraped-off paint flakes. Another cause can be not collecting the waste water. Sediment bound TBT was also indicated as a potential source of TBT, as degradation rates showed to be low.

Information on alternatives, national measures, international measures taken through time, and discussions within the MEPC are provided in IMO (2002). Measures in various countries are also summarised in Bray and Langston (2006).

The sources listed in Table A.20 were indicated to be 'significant' in available documents (see reference list). However, most of these sources were not quantified for the whole of the EU. Therefore, sources could not be expressed in terms of proportion of total load to water (%).

The existing and possible measures at Member State and EU level, as provided by the participants of the ad hoc Drafting Group meetings, are given in Table A.20. Information on national measures was mostly based on information provided by the United Kingdom and the Netherlands. National measures may therefore not be considered to be broadly applied among EU Member States, since information about measures of individual Member States was not available at the time this fact sheet was assembled. National measures were only listed if these deviated from the EU measures. This fact sheet is primarily confined to legislative tools. For technical controls is referred to the SOCOPSE and SCOREPP projects.

Table A.20 Sources and measures TBT

Source/ pathway	**Legislative and non-legislative tools**			
	Existing measures		**Possible measures / measures in preparation**	
	National	**EU/international**	**National**	**EU/international**
General	Flanders: Restrictions in use and in bringing on to the market : this is a federal matter; more information can be obtained from *FOD Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu DG Leefmilieu, Afdeling Risicobeheersing* (FOD, 2012).	Directive on Priority Substances (Directive 2008/105/EC)	REACH: National authorities can bring up candidate substances for authorisation according to Annex XV. Substances in Annex XV are not allowed to be used in production and products.	
		REACH Regulation 1907/2006, Annex XVII		

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		**Possible measures / measures in preparation**	
	National	**EU/international**	**National**	**EU/international**
Antifouling paint	UK: • good practice on waste management in shipyards and ports (UK); • help prevent illegal use of old TBT containing products.	REACH Regulation 1907/2006, Annex XVII	UK: Navigation: • ban on marketing of TBT as a biocide in the EU; • non-application of TBT to boat hulls by July 2003. From January 2008 TBT should not be used on ship hulls or there should be a coating to prevent leaching of underlying TBT anti-foulants; • help prevent illegal use of old TBT containing products; • develop national guidance framework on dredging and disposal of dredgings to inform Programme of Measures to meet WFD objectives; • apply national guidance framework on dredging and disposal of dredgings to refine local measures as appropriate (where not disproportionately costly or technically infeasible); • review existing controls for dredging and disposal of dredgings inside and outside harbour limits as appropriate.	
	UK: Statutory Instruments 2009 No. 2796. Implementing IMO AFS and EU Regulation 782/2003.	International Maritime Organisation: convention[2]		

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		**Possible measures / measures in preparation**	
	National	**EU/international**	**National**	**EU/international**
		Regulation No 782/2003 on the prohibition of organotin compounds on ships.		
		Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR)[1]: recommendations (pm).		
Remaining biocidal use (e.g. wood preservative for timber)	Flanders: Restrictions in use and in bringing on to the market : this is a federal matter; more information can be obtained from *FOD Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu DG Leefmilieu, Afdeling Risicobeheersing* (FOD, 2012).	REACH Regulation 1907/2006, Annex XVII Removal from market according to Biocidal Products Directive (98/8/EC).	• UK: Investigate emissions from installations (focusing on ship yards, timber treatment plants or treated timber storage areas (imported timber) and appraise options (to reduce at source or treat) to meet EQS and for priority substances and priority hazardous substances, reduce/cease emissions in this or subsequent rounds.	
Historical contamination, resuspension of contaminated sediments	Decree on soil quality regulates use of diffusely contaminated soil and sediment (NL).		UK: • development and application of guidance on dredging and disposal of dredging)(Pollution Reduction Plan (PRP), UK); • investigate losses from contaminated land, groundwater and sediments and appraise options for remediation to meet EQS and reduce/cease losses in this or subsequent rounds.	Consider the development of guidance for risk assessment of contaminated soils and sediments (spots and diffuse sites).

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		**Possible measures / measures in preparation**	
	National	**EU/international**	**National**	**EU/international**
Accidental spills in production and use	NL: Act on soil protection.	Seveso directive on the control of major accidents involving dangerous substances (96/82/EC)[6]: applicable to establishments containing dangerous substances in quantities exceeding threshold levels.		Consider tighter limits under Directive 2008/1/EC concerning Integrated Pollution Prevention and Control (IPPC).
Effluent sewage treatment plants[4]			UK: • restrict the use of compounds containing TBT in plastic in applications where the TBT may leach , e.g. PVC use in garage roofs, guttering etc. Substitution of TBT in PVC (Pollution Reduction Plan (PRP), UK); • voluntary agreement with building industry to not use plastics containing TBT in applications where the TBT may leach; • investigate emissions from WWTPs and confirm whether further investigation into sources discharging to sewer is required.	Consider the ban on use of other tin compounds which contain TBT as impurity[3]; REACH: Consider appointing TBT as a substance of very high concern (SVHC) under REACH.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		**Possible measures / measures in preparation**	
	National	**EU/international**	**National**	**EU/international**
Products processing: paper, pulp and board Food/animal processing Pharmaceutical manufacture Cement industry	NL: Application of best available techniques (BAT) for all installations on a case-by-case approach. Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation: • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).	IPPC (2008/1/EC)[5]		REACH: Consider appointing TBT as a substance of very high concern (SVHC) under REACH.
	Flanders: Restrictions in use and in bringing on to the market : this is a federal matter; more information can be obtained from *FOD Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu DG Leefmilieu, Afdeling Risicobeheersing* (FOD, 2012).	REACH Regulation 1907/2006, Annex XVII	UK: Local pollution prevention campaign (including, where appropriate, campaigns to raise awareness of marketing and use restrictions).	

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		**Possible measures / measures in preparation**	
	National	**EU/international**	**National**	**EU/international**
Chemical industry (basic organic chemicals)	NL: Application of best available techniques (BAT) for all installations on a case-by-case approach. Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents has to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation: • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).	IPPC (2008/1/EC), BAT reference document[5]	UK: Investigate emissions from installations and appraise options (to reduce at source or treat) to meet EQS and reduce/cease emissions in this or subsequent rounds.	REACH: Consider appointing TBT as a substance of very high concern (SVHC) under REACH.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		**Possible measures / measures in preparation**	
	National	**EU/international**	**National**	**EU/international**
Organotin production plants	NL: Application of BAT for all installations on a case-by-case approach. Estionia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. Flanders: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).	IPPC (2008/1/EC), BAT reference document [5]	UK: Investigate emissions from installations and appraise options (to reduce at source or treat) to meet EQS and reduce/cease emissions in this or subsequent rounds.	REACH: Consider appointing TBT as a substance of very high concern (SVHC) under REACH.

Source/ pathway	Legislative and non-legislative tools			
	Existing measures		**Possible measures / measures in preparation**	
	National	**EU/international**	**National**	**EU/international**
Metal industry	NL: Application of BAT for all installations on a case-by-case approach. Estonia: According to the IPPC requirements enterprises have to follow BAT recommendations. Regular monitoring of effluents have to be performed by enterprises as well as measures of reduction or avoidance of emissions. According to the Water Act the same obligations are prescribed by water permits for those enterprises which are not obliged to have IPPC permits. F landers: A (point) discharge of a dangerous substance (in a concentration above the EQS) is only allowed when there is a prior authorisation: • in these authorisations BAT always need to be applied (for all installations – not only IPPC installations); • for priority hazardous substances, which are required to be phased out, Flanders tries to set emission limit values as low as possible, without taking dilution in the surface water into account (measures such as closed circuit, and substitution are preferable to end-of-pipe-measures).	IPPC (2008/1/EC), BAT reference document[5]	UK: Investigate emissions from installations and appraise options (to reduce at source or treat) to meet EQS and reduce/cease emissions in this or subsequent rounds.	REACH: Consider appointing TBT as a substance of very high concern (SVHC) under REACH.

[1] OSPAR has made two recommendations concerning tributyltins, namely:
Paris Commission (PARCOM) Recommendation 87/1 on the use of tributyl-compounds;
PARCOM Recommendation 88/1 on measures to reduce organotin compounds reaching the aquatic environment though docking activities. Furthermore organotin compounds are on the OSPAR list of chemicals for priority action. This will have as a consequence that organotins are subject to a cessation target by 2020 of discharges, emissions and losses. OSPAR 2000 agreed on the background document on organotins, in which the actions have been agreed that are necessary to achieve the cessation target. Although these recommendations do not have regulatory status, Member States may consider adopting the recommendations and implementing them in national rules.

[2] International Convention on the Control of Harmful Anti-fouling Systems on Ships, adopted on the 5th October 2001 of the International Maritime Organisation (IMO). By 1 January 2008 ships either:
1. shall not bear such compounds on their hulls or external parts or surfaces; or
2. shall bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems.
This applies to all ships (including fixed and floating platforms, floating storage units (FSUs), and Floating Production Storage and Off take units (FPSOs). However, the Convention does not apply when an insufficient number of convention states have ratified, as is the case at this moment. The draft Pollution Reduction Plan for TBT of the UK mentions that the UK is seeking for ratification, but this is delayed by discrepancies between the Convention requirements and the requirements of Regulation 782/2003 (EC). The Council Regulation is found to be stricter concerning the introduction of barrier coatings.

[3] In the UK (draft Pollution Reduction Plan, PRP) levels of TBT have been found in effluent from sewage treatment plants (STPs) and in trade effluents above the Environmental Quality Standard (EQS). Levels in trade effluent may be due to the use of other tin compounds that contain TBT as an impurity or to TBT in raw materials such as paper sent for recycling. Levels in sewage treatment plants effluent might be due to trade effluent discharges and contributions from diffuse sources. TBT is an impurity in dibutyltin (DBT) which has principally been used as an anti oxidant in PVC. Leaching of TBT from PVC to water may be a significant (diffuse) source of TBT in the aquatic environment. TBT is found as an impurity in products such as textiles, and materials in contact with food.
In the WFD fact sheet on TBT discharges in sewage effluents or storm water as a result of run off of buildings due to wood conservation and paint additives are indicated as potential pathways which may result in or contribute to potential failure of WFD objectives. Similarly, households and consumer use are indicated as potential sources or routes contributing to potential failure of WFD objectives due to application of paints and products with organotin based stabilizers.

[4] The UK draft Pollution Reduction Plan for TBT:
'The EU Commission is currently considering proposals for additional restrictions on the use of organotin compounds, including TBT and other organotin compounds where TBT may be present as an impurity. A summary of the proposals are:
Recommendation
To consider at Community level, marketing and use restrictions under Council Directive 76/769/EEC (marketing and Use Directive) on <u>all uses</u> of:

- *Tri-substituted organotins, in particular tributyltin (TBT) and triphenyltin (TPT) compounds;*
- *Dibutyltin (DBT) compounds as stabilisers in all consumer (PVC) products;*
- *Dioctyltin (DOT) compounds as stabilisers in all consumer (PVC) products with a three-year phase-out period;*
- *Dibutyltin (DBT) and dioctyltin (DOT) compounds in plasticised PVC, unless used in steel (or coil) coating;*
- *Dibutyltin (DBT) and dioctyltin (DOT) compounds as silicone catalysts for RTV-2 DIY moulds, baking trays and baking paper coatings and in RTV-1 sealants, with a three-year phase out period for use of dioctyltin (DOT) compounds in RTV-1 sealants.*

Uses of organotins in plant protection products, food and food contact materials, biocides, medical devices and applications, and as intermediates in chemical synthesis, are not covered by these recommendations as these uses (apart from intermediates) fall under specific regulatory frameworks (or legislation) which are more appropriate for addressing the identified risks.' Navigation task force: The recent addition of these compounds to the

Marketing and Use Directive will effectively put in place the proposed controls by the UK Health and Safety Executive.

[5] Organotin compounds are listed in Annex III to the IPPC. This annex is an 'indicative list of the main polluting substances to be taken into account if they are relevant for fixing emission limit values'.
Several BREFs (BAT reference documents) have been developed, e.g. on large volume organic chemicals, on ferrous metals and non-ferrous metals and on refineries. These BREFs do no refer to TBT specifically, but describe techniques or processes aiming to reduce emissions of categories of substances such as organic substances.
For metal industry, paper and board production and food processing, capacity thresholds are set below which the installations do not fall under the requirements of the IPPC.

[6] Seveso Directive: Member States shall ensure that the operator is obliged to take all measures necessary to prevent major accidents and to limit their consequences for man and the environment. The operator needs to draw up a document setting out his major accident prevention policy. Requirements of the document are laid down in the annexes to the Seveso Directive. Among the dangerous substances are substances very toxic to aquatic organisms (R50) and toxic (T), thereby including TBT present above certain threshold amounts.

Relevant legislation tributyltin (TBT)
The regulation of tributyltin is at present confined to six different fields. These are discussed on the following sections.

Marketing
The marketing and use is regulated under the REACH Regulation (EC/1907/2006). By means of amendment of Annex XVII through regulation EC/552/2009 the use of organostannic compounds as biocide or in the treatment of industrial waters was regulated. The application of tri-substituted organostannic compounds, dibutyltin compounds and dioctyltin compounds in articles and consumer products was regulated by means of amendments through regulation EC/276/2010.
Marketing and use of organostannic compounds used as antifouling amended to the previous Marketing and Use Directive (76/769/EC) by means of Directives 1999/51/EC and 2002/62/EC after discussions and later on decisions made under the International Convention on the Control of Harmful Anti-fouling Systems on Ships of the IMO. The Convention text can be found on IMO (2012):

Anti fouling
In 2003 the regulation on the prohibition of organotin compounds on ships (EC/782/2003) was published. The EU considered it necessary to publish this regulation as not all the resolutions of the Anti Fouling System Conference could be implemented through the Marketing and Use Directive. The new directive, updated by means of EC/536/2008 and EC/219/2009 also regulated existing tributyltin and contained provisions considering non-EU ships entering EU ports. The regulation indicated that ships bearing an active TBT coating on their hulls will no longer be allowed in Community ports.

Biocides
Tibutyltin compounds have not been included as an active ingredient in Annex I of the Biocidal Products Directive (98/8/EC). Therefore it is prohibited to place them on the market or use them. Active ingredients in Annex I or IA can be found on the biocides directive of the European Commission (European Commission 2012d). A decision on the non-inclusion of bis(tributyltin) oxide was

taken by means of regulations EC/1048/2005 amending Regulation (EC) No 2032/2003.

Plant protection products
A decision on the non-inclusion of bis(tributyltin) oxide in the Plant Protection Products Directive (91/414/EC) was taken by means of regulation EC/2076/2002 which lists tributyltinoxyde in the list of active substances which are not included as active substance in Annex I to Directive 91/414/EEC.

Import and export
All tributyltin compounds are included in Annex I of regulation EC/196/2010, which implements the Rotterdam Convention on the Prior Informed Consent Procedure (PIC procedure). Under this regulation the EC decides on the permission to import chemicals subject to the prior informed consent (PIC) procedure.

Water Framework Directive
Tributyltin is incorporated in the Directive on Priority Substances (2008/105/EC) of which the relevant text is copied below.

Council directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy
In consideration (6) it is described that: '*In accordance with Article 4 of Directive 2000/60/EC, and in particular paragraph 1(a), Member States should implement the necessary measures in accordance with Article 16(1) and (8) of that Directive, with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances*." and in consideration 20) that "*It is necessary to check compliance with the objectives for cessation or phase-out, and reduction, as specified in Article 4(1)(a) of Directive 2000/60/EC, and to make the assessment of compliance with these obligations transparent, in particular as regards the consideration of significant emissions, discharges and losses as a result of human activities*'.
Article 5.5.describes that the Commission shall verify that emissions, discharges and losses are making progress towards compliance with the reduction or cessation objectives.
Annex I fo directive 2008/105/EC with the environmental quality standards is provided in the Annex on cadmium.

National measures beyond EU legislation
In 2000 and 2001 Belgium and Germany informed the Commission that they intended to apply stricter measures regarding organostannic compounds than those contained in Directive 1999/51/EC which amended the Marketing and Use Directive (76/769/EC). Belgium intended to apply more restrictive measures than those in directive 1999/51/EC, as they amount to a total ban on the marketing and use of organostannic compounds in antifouling products (2000/509/EC). Germany had drafted national measures that intended also to limit the maximum content of triorganic-tin compounds for a number of products such as heavy industrial textiles and consumer products (2001/570/EC). Both requests were rejected.

A LIFE-Environment demonstration project, carried out by the Antwerp Port Authority, aimed to show how TBT-heavy sediments could be removed, treated and reused. The project, 'Development of an integrated approach for the

removal of TBT' (LIFE02 ENV/B/000341), therefore set out to address questions that have relevance for all ports worldwide.

Appendix 6 Priority substances that may prevent the achievement of the WFD objectives

The table A.21 presented below was based on the responses sent by Member States till 02/03/2009 (10 out of 14 reporting countries). For the following Members States, spot/local problems have been identified: SI (Cd and Hg - spot problems), BE-W (only from atmospheric deposition), IE (PAH – in one or two samples), CY (Cd and Ni - spot problems) and FI (Cd and Ni - only for the rivers from the West Coast). For EE none of priority substances is preventing the achievement of the WFD objectives.
Three kinds of situations that may cause the failure of environmental objectives due to the pollution coming from were identified:

- diffuse and point sources as well as the long range transport;
- diffuse sources and long range transport;
- uncertain or unknown sources.

Table A.21. Countries for which a certain substance is considered as preventing the achievement of the WFD objectives

Priority substances that may prevent the achievement of the WFD objectives	**Member States**
PAH*	NL, IT, FR, SE, BE-W, HU[3], RO[3], NO[4]
TBT*	NL, IT, UK, FR, SI[5], SE, DK
Cadmium*	NL, SE, HU[1,2], RO[3], NO[4]
Mercury*	NL, SE, HU[1], RO[3]
Lindane*	NL, HU[1], RO[3], NO[4]
Nonylphenol*	SE, DK
HCB*	IT, RO[3]
PentaBDE*	SE, NO[4]
HCBu*	HU[2]
Endosulfan*	HU[2]
Chloralkanes, C_{10-13}*	NO[4]
DEHP	UK, SE, FR, NO[4]
Nickel	SE, RO[3], NO[4]
Lead	SE, RO[3], NO[4]
Drins	NL, RO[3]
Isoproturon	HU[1], NO[4]

Atrazine	IT
Chlorfenvinfos	NO[4]
Diuron	HU[2]
DDT	RO[3]
Fluoranthene	NO[4]
Naphtalene	NO[4]
Octylphenol	SE
Pentachlorophenol	NO[4]
Triclormethane (Cloroform)	HU[2]
Trichlorobenzenes	HU[3]

* Priority hazardous substances
1 - Possible at risk (based only on MAC)
2 - Possible at risk (based only on AA)
3 – Possible at risk
4 – Based on literature survey
5 – Only for marine waters

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