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Thematic Strategy on Sustainable Use of Plant Protection Products

Prospects and Requirements for Transferring Proposals for Plant Protection Products in Biocides

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Thematic Strategy on Sustainable Use of Plant Protection Products – Prospects and Requirements for Transferring Proposals for Plant Protection Products to Biocides

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Foreword

Biocides are highly active substances used in a broad pattern as it is reflected by the 23 different product types (PT). Biocides are able to kill, to destroy or to deter living organisms. Due to these inherent hazardous properties biocides pose potential risks to human health and the environment. If such products are applied near to humans or introduced into the environment, there is a high probability that they cause damage to people and/or wildlife. Biocides share this capability with pesticides used as plant protection products. With regard to plant protection products a dual approach has been established:

- an authorisation procedure as given in the Regulation 1107/2009/EC concerning the placing of plant protection products on the market as a prerequisite for the marketing of individual substances and products - and in parallel
- an approach which does not address individuell products but aspects of the overall use of plant protection products in general as given in the Directive 2009/128/EC establishing a framework for Community action to achieve the sustainable use of pesticides.

It seems to be sensible that such an approach is appropriate for biocides as well, as authorised biocides are still biocides - which means that they keep their ability in killing living organisms. The lesser the amount to which biocides are used, the lesser should be the possible damage to humans and the environments. Therefore also for biocides an approach which aims at reducing their use seems to be reasonable.

Concerning the emission of biocides to the environment only limited reliable information is available to date and biocides are rarely considered in monitoring programs. Notwithstanding, several studies from research projects clearly demonstrate that biocides are regularly found in environmental samples.

The first experiences in biocidal product authorization raised many important aspects about the use of biocides like

- the use of biocides (e.g. insecticides, repellents or antifoulings) in sensible areas (e.g. in protected areas as described in Art. 12 of Directive 2009/128/EC establishing a framework for Community action to achieve the sustainable use of pesticides or water supply areas),
- the obligation to minimize the use of biocides, for instance by taking into account of preventive and/or non-biocidal measures,
- so called good practice of biocide application,
- so called integrated pest management,
- resistance management ,
- the need for education and training - expert knowledge with regard to high risk product types (e.g. rodenticides),
- handling, storage, disposal,
- public awareness raising.

These aspects are very similar to those regulated for the use of plant protection products. The Thematic Strategy on sustainable use of pesticides has been implemented in the Framework Directive 2009/128/EC on sustainable use of pesticides only for plant protection products so far. Until now there exists no harmonised approach to minimise hazards and risks of biocides to human health and the environment during the use phase. While the Biocide Product Directive 98/08/EC and the new Biocide Regulation focus on the procedure for including active substances in the Annexes of the Directive and the authorisation of biocidal products, there are no concrete requirements for the use phase of biocidal products. The new Regulation addresses the sustainable use of biocides under Art. 18 by obliging the Commission to present to the Council and the European Parliament a report on sustainable use of biocidal products. That report shall, inter alia, examine:

(a) the promotion of best practices as a means of reducing the use of biocidal products to the minimum;

(b) the most effective approaches for monitoring the use of biocidal products;

(c) the development and application of integrated pest management principles with respect to the use of biocidal products;

(d) the risks posed by the use of biocidal products in specific areas such as schools, workplaces, kindergartens, public spaces, geriatric care centres or in the vicinity of surface or groundwater and whether additional measures are needed to address them;

(e) the role that the improved performance of the equipment used for the application of biocidal products could make to sustainable use.

On basis of that report, the Commission shall, if appropriate, present a legislative proposal.

The main objectives of sustainable use of biocides are the protection of the environment especially of water bodies and soil, the preservation of biodiversity, the minimisation of hazards to human health, and the avoidance of resistance development.

The Federal Environment Agency of Germany (UBA) conducted from 2008 to 2011 a project with the title "Thematic Strategy on Sustainable Use of Plant Protection Products – Prospects and Requirements for Transferring Proposals for Plant Protection Products to Biocides" (UFOPLAN-Ref. No. FKZ 3708 63 400). Within the project the possibilities and requirements for adapting measures as prescribed in the Framework Directive 2009/128/EC on sustainable use of pesticides to the biocide area have been systematically analysed, with specific focus on wood preservatives, insecticides, and antifouling agents. This analysis of the instruments for improving sustainable use of pesticides described in Directive 2009/128/EC revealed that the structure of certain instruments can be transferred to the biocide area, but some biocide specific adaptations are required, not only for biocides in general, but also for the several PTs or specific applications.

The UBA project analyses relevant aspects of the sustainable use of biocides specific for the product types wood preservatives, insecticides and antifouling agents and provides suggestions and recommendations which could be useful to stipulate the EU discussion on sustainable use of biocides.

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16. Abstract

The sustainable use of pesticides pursues, independent of the authorisation of single products, the aim to minimise existing environmental risks of pesticide use and therefore contribute to the reduction of its impact on the environmental protection goals. The Thematic Strategy (TS) and the Framework Directive 2009/128/EC (FWD) on sustainable use of pesticides have so far only been implemented for plant protection products (PPP). For biocides there exists no harmonised approach. Within the project the possibilities and requirements for transferring measures of the FWD to the biocide area have been analysed, with specific focus on wood preservatives, insecticides, and antifouling products. Several biocidal active substances are found in the outlets of sewage treatment plants and in surface water, but an inventory of the present environmental impact as well as reliable data on biocide consumption and use patterns, which could be used to identify key action areas, are generally missing. These data are urgently needed for the development of suitable indicators and the definition of the objectives. Sustainable use of biocides addresses the three issues; social, environmental and economic impact at which the ecological background assigns the borderline and beam barrier of the economic and social development. A systematic analysis of the instruments for improving sustainable use of pesticides described in TS and FWD indicated that many issues can be transferred to the biocide area. This concerns e.g. education and training, requirements for sales, the establishment of awareness programmes, control of the machinery for biocide application, the development of best practice standards based on integrated pest management principles, and the collection of statistics on biocide consumption. Some biocide specific characteristics need to be considered: E.g. unlike PPP, the intended use of some biocides is to be directly applied in water bodies or indoors. Furthermore for some product types, emissions during the service life of biocides (e.g. through leaching) are more relevant than during the application phase. The authors recommend the development of an action framework on sustainable use of biocides on European level. Key problem areas and action options should be identified and prioritised after analysis of existing data. These measures could be implemented by establishing a new TS or FWD on biocides or by amending the existing TS or FWD one on pesticides. However certain measures could be first implemented on national level and then be included in a national action plan. A prioritisation of biocide uses to be considered is required. Later on, existing national measures could be implemented in a general strategy on sustainable use at European level.

17. Keywords
biocides, Biocidal Products Directive, sustainable use, pesticides, integrated pest management, best practices, risk awareness

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16. Kurzfassung

Die nachhaltige Verwendung von Pestiziden verfolgt das Ziel, unabhängig von einzelnen Produkt-Zulassungen, bestehende Risiken der Pestizid-Anwendung zu minimieren und so zur Entlastung der Schutzgüter beizutragen. Die Thematische Strategie (TS) und die Rahmenrichtlinie 2009/128/EG (RRL) zur nachhaltigen Verwendung von Pestiziden berücksichtigen bisher nur Pflanzenschutzmittel (PSM). Für Biozide existiert keine harmonisierte Herangehensweise. Im Projekt wurden die Möglichkeiten und Erfordernisse zur Übertragbarkeit der Maßnahmen der RRL auf den Biozidbereich analysiert. Der Focus lag auf Holzschutzmitteln, Insektiziden und Antifoulingprodukten. Obwohl verschiedene Wirkstoffe im Ablauf kommunaler Kläranlagen und im Oberflächenwasser nachgewiesen werden, fehlen verlässliche Daten zum Biozidverbrauch und den Verwendungsmustern ebenso wie eine Bestandsaufnahme der bestehenden Umweltbelastung, die als Grundlage für die Identifizierung von Handlungsschwerpunkten herangezogen werden könnten. Diese Daten werden dringend für die Entwicklung geeigneter Indikatoren und die Festlegung von Zielen benötigt. Die nachhaltige Verwendung von Bioziden adressiert die drei Aspekte der sozialen, umweltbezogenen und wirtschaftlichen Ziele der Nachhaltigkeit, wobei die ökologischen Grundlagen die Grenzen und Leitplanken der wirtschaftlichen und sozialen Entwicklung markieren. Die systematische Analyse der für PSM festgelegten Instrumente zur Verbesserung einer nachhaltigen Verwendung von Pestiziden, die in der TS und der RRL beschrieben sind, ergab, dass viele Aspekte auf den Biozidbereich übertragen werden können. Dies betrifft z.B. die Aus- und Fortbildung, Anforderungen an den Verkauf, Informationskampagnen zur Verbraucher-Sensibilisierung, die Kontrolle der Anwendungsgeräte für Biozide, die Entwicklung von besten Techniken auf Basis der Prinzipien der integrierten Schädlingsbekämpfung und Statistiken zum Biozidverbrauch. Einige biozidspezifische Besonderheiten müssen jedoch berücksichtigt werden: Beispielsweise werden - anders als bei PSM - einige Biozide bestimmungsgemäß in Wasserkörpern oder in Innenräumen eingesetzt. Darüber hinaus sind für einige Produktarten die Emissionen während der Nutzungsphase (u.a. durch Auswaschung) weit bedeutender als während der Anwendungsphase. Die Autoren empfehlen die Entwicklung eines Aktionsrahmens zur nachhaltigen Verwendung von Bioziden auf EU-Ebene. Unter Auswertung der vorhandenen Daten sollten Problemschwerpunkte und Handlungsoptionen identifiziert und priorisiert werden. Diese Maßnahmen könnten dann durch Auflage einer neuen TS oder RRL für Biozide oder durch Änderung der bestehenden TS oder RRL für Pestizide eingeführt werden. Bestimmte Maßnahmen könnten aber auch zunächst auf nationaler Ebene etabliert und in einem nationalen Aktionsplan integriert werden. Eine Priorisierung der zu berücksichtigenden Biozidanwendungen ist erforderlich. Später könnten die auf nationaler Ebene getroffenen Maßnahmen in eine generelle Strategie zur nachhaltigen Verwendung von Bioziden auf EU-Ebene münden.

17. Schlagwörter
Biozide, Biozid-Produkte-Richtlinie, nachhaltige Nutzung, Pestizide, Integriertes Schädlingsmanagement, Beste Techniken, Risikowahrnehmung

18. Preis

19.

20.

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List of Abbreviations

BAT	Best Available Techniques
BBA	German Biological Research Centre for Agriculture and Forestry (now JKI)
BLAC	Federal/Federal State Working Committee Chemical Safety (Bund/Lände Arbeitsgemeinschaft Chemikaliensicherheit)
BPD	Biocidal Products Directive
BREF	Best Available Technique Reference Documents
CA	Competent Authority
CAR	Competent Authority Assessment Report
CEN	European Committee for Standardisation
CEPA	Confederation of European Pest Control Association
CEPE	European Committee for Paints and Inks
CIRCA	Communication & Information Resource Centre
CSTEE	Scientific Committee on Toxicity, Ecotoxicity and the Environment
DAR	Draft Assessment Report
EAP	Environment Action Programme
EC	European Communities or European Commission
EMEA	European Medicines Agency (since December 2009 EMA)
ENTAM	European Network for Testing Agricultural Machines
EU	European Union
EP	European Parliament
EQS	Environmental Quality Standards
GP	Good Practice
GPPP	Good Plant Protection Practice
HACCP	Hazard Analysis and Critical Control Points
HAIR	Harmonised environmental Indicators for pesticide Risk
IPM	Integrated Pest Management
IPPC	Integrated Pollution Prevention and Control
IVA	Industrieverband Agrar e. V.
JKI	German Federal Research Centre for Cultivated Plants – Julius Kühn-Institut
MS	Member State
JRC	Joint Research

NAP	National Action Plan
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PPE	Personal Protective Equipment
PPP	Plant Protection Products
PPPR	Plant Protection Products Regulation
PT	product type
REACH	Regulation (EC) No 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals
RMM	Risk Mitigation Measure
SPISE	Standardised procedure for the inspection of sprayers in Europe
VAT	Value Added Tax
VOC	Volatile Organic Compounds
vPvB	very persistent and very liable to bioaccumulate
WFD	Water Framework Directive
WHO	World Health Organisation

0 Introduction

In June 2006, the “Thematic Strategy on Sustainable Use of Pesticides" was accepted by the European Commission. The implementation, through Framework Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides, aims at minimising hazards and risks to human health and the environment associated with the use of pesticides. In addition, the Directive promotes inter alia the use of an integrated pest management and alternative techniques such as non-chemical alternatives. Up to now the Pesticides Thematic Strategy and the corresponding directive focus on plant protection products. However, the possibility of extending the directive to biocides is retained.

While the Biocidal Product Directive and the national Chemicals law focus on the procedure for including active substances in the Annexes of the Directive and the national authorisation and mutual recognition of biocidal products, the use phase of biocidal products is not considered. Thus, for biocides there is a particular need of developing specific measures for their sustainable use.

The project aims at identifying possibilities and requirements to transfer the measures of the Thematic Strategy on Sustainable Use of Pesticides to the biocide area. Further it elaborates concrete proposals for three example product types (wood preservatives, insecticides and antifouling agents). The sustainable use of biocides covers measures for the protection of occupational and human health as well as measures for the protection of the environment. Although these can not always be seen as separate items, this project focuses on the environmental point of view. The results of the project will be brought into the upcoming development and harmonization processes on a strategy on sustainable use at EC level.

This report describes the final results of a systematic analysis of measures proposed within the Frame Directive 2009/128/EC on “Sustainable Use of Pesticides“ and its applicability for biocides. Annex I provides the results of a literature research on the occurrence of biocides in the environment. Annex II, III and IV document the case studies performed on the three product types PT 8 (wood preservatives), PT 18 (insecticides, acaricides and products to control other arthropods), and PT 21 (antifouling products).[1]

1 In this report PT 18 is referred to as insecticides but includes all other products for controlling arthropods

1 Objectives of sustainable use of biocides

Biocides are intended to kill, to destroy or to deter living organisms. If such products are applied in the proximity of humans or if they are released into the environment, there is a high probability that they might cause damage to man and wildlife. Biocides share this capability with pesticides used as plant protection products. Concerning plant protection products, there is an overall consensus that their general benefits (protection of food production from pests) justify to a certain degree the overall risks arising from their use. Otherwise – without such a general benefit - risks from such pesticides would be unacceptable, at least to the environment. It seems to be legitimate that a similar discussion should be undertaken about the general attitude to biocides. Is there a general consensus about tolerable risks from biocides? Or should their risk be tolerated only in justified cases and certain situations?

1.1 Biocides in the environment

Biocides are intended to destroy, deter, render harmless, prevent the action of, or otherwise exert a controlling effect on any harmful organism by chemical or biological means (Article 2 (a) Directive 98/8/EC). Due to these inherent hazardous properties, biocides pose potential risks to human health and the environment. The discussion on the effects of biocides began with a focus on human health impacts. The scandal of health damages caused by wood preservatives in the 1970s and 1980s, as well as the discussion on pyrethroids used for textile finishing and for insect control in private households, were the reasons to regulate biocidal products. Consequently, active substances with a high risk, such as Pentachlorophenol or Lindane, were removed from the market. In the environmental area, the impacts of antifouling agents used for ship hull coating in particular have been discussed since the early 1980s. The extremely high ecotoxicity and endocrine effects of Tributyltin compounds, e.g. the so-called imposex effects on snails, resulted in a worldwide ban on these compounds.

Reliable data on biocide consumption and use patterns, which could serve as a first approximation for prioritising the most relevant active substances to be included in monitoring programmes or in a risk minimising strategy, are only available in a few European countries (e.g. the Nordic countries, and Switzerland). Rough estimates of the biocides market from several sources suggest that about 25% of the total pesticides market can be attributed to biocides (Gartiser et al., 2007). Some consumption estimations, e.g. on disinfectants in hospitals, biocides in cooling water, disinfectants/bleaching agents/preservatives in household cleaning products, are available from several research projects funded by the German Environmental Agency (Kahle et al. 2009). There are only few data available on the overall emissions of biocides to the environment.

In Switzerland, out of 277 active biocidal substances, 22 have been pre-selected as candidate biocidal substances with relevance for surface water based on consumption and degradability data (Knechtenhofer et al., 2007).

With a few exceptions, such as Triclosan, organotin compounds or pesticides with multiple uses, biocides are seldom included in routine monitoring programmes. Notwithstanding, several studies from research projects clearly demonstrate that biocides are regularly found in environmental samples (see Annex I). Disinfectants and preservatives such as Triclosan and quaternary ammonium compounds, the fungicides Propiconazole and Tebuconazole, or the repellent Diethyltoluamide (DEET), have been detected in the effluent of sewage treatment plants (STPs). The fungicide Terbutryn and the herbicides Carbendazim and Diuron are found in surface water (e.g. Kahle et al. 2009).

The concentrations of the biocides Carbendazim, Diazinon, Diuron, IPBC, Irgarol 1051, Isoproturon, Mecoprop, and Terbutryn in the inlet and outlet of municipal STPs indicated that many biocides are not completely removed during wastewater treatment. Average elimination of the mentioned substances was usually found to be below 50%, except for Isoproturon (63%) and Terbutryn (72%) (Singer et al. 2010).

In urban environments, leaching from facade coatings has been identified as the main emission sources for these biocides. Similarly, the treatment of bitumen felts on flat roofs against rooting through plant roots seems to be a major emission source of the herbicide Mecoprop (Wittmer 2009). Some of the biocides found in surface water are also used for plant protection purposes, but obviously biocides contribute significantly to the overall emissions. Recently, emissions of Tolylfluanid have raised concern because the degradation product N, N-Dimethylsulfamide (DMS) is a precursor for the carcinogen N-Nitrosodimethylamine (NDMA), which is released during drinking water ozonisation (Schmidt et al., 2008). While the approval of Tolylfluanid for plant protection purposes has been withdrawn in Germany, the substance is still used as biocidal preservative (PT 7, 8, 10) and as antifouling agent (PT 21). Annex I of this report contains the results of the literature search on biocides found in environmental media which has been carried out within this study.

1.2 Regulatory framework and objectives of sustainable use of pesticides

Following the Sixth Environment Action Programme of the European Community 2002-2012 (6th EAP) in 2002, the development of seven Thematic Strategies for prioritised fields[2] is foreseen, among them pesticides. Thematic Strategies are instruments for achieving defined objectives in specific areas that follow a comprehensive strategic approach. They build on the existing regulatory framework and aim to integrate defined measures not only into the regulatory framework of this specific field but also into policies and legislation of other areas. The Thematic Strategies can be seen as key elements of the Commission's Better Regulation Strategy.

Directive 2009/128/EC on sustainable use of pesticides defines pesticides as plant protection products or biocidal products (Article 3 (10)). At present, this Directive applies to pesticides which are plant protection products. However, it is anticipated that the scope of this Directive will be extended to cover biocidal products (recital clause 2 of Directive 2009/128/EC).

The background for developing a thematic strategy on sustainable use of pesticides was that - although plant protection products (PPP) have been regulated for a long time - unwanted amounts of certain pesticides can still be found in environmental compartments (in particular soil and water). Also, residues exceeding regulatory limits still occur in agricultural products. For biocides, there exists an equivalent level of concern as for plant protection products, because both are intended to control harmful organisms: It was recognised that for PPP and for biocides there is a clear legislative gap concerning the use phase (figure 1).

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[2] These are: soil and the marine environment (in the priority area of biodiversity), air, pesticides and urban environment (in the priority area of environment, health and quality of life) and natural resources and waste recycling (in the priority area of natural resources and waste), http://ec.europa.eu/environment/newprg/intro.htm

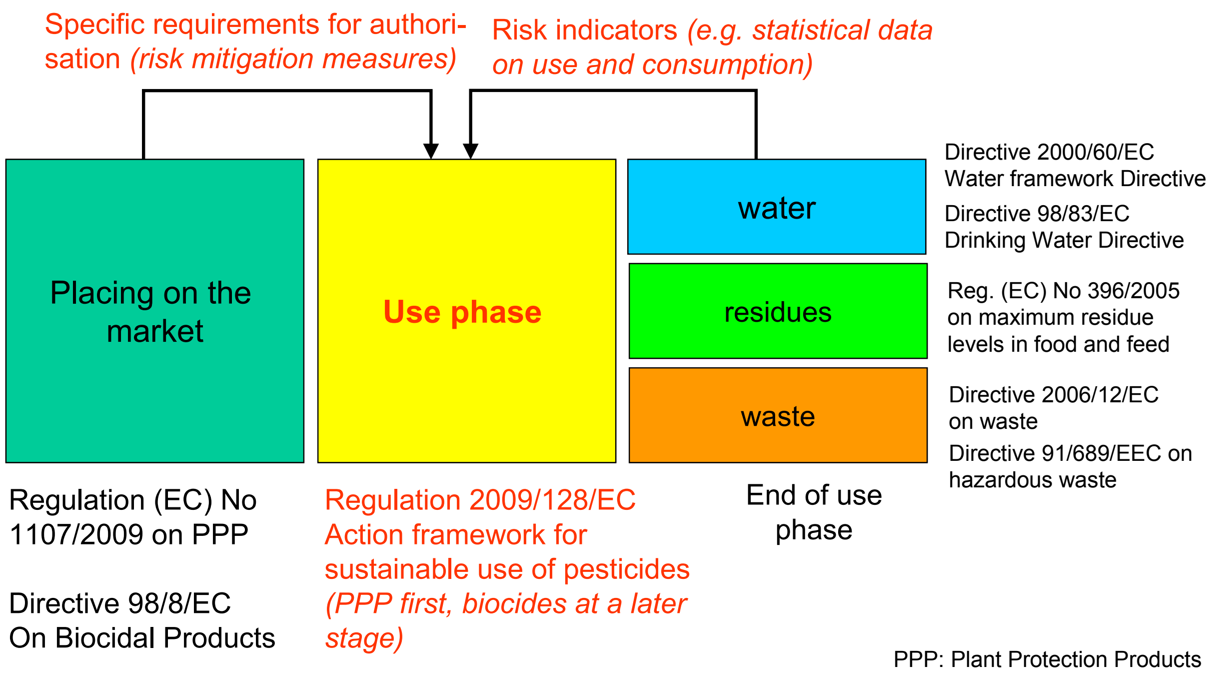

Figure 1: Position of the use phase within the life cycle of pesticides

Regulation (EC) No 1107/2009 and Directive 98/8/EC concerning the placing of plant protection products and biocidal products on the market only address the conditions for the manufacture and placing on the market of active substances used in PPP or in biocidal products (authorisation process). The end-of life stage of pesticides is considered e.g. in Regulation 396/2005/EC on maximum residue levels of pesticides in food/feed, the Water Framework Directive (WFD) 2000/60/EC, or the Drinking Water Directive 98/83/EC where maximum thresholds of pesticides (including their metabolites) are defined. Nevertheless residues exceeding the regulatory thresholds are still found in agricultural products and unwanted amounts are monitored in the environmental media, especially water and soil. These observations have led to the conclusion that rules reducing risks to human health and the environment from the use phase of pesticides are only insufficiently defined in the existing legislative framework. This gap should be closed by a Thematic Strategy on sustainable use of pesticides.

There are two mechanisms within existing legislation which have an influence on the use phase. First, conditions of use and risk mitigation measures (RMM) may be prescribed within product authorisation. Second, risk indicators which identify risks from the use of pesticides on human health and/or the environment may have an influence on the use phase and on the approval requirements for products. Monitoring data on pesticides in environmental samples is one example of a risk indicator.

1.3 Definition of sustainable use of pesticides

Definitions of sustainability often refer to the "three pillars" of social, environmental and economic sustainability. In theory these three pillars should be well balanced. Often, however, the main emphasis is on economic aspects, which is not considered as being sustainable. Thus social and environmental aspects need to be considered along with economic requirements. Neither for plant protection products nor for biocidal products is there a generally accepted definition of “sustainable use”. In principle “sustainable use” goes beyond regulatory decision making for product authorisation and seeks additional opportunities for further risk reductions that can be achieved while ensuring effective action against harmful organisms. In the plant protection area, some regulatory experts refer to the definition of “integrated pest management” (IPM) which is considered as one appropriate tool in the context of “sustainable use of pesticides". Others consider that sustainable use goes further than IPM.

The three pillar model for sustainability seems appropriate for defining sustainable use of pesticides and biocides. The social dimension refers to human health, general hygiene conditions in workplaces and residential areas. The environmental dimension refers to the protection of water resources, soil, non-target organisms and biodiversity. The economic dimension refers to the protection of commodities, materials, livestock breeding, and industrial processes.

Article 3 (6) of Directive 2009/128/EC defines “integrated pest management” as *“careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. “Integrated pest management” emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.”* This definition refers to the need for *“careful consideration of all available methods”*, the *“integration of appropriate measures”* and incorporates the three pillars of sustainable development *("economically and ecologically justified;" "minimisation of risks human health and the environment"*). It is questionable whether the definition of IPM would be appropriate for describing sustainable use of those pesticides which are intended to control non-agricultural pests and other harmful organisms.

According to the OECD work on risk reduction of pesticides, the objective of "sustainable use" is risk reduction, especially aiming at a significant reduction of misuses, better compliance with existing regulations and use only at the "necessary minimum". The necessary minimum can be described as pesticide use intensity where optimum efficacy is combined with the minimum quantity necessary. It depends on application parameters (pesticide selected, dosage, time, application equipment available), local conditions and using alternatively reliable non-chemical measures. IPM is mentioned as the key strategy for a sustainable use of pesticides, together with training and certification schemes for users, advisors and distributors (OECD 2009).

The FAO published a "Code Conduct on the Distribution and Use of Pesticides" which considers the life-cycle concept of pesticide management. It aims to address sound management of pesticides, focuses on risk reduction, protection of human and environmental health, and support for sustainable agricultural development by using pesticides in an effective manner and applying IPM strategies. However, a definition of sustainable use is not included (FAO 2002).

In the biocides area Article 3 (7) of Directive 98/8/EC on biocidal products requires that *„Member States shall prescribe that biocidal products are to be properly used. Proper use shall include compliance with conditions established pursuant to Article 5 and specified under the labelling provisions of this Directive. Proper use shall also involve the rational application of a combination of physical, biological, chemical or other measures as appropriate, whereby the use of biocidal products is limited to the minimum necessary. Where biocidal products are used at work, use shall also be in accordance with the requirements of Directives for the protection of workers."*"

To summarise, there exists no harmonised definition of "sustainable use of pesticides" but it is clear that "sustainable use" is broader than "proper use" or "good and best practices", and that "IPM" is an integral part of proper use. Sustainable use also includes social and economic (as well as environmental) objectives. Thus the benefits of the use of biocides on human health, material protection and monument conservation have to be taken into account. In the context of such considerations, the need to apply biocides should be questioned. According to environmental authorities, the application of plant protection products in private areas can rarely be justified from an environmental point of view. The same is true if biocides are applied for reasons related to lifestyle. Consideration of pest control is only necessary in those cases where there is a real need to control so called harmful organisms; in all other cases biocides should not be applied.

Although no definition of sustainable use of biocides exists so far, this definition could implement the definition of proper use of Article 3 (7) of Directive 98/8/EC and the existing definition of IPM from Directive 2009/128/EC. One appropriate definition (to be discussed among stakeholders) proposed is: *"Sustainable use of biocides means a responsible use of biocidal products in a way that the objectives of hygiene, preservation and pest control can be achieved with the least possible adverse impacts to the environment and society (including human health) on a short-term and long-term timescale and promoting/encouraging the use of integrated control of harmful organisms, of preventive and alternative approaches or techniques such as non-chemical alternatives to biocides."*

This working definition addresses the three pillars of social, environmental and economic sustainability. Directive 2009/128/EC describes several instruments for achieving the objectives of sustainable use such as training, sales of pesticides, information and awareness raising, requirements for pesticide application equipment and specific practices and uses such as IPM. The relationship of IPM (or Integrated control of harmful organisms), proper use and sustainable use of biocides might be illustrated as follows:

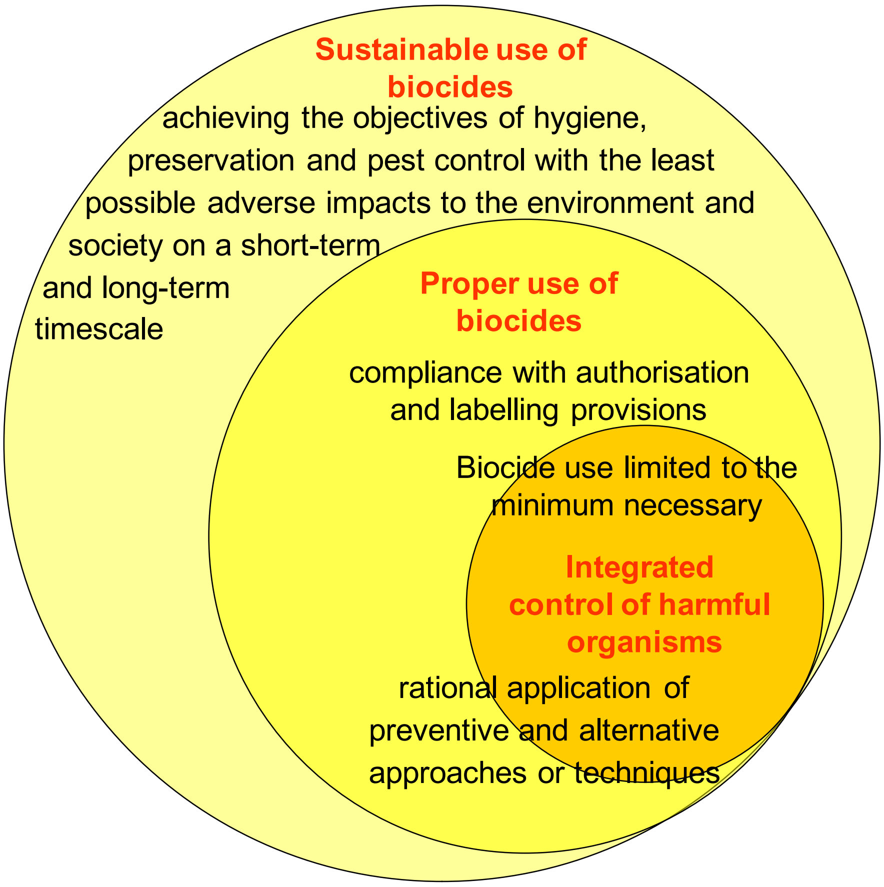

Figure 2: Relationship of IPM, proper use, and sustainable use of biocides

There is an overlap between integrated control of harmful organisms and "proper use" because the "minimum necessary" and the "consideration of non-biocidal measures" are included in both definitions. Sustainable use also includes further instruments within a general strategy for approaching the objectives of minimisation of risks, such as information to the public, training, awareness raising etc.

Nevertheless, before starting to analyse the three pillars of sustainability, there is a prerequisite which has to be addressed: the question whether individual application of biocides is sensible, needed and justified.

2 Legislative Background

2.1 Directive 2009/128/EC on Sustainable Use of Pesticides

In 2002, the European Parliament and the Council initiated a thematic strategy on the sustainable use of pesticides. In the Community, "Thematic Strategies" follow a holistic concept in addressing a specific topic by integration of the measures of the strategy in existing policies and new legislation. The thematic strategy complements the existing legislative framework by targeting the use phase of plant protection products. In 2006, the Commission presented a final draft of a "Thematic Strategy on the Sustainable Use of Pesticides" which was approved by the European Parliament on 13 January 2009.[3] In October 2009, Directive 2009/128/EC establishing a framework for Community action to achieve the sustainable use of pesticides was adopted. The main issues of the Thematic Strategy and of Directive 2009/128/EC include:

- Establishment of National Action Plans (NAPs); within such National Action Plans Member States shall set their quantitative objectives, targets, measures and timetables to reduce risk and impacts of pesticide use on human health and the environment and to encourage the development and introduction of integrated pest management and of alternative approaches or techniques in order to reduce dependency on the use of pesticides (Directive 2009/128/EC, recital 5)
- Improvement of awareness and training of professional users and distributors including a certification systems to record such training (Directive 2009/128/EC, recital 8)
- Awareness raising of the general public (with particular attention to non-professional users), through campaigns and information passed on through retailers (Directive 2009/128/EC, recital 10)

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[3] COM(2006) 372 final Communication from the Commission concerning "A Thematic Strategy on the Sustainable Use of Pesticides" http://eur-lex.europa.eu/LexUriServ/site/en/com/2006/com2006_0372en01.pdf SEC (2006) 895 « TECHNICAL » ANNEX http://register.consilium.europa.eu/pdf/en/06/st11/st11902-ad01.en06.pdf

- Inspection of application equipment (Directive 2009/128/EC, recital 13)
- Prohibition of aerial spraying (should only be used by way of derogation where it offers clear advantages and also environmental benefits compared to other spraying methods) (Directive 2009/128/EC, recital 14).
- Enhanced protection of the aquatic environment and risk reduction e.g. by defining areas of strongly reduced or zero pesticide use (Directive 2009/128/EC, recital 15).
- Promotion of low pesticide-input farming, and Integrated Pest Management (IPM), and development of Integrated Pest Management standards. Member States shall describe in their National Action Plans how they ensure that the general IPM principles are implemented by all professional users by 1 January 2014 (Directive 2009/128/EC, recital 18, 19 and Article 13 (4)).
- Specific measures addressing appropriate handling of pesticides, including storage, diluting and mixing the pesticides and cleaning of pesticide application equipment after use, and recovery and disposal of tank mixtures, empty packaging and remnants of pesticides (Directive 2009/128/EC, recital 17)
- Exchange of information on the objectives and actions to the Commission and other Member States. The Commission should submit relevant reports accompanied, if necessary, by appropriate legislative proposals (Directive 2009/128/EC, recital 6).
- The National Action Plans shall include indicators to monitor the use of plant protection products containing active substances of particular concern, especially if alternatives are available (Directive 2009/128/EC, Article 4). In the Thematic Strategy the Improvement of monitoring of residues and environment as well as the establishment of exposure studies has also been suggested.
- In the Thematic Strategy the current situation with varying Value Added Tax (VAT) rates on Plant Protection Products, which puts farmers in various Member States in an unequal situation, has also been criticised. The application of normal VAT rate to pesticides, in order to reduce the incentive

for illegal cross border exchange of non-authorised products due to price differentials, has been suggested.

According to the Thematic Strategy, the progress in risk reduction should be measured through appropriate harmonised indicators, some of which have been developed under the HAIR project completed in 2007[4].

In 2006, an impact assessment was carried out by the Commission services concerning the Thematic Strategy on the Sustainable Use of Pesticides[5, 6]. The impact assessment led to the rejection of the two additional measures proposed as part of the Thematic Strategy “legally binding quantitative use reduction targets” and “setting up of taxes / levies at Community level”.

On 24 October 2007, the European Parliament (EP) published a resolution on the draft version of the Thematic Strategy on Sustainable Use of Pesticides.[7] This criticized the fact that the Thematic Strategy only covers plant protection products, which constitute only a part of pesticides. The EP called on the Commission forthwith to include pest control products (biocidal product types 14-19) as defined in Annex V to Directive 98/8/EC of the European Parliament and of the Council of 16th February 1998 concerning the placing of biocidal products on the market within the scope of the Thematic Strategy, as they pose similar risks to human health and the environment. Furthermore, the EP urged the Commission to extend the scope of the Thematic Strategy to include other biocides as soon as possible.

In the Framework Directive 2009/128/EC on Sustainable Use of Pesticides, it is anticipated that the scope of the Directive will be extended to cover biocidal products, without giving further details.

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4 Harmonised environmental Indicators for pesticide Risk (HAIR) http://www.rivm.nl/rvs/risbeoor/Modellen/HAIR.jsp

5 SEC(2006) 894, The Impact Assessment of the Sustainable Use of Pesticides, Commission Staff Working Paper accompanying the Proposal for a Directive of the European Parliament and of the Council establishing a framework for Community action to achieve a sustainable use of pesticides COM(2006) 373 final http://ec.europa.eu/governance/impact/docs/ia_2006/sec_2006_0894_en.pdf

6 In parallel, a study has been elaborated by an external consultant (BiPRO) assessing economic impacts of the specific measures to be part of the Thematic Strategy on the Sustainable Use of Pesticides. BIPRO Beratungsgesellschaft für integrierte Problemlösungen. Assessing economic impacts of the specific measures to be part of the Thematic Strategy on the Sustainable Use of Pesticides REFERENCE: ENV.C.4/ETU/2003/0094R FINAL REPORT October 2004 http://ec.europa.eu/environment/ppps/pdf/bipro_ppp_final_report.pdf

7 P6_TA-PROV(2007)0467 Thematic strategy on the sustainable use of pesticides, European Parliament resolution of 24 October 2007 on a Thematic Strategy on the Sustainable Use of Pesticides (2007/2006(INI)) ➔ http://chemicalwatch.com/downloads/pesticides_resolution.pdf

2.2 Regulation (EC) No 1107/2009 concerning plant protection products

In June 2011, Regulation (EC) No 1107/2009 which governs the placing on the market of plant protection products replaced the Directive 91/414/EEC. Inter alia the Regulation aimed to impose appropriate conditions supporting the objectives in accordance with Directive 2009/128/EC on sustainable use of pesticides (Recital 29 of Regulation (EC) No 1107/2009). In order to ensure a high level of protection of human and animal health and the environment, plant protection products should be used properly, in accordance with their authorisation, having regard to the principles of IPM and giving priority to non-chemical and natural alternatives wherever possible (recital 45). Article 31 describes the contents of authorisations which, in addition to a general description of the maximum dose, the period between applications and harvest the maximum number of applications, the restrictions with respect to the use area, user category and the distribution may also contain indications for proper use according to the principles of IPM. Article 55 prescribes that plant protection products shall be used properly. Proper use shall include the application of the principles of good plant protection practice and compliance with the authorisation conditions and labelling. Proper use shall also comply with the provisions of Directive 2009/128/EC and, in particular, with general principles of IPM.

Article 36 of the Regulation states *that "a Member State may refuse authorisation of the plant protection product in its territory if, due to its specific environmental or agricultural circumstances, it has substantiated reasons to consider that the product in question still poses an unacceptable risk to human or animal health or the environment."*

Within the transition period, the active substances approved for use in plant protection products are listed in Annex I the Directive 91/414/EEC. The lists contain specific provisions concerning the authorisation, including appropriate RMM, similar to the provisions introduced in Annex I of the BPD. However, with a few exceptions, no specific provisions have been included. Most often the provisions refer only to "appropriate RMM".[8]

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[8] Only few examples on RMM are given: Depuration of Thiabendazole after treatment with diatom earth or activated carbon; Spotwise application of Propiconazole; buffer zones to be considered while applying Chlorpyrifos, Chlorpyrifos-methyl, MCPA or MCPB; minimum holding periods for water in rice cultivation prior to discharge after the application of Azimsulfuron. For Methamidophos, Procymidone, Dinocap or Fenarimol judicious timing of the application and the selection of those formulations which minimise exposure of birds, mammals and appropriate distances to surface water bodies to protect water organisms are considered.

2.3 Directive on machinery for pesticide application

Directive 2009/127/EC of 21 October 2009 on machinery for pesticide application has been accepted as an amendment to the Machinery Directive 2006/42/EC. To date, application equipment for biocidal products is not covered. However, since it is anticipated that the scope of Framework Directive 2009/128/EC will be extended to cover biocidal products, the extension of the scope of the environmental protection requirements to machinery for the application of biocidal products should be examined by the European Commission by 31 December 2012. It is evident that optimising the equipment for biocide application is one important tool for risk mitigation. Examples are the design of the equipment to enable safe filling and emptying and easy and thorough cleaning, but also to prevent leakage of biocides from the equipment. In addition, the efficiency of application influences exposure to the environment (vacuum pressure impregnation of wood preservatives may reduce leaching during the use phase, ultra low droplet size of insecticides may reduce overall amount of biocides applied).

2.4 Regulation (EC) No 1185/2009 concerning statistics on pesticides

The Regulation (EC) No 1185/2009 concerning statistics on pesticides does not so far consider biocides but indicates that the scope may be expanded at a later stage so as to include biocides. The argument was that the *“effects of the Directive 98/8/EC will not become apparent until the first evaluation of active substances for use in biocidal products is finalised”* and that *“neither the Commission nor most Member States currently have sufficient knowledge or experience to propose further measures regarding biocides.”* However, it is “*anticipated that, taking into account the results of the evaluation of Directive 98/8/EC and on the basis of an impact assessment, the scope of this Regulation will be extended to cover biocidal products.*”

The previous draft versions of the Regulation on statistics in Article 3 imposed reporting obligations on suppliers of the products placed on the market and on professional users on records to be kept on the use of plant protection products.[9] These obligations have now been removed from the final version of Regulation (EC)

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[9] http://www.insee.fr/ue2008/en/documents/COM-(2006)-778.pdf

No 1185/2009 to Article 67 of Regulation (EC) No 1107/2009 concerning the placing of plant protection products on the market.

Although, according to the Commission, tonnage data are considered as being confidential and the generation of such data as being costly[10], any data that improve knowledge about production, use patterns, typical applications and consumption would be very useful for the risk assessment of biocides. Similar to the crop-specific data collection of plant protection products, PT specific data are required in the biocide area.

2.5 Biocidal Product Directive (98/8/EC)

The Biocidal Product Directive (BPD) requires that biocidal products may only be authorised when they have no unacceptable effects on human or animal health and on the environment (Article 5). The BPD does not consider the use phase of biocides in detail. However, Article 5 (3-4) allows Competent Authorities to link the authorisation of a biocidal product to conditions relating to marketing and use that are necessary to protect the health of distributors, users, workers and consumers or animal health or the environment. Article 3 (7) requires Member States to prescribe that biocidal products are properly used. Proper use shall include compliance with conditions established pursuant to Article 5 and specified under the labelling provisions of this Directive. Proper use shall also involve the rational application of a combination of physical, biological, chemical or other measures as appropriate, whereby the use of biocidal products is limited to the minimum necessary. Labelling requirements for biocidal products according to Article 20 of the BPD include the provision of information on identity, uses, mode of application, dosage, and precautionary measures (e.g. personal protective clothing and equipment) among other issues. While labelling requirements cover product related measures implemented after purchase, an important part of sustainable use is related to IPM strategies, which include preventive measures.

The proposal of the Commission for a biocides regulation replacing Directive 98/8/EC is currently being discussed among Member States (European Commission 2009).[11]

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[10] CA-Nov07-Doc.6.3: Note on the provision of information concerning tonnage of active substances/biocidal products placed on the market

[11] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0267:FIN:EN:PDF

In a report of the European Parliament on this proposal, several amendments have been suggested which refer to sustainable use: In Article 15 (5) a new subparagraph requires that *"Infestation with harmful organisms should be avoided by means of suitable deterrents to banish or repel such organisms. In addition, other precautionary steps should be taken, e.g. proper warehousing of goods, compliance with hygiene standards and immediate disposal of waste. Only if such measures have no effect should further steps be taken. Biocidal products that pose lower risks for humans, animals and the environment should always be used in preference to other products where those lower risk products provide an effective remedy in particular situations. Biocidal products that are intended to harm, kill or destroy animals that are capable of experiencing pain and distress should be used as a last resort."*

Additionally it is suggested that within two years after adoption of the Regulation *"mandatory measures shall be established and implemented with a framework directive for Union action in order to achieve the sustainable professional use of biocidal products including the introduction of National Action Plans, integrated pest management, risk reduction measures and the promotion of alternatives."'*[12]

2.6 IPPC Directive

Under Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC-Directive) several best available techniques (BAT) Reference Documents (BREFs) on have been developed for different sectors. In this context, BAT means the most effective and advanced stage in the development of activities and their methods of operation which are economically and technically suitable to prevent or reduce emissions to the environment. Although these BREFs have no legally binding status, they are often referred to by the relevant authorities when defining BAT and limit values for discharges and emissions. The following BREFs also cover the use of biocides in the respective sectors, directly or indirectly:

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[12] http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A7-2010-0239+0+DOC+PDF+V0//EN

BREF	Date	PT
Intensive Rearing of Poultry and Pigs	07.2003	3, 18
Slaughterhouses and Animals By-products Industries	05.2005	4
Food, Drink and Milk Industries	08.2006	4
Surface Treatment using Organic Solvents	08.2007	8, 21
Textiles Industry	07.2003	9
Tanning of Hides and Skins	02.2003	9
Industrial Cooling Systems	12.2001	11
Pulp and Paper Industry	12.2001	12
Emissions from Storage (refers to storage of hazardous chemicals, including pesticides)	07.2006	-

In December 2007, the Commission adopted a proposal for amending the IPPC together with seven other Directives, among them the Solvents Emissions Directive, into a single comprehensive Directive on industrial emissions. The Solvents Emission Directive 1999/13/EC covers processes with the use of volatile organic compounds (VOC), such as coating of ships with antifouling agents or wood impregnation. Installations for the preservation of wood with a production capacity above 75 m³ per day would in future be covered by IPPC (independent of whether or not organic solvents are used). However, considering biocides in BREF documents would require a shift in BREF development because (with a few exceptions), these do not relate to specific substances but focus on emission control as a whole.

2.7 EU Water Framework Directive (2000/60/EC)

According to the EU Water Framework Directive 2000/60/EC (WFD), proposals for emission control measures and environmental quality standards shall be elaborated for priority substances. Point source discharges into surface waters should be controlled by setting emission limit values and emission control standards based on BAT according to the IPPC Directive. A working group on priority substances has been established to work on the implementation of the priority substance related issues (selection of substances, monitoring, environmental quality standards (EQS) setting, source screening and emission controls).[13] In principle, the same instruments for reducing emissions are applied as for existing substances: the definition of EQS, the implementation of BAT and the monitoring of priority substances. Because only a

[13] http://ec.europa.eu/environment/water/water-framework/objectives/pdf/strategy3.pdf

few biocides have been so far considered in Annex X of the WFD on priority substances (Isoproturon, Diuron, Naphthalene), the ongoing process for including further priority substances into Annex X also influences the risk mitigation of biocides. Currently, several insecticides are being discussed as biocidal candidates for selection as priority substances (Permethrin, Cypermethrin, Deltamethrin, Dichlorvos, Diazinon) based on a study on monitoring-based prioritisation of further potential priority substances candidates (James et al. 2009). The inclusion of further biocidal active substances in monitoring programmes is a prerequisite for prioritising RMM from an environmental point of view.

2.8 Other regulatory areas

Sustainable use is (partly) considered in several other regulatory areas. Regulation (EEC) No 793/93 on the evaluation and control of the risks of existing substances (now implemented in Regulation (EC) No 1907//2006 (REACH)) refers to risk reduction measures for workers and/or the environment recommended by the Scientific Committee on Toxicity, Ecotoxicity and the Environment (CSTEE). The risk reduction options relate to point emissions from manufacturing and industrial use, the development and application of BAT as well as to the establishment of Environmental Quality Standards (EQS) and monitoring of substances. For some substances, such as Diphenylether octabromo derivatives, more detailed recommendations on data gaps and options regarding the restriction of marketing and use have been suggested (Recommendation 2002/755/EC).

Concerning 3,4-dichloroaniline, the recommendation states that the legislation for plant protection products (Directive 91/414/EEC) and for biocides (Directive 98/8/EC) is considered to give an adequate framework to limit the risks of the substance to the extent necessary. The release of 3,4-dichloroaniline from Diuron used as an herbicide on sealed surfaces should be considered in the risk assessment and misuse of Diuron should be prevented.

REACH defines “Risk Management Measures” as measures in the control strategy for a substance that reduce the emission of and exposure to a substance, thereby reducing the risk to human health or the environment. In the guidance document on information requirements and chemical safety assessment, Chapter R.13 states that the prevention and reduction of emissions of dangerous substances by process integrated measures are usually preferred over end-of-the pipe techniques. Good housekeeping can address both occupational and environmental exposure and can be based on sector specific process recommendations or definition of BAT under the IPPC Directive. Basically two relevant types of risk management measures are distinguished for consumers:

- Product integrated risk management measures under the control of the supplier, such as the chemical composition and the functional design
- Consumer instruction/communication on safe use such as technical use instructions, instructions on protective clothing, instructions on storage and disposal

It is stated that consumer exposure assessment should also take into account reasonably foreseeable misuse. Exposure to the environment from misuse is not mentioned specifically in the guidance.

Sustainable use of chemicals is often attributed to “sustainable chemistry” or green chemistry. The addressees are companies producing chemicals or related products. There exists a European Technology Platform for Sustainable Chemistry which seeks to boost chemistry, biotechnology and chemical engineering research, development and innovation in Europe.[14]

Sustainable use of medicinal products often refers to the conservation and protection of medicinal plants in the context of their natural habitats, biodiversity and bio-piracy (Hamilton 2004). The term “sustainable pharmacy” is used for a new approach addressing environmental, economic and social aspects of pharmacy. One focus lies on environmental issues along the whole lifecycle of a pharmaceutical entity, including aspects of resources, energy input and waste e.g. during synthesis and production of an active pharmaceutical ingredient. Furthermore, degradability of the compounds themselves after their use and reduction of the environmental risk caused by pharmaceuticals is considered. Another issue is the contribution of people using pharmaceuticals (pharmacists, medical doctors and patients) to more efficient use of pharmaceuticals with a lower environmental burden and less risk for drinking water (Kümmerer et al. 2010). The European Medicines Agency (EMAE) specifies in its revised EMEA guidelines on environmental impact assessment for veterinary medicinal products that risk mitigation *“can be used to restrict the risk associated with a product to an acceptable level, or even to completely remove such a risk*” (EMEA 2008). The EMEA guideline for the environmental risk assessment of medicinal

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[14] http://www.suschem.org/en/about.

products for human use specifies that when the possibility of environmental risks cannot be excluded, precautionary and safety measures such as an indication of potential risks presented by the medicinal product for the environment on the product label with recommendations on product storage and disposal (EMEA 2006). While RMM can be considered in the authorisation procedure of related chemicals and/or products, the “sustainable use” approach consists of a broader strategy beyond regulatory decisions. The efficiency and practicability of RMM for biocidal products, with emphasis on wood preservatives and insecticides, have been evaluated by the consultant in research project FKZ 3709 65 402 on behalf of the German Federal Environment Agency (Gartiser et al. 2010).

3 Measures, tools and targets set up within Directive 2009/128/EC

3.1 Measures for sustainable use of plant protection products - overview

Framework Directive 2009/128/EC for the sustainable use of pesticides specifies measures to reduce risks and impacts of pesticide use on human health and the environment and promotes the use of IPM and of alternative approaches or techniques such as non-chemical alternatives to pesticides. The measures proposed in Articles 5-14 of Framework Directive 2009/128/EC are summarised in Figure 3:

Figure 3: Measures proposed for a sustainable use of PPP

According to Article 4 of Directive 2009/128/EC, MS shall adopt National Action Plans (NAP) to set up quantitative objectives, targets, measures, and time tables to reduce risks and impacts of pesticide use. The NAPs shall address the different measures and shall include indicators to monitor the use of plant protection products. The objective of appropriate risk indicators is to measure the progress achieved in the reduction of risks and adverse impacts from pesticide use. Harmonised risk indicators will be established at Community level but MS are also allowed to use their national indicators. Progress in the reduction of risks and the measures applied will be reported to the Commission.

The Thematic Strategy on Sustainable Use of Pesticides is accompanied by activities to gather reliable data and expert knowledge and to develop further guidance:

- An expert group has been established at EU level
- From 21 October 2009, Directive 2009/127/EC on machinery for pesticide application has been accepted as an amendment to the Machinery Directive 2006/42/EC. To date, application equipment for biocidal products is not covered but it is envisaged that this might included at a later stage.
- Regulation (EC) No 1185/2009 concerning statistics on plant protection products COM (2006) 778 final) will improve data to be used as harmonised risk indicators and to follow the progress on sustainable use of pesticides (biocides are excluded so far).
- In October 2009 Regulation (EC) No 1107/2009 concerning the placing of plant protection products on the market has replaced Directive 91/414/EEC. It aims at harmonising the placing on the market of plant protection products[15].
- A guidance document for establishing IPM principles have been drafted (European Commission 2009)[16].
- Several research projects have been funded by the Commission for developing guidance and concepts on pesticide risk assessment and management.

The different instruments and measures and their relationship are shown in Figure 4.

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[15] COM(2006) 388 final, 2006/0136 (COD), Brussels, 12.7.2006 http://ec.europa.eu/food/plant/protection/evaluation/com2006_0388en01.pdf

[16] http://ec.europa.eu/environment/ppps/pdf/draft_guidance_doc.pdf

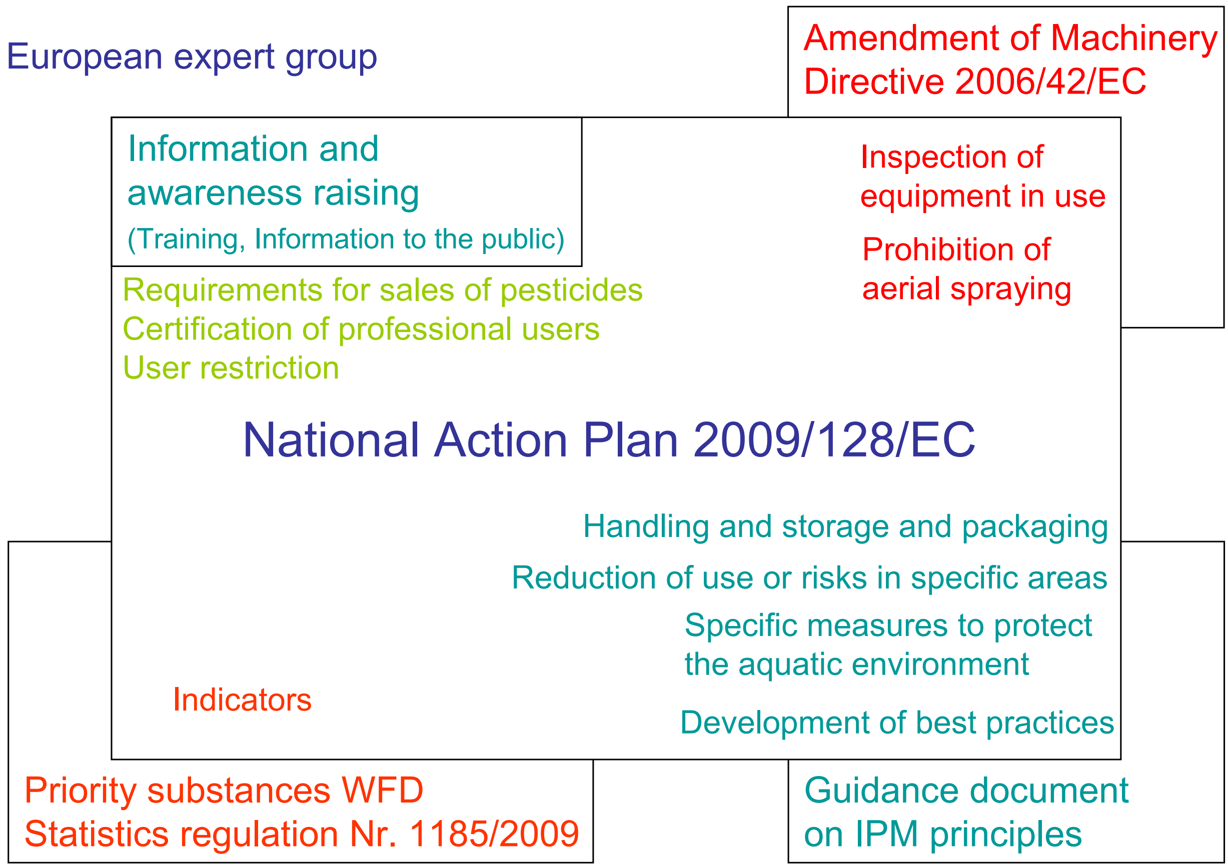

Figure 4: Instruments and measures for sustainable use of pesticides

Regulatory options, such as requirements for sales, certification of professional users and user restriction can be distinguished from technical options, such as the control of the equipment. In addition, the development of IPM principles and best practices (improving knowledge) is complemented by the distribution of that information to the public. Risk indicators serve to set and control the goals on risk reduction as defined in the National Action Plan and to select the most efficient measures.

3.2 Measures for sustainable use of plant protection products – description and discussion

In the following sections the measures proposed in Framework Directive 2009/128/EC on the Sustainable Use of Pesticides are described and environmental issues are discussed in greater detail.

3.2.1 Training (Article 5)

According to Article 5 of Framework Directive 2009/128/EC on Sustainable Use of Pesticides, MS shall ensure that all professional users, distributors and advisers have access to appropriate training and shall establish certification systems providing evidence of attendance at training. All professional users, distributors and advisors should have access to appropriate training by bodies designated by the competent authorities. The Directive defines “professional users" in Article 3 as “any person who uses pesticides in the course of their professional activities, including operators, technicians, employers and self-employed people”. There is no distinction made between “professional” and “specialised professional” users.[17]

Training shall consist of both initial and additional training to acquire and update knowledge as appropriate. The training shall be designed to ensure that such users, distributors and advisors acquire sufficient knowledge regarding the subjects listed in Annex I of Directive 2009/128/EC, taking account of their different roles and responsibilities.

Member States shall establish certification systems which, as a minimum, provide evidence of sufficient knowledge of the subjects listed in Annex I acquired by professional users, distributors and advisors either by undergoing training or by other means. Certification systems shall include requirements and procedures for the granting, renewal and withdrawal of certificates. Annex I describes the minimum content of training measures. It comprises information about:

- All relevant legislation,
- The hazards and risks associated with pesticides,
- Integrated pest management strategies and techniques,
- Initiation to comparative assessments at user level,
- Measures to minimise risks to humans, non-target organisms and the environment,
- Risk-based approaches which take into account the local climate, soil and crop types,
- Procedures for preparing pesticide application equipment,
- Use of pesticide application equipment and its maintenance, and specific spraying techniques,
- Emergency action in case of accidental spillage and contamination,

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[17] Some Inclusion Directives for including active substances in Annex I of the BPD distinguish between “professional” and “specialised professional” users. “Professional use” can be regarded as any occupational application of biocides; “specialised professional use” refers to specific training or education required for the application of biocides.

- Special care in protection areas,
- Health monitoring and access facilities to report on any incidents,
- Record keeping on any use of pesticides.

3.2.2 Requirements for sales of pesticides (Article 6)

According to Directive 2009/128/EC (9), sales of pesticides, including internet sales, are important elements in the distribution chain where specific advice on safety instructions for human health and the environment should be given to the end user. Recommendations should be given for non-professional users, in particular on safe handling and storage of pesticides as well as on disposal of the packaging.

Article 6 of Directive 2009/128/EC specifies that distributors selling pesticides classified as toxic or very toxic need at least one certified person in their employment, who shall be present and available at the place of sales to provide information to customers.

MS shall take the necessary measures to ensure that sales of pesticides not authorised for non-professional use shall be restricted to professional users holding a certificate. Distributors shall provide general information regarding the risks of pesticide use, in particular on hazards, exposure, proper storage, handling and application, as well as disposal.

Article 6 of Directive 2009/128/EC further requires Member States to ensure that certified distributors provide adequate information to customers on pesticide use, health and environmental risks and safety instructions. Micro distributors selling only products for non-professional use may be exempted, if they do not offer for sale pesticide formulations classified as toxic, very toxic, carcinogenic, mutagenic or toxic for reproduction. Sales of pesticides authorised for professional use should be restricted to certified persons.

3.2.3 Information and awareness-raising (Article 7)

Article 7 of Directive 2009/128/EC requests Member States to inform the general public and to promote and facilitate information and awareness-raising programmes and the availability of accurate and balanced information relating to pesticides for the general public, in particular regarding the risks and the potential acute and chronic effects for human health, non-target organisms and the environment arising from their use and the use of non-chemical alternatives. Additionally, systems for gathering information on acute and chronic poisoning incidents, as well as chronic poisoning, should be established. Further, the development of a guidance document on monitoring and surveying of the impacts of pesticide use on human health and the environment is envisaged.

3.2.4 Inspection of equipment in use (Article 8)

Article 8 of Directive 2009/128/EC on sustainable use of pesticides requests Member States to ensure that pesticide application equipment in professional use shall be subject to inspections at regular intervals (3-5 years). MS shall establish certificate systems designed to allow the verification of inspections. By way of derogation and following risk assessment, handheld pesticide application equipment (e.g. knapsack sprayers) or application equipment that represents a very low scale of use may be exempted. These shall be listed in the National Action Plan. Where exemptions are granted from regular inspections, operators should be informed of the need to change the accessories regularly, and of the specific risks linked to that equipment. Additionally MS shall ensure that operators are trained for the proper use of that application equipment.

Annex II to Directive 2009/128/EC describes the requirements relating to the inspection of pesticide application equipment. The equipment must be in a condition so as to be filled and emptied safely, easily and completely; leakage of pesticides must be prevented; and easy and thorough cleaning must be guaranteed. Particular attention should be paid to the power transmission parts, the pump, the agitation devices for achieving an even concentration, the spray liquid tank (e.g. indicator of tank content, filling and emptying devices, filters, and mixers), measuring systems for measuring and adjusting pressure and/or flow rate, and pipes and hoses of the application equipment. The development of harmonised standards for pesticide application equipment is required.

These objectives have been introduced by Directive 2009/127/EC on machinery for pesticide application, amending Directive 2006/42/EC on machinery which provides rules on the placing on the market of pesticide application equipment. The scope of the Directive is limited to machinery for the application of pesticides that are plant protection products. However, since it is anticipated that the scope of the Framework

Directive on sustainable use of pesticides will be extended to cover also biocidal products, it should be examined by the Commission by 31 December 2012 on how the extension of the scope of the environmental protection requirements to machinery for the application of biocidal products could be realised (2009/127/EC, recital 3).

In Germany the manufacturer, distributor or importer of new types of plant protection equipment is requested to confirm that its design allows the proper use of the equipment (mandatory declaration procedure). The Federal Research Centre for Cultivated Plants (Julius Kühn-Institut, JKI) publishes the so called Plant Protection Equipment List, which lists plant protection equipment adhering to these requirements. In addition, equipment or parts thereof, e.g. nozzles, can be subjected to an inspection on a voluntary basis (voluntary approval/inspection procedure). The JKI has kept a register of “Loss reducing equipment” since 1993 which includes specific use conditions and determines “basic drift values” which are used in the risk assessment for non-target organisms. Drift reduction is considered as an important risk mitigation measure. The JKI also carries out inspections in compliance with procedures set out by the European Network for Testing Agricultural Machines, ENTAM. For sprayers, a Standardised Procedure for the Inspection of Sprayers in Europe (SPISE) was established in 2004.[18] According to experts from the JKI, the new requirements imposed by Directive 2009/128/EC on sustainable use of pesticides will have minor impacts for those MS that have established procedures for equipment control already (e.g. Germany, the Netherlands, Belgium), while others such as France, Spain, Italy, Hungary or Greece will have to inspect some 100.000 items of plant protection equipment in a relatively short time.[19]

3.2.5 Prohibition of aerial spraying (Article 9)

Article 9 of Directive 2009/128/EC prohibits aerial spraying in general. In the context of the Directive, aerial spraying means application of pesticides from an aircraft (plane or helicopter). Exceptions can be made only if there are no viable alternatives available or aerial spraying is superior to land-based application of pesticides in terms of health and environmental effects. Pesticides applied need a specific approval for aerial spraying of crops. Particular requirements for these uses have to

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18 http://www.jki.bund.de

19 http://www.bmelv.de/SharedDocs/Standardartikel/Landwirtschaft/Pflanze/Pflanzenschutz/JKI-Pflanzenschutzgeraete.html

be established by Member States. The enterprise that is responsible for providing aerial spray applications shall be certified by a competent authority. The operator carrying out the aerial spraying must hold a certificate from Member States. If the area to be sprayed is in close proximity to areas open to the public, specific risk management measures must be taken to exclude or reduce any effects on the public. Aerial spraying is prohibited in close proximity to residential areas.

3.2.6 Information to the public (Article 10)

Article 10 of Directive 2009/128/EC leaves it to the MS to include further provisions on informing persons who could be exposed to spray drift in their National Action Plans. This provision addresses the need to minimise exposure of bystanders potentially occurring through aerial applications, or those resulting from aerial sprayers or boom sprayers.

3.2.7 Specific measures to protect the aquatic environment and drinking water (Article 11)

Article 11 of Directive 2009/128/EC requires MS to ensure that, when pesticides are used in the vicinity of water bodies, preference is given to products that are not classified as dangerous for the aquatic environment. Moreover, the most efficient application techniques should be used, for example low-drift application equipment.

MS shall ensure that appropriate buffer zones are established on fields adjacent to water courses. Here, pesticides must not be applied or stored. In particular, protective safeguard zones must be established for surface and groundwater used for the abstraction of drinking water.

Use of pesticides along transport routes, e.g. railway lines or on sealed or very permeable surfaces should be minimised or prevented.

Article 7 of the WFD (Directive 2000/60/EC) requires Member States to establish safeguard zones for water bodies used for drinking water production. In Germany, for drinking water protective areas, three distinct zones have been defined in order to protect ground water resources. In protection zone I (remedial zone), which includes a distance of at least 10 m around the pumping device, any kind of agricultural or other usages are forbidden. In protection zone II, which is defined as the “50-day-line” where most microorganisms are eliminated, any commercial and agricultural use is not allowed, thus excluding the use of plant protection products. Protection zone III, which comprises the whole catchment area of the groundwater, serious endangering from application of liquid manure or sewage sludge, as well as from heavily degradable chemicals such as plant protection products and other pesticides, is not allowed (Zhu et al. 2008). Similarly, in the United Kingdom there are “groundwater source protection zones” which distinguish an inner protection zone (50 day travel time and as a minimum 50 m) and an outer protection zone (400 day travel time from a point below the water table).[20]

In Annex X of the WFD, priority substances have been identified for which a progressive reduction of emissions to water is intended. The list contains several plant protection products: Alachlor, Atrazine, Chlorfenvinphos Chlorpyrifos, Diuron, Endosulfan, Isoproturon, and Simazine. Most pesticides included in monitoring programmes belong to the chemical class of herbicides.

The German Federal Water Act from 2009 (§38 WHG) for the first time defines a legal framework for the management of the buffer zones of surface water (usually 5 m) for reducing diffuse entries of pollutants.

3.2.8 Reduction of pesticide use and risks in specific areas (Article 12)

According to Article 12 of the Framework Directive 2009/128/EC the use of pesticides shall be prohibited or restricted to the minimum necessary:

- in areas used by the general public as public parks and gardens, sports and recreation grounds, school grounds and children's playgrounds, and in the close vicinity of healthcare facilities;
- protected areas, such as Natura 2000 sites[21] protected in accordance with Directive 79/409/EEC on the conservation of wild birds and 92/43/EEC on the conservation of natural habitats and of wild fauna and flora and in
- protected areas as defined in the Water Framework Directive 2000/60/EC.

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[20] http://www.environment-agency.gov.uk/homeandleisure/37805.aspx

[21] Under the title “Natura 2000 sites” a coherent European ecological network of special areas of conservation has been set up. This network is composed of sites hosting certain natural habitat types (defined in Annex I to Directive 92/43/EEC) and habitats of certain species (listed in Annex II to Directive 92/43/EEC). In addition, the Natura 2000 network includes special protection areas classified pursuant to Directive 79/409/EEC.

If the use of plant protection products cannot be avoided in these sensitive areas, use of biological control measures or low-risk pesticides should be considered prior to using pesticides. In addition, appropriate risk management measures should be applied.

The aquatic environment is a compartment that is particularly sensitive to pesticides. The Thematic Strategy addresses this issue by stressing that surface and ground waters should be protected from pollution by appropriate measures that reduce their exposure to spray drift, drain flow and/or run-off (see section 3.2.7).

The establishment of buffer and safeguard zones alone may not be sufficient to adequately protect the aquatic environment. Open land and laboratory studies in Mecklenburg-Western Pomerania in Germany documented that, despite a 20 m buffer zone, as laid down in the rules of good agricultural practice for pesticide use, relevant concentrations of the pesticides Isoproturon and Cypermethrin were found in the surface waters of agricultural landscapes. In addition, high concentrations were found in the spawn and larva of the fire-bellied toad. This is a species protected by Directive 92/43/EEC (MLUV Brandenburg, 2003; reported in PAN Germany 2008). It is therefore necessary to extend protection measures beyond the establishment of buffer and safeguard zones in order to protect the aquatic environment and endangered, particularly vulnerable species in very sensitive areas.

Despite the fact that, according to the Thematic Strategy, the use of pesticides shall be prohibited or restricted in very sensitive areas, the conservation of biodiversity is not explicitly mentioned as the subject of protection within the Thematic Strategy. However, Directive 92/43/EEC (a Directive that is referred to in the Thematic Strategy) states that its “aim is to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora”. The proposal for a biocides regulation replacing the BPD introduces the “impact on biodiversity and the ecosystem” “as unacceptable effects”, which might cause the rejection of applications for authorisations.

The revised version of the German Programme for the Reduction of Chemical Plant Protection Products (BMVEL 2008) stresses that reducing the amount of pesticides in the environment and also subsequent risks will also serve nature conservation and biological diversity. For this reason, the National Action Plan on Sustainable Use of

Plant Protection Products has been incorporated as a fixed component in the National Biodiversity Strategy, reflecting the coherence between biodiversity and sustainable use of pesticides.

In the UK pesticide reduction programme, provisions are made to link relevant measures to those taken to preserve biodiversity. One expert group in the British reduction programme is concerned with the subject of biodiversity. One of the targets is to stop the decline in the bird population on agricultural land by 2010. Yearly inspections of bird populations are part of the reduction programme (PSD 2007).

However, as already mentioned above, the use of pesticides cannot always be avoided even in very sensitive areas, for example Natura 2000 sites. The risk associated with pest control must be weighed against the risks to the environment if the pest is not controlled. In practice, for example, if trees within the sensitive areas are infested by bark beetles, the potential damage caused by insects should be weighed against the potential damage to the ecosystem resulting from the application of plant protection products. If the pesticide application is considered to be unavoidable, appropriate risk management measures need to be established to protect the sensitive ecosystem in the conservation area.

3.2.9 Handling and storage of pesticides and treatment of their packaging and remnants (Article 13)

Article 12 requests MS to adopt necessary measures to ensure that handling of pesticides will not endanger the health or safety of humans and the environment. This includes all activities before and after application of pesticides, handling of packaging and remnants after application and cleaning of equipment. The same measures are required for pesticides authorised and used by non-professional users, to avoid dangerous handling operations.

<u>Handling and storage (including dilution and mixing)</u>

The use of concentrates requires an additional mixing and loading stage during which spillage and leakage can easily occur. Use of water-soluble packaging has been proposed in several guidance documents for the safe use of Plant Protection Products (e.g. Scottish Executive 2004). These packages, made of e.g. polyvinyl alcohol (PVA), reduce exposure through direct contact with the product during the mixing and loading stage and enable accurate dosing.

For amateur users, little data is available on storage and use of home pesticides (both plant protection products and biocides). In a UK study, the highest use of pesticides occurred in the garden, followed by homes, on pets and against head lice (the last mentioned are considered medicinal products). On average, 3.5 products per year were applied per household. Insecticides were the most common type of pesticide used in homes. Half of the pesticides were stored indoors, most commonly in kitchens; secondly in garages and sheds (Grey et al. 2006).

Cleaning of equipment and treatment of remaining mixtures after application

The cleaning of equipment after use and drainage of remaining mixtures from non-agricultural surfaces have been identified as the major cause of emissions to surface water. Thus, it is considered best practice to apply diluted liquids from cleaning processes directly on the areas previously treated. Direct or indirect discharge to sewers is prohibited (Anonymous 2005). For herbicides used as plant protection products, it is known from large-scale studies that about 2% of the total mass applied is ultimately lost to surface waters and that losses primarily occur during and immediately after the application. Spills during filling of spraying equipment, cleaning of the equipment and processing of spray waste on paved surfaces are examples of poor management practices. Careful pesticide handling is therefore a highly effective strategy for risk mitigation (Holvoet et al., 2007).

Treatment of packing and remnants

In Germany, since 1996 the agricultural pesticide industry and distributive trade has offered a German-wide recycling system for packaging used for its products by means of PAMIRA-System. Once a year, the 250 collection points are open for one to four days in which the farmer can return his used packaging. This packaging is checked with regard to its cleanliness and then registered and processed by efficient disposal companies. The processed plastic canisters are recycled to be used as a source of energy in cement plants or as raw material for the production of methanol. For the farmer, the return of packaging is free of charge. In 2008 in total 2262 t packaging material was recollected, corresponding to a rate of return of 60%

(http://www.pamira.de/). Similar voluntary collection schemes for crop protection packaging exist also in other Member States.

In France, ADIVALOR (Agriculteurs, Distributeurs, Industriels pour la VALORisation des déchets agricoles) collected about 3900 tonnes of packaging waste in 2006, which represents a recovery of more than 50% of empty containers produced (http://www.adivalor.fr/docs/adivalor-english-presentation.pdf).

Non professional users

Considering non-professional users, MS shall take all necessary measures regarding pesticides to avoid dangerous handling operations, such as the use of pesticides of low toxicity, ready to use formulations and limits on sizes of containers or packaging.

3.2.10 Integrated Pest Management (Article 14)

According to the Framework Directive 2009/128/EC, MS shall take all necessary measures to promote low pesticide-input pest management and to ensure that professional users of pesticides shift towards a more environmentally-friendly use of all available crop protection measures. To do so, MS shall establish or support the establishment of all necessary conditions for implementation of IPM and shall ensure that farmers have at their disposal systems, including training and tools for pest monitoring and decision making, as well as advisory services on IPM. Article 31 of Regulation (EC) No 1107/2009 on plant protection products prescribes that MS should consider indications for proper use according to the principles of IPM in their authorisations.

Article 14 of Directive 2009/128/EC defines "Integrated Pest Management" as “careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. IPM emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms”.

Article 14 and Annex III of Directive 2009/128/EC describe the following general principles of IPM for prevention and/or suppression of harmful organisms:

- Crop rotation
- Use of adequate cultivation techniques
- Use of resistant/tolerant cultivars and standard/certified seed and planting material
- Use of balanced fertilisation, liming and irrigation/drainage practices
- Preventing the spreading of harmful organisms by hygiene measures (e.g. by regular cleansing of machinery and equipment)
- Protection and enhancement of important beneficial organisms

The Thematic Strategy requires Member States to promote low pesticide-input pest management, wherever possible giving priority to non-chemical methods, so that professional users will switch to practices and products with the lowest risk to health and environment. The measure shall be specified in the national action plans.

Additionally, Member States shall establish incentives to encourage professional users to implement crop or sector-specific guidelines for IPM on a voluntary basis. Public authorities and/or organisations representing particular professional users may draw up such guidelines.

The European Commission initiated a study in 2009 on the development of guidance for establishing IPM principles. Therein eight general principles have been identified (European Commission, 2009, see table 1).

The study evaluated existing definitions and approaches of general IPM principles and examples of crop specific IPM measures throughout Europe and North America. The concept of IPM is distinguished from Good Plant Protection Practice (GPPP) which has been implemented in several Member States. While GPPP can be seen as a basic strategy defining minimum requirements and strict compliance with legal regulations, the concept of IPM goes beyond this, attempting to minimize the use of pesticides in a holistic approach.

Table 1: Integrated Pest Management (IPM) principles proposed for being implemented in the Thematic Strategy

1	Measures for prevention and/or suppression of harmful organisms	Prevention of key pests, diseases and weeds by choice of appropriate resistant/tolerant cultivars, optimum crop rotation, adequate cultivation techniques, balanced fertilisation and irrigation practices; Protection and enhancement of important natural enemies.
2	Tools for monitoring	Monitoring of pests, diseases and weeds for determining whether and when to apply direct pest control measures; Scientifically sound warning, forecasting and early diagnosis systems to be used for decisions.
3	Threshold values as basis for decision-making	Robust and scientifically sound threshold values for decision making; considering differences in varietal susceptibility; spraying during certain weather conditions not recommended (i.e. wind velocity > 5 m/s, temperature > 25°C, relative humidity <50%).
4	Non-chemical methods to be preferred	Preventive (indirect) plant protection measures to be considered and applied before intervention with control (direct) measures; biological, biotechnical and physical methods to be preferred; weed to be achieved by non-chemical methods as far as possible.
5	Target-specificity and minimization of side effects	When direct plant protection methods have to be applied, priority given to measures which have the minimum impact on human health, non-target organisms and the environment; application of appropriate products; impact to be minimised by calculating dose for a given phenological crop stage.
6	Reduction of use to necessary levels	Application to be limited to the lowest possible area (e.g. band spraying, spot treatments); use of best application techniques to minimize drift and loss; purchase and use of spraying equipment producing the least drift and pesticide loss to be encouraged.
7	Application of anti-resistance strategies	Where risk of resistance is known and where repeated application of plant protection products in the crops is required, regional organisations to provide clear recommendations or mandatory requests for an anti-resistance strategy.
8	Records, monitoring, documentation and check of success	Documentation of the mode of application, the accurately calculation of the application, the official pre-harvest intervals and the safe disposal of obsolete pesticides.

Regulation (EC) No 1107/2009 concerning the placing of plant protection products on the market intends that applying general standards of IPM, as described in Directive 2009/128/EC on the sustainable use of pesticides, should be made mandatory from 2014 onwards. The development of IPM standards on pest and crop management and the use of low-risk plant protection products as well as of non-chemical methods are assigned the highest priority.

3.2.11 National Action Plans and indicators – national measures

According to Article 4 of the Thematic Strategy, MS shall adopt National Action Plans to set up their quantitative objectives, targets, measures and timetables to reduce risks and impacts of pesticide use on human health and the environment. MS shall also include indicators to monitor the use of PPP. Member States have to bring into force the laws, regulations and administrative provisions in order to comply with the Directive. By doing so, they have to define targets, measures, and indicators on their own. Examples are:

Prohibition of the use of some pesticides: The reduction of hazards and risks resulting from the use of pesticides by restriction of certain substances and information and enabling of workers to better protect themselves can be seen as an additional measure. For example, Denmark (DK) banned the most dangerous endocrine disrupters from being used in glasshouses; in addition, a website was published to inform in particular pregnant employers, employees and doctors about PPP (www.gravidmedjob.dk). The Netherlands defines specific targets for reducing the risks for fresh water and drinking water by 95%.

Quantitative use reduction: Quantitative use reduction is not addressed in the Thematic Strategy but quantitative reduction targets can be defined at national level. For example, France (FR) aims at reducing the use of pesticides by 50% by 2018, by encouraging alternatives and a ban of 40 selected substances by 2010. Use reduction and risk reduction is also extended to the non-farming sector.

According to the German National Action Plan on sustainable use of PPP, it is aimed to reduce the risks resulting from the use of PPPs by 25 % by the year 2020. (BMVEL, 2009)

Taxes/levies on selected pesticides: Although the introduction of taxes for achieving quantitative use reduction target was not recommended in the impact assessment study prepared by the Commission in 2004 (Bipro study), it has been implemented for example in Denmark and Belgium. The taxes/levies are used for financing supporting measures and advisory service.

Training, awareness raising and control: Although "training and awareness raising" measures are already part of the Thematic Strategy, "control" is only foreseen in the framework of control of equipment. Hence control can be seen as an additional national measure. In some MS, specific advisory services for farmers have been implemented (e.g. DK, Italy (I)). Additionally, support for farmers by different means is foreseen; e.g. Denmark and France provide regional forecasts and warning systems on pests and specific guidance for decision making. The strengthening and extension of independent advisory structures, e.g. advisor training and further education, quality assurance, certification and inclusion of private advisory services, is seen as an adequate measure in Germany. Also, knowledge transfer and other measures for the use of PPPs in non-agricultural areas and between different users, e.g. professional users, advisors and distributors have been identified as important measures at national level.

Research and development (R&D): Research and development is identified as a key task in reducing risks and impacts of pesticide use. Strengthening in the field of R&D was therefore implemented as a clear objective in NAPs in Denmark and France. For example, France laid the focus on research on systems with low pesticide use.

Indicators: European wide harmonised risk indicators which will be referred to in Annex IV shall be established, but MS may continue to use existing national indicators or adopt additional ones, by using statistical indicators, by identifying trends and priority items. The result of the evaluation shall be reported to the Commission and other MS.

The development of indicators is foreseen in the Thematic Strategy. Further, the development of specific indicators is another measure implemented at national level, as it is a precondition for any evaluation on national and regional level. For example DK and F developed treatment frequency indices. Another measure is to develop specific risk indicators, e.g. maximum residue limits for the assessment of health and environmental effects. Up to now several tools and sets of indicators exist; e.g. the environmental indicator tool SYNOPS[22] and statistical data received from the NEPTUN survey[23], these are intended to be used as a basis for the further development of targets, indicators and evaluation. In France, monitoring of

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22 http://www.jki.bund.de/nn_804620/DE/Home/pflanzen__schuetzen/pfsmittel/risiken__SYNOPS/risiken__SYNOPS__node.html

23 http://www.jki.bund.de/cln_044/nn_804440/DE/Home/koordinieren/neptun/neptun.html__nnn=true

unexpected effects from the use of pesticides is also part of the NAP. In the UK there is a specific focus on pesticide used by amateurs. Further, a need for the development of more indicators, e.g. for the assessment of biodiversity, has also been identified.

4 Measures for sustainable use of biocides

4.1 Existing approaches for sustainable use of biocides

Some aspects concerning the use phase of biocidal products are already addressed in the authorisation process. According to Directive 98/8/EC (e.g. Annex VI, 62, 72) on the placing on the market of biocidal products, competent authorities may impose conditions on the use of the product or prescribe risk management measures. The risk management measures are, however, always relevant only for the specific biocidal product. Provisions on sustainable use would look at the risks arising from the use of all biocidal products. Measures aimed at ensuring the sustainable use of biocidal products would be applicable to a group of, or to all, biocidal products or for specific applications such as aerial spraying.

4.1.1 Results of the COWI-study

In 2008, the EU Commission contracted a study on the assessment of different options to address risks from the use phase of biocidal products. The final report, "Assessment of different options to address risks from the use phase of biocides", was published in March 2009 (COWI 2009).

The purpose of the study was to "help identify the appropriate measures and legal instruments that would allow ensuring a sustainable use of biocidal products". Five types of approaches (and their technical options) were identified to reduce the risk in the use phase of biocides:

- Reduce quantities to optimal levels (optimising the dosage, prevent growth of organisms, application of non-biocidal techniques, avoid using biocides where prevention is not essential)
- Reduce hazardousness (technical improvements, imported articles/ materials, use of less hazardous biocides for less demanding applications)
- Reduce releases and exposures by application (use of appropriate application techniques and equipment, use appropriate personal protection equipment)
- Reduce releases and exposures in the service life phase (reduce the release rate of biocides from products and articles, prevent inappropriate use of biocide treated materials/articles e.g. indoor use of preserved wood)

- Prevent development of resistance (change between different biocides, prevent using biocides at sub-lethal levels)

Among the measures to achieve the approaches, the following ones were analysed more in detail:

- Training and certification of professional users
- Certification and inspection of application equipment
- Long term good practice and prevention

Considering the development of harmonised good practice (GP) reference documents, the establishment of Technical Working Groups comprising nominated experts from EU Member States, industry and environmental NGOs with the Joint Research Centre (JRC) as coordinating body was suggested, similar to the BAT Reference Documents (BREF) approach of the IPPC Directive. The German study on "Good practice of biocide use" was cited in detail as an example of the structure and the contents reference documents could include (Gartiser et al., 2005). These reference documents could be used as a basis for training of professional users by public organisations, industry or educational institutes. For some specific application areas, such as rodent control, guidance on best practice has been already developed (e.g. Central Science Laboratory, 2002).

In relation to the certification and inspection of application equipment, the German study on good practice for the use of biocides, which describes a number of equipment types for which certification procedures exist in Germany has again been cited. However, a Danish study on the impact of a control system for plant protection equipment concluded that the environmental and health impact will probably be very small and mostly an effect of phasing out old equipment (Dubgaard et al., 2007, cited in COWI, 2009).

Considering long term good practice and prevention, the COWI study concluded that measures such as IPM as used in the plant protection sector, including prevention, pest monitoring, use of thresholds (blanket restrictions), lowest use of chemicals and use of substitutes, are in principle also applicable for many biocidal applications.

The measures proposed in the COWI study mainly focus on professional users of biocides, while non-professional users are only indirectly affected (e.g. through use restrictions, sale restrictions, information/awareness raising campaigns).

Use restriction of biocides in sensitive areas on bodies of water has been identified as one option. Such restriction may be relevant for applications in very vulnerable environments. The COWI study gives the following examples of measures implemented in some Member States:

- Prohibition of the use of antifouling products in fresh water
- Some biocides may only be used indoors
- Restrict the use of some insecticides for the control of mosquitoes for use in cases of epidemic of disease
- Restrict the use of biocides in designated nature and landscape conservation areas or water protection zones
- Restrict the use of biocides in the environs of drinking water resources, public buildings (e.g. schools, kindergartens, etc.).

To date, according to the COWI study, restriction of the general use of biocides in designated areas is not considered appropriate at Community level and the measure is not included in the assessment.

4.1.2 Evaluation of documents discussed at CA-meetings

Several RMM for biocides are currently being discussed by Competent Authorities (CA).[24]

Spraying of wood preservatives

While few Member States completely forbid the spraying of wood preservatives by amateur users, most CA suggest that this should not be required as a general rule. They recommend that spraying by non-professional users should be prohibited if the exposure assessment results in unacceptable risks, with the need to use personal protective equipment (PPE).[25] The reason is that the use of PPE for reducing exposure and of ensuring the safe use of the product is not considered acceptable for non-professional users. The Technical Note for Guidance on human exposure includes a scenario of spraying for amateur users without assuming the use of PPE.[26]

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[24] It should be noted that the CA-meetings have an advisory status while decisions are taken by the Standing Committee on Biocidal Products.

[25] Spraying method of wood preservatives for amateur users. 26th CA meeting, CA-Sept07-Doc.5.3 – Final

[26] Use of Personal Protective Equipment. 27th CA meeting, CA-May08-Doc.6.2

Use restrictions on rodenticides

It has also been proposed to restrict the user category of anticoagulant rodenticides to professionals, for resistance control and because many of them are classified as PBT substances. Nevertheless, there is no general restriction at the Community level. Because of the very sensitive nature of this issue, Member States should be allowed to decide on use categories, especially restrictions of use categories on their own.

However, restrictions on the area of use to that in and around buildings have been proposed as option for preventing primary and secondary poisoning. These provisions could be combined with the category of users and the product design. It may, for instance, be possible to restrict the outdoor use of a given anticoagulant to professionals only, whilst the amateur use of the same anticoagulant in a ready-to-use product may be restricted to indoor use.

Provisions on the composition of the product may also be useful to reduce the risk of primary and secondary poisoning. Among these is the indication of a maximum concentration allowed in biocidal products and the inclusion of a bittering agent in formulations to reduce the risk of accidental ingestion, by children in particular. Similarly, the inclusion of a blue dye renders the product unattractive to non-target animals like birds. In addition, in cases of accidental ingestion, the presence of a dye may help to confirm that there has been ingestion and thus facilitate antidote treatment.

Because the choice of the most appropriate RMM is closely linked to the design, pack size, area of use, category of users, conditions of use and composition of the final product, according to the Commission the choice of specific RMM should be deferred to the product authorisation stage when all the details of the products to be placed on the market are available. The objective of Annex I inclusion should thus be to identify general RMM, which can apply to all products, as well as specific risks/hazards to be addressed at the product authorisation stage.[27]

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27 RISK MITIGATION MEASURES FOR ANTICOAGULANTS USED AS RODENTICIDES. CA-March07-Doc.6.3 final – revised after 25th CA meeting

From the discussions at the CA meetings, it is clear that, although some Member States suggested that RMM should be harmonised at EU level through specific provisions in the Annex I inclusions, others and the Commission deferred these to the (national) product authorisation level.

4.1.3 Evaluation of (draft) Inclusion Directives and Assessment Reports

Suitable measures to reduce risks are quoted in the Inclusion Directives. To date, several active substances of product types 8, 14 and 18 have been included in Annex I of Directive 98/8/EC. The Inclusion Directives describe different RMM which shall be considered during the authorisation of biocidal products containing these particular active substances[28]. Although this study focuses on active substances used in PT 8 and PT 18, the RMM described for other product types so far have also been evaluated, because they might provide further information on risk mitigation for biocides. The specific provisions for product authorisations available so far are summarised in table 1.

Table 2: Provisions for product authorisations from the Inclusion Directives

	Risk mitigation measures	Examples
A) Placing on the market		
User restriction	Restriction of the use of the fumigant sulfuryl fluoride to **trained professionals**	Sulfuryl fluoride, PT 8, 18
	Use of aluminium phosphide releasing phosphine fumigant only by **specifically trained professionals** (in the form of ready-for-use products for PT18) while applying appropriate RMM (personal and respiratory protective equipment, use of applicators).	Aluminium phosphide, PT 14, 18 Trimagnesium diphosphide. PT 18
	Restriction to industrial operators.	K-HDO, PT 8
	Restriction to professional use only as potential RMM. *)	Bromadiolone, Chlorophacinone Coumatetralyl Difenacoum Difethialone Flocoumafen (all PT 14)
Intended uses and area of	**Restriction of use** of K-HDO for the treatment of wood that may enter in direct contact with infants.	K-HDO, PT 8

[28] http://ec.europa.eu/environment/biocides/annexi_and_ia.htm
http://ecb.jrc.ec.europa.eu/esis/index.php?PGM=bpd

application /	Restriction of the use class for certain wood preservatives: No **in-situ treatment of wood** outdoors *) Restriction of the use class for certain wood preservatives for wood that will be in continuous contact with water or weathering allowed.*)	Boric acid Disodium octaborate Propiconazole Tebuconazole Thiabendazole Thiamethoxam Tolylfluanid (all PT 8) Boric acid Disodium octaborat Propiconazole Clothianidin Tebuconazole Thiabendazole Thiamethoxam Tolylfluanid (all PT 8)
	Restriction of in situ treatment of wooden structures near water, where direct losses to the aquatic compartment cannot be prevented, or for wood that will be in contact with surface water.	Thiacloprid, PT 8
	No treatment of areas where other burrowing mammals than the target species are present.'	Aluminium phosphide, PT 14
	Member States shall assess outdoor use of phosphine releasing compounds before such application is granted.	Magnesium phosphide, PT 18
Package size	Minimisation of primary and secondary exposure of humans, non-target animals and the environment to rodenticides by setting an upper limit to the package.	Bromadiolone Chlorophacinone Coumatetralyl Difethialone Difenacoum (all PT 14)
Design of the biocidal product mode of application	Some rodenticides shall not be used as **tracking powder**.	Bromadiolone Difenacoum Flocoumafen Difethialone (all PT 14)
	Limitation of nominal concentration of the active substance in the products of some rodenticides and authorisation of ready-for-use products only.	Alphachloralose < 40 g/kg Bromadiolone < 50 mg/kg Chlorophacinone < 50 mg/kg Coumatetralyl < 375 mg/kg Difenacoum <75 mg/kg Difethialone <25 mg/kg (all PT 14)
	For amateur uses, only ready-to-use products shall be authorised.	Indoxacarb, PT 18 Bromadiolone, PT 14 Difenacoum, PT 14 Difethialone, PT 14
	Some biocidal products (in this case rodenticides) shall contain an aversive agent and, where appropriate, a dye.	Difethialone, PT 14 Difenacoum, PT 14
B) Application of biocidal products		
Equipment	Restriction K-HDO as wood preservative to industrial use in **fully automated and closed equipment.** *)	K-HDO, PT 8
	Minimisation of primary and secondary exposure to rodenticides by obligation to use tamper resistant and secured bait boxes. *)	Alphachloralose Bromadiolone Chlorophacinone Coumatetralyl Difenacoum Difethialone Flocoumafen (all PT 14)
Personal protective equipment	Use of appropriate **personal protective equipment** for reducing human exposure at industrial and/or professional use to certain wood preservatives.	Most wood preservatives

	Appropriate RMM for operators and bystanders exposed to the fumigants.	Sulfuryl fluoride, PT 8, 18
	Use of phosphine releasing fumigants only while using appropriate personal and respiratory protective equipment, use of applicators	Aluminium phosphide, PT 14, 18
Further RMM	Removal of all food items.	Sulfuryl difluoride, PT 18
	Minimisation of the potential exposure of humans, of non-target species and of the aquatic environment. Products shall not be placed in areas accessible to infants, children and companion animals.	Indoxacarb, PT 18
C) Post application		
Storage of treated wood	**Storage** of timber freshly treated with wood preservatives under shelter or on impermeable hard standing surfaces to prevent direct losses to soil or water.	IPBC Boric oxide Clothianidin Dichlofluanid Fenpropimorph Propinconazole Tebuconazole Thiabendazole Thiamethoxam Tolylfluanid (all PT 8)
Waiting period	After potential exposure to food, adherence to waiting periods which ensure MRLs set out in Regulation (EC) No 396/2005.	Aluminium phosphide, PT 18 Magnesium phosphide, PT 18
Disposal	**Collection** of any losses of wood preservatives for reuse or disposal.	Most wood preservatives
Drainage	Minimisation of the potential exposure of the aquatic environment by • Products shall be positioned away from external drains. • Unused products shall be disposed of properly and not washed down the drain.	Indoxacarb, PT 18
Wastewater treatment	Waste waters containing acrolein shall be monitored prior to discharge. Where necessary waste waters shall be held in suitable tanks or reservoirs or appropriately treated before discharge	Acrolein, PT 12
D) Further regulatory options		
Comparative risk assessment	Some rodenticides are subject to a comparative risk assessment due to their identified risks.	Bromadiolone Chlorophacinone Coumatetralyl Difenacoum Difethialone Flocoumafen (all PT 14)
Population exposed	Member States shall assess the populations that may be exposed to the product and the use or exposure scenarios that have not been addressed at the risk assessment	Acrolein, PT 12 Alphachloralose, PT 14 Aluminium phosphide, PT 14, 18 Boric acid, PT 8 Boric oxide, PT 8 Clothianidin, PT 8 Disodium octaborate, PT 8 Indoxacarb, PT 18 K-HDO, PT 8
Monitoring	Monitoring of sulfuryl fluoride concentrations in remote tropospheric air	Sulfuryl fluoride, PT 8, 18

*) Condition may be modified according to the outcome of a risk assessment

While only a limited number of active substances has been included in Annex I of the BPD, far more draft Competent Authority Reports (CARs) are currently being discussed at the Community level. Parts of the reports (Doc I) are considered non-confidential and therefore available to the public.[29] Although most of these CARs are still not finalised and therefore might be subject to amendments, the RMM described there have been analysed in detail within another project (Gartiser et al. 2010).

4.2 Transferability of measures proposed for pesticides to biocides

The analysis of transferability of measures proposed for pesticides to biocides follows a systematic approach, based on the general structure imposed by the corresponding articles of the Framework Directive 2009/128/EC on sustainable use of pesticides. This structure is partly extended or adapted according to the specific needs for the sustainable use of biocides. The objective of this approach is to have a common structure for the evaluation of general measures to be considered for all biocides. The same structure will also be used for deriving specific measures for certain product types and detailed measures for selected application scenarios in the case studies. Additionally, the analysis identifies which measures proposed for plant protection products are not transferable to the biocide sector.

4.2.1 Overview

The following overview describes measures proposed in the “Thematic Strategy on the Sustainable Use of Pesticides” and their potential for transfer to the biocides area. The elements referred to in figure 5 are analysed more in detail in the corresponding subchapters.

[29] http://circa.europa.eu/Public/irc/env/bio_reports/library?l=/review_programme/ca_reports/pt18_insecticides&vm=detailed&sb=Title

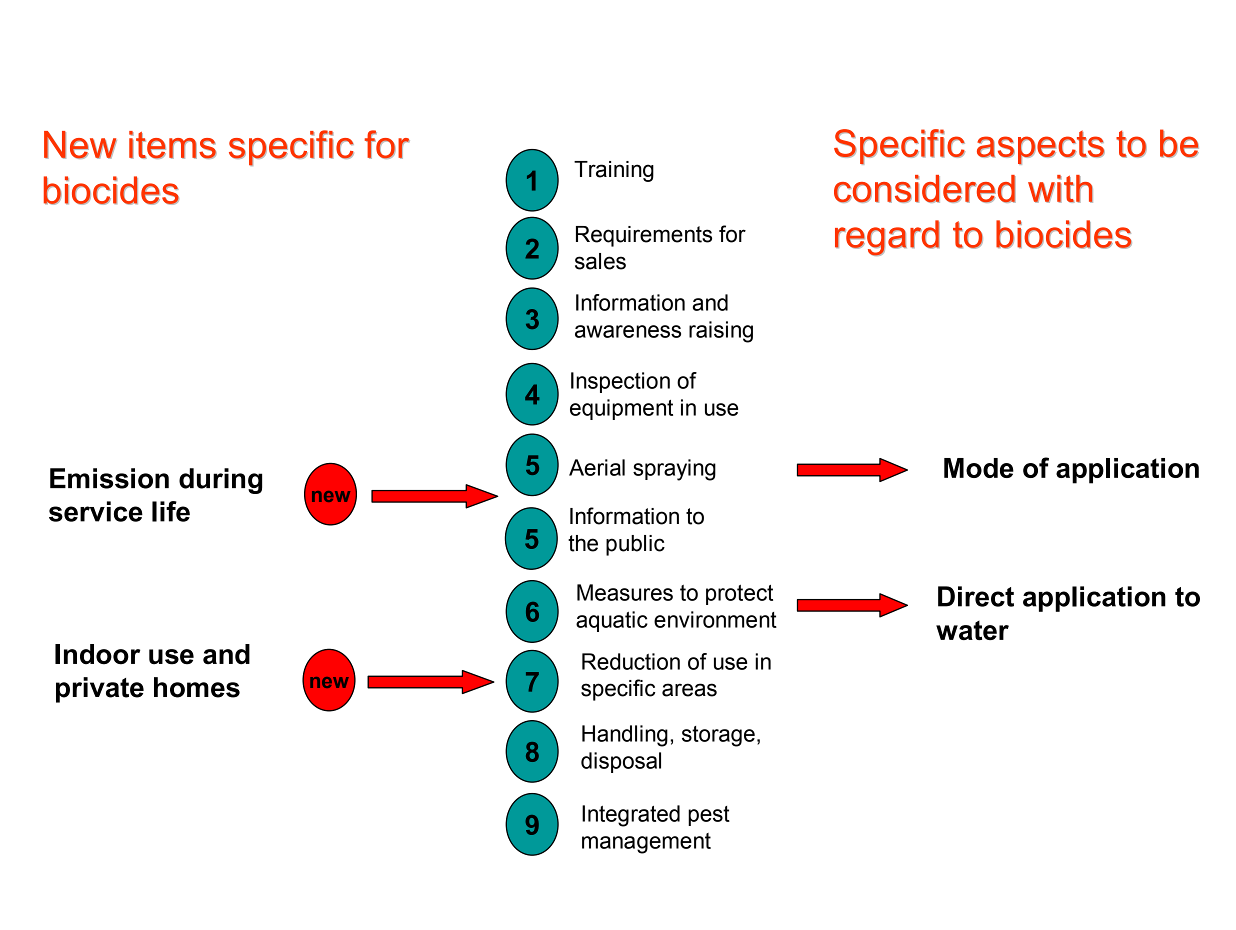

Figure 5: Elements of sustainable use of biocides (Overview)

Most instruments implemented by Directive 2009/128/EC for Plant Protection Products also apply to the use of biocides.

Moreover, the form of the biocide (e.g. type of formulation) and the mode of application often determine human exposure and emission to the environment and should be considered. As biocides are often applied indoors in private homes or public facilities, the exposure of operators, bystanders and pets during the application needs to be considered with regard to a sustainable use of biocides.[30] Indoor use and private homes could thus be considered as "sensitive areas". Another element specific for preservatives is the service life. It is known that leaching of wood

30 This is proven e.g. by the fact that house dust still contains considerable amounts of very old biocides such as Chlorpyrifos, DDT, Hexachlorobenzene, Lindane, and Pentachlorophenol, which have been banned since years (Müssig-Zufika et al., 2008).

preservatives, masonry biocides or antifouling agents through leaching during the service life is of more relevance than during the application.

The transferability of these elements of the Thematic Strategy on pesticides to biocides is discussed more in detail below.

4.2.2 Training (Article 5)

The use of good practice reference documents and standards, in particular with respect to the training and certification of professional users, was identified as an essential measure for the sustainable use of biocides in the COWI study.

Training and/or certification of professional users could be envisaged as obligatory for certain PTs, including pest control (PT 14, 15, 18, 23) or disinfection in public facilities with relevance on human health (PT1-5).[31] For other PTs, like PT 8 and 21, the best practice application of biocides could be included in the curricula for training of professionals. For non-professionals, information campaigns to raise the awareness of the public are another means of preventing and/or reducing improper use of biocides. See also awareness programmes, Article 7.

Professional education and training for pest control workers (PT 14, 15, 18, 19, and 23) and for public health operators (PT1, 2, 5) already exists. For example, the curriculum for the training of pest controllers includes:[32]

> Safety and occupational health, relevant laws, information sources, operational procedures, use and maintenance of equipment, handling and use of hazardous chemicals and pest control agents, RMM to avoid exposure of operators and bystanders, avoidance of environmental contamination, monitoring of pests, planning and realisation of pest control measures, consultancy of customers, quality assurance.

Many of these elements correspond to the items described in Annex I of Directive 2009/128/EC of sustainable use of pesticides. Training for pest controllers is a three-year program in Germany.

[31] In some MS (e.g. Germany) biocidal products of PT 15, 17 and 23 may not be authorized by national law and are excluded from the mutual recognition procedure.

[32] http://www.gesetze-im-internet.de/bundesrecht/sch_dlbekausbv/gesamt.pdf

In other biocidal application areas, professional associations and research institutes offer training measures for professional users. Some examples are:

- The Paper Technology Foundation (Papiertechnische Stiftung, PTS) offers research and consultancy for the paper industry and organises seminars, workshops and symposia in the fields of chemical and water management, surface technology etc.[33]
- The Association of the Lubricant Industry (Verband Schmierstoff-Industrie e.V., VSI,) has several working groups dealing with the use of cooling lubricants and publishes application guides for uses.[34]
- The German Association for Wood Research (Deutsche Gesellschaft für Holzforschung e.V.) publishes numerous guidance documents on best practices in wood protection and biocide application.[35]
- The German Pest Operator Association (Deutscher Schädlingsbekämpfer-Verband e.V., DSV) offers training and education measures to their members and also develops technical standards for pest control (TRNS). [36]

The Confederation of European Pest Control Association (CEPA) published the Roma Protocol in April 2008, a commitment to professional standards for the European pest management industry. This envisages a certification system for companies or individuals, as well as the development of CEN (European Committee for Standardisation) standards describing criteria for the quality of services. Training and periodic updating in technical, commercial, administration and customer services issues is required to obtain and maintain an authorisation. The training includes lectures on biology and entomology, characteristics of general biocidal products, risk management, environmental impact assessment procedures, consumer awareness campaigns as well as operator safety measures (CEPA 2008). According to CEPA, some 38.000 persons are employed in about 6.800 European pest control companies. They have a total turnover of 1.501 million EUR. Rodent and insect controls are the largest segments, representing 78% of the turnover of all activities (CEPA 2003). In 1998 CEPA reached agreement with the European Commission to work on a training programme for the industry. The objective was to create a basic

[33] http://www.ptspaper.de

[34] http://www.vsi-schmierstoffe.de

[35] http://www.dgfh.de/

[36] http://www.dsvonline.de

training tool in the form of a manual and a CD, which would help co-ordinate training across Europe.

According to CEN, the upcoming work proposal by CEPA will not address the issue of pest control itself, but the services offered and performed by pest controllers as well as the qualification needed and relevant curricula. In July 2010, a new project committee on “services of pest management companies” was adopted (CEN/TC 404). The first meeting of the project committee was scheduled for the 2nd of December 2010. The time frame for standard development is three years from the date of the acceptance of the proposal by the CEN Members. No draft working document is available to date.[37]

Conclusions:

There are several ongoing national activities for education and training of professional users, established by professional associations and research institutes. It seems that guidance development on best practices as basis for training measures takes place only at national level. For this reason, it seems difficult to obtain an overview of the various activities in member states.

The only European activity known is that of CEPA for pest control services. A German technical standard of the pest control operator association is available. While education and training clearly need to be embedded in national (or local) engagement, there is clearly a lack of exchange of knowledge and expertises among Member States.

4.2.3 Requirements for sales (Article 6)

The application of Article 6 of Directive 2009/128/EC on sustainable use of pesticides to the distribution of biocides through certified distributors, providing adequate information to customers, would be an effective instrument for improving sustainable use. The Directive stipulates that non-certified distributors or retailers may not sell biocidal products classified as toxic (T), very toxic (T+) or harmful (R40, R62, 63, 68) or oxidising (O) or extremely flammable (F+). These rules have already been

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[37] Personal communication of Ms Maitane OLABARRIA UZQUIANO, CEN - European Committee for Standardization from 08.11.2010

implemented into German law.[38] Self service sale of any plant protection product is prohibited in Germany, according to § 22 Abs. 1 of the plant protection law (Pflanzenschutzgesetz), irrespective of their classification. Therefore, plant protection products in supplying stores are shelved in locked cupboards and customers have to ask certified staff when purchasing pesticide products. To obtain relevant authorisation, sales people have to attend seminars (two days) and pass an exam.[39] These provisions could be extended to cover/include biocides for consumer use. In Germany these are sold in open shelves through self service or internet commerce. Some biocidal products, for example disinfectants for hands, surfaces or laundry (intended for human health purposes) could be distributed via pharmacies to the general public in order to obtain advice on the application of these products and on general hygiene requirements. Biocides for professional use are generally distributed via other supply chains where these provisions do not apply. Here often the suppliers' field staff advise their customers which biocidal product to apply. The qualifications of these distributors could also be certified, according to the requirements of Directive 2009/128/EC.

The German working group on chemical safety of the federal and federal states authorities published a guidance document on good practice for internet chemical commerce (BLAC 2009). This refers to legal requirements, such as indication of the hazardous properties of substances and mixtures which lead to a classification into risk-phrases (in future: hazard classes) according to Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures. Additionally, recommendations beyond the legal requirements are described. For example, it is recommended to publish the safety data sheets and product leaflets on the internet, as is already done by many companies. Customers should be asked to confirm their attention to safety measures before purchasing hazardous products. A reference on the package label to the web-site providing further information, such as safety data sheets, is useful. The website should inform customers that carcinogenic, mutagenic or reproductive toxic substances of categories 1 and 2 (in future 1a and 1b) must not be delivered to private users and that toxic and very toxic substances must only be sold to competent and experienced customers (private or commercial). A reference

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[38] ChemVerbotsV - Chemikalien-Verbotsverordnung vom 13. Juni 2003, last amendment 21.08.08

[39] Pflanzenschutz- Sachkundeverordnung vom 28. Juli 1987, last amendment on 7.5.2001 S. 885

of acceptable verification and/or certification schemes is recommended. The retailer must keep account of the recipients (BLAC 2009).

Article 6 of Directive 2009/128/EC also requires distributors selling pesticides to provide adequate information to customers as regards pesticide use, health and environmental risks and safety instructions both to professional and non-professional users. Essential information documents to be provided to professional customers are the safety data sheet and product leaflets. Private customers have to be informed adequately via the product label, in particular on hazards, exposure, proper storage, handling, application and safe disposal.

For rodenticides, the Inclusion Directives prescribe an upper limit to the package size as RMM in order to minimise primary and secondary exposure of humans, non-target animals and the environment. In Germany, the packaging size of wood preservatives for non-professionals has been limited to 750 ml, according to a voluntary agreement with industry.[40] In fact, lower amounts of wood preservatives supplied to consumers can be considered as a RMM to avoid extensive use indoors (see DIN 68 800-3).

Conclusion:

The requirements for sales of biocides could be adapted to those proposed for plant protection products as envisaged in Directive 2009/128/EC on sustainable use of pesticides. Some exemptions might apply for biocides where no risks have been identified. For example disinfectants used for drinking or swimming water treatment in the public health sector may be assumed to be applied by trained professional users. There also exist provisions for best practice of internet commerce but doubts remain whether these are followed.

4.2.4 Information an awareness-raising (Article 7)

Raising awareness of the general public (non-professional users), as well as of professional applicants, is essential for the proper use of biocides. Information about best practices, occupational health campaigns, promotion of so-called ecolabels, and the information system on biocides (web-based and print media based) are examples of suitable programmes to be established in NAPs.

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[40] http://www.holzfragen.de/seiten/pop_biozide.html

The addressee of awareness programmes is the general public, to which accurate and balanced information relating to the risk of biocides arising from their use, their service life (e.g. treated articles) and the use of “low risk products” and non-chemical alternatives should be provided and promoted.

For both, private users and professionals, the product label and additionally application instruction documents are the primary information sources. Quality and completeness of label and instruction documents are therefore essential. The classification, packaging and labelling of biocidal products according to Article 20 of the BPD can be regarded as minimum requirements. However, a general limitation concerning the labelling of biocidal products is the limited space available for the labels on the packages of many ready to use products. Additionally, some suppliers misspend the limited space for multilingual instructions, the text being unreadable for many users. In interviews with pest controllers, it has been suggested that the product labels, application instructions and safety data sheets should be evaluated together with the authorisation or registration of the respective products.[41,42]

In addition to these minimum requirements already imposed by the Biocidal Product Directive, raising awareness of the general public (non-professional users) as well as of professional users is essential for proper use of biocides. The following programmes could be envisaged:

- Information gathering and documentation of best practices
- Occupational health campaigns by employer's insurance associations or authorities.
- Promotion of ecolabels with application of biocides
- Information system on biocides (web-based and print media based) and alternative measures

The quality of information is also dependent on the development of best practices or IPM tools (see 3.2.10).

The Framework Directive 2009/128/EC on sustainable use of pesticides requires MS to provide information about the health and environmental effects of pesticides and

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[41] Personal communication Dr. Harald Fänger Killgerm GmbH, Neuss, Germany.

[42] A draft label is part of the obligatory data package for product authorisation according to Article 8 of Directive 98/8/EC.

about non-chemical alternatives. In Germany a web-based information system (web portal combined with print media) has been established for the general public (www.biozid-portal.de). The special portal developed and run by the Federal Environment Agency (www.biozid.info) is a part of the information system and aims to provide information to the general public about physical, chemical and other measures as alternatives for the use of biocidal products or for minimization of their use, the focus lying on the description of preventive measures.

Conclusion:

The requirement for MS to develop and establish awareness programmes is an important instrument for supporting sustainable use of biocides and should be considered in NAPs.

4.2.5 Inspection of equipment in use (Article 8)

For biocides, dosing apparatus' for the preparation of a disinfectant solution from concentrates can be distinguished from the equipment for application/distribution. Several national standards for equipment for biocide application have been identified in MS, including those for the application of biocides in PT 1-5, 8, and 18.

The draft amendment Directive on machinery for pesticide application of September 2008 included in its definition machinery for the application of both plant protection products and biocidal products for pest control, belonging to PT 14 through PT 19. However, the European Parliament voted against this in April 2009. This was done with the argument that the Framework Directive (now Directive 2009/128/EC) applies to plant protection products only and, therefore, its scope should be limited to plant protection products. In consequence, Directive 2009/127/EC on Machinery for Pesticide Application does not yet consider biocides. However, it is anticipated that the scope of Framework Directive 2009/128/EC will be extended to cover biocidal products. An extension of the scope of the environmental protection requirements to machinery for the application of biocidal products will likely be examined by the European Commission by 31 December 2012.

As Directive 2009/128/EC on sustainable use of pesticides allows derogation from the certification of application equipment for plant protection products for handheld pesticide application equipment or knapsack sprayers, or application equipment that represent a very low scale of use, it is questionable whether all biocide application equipment would fall under a future Machinery Directive including biocidal products application equipment. However, the Thematic Strategy requires a risk assessment for applying the equipment being exempted. Manual pressure aerosol or trigger sprays which are used for both plant protection and biocidal purposes, primarily by consumers, have not been considered within the Machinery Directive so far. Thus no existing standards are known.[43] By contrast, several standards have been and are being developed for knapsack sprayers and compressed air sprayers (with compressor) which are also used in both sectors (Herbst et al. 2002). The following examples from ISO Technical Committee TC 23/SC 6 and CEN have been identified (taken from the ISO and CEN Websites)[44]:

- ISO 19932 part 1 and 2: 2006: Equipment for crop protection -- Knapsack sprayers -- Part 1: Requirements and test methods, Part 2: Performance limits
- EN 12761 part 1 and 2: 2001: Agricultural and forestry machinery - Sprayers and liquid fertilizer distributors - Environmental protection - Part 1: General, Part 2: Field crop sprayers
- EN ISO 28139:2009: Agricultural and forestry machinery - Knapsack combustion-engine-driven mistblowers - Safety requirements (ISO 28139:2009

Other national and European Directives on product safety already apply to biocidal application equipment or packaging:

Aerosol dispensers Directive 75/324/EEC (amended by Directive 2008/47/EC)

Aerosol dispensers are non-reusable containers mainly made of metal containing a compressed gas with liquids, paste or powders allowing the contents to be ejected as solid or liquid particles. In the biocide sector their use is very common. Aerosol dispensers are used for the application of disinfectants (PT 1, 2, 3, 4), preservatives 8, 10), pest control agents (PT 18, 19) and others (PT 21). For metal aerosol dispensers the Directive limits the total volume of the container to 1000 mL. The safety provisions refer to general aspects like maximum pressure allowed, bursting under higher temperature, flammability of the content and labelling of the containers. Use related provisions like the size of the droplets are not considered

Dosing systems

National standards for dosing apparatus' exist for specific applications, for example in hospital hygiene as well as in the treatment of drinking and swimming water. However no international standards are available. As well as disinfectants, dosage systems are used in many other applications where biocide concentrates have to be diluted (especially in PT 11, 12, 13).

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43 Personal communication Dr.-Ing. Heinz Ganzelmeier, Justus-Kühne-Institut, Germany from 07.09.2009

44 http://www.iso.org/iso/home.htm; http://www.cen.eu/cenorm/homepage.htm

High pressure cleaner

High pressure washers and steam cleaners are often used for the application of surface disinfectants. An international standard on safety requirements exists, but focuses primary on the electrical installation (EN 60335-2-79).

Impregnating vessels for wood preservatives

Vessels for pressure treatment of wood using water-soluble impregnating agents or coal tar oil (creosote) fall under the Pressure Equipment Directive (97/23/EC) and the Machinery Directive 2006/42/EC. There are several impregnation efficiency standards of industrial or public associations, but no international standards on the construction of these vessels.

Conclusion:

The availability of appropriate equipment for the application of biocides is an important instrument for the minimisation of exposure and targeted dosage of biocides and providing for secure and proper use. The Directive on Machinery 2006/42/EC should be amended to include machinery and equipment for the application of biocides. Initiatives for harmonisation and standardisation of the machinery for biocide application only exist in rudimentary form.

4.2.6 Prohibition of certain modes of application (Adaptation of Article 9)

The Framework Directive 2009/128/EC specifically quotes aerial spraying as a mode of application to be restricted. As aerial spraying of biocides is actually used to control mosquitoes and oak procession moths (see below), it is appropriate to consider a prohibition on aerial spraying of biocides.

In the biocide area, the physical form of the biocide and the mode of application are of major relevance. For example, spraying of insecticides indoors might cause higher exposure to humans and the environment than their application as bait. Therefore, this instrument should be amended to cover other modes of application of biocides.

Prohibition of aerial spraying

In the present study, two scenarios have been identified where biocides are being applied on a large scale from helicopters.

These are the application of *Bacillus thuringiensis* toxins through helicopters in the Upper-Rhine area for mosquito control and the control of oak procession moths (*Thaumetopoea processionea*) in oak forests, the fine hairs of which can cause allergic reactions in sensitive individuals. In both cases, aerial spraying should only be allowed as a last resort by way of derogation, where it offers clear advantages compared to other application methods. According to proposals from the environmental authorities, it has to be considered whether possible risks to human health from certain pests could also be controlled by preventing people from entering infested areas. If this is possible, this option has to be selected. People could also be protected against mosquitoes by keeping them away from river banks, and sensitive individuals should avoid oaks as long as the hairy canker worms are around.

Large scale mosquito control or the control of oak processing moths by conventional insecticides might have considerable impacts on the environment and should be avoided from an ecological point of view. There are applications with lower environmental concern, such as the use of *Bacillus thuringiensis* toxins, which might be exempted from a general prohibition.

<u>Prohibition of spray applications or fogging by non-professional users</u>

The restriction of spraying application of wood preservatives to professional users has been rejected at the competent authority meetings (see 3.1.2).

In a German study on occupational exposure to insecticides, safe use of total release foggers (one-shot aerosol cartridges) by non-professionals has been questioned (Schneider et al. 2008). These products are also available to the general public (e.g. in pet shops and on-line orders in internet stores). Indoor foggers are used to apply biocides against infestations by fleas (from pets). They have residual efficacy (up to 6 months).

<u>Other restrictions in the modes of application</u>

The limitation of tracking powders as rodenticides is already considered in the inclusion directives of some rodenticides. Here, the use of tracking powder is restricted for some active substances. Other examples are the need for fumigants to be applied only by specifically trained professionals or the authorisation of only ready–for-use-products for non-professional uses.

Conclusions:

There are biocidal modes of application which may result in considerable human and/or environmental exposures. These should be considered for use restriction measures. According to Directive 2009/128/EC on sustainable use of pesticides, aerial spraying should be prohibited in general. Derogations are possible if there are no alternatives available or if aerial spraying is likely to result in lower risks compared to other spraying methods. The pesticides used must be explicitly approved for aerial spraying. Relevant provisions can immediately be adjusted to include biocides.

Considering other modes of application, there is a close relationship to the user category (professional, non professional). Only for some rodenticides, insecticides and wood preservatives has the mode of application been restricted (no tracking powder but baits, fumigants restricted to certified professionals). This is already considered in several inclusion directives. To date, there are no proposals for certain modes of application to be restricted for a whole PT.

4.2.7 Emission during service life (New Article)

Instruments for reduction of environmental emissions during service life are not considered in Directive 2009/128/EC on sustainable use of pesticides, because here it cannot be distinguished from the application phase. However, for biocides used for preservation of materials (PT 6-10) and antifouling agents (PT 21), a considerable proportion of the total emissions take place during the service life, through leaching or the removal of coatings or treated articles. Therefore, in contrast to plant protection products, the service life of biocidal products should be considered in detail in addition to the use phase. Measures to be considered for risk reduction during the service life are the restriction of the use class of certain wood preservatives, requirements for the processing of treated articles or for the removal of biocide coatings.

4.2.8 Information to the public (Article 10)

Framework Directive 2009/128/EC in Article 10 specifically addresses provisions on informing persons who could be exposed to the spray drift (both aerial and boom sprayers). Few scenarios of large scale biocidal aerial applications have been identified. This measure may therefore be adapted as follows:

Considering information requirements to the general public, as biocides are often applied in the surroundings of human habitats, exposure of bystanders might be important. In contrast to plant protection products, the problem of residential bystander exposure to biocides also arises. This covers people exposed to the residues in the air and on surfaces in the house after biocide application. Additionally, biocides often are applied by non-professionals.

Therefore providing further information on safe use of biocides, preventive or non-chemical control measures to the general public would be a suitable instrument of sustainable use of biocides. This could be combined with programmes for awareness raising (see article 7).

The RMM guidance document for anticoagulant rodenticides already states that, when the product is being used in public areas, the areas treated must be marked during the treatment period. A notice explaining the risk of primary or secondary poisoning by the anticoagulant, as well as indicating the first aid measures to be taken in case of poisoning, must be made available alongside the bait.[45]

4.2.9 Specific measures to protect the aquatic environment and drinking water (Article 11)

The requirement of Directive 2009/128/EC, that preference should be given to products that are not dangerous for the aquatic environment when pesticides are used in the vicinity of water bodies, can immediately be transferred to the biocide sector. For example, Diflubenzuron (classified as dangerous for the environment) is the preferred active substance for oak processing moths instead of *Bacillus thuringiensis* (not dangerous for the environment), mostly for economical reasons (Anonymous, 2008).[46]

Directive 2006/118/EC on the protection of groundwater against pollution and deterioration defines Pollutant Quality Standards, among them thresholds for active substances in pesticides (plant protection products and biocides) and their relevant metabolites, degradation and reaction products: 0.1 µg/l (per single substance) and

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[45] http://ec.europa.eu/environment/biocides/pdf/anticoagulants.pdf

[46] Supply cost for the active substances Diflubenzuron is 5 EUR/ha and for Bacillus thuringiensis is 150 EUR/ha. However also other factors apply: For a successful BTI application moderate temperatures are required and it must not rain for 48 h. Additionally the survival rate of oak processing moths is higher when applying BTI (Anonymous 2008).

0.5 µg/l (total). In principle, the Water Framework Directive as well as the concept of drinking water protection zones refer to both plant protection products and biocides. The establishment of groundwater protection zones for drinking water exploitation is one example where the application of toxic substances, fertilizers, plant protection agents, etc., is restricted or forbidden in order to protect the quality of water resources.

Annex X of the Water Framework Directive 2000/60/EC (WFD) identifies priority substances for which a progressive reduction of emissions to water is intended. Among them are several biocides which a) are supported for Annex I inclusion (Isoproturon (PT 7, 9-12), Diuron (PT 7, 10), Naphthalene (PT 19); b) have been withdrawn from the review programme (Chlorpyrifos, Lindane); or c) have been identified for potential biocidal purposes but have not been notified (Endosulfan, Hexachlorocyclohexane, Pentachlorophenol, Simazine, Trichloromethane). The overlap with plant protection active substances is evident. These priority substances are included in monitoring programmes. Directive 2008/105/EC describes environmental quality standards (EQS) for these 33 priority substances / substance groups.

The process for including further priority substances in Annex X of the WFD is ongoing. Annex III of Directive 2008/105/EC indicates further substances that are subject to review for possible identification as priority substances. Among them are Dicofol, which has been identified but not notified, and “free cyanide”, which is released from the use of hydrogen cyanide (fumigant supported in the Review programme).

The Commission contracted a study on monitoring-based prioritisation of further potential priority substance candidates (James et al. 2009). From 316 substances selected as candidates for prioritisation, monitoring data were analysed and predicted no effect concentrations (PNEC values) in water, sediment and/or biota were derived. Priority was assigned according to risk ratios, i.e. PEC/PNEC. Forty-four organic substances have been selected for further evaluation. Among these are several substances which have been identified or notified as biocidal actives (see table 3)

Table 3: Biocidal candidates for selection as priority substances

Identified biocidal active substances	Notified active substances	
Malathion *, Dicofol, Phoxim, Pirimiphosmethyl *, Trichlorfon *, Fenthion, Chlorpyrifosmethyl, Methoxychlor, and Chloroacetic acid *	Permethrin *	PT 2, 3, 6, 8, 9, 18
	Cypermethrin	PT 8, 9, 18
	Deltamethrin *	PT 18
	Dichlorvos	PT 18
	Fenitrothion *	PT 18
	Diazinon *	PT 18

Those biocidal active substances which have only been identified as such, but are no longer being supported in the review programme for existing biocidal active substances, must not be marketed for biocidal use. There is, however, the possibility to reintroduce them as new active substances for evaluation. Some substances, marked with an asterisk (*) have been identified as candidates for de-selection. These need further investigation, because only limited monitoring data were available.

In addition to this research project, the European Chemicals Bureau coordinates an advisory group to the European Commission which is developing a new concept for an optimised prioritisation strategy for future ranking. For substances for which monitoring data are not available at the required quality level, a modelling-based approach to assess potential exposure needs to be implemented. Information such as overall tonnage used, proportions of this tonnage going to particular uses and emissions from these uses may be used as input to a simple partitioning model (Lepper et al. 2008).

It is expected that, as a result of all these activities, about 10-20 priority substances will be selected for inclusion in Annex X of the WFD by January 2011.[47]

As a result of the literature review of this study (Annex I), existing lists of priority substances do not specifically consider biocides and monitoring of only these substances seems not to be appropriate for identification of deficiencies in the sustainable use of biocides. Those biocides included in these lists have mainly been banned and their occurrence in the environment is due to application in the past.

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47 Personal communication Dr. Joachim Heidemeier, German Environmental Agency from 26.10.09

Conclusions:

The requirements of the Water Framework Directive, as well as the concept of drinking water protection zones, apply to both plant protection products and biocides. Additional measures might be envisaged where biocides are directly emitted to the environment, such as cooling water biocides (see 3.2.8). The identification of further priority substances and their monitoring in the environment is a prerequisite for setting environmental quality criteria (see Annex I).

4.2.10 Reduction of use or risks in specific areas (Article 12)

Similarly to plant protection products, the use of biocides should also be prohibited or restricted to the absolute minimum necessary in areas used by the general public or by sensitive populations, or in areas assigned to the conservation of wild birds, natural habitats and of wild fauna and flora. In this context, the aquatic environment and drinking water can also be regarded as sensitive areas (see Article 11). The following outdoor applications or uses have been identified in this regard:

- Wood preservatives used for fences or other construction facilities (e.g. cabins, jetties) in sensitive areas.
- Rodenticides used for open application outside of buildings. Here the protection of non-target organisms (pets and wildlife) is of major concern. Through suitable product design, like bait, environmental release of the active ingredient should be minimized.
- Cooling water biocides applied in cooling systems which discharge to water bodies within the sensitive area.
- Insecticides applied for mosquito control and against oak procession moths should be prohibited in sensitive areas (with exemptions after careful evaluation of all alternatives).
- Disinfectants and insecticides applied in stables which are released to manure storage systems may be prohibited in sensitive areas
- Antifouling agents are released during the application, use life and removal stages. Antifouling agents should only be applied if there is a really a need and should be prohibited, especially for private use, in case of an adverse risk/benefit ratio.
- Treatment of liquid manure with larvicides (insecticides) followed by manure application to soil as a fertiliser.

In addition, the disinfection of wastewater, bathing water, algaecides for water pools and aquariums (PT 2), piscicides (PT 17, not allowed in most MS) may lead to emissions to water bodies. Biocides used for general disinfection (PT 2) and water processing (PT 11, 12, 13) may also be emitted indirectly after passing through a municipal treatment plant. Surface water can be regarded as a sensitive area per se.

Many biocides are applied by private users in their homes (especially PT 1, 2, 18, 19). For biocides used indoors, the protection targets are humans and pets. Here also the problem of residential bystanders to biocides arises. Other biocides are applied in the surroundings of homes (PT 14). Therefore, private homes could be considered as a "sensitive area" from a human health view.[48]

Conclusions:

There are biocidal applications which cause direct emissions to the environment. There are examples where biocidal uses in sensitive areas should be prohibited in general (e.g. private use of antifouling agents, wood preservatives, emission of cooling water biocides). An assessment of potential measures of sustainable use for some of the most relevant applications is part of the case studies (see Annex II - IV).

4.2.11 Handling and storage of biocides and their packaging and remnants (Article 13)

The general rules for storage and transport of chemicals as described in national guidelines such as TRGS 510 should be considered.[49]

Most aspects concerning the handling and storage of pesticides and their packaging and remnants also apply to biocides.

- Use of appropriate sizes of containers to minimize remnants. Oversizing of packages should be avoided
- Restriction of the use of concentrates in order to avoid exposure during the mixing and loading stages, where the risk of spillage and leakage is increased
- Restriction of the marketing of concentrates to professional users only. Marketing of ready-to-use products to non-professional users.
- Use of water soluble packaging for preparing working solutions while avoiding direct contact and enabling accurate dosing
- The establishment of a recycling system for packaging used for biocides

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[48] Directive 2009/128/EC defines sensitive areas as Natura 2000 sites or other places such as public parks and gardens, sports and recreation grounds, school grounds and children's playgrounds, and in the close vicinity of healthcare facilities, where the risks from exposure to pesticides are high.

[49] TRGS 510 Storage of hazardous substances in non-stationary containers. October 2010 http://www.baua.de/en/Topics-from-A-to-Z/Hazardous-Substances/TRGS/TRGS-510.html

In general, the packaging size and the quantity of the product should reflect its intended use. Oversized packages should be avoided, as they are likely to result in unused biocide residues. For the general public, the size of biocidal product packages should generally be smaller than for professional applicants. For example, in Germany, the packaging sizes of wood preservatives for use by non-professionals have been limited to 750 ml in a voluntarily negotiated agreement with the industry.[50]

The use of concentrates by non-professionals should be avoided in order to avoid exposure at the mixing and loading stage. Thus, the marketing of “ready-for-use” biocidal products should be given preference. The Inclusion Directives for most rodenticides limit the concentration in order to prevent (or at least reduce the risk of) poisoning of pets and other non-target organisms.

The use of water soluble packaging has been suggested for some biocide applications such as swimming pools, toilet tanks and recirculating water cooling systems[51]. There are a few biocidal products, especially wood preservatives, on the market which use water soluble packages. These systems allow preparation of working solutions from sealed concentrates.

In Germany, the responsibility of the supplier for the collection of packing and remnants of biocides is only applied to larger packages, such containers for antifouling agents or wood preservatives. Here, Directive 1999/13/EC on volatile organic compounds (solvents) has provided the legislative basis for these re-collection systems (workshop protocol “sustainable use of biocides”, Berlin, 25.2.2010).

For most biocidal products, residues should be collected by municipal collection systems for hazardous substances. The question of whether empty packages should be separately collected depends on the contamination of the packaging and the active substances used. For some applications, such as large barrels of wood

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[50] http://www.holzfragen.de/seiten/pop_biozide.html

[51] http://www.patentstorm.us/patents/5851406/description.html

preservatives, the packages might be returned to the supplier, following the example of plant protection products.[52]

Conclusions:

The disposal of product residues and packages by municipal collection systems for hazardous substances should be facilitated/promoted. For some applications, the packages might be returned to the supplier, following the example of plant protection products. Due to the broader range of possible applications of biocides compared to plant protection products it is, however, questionable whether suitable collection systems could be established.

4.2.12 Integrated Pest Management (Article 14)

Good practices in biocide application include the identification of a need (problem analysis, identification of pests and their threshold), the examination of potential measures to control pests and the consideration of preventive and/or non-biocidal measures. All these elements are part of IPM as applied in the plant protection area.

IPM is a decision making process which uses principles, practices and procedures applied to improve pest-control outcomes. While non-integrated pest control measures are primarily aimed at simply killing pests, the objective of IPM is also to eliminate the source of pest problems. In the WHO book on ”Public health significance of urban pests” (Bonnefoy et al. 2008) one chapter deals exclusively with IPM in general and specific principles are described for each pest. IPM principles were first developed to control agricultural pests but are increasingly used for general pest control. IPM integrates knowledge of pest biology, the environment and available technology including the use of biocides. The WHO book follows the definition of the US National Pest Management Association (NPMA, http://www.pestworld.org/) on IPM, in which five steps are specified:

1. Inspection (determine whether a current or potential pest exists at a specific location)

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[52] Since 1996 used packaging of plant protection products are collected and incinerated in cement kiln on an initiative of the German Crop Protection, Pest Control and Fertilizer Association (IVA, see http://www.pamira.de/).

2. Identification (accurate identification of pests and conditions that can support pests present at a specific site)
3. Establishment of threshold levels (establishing site-specific pest-population level that can be tolerated)
4. Employment of two or more appropriate control measures (design and implementation of an IPM programme necessary to suppress pest infestation while considering all practical, reasonable and effective control measures)
5. Evaluation of effectiveness (determination whether the IPM plan was implemented as designed and whether the objectives of the plan, pest reduction, were attained).

IPM considers pest biology and behaviour as well as the specifics of the environmental living conditions required by the pest. Table 4 shows the ways in which IPM differs from conventional pest control.

Table 4: Differences between IPM and non-integrated pest control

Pest management programme components	**Non-integrated pest control**	**IPM**
Programme strategy	Reactive	Preventive
Customer education	Minimal	Extensive
Potential liability	High	Low
Emphasis	Routine pesticide application	Pesticides used when exclusion, sanitation and other means are inadequate
Inspection and monitoring	Minimal	Extensive
Use of non-chemical controls	Minimal	Extensive
Positive identification of pests	Sometimes	Required
Use of pest thresholds	Minimal	Extensive
Outcome evaluation	Sometimes	Required

Source: WHO 2009

In addition to general IPM, principles the WHO (2009) presents several examples of IPM measures for specific pests.

Example: IPM measures against cockroaches (summary):
Cockroach infestations can result in serious contamination of food and have been shown to transfer disease pathogens. In addition, cockroaches can cause allergic reactions. Hence, cockroaches in dwellings and food processing areas need to be controlled. Originating from Africa, they are now cosmopolitan pests. Conventional treatment consists of the preventive and reactive application of insecticides with sprays and dust. Basic IPM programmes to control cockroaches were initiated in the 1980s. By applying IPM, the amount of insecticides can be reduced by 90 percent compared to conventional treatments. Removal of debris, harbourage sites and food sources is an element in integrated cockroach control programmes. The species should be identified and the location infested needs to be properly inspected. One main potential for reducing the amount of insecticides applied is to identify areas that do not need to be treated. Careful monitoring with cockroach traps using attractants or pheromones is used for determining the level of infestation. But traps alone do not effectively control cockroaches, particularly German cockroaches (*Blattella germanica*). Application of bait will result in reduction of cockroach numbers. Indeed the development of baits has revolutionized cockroach control, especially in the control of the German cockroach. Alternative strategies consist of non-chemical treatment by applying heat. Most household insect pests are extremely sensitive to high temperatures. At 52ºC, a 30-minute exposure kills 100% of adult male German cockroaches. In field studies, it was possible to control German cockroaches by heating food handling areas in buildings to 46ºC for 45 minutes.

Although IPM of biocides focuses on pest control of rodents and insects, the principles can also be applied to other biocide applications.

The COWI-study on the use phase of biocides refers to the study "Description of the appropriate use and good practice (GP) during the use and disposal of biocidal products". Here, a uniform structure is proposed illustrating which items reference documents could include (Gartiser et al. 2005). Table 5 shows a comparison between elements of good practice and IPM.

Table 5: Comparison of good practice and integrated pest management

Good Practice (German study)	Integrated pest management (NPMA)
1. General principles and goals of the GP	
2. Description of the area of application	
3. Determination of the need for a biocides application (problem analysis, definition of the goal)	Inspection (determine whether a current or potential pest exists at a specific location) Establishment of threshold levels (establishing site-specific pest-population level that can be tolerated)
4. Examination of the measures and decision making	Identification (accurately identification of pests and conditions that can support pests present at a specific site)

Good Practice (German study)	Integrated pest management (NPMA)
5. Preventative, non-biocidal measures	Employment of two or more appropriate control measures (design and implementation of an IPM programme necessary to suppress pest infestation while considering all practical, reasonable and effective control measures).
6. Proper use of biocidal products: 6.1 Selection of low-risk products 6.2 Minimising the amount of biocide used 6.3 Licensing of equipment 6.4 Applying risk management measures 6.5 Controlling of success 6.6 Waste disposal	 Evaluation of effectiveness
7. Documentation	Determination whether the IPM plan was implemented as designed and whether the objective of the plan, pest reduction, was attained.
8. Storage and transport	

NPMA: US National Pest Management Association ()

The qualification of the user (education and training, professional certification) as well as the communication of hazards and risks was considered of decisive importance as a supporting measure for the realisation of and compliance with GP, but was not regarded as being part of the GP.[53] The study concluded that the GP reference document cannot do without references to legislation or other regulating documents, such as DIN-standards or information sheets from professional associations, in which the basic information is given. Indeed, CEPA intends to develop common criteria by participating in the work of CEN (European Committee for Standardisation).

The GP-structure reflects several elements of IPM principles, such as the problem analysis and decision making process, the consideration of preventive and non-biocidal measures as well as the determination of success and documentation. The application of the biocidal product and related measures to protect users and the environment from exposure is not a main focus in the IPM strategy of the US National Pest Management Association.

[53] However, qualification of users and communication are part of sustainable use of biocides.

The IPM principles proposed for sustainable use of pesticides include further provisions, namely the routine monitoring of harmful organisms, the preference for non-chemical methods, the application of anti-resistance strategies and the reduction of use to the minimum necessary (see 2.2.10).

One aim of the Thematic Strategy on pesticides is to establish expert groups to facilitate information exchange of best practices in the field of sustainable use of pesticides and IPM at a Community level (Article 18 of Directive 2009/128/EC). This could easily be adopted to cover biocides application.

Conclusions:

While some elements of IPM principles for plant protection, such as crop rotation, use of adequate cultivation techniques, use of resistant/tolerant cultivars and use of balanced fertilisation refer to good agricultural practice, most of the IPM-principles described above seem also to be applicable for biocides. Development and promotion of IPM guidance for pest control is considered one of the most promising instruments for the sustainable use of biocides.

4.2.13 Indicators

Data on the quantities of biocidal active substances and products produced or sold are not available. According to Annex II A, point 5.8 of the BPD, industry should provide data on the likely tonnage to be placed on the market. Although the evaluation of these data in the COWI study revealed very useful information about the biocide market, the figures are too aggregated to allow for an interpretation of use patterns. Regulation (EC) No 1185/2009 on statistics on plant protection products does not consider biocides, but indicates that the scope may be expanded at a later stage so as to include biocides.

Although, according to the Commission, tonnage data are considered as being confidential and the generation of such data as being costly, data on production, use pattern, typical applications and consumption would be very useful for assessing the risk associated with the use of biocides. Considering the progress of REACH and the Thematic Strategy of pesticides, there is a concern that biocides would be behind other chemical groups with respect to the availability of quantitative use data in the near future.

For substances for which no monitoring data are available, a modelling-based approach to assess potential exposure needs to be implemented for selecting priority substances in water policy. Information such as the overall tonnage used, the proportion of this tonnage going to particular uses and emissions from these uses may be utilized as input parameters (Lepper et al. 2008). The establishment of maximum residue levels (MRL) for residues of active substances in food or feed and their surveillance are further indicators on the sustainable use of biocides. It is expected that the development of MRLs will be relevant[54] for active substances used in PT 3, 4, 5, 18, 19 and 20.

Conclusion:

The inclusion of biocides into the scope of the Regulation on statistics on plant protection products is recommended, in order to obtain the data bases urgently needed for the development of suitable indicators. Other indicators already implemented at a national level (e.g. monitoring in environmental media, food, and feed, survey of poisoning cases) should be harmonised at EU level.

4.2.14 Additional national measures

In the following, possible additional measures are described. They are already implemented in certain MS. These measures are not directly addressed by the Thematic Strategy and therefore can be regarded as additional measures. The information is extracted from the COWI study, Annex 2 which summarises the replies of MS to the Commissions questionnaire on measures on the use phase of biocides. Further information was obtained through a short survey to the European Network for the Durable Exploitation of Crop Protection Strategies (ENDURE)[55] initiated by Dr. Hommel from the Julius Kühn-Institute.

Restriction of use, restriction of substances:

The restriction of use to certain user groups, e.g. professional users, is not explicitly mentioned in the Thematic Strategy as it is the subject of the authorisation process. Therefore, it is left open to MS to implement additional national restrictions.

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54 Establishment of maximum residue levels for residues of active substances contained in biocidal products, CA-Sept09-Doc.3.4a

55 http://www.endure-network.eu/endure_publications

Restrictions on the use of certain biocides with regard to specific areas is already part of Articles 11 and 12 and a general restriction for consumers to use very toxic, toxic, and CMR products Cat. 1 and 2 is found in several MS.

In several MS, among them e.g. Belgium, Hungary, the use of certain products is restricted to certified users as an additional risk reduction measure, especially for PT 14, PT 18, and PT 19. Lithuania also restricts the use of PT 2. France also restricts the use to professional users of products from PT 3 and PT 18 with regard to BSE and mosquito control. Slovenia also restricts the use of biocides from PT 5 if there are any risks for certain users. In Denmark, rodenticides are only authorised for professional use and there exist obligatory training/certification schemes for applicants.

On the contrary, Hungary for example only restricts the place of use (nature conservation areas) and specific products, but not complete PTs.

Taxes on sales of biocides:

In Denmark there is a biocide tax of 3% on most products and of 35% for insecticides (as for plant protection insecticides). So far, the tax only relates to the 6 PTs for which an authorisation system had been established before the BPD.

In Belgium, the Programme for the Reduction of Pesticides and Biocides (PRPB) is financed by general contributions from the chemical industry, through the fund for raw materials and products. The contribution is proportionate to the inherent risk of the product and its sales in Belgium. The inherent risk is determined on the basis of a score that is assigned to the various risk sentences on the product labels.[56]

Indicators and statistics:

Data collection is carried out in several MS but there is no harmonisation of the type of data to be collected. Information on biocides can cover data on manufacture, sales and use but also information on poisoning cases or the number of professional users, or specific areas where the use is restricted.

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[56] http://www.health.belgium.be/eportal/Environment/Chemicalsubstances/PRPB/index.htm

For example, in Finland retailers, distributers and producers have to provide data to the national authorities (STTV, SYKE) on biocidal products yearly. The data covers information on production, import/export and sales. Romania also collects data on import and export volumes, as well as on sales, general use, professional and non-professional use. Spain, Belgium Slovenia and Sweden collect data on sales of some active substances from specific product types (mainly PT 8, 14, 18) or with specific properties (toxic and very toxic, CMR) according to the COWI-study. As well as statistics on manufacture and sale of biocides, some MS (e.g. Hungary) also collect data on the number of certified professional users.

In Denmark the sales of both pesticides and biocides under the old authorisation system (PT 8, 12, 14, 18, 19, and algaecides) are reported in terms of active substances as well as of formulated products.[57]

In some MS, data on poisoning cases are collected but a harmonised method of collection is lacking. France suggested the harmonisation of poisoning control systems, for human as well as for animals and bio-monitoring to allow some exchange and comparison at EU level.

The COWI questionnaire also included questions regarding additional measures to reduce risks, where some MS gave their ideas.

France suggested working further on the mixing of biocidal products, on the cumulative use of biocidal products with or without the same active substance and on the management of resistance. Furthermore, the development of Emission Scenario Documents for “orphan” Product Types is mentioned as a measure to increase knowledge on uses and harmonisation.

Germany suggested to focus more on releases into the environment due to various types of use, e.g. as PPP, biocide, building material or release resulting from treated materials. The latter could also be subject to regulation.

Italy proposed to promote research and investigation activities on sanitary and environmental impacts of biocides. Further, a local control system and reporting of

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57 http://www.mst.dk/Virksomhed_og_myndighed/Bekaempelsesmidler/Pesticider/pesticidstatistik/Landbrug/

uses should be mandatory. For assessing food chain contamination, studies and sampling of predators near treated zones are proposed.

The additional measures of a general quantitative use reduction and the introduction of taxes/levies as described for PPP are not mentioned in the questionnaires from any of the MS.

Conclusion:

The measures which are already included in the Thematic Strategy cover a broad range, but also leave room for additional national provisions.

5 Implementation of provisions for sustainable use of biocides

In an impact assessment concerning the revision of the BPD, a preliminary analysis of options to address sustainable use of biocides and the advantages and disadvantages of each option was carried out (Vernon et al., 2008). The following options were considered:

1. No action at present;
2. Include some biocides (pest control agents) in the Directive on Sustainable Use of Pesticides;
3. Include provisions on safe and sustainable use in the BPD; and
4. Create an independent framework on the safe and sustainable use of biocides.

The main advantages and disadvantages of the different options were described as follows:

No action at present	Include pest control biocides in the Directive on Sustainable Use of Pesticides	Include provisions on use in the BPD	Develop specific framework legislation on biocides
advantages			
No changes but some cost savings through no taking action.	Would strengthen the development of national plans for safe use of all pest control agents.	Would strengthen the development of national plans for safe use of all biocidal products.	All measurers proposed can be discussed in detail with all stakeholders. Harmonisation of national action plans within Europe. Thematic strategy for the use of biocides could be linked with product-type overlapping. Development of use-specific, technical rules
Disadvantages			
Public pressure to establish rules for sustainable use might cause that individual member states develop own national actions which hinders harmonisation and mutual recognition. Risks to human health and the environment during the phase are not adequately	No major changes but potentially some costs associated with training of professional users. Further discussion on the proposal on a pesticide Thematic Strategy would be required. Differing mode of application and exposure of most biocides compared to	No major changes but potentially some costs associated with training of professional users. Experienced staff needed to develop measures on safe use for all biocidal products. General statements on safe use may not be detailed enough.	Developing the framework takes time and effort. Long range process which delays measures becoming effective. Specific measures on safe use at MS level might hinder mutual recognition of product authorisation. However, considering safe use of biocides,

addressed.	pesticides require different considerations Development of the thematic strategy could be delayed.	Specific measures on safe use at MS level might hinder mutual recognition of product authorisation. However, considering safe use of biocides, trade issues are only of secondary nature in these circumstances.	trade issues are only of secondary nature in these circumstances.

Source: Vernon et al. (2008)

This analysis was not developed further in the next stages of the project because the Commission initiated the COWI study (COWI 2009, see chapter 4.1.1).

At the Bonn workshop on the Revision of the BPD in April 2008, most participants objected to inclusion of pest control biocides within the Thematic Strategy for pesticides, because the differing mode of application and exposure of most biocides compared to pesticides would need different considerations. Producers, formulators, and regulatory consultants also confirmed that, even when the same active substances are used in both plant protection products and biocidal products, the mode of application, the formulation and exposure of respective products differ considerably. In addition, veterinary pharmaceuticals (directly applied to the skin of the animal) and biocides (used for the surroundings of the animals) usually have different formulations. There was a broad agreement that a better description of IPM and good practice standards are necessary at EU level. Some participants welcomed a new framework directive on the use phase; others considered the use phase to be covered already by Article 20 in the BPD (BMU 2008).

On 23 April 2008 the Commission organised an expert workshop on environmental and human health impacts of biocides.[58] The participants identified a need for more data on the quantities of biocidal products (e.g. sales, consumption, and use) so that general trends can be identified. Some participants considered that, before the impacts of the Biocides Directive are known though the implementation of the authorisation stage, it is premature to assess whether further actions on sustainable use might be necessary. Specific issues of concern identified were wildlife impacts, levels and impacts of anti-fouling agents in fresh water and anti-microbial resistance. In addition, there was concern about the lack of incentives for low risk products,

58 http://ec.europa.eu/environment/biocides/sust_use.htm

which are being lost from the market but could substitute those with higher risks. The promotion of low risk products could represent a part of the sustainable use strategy. It was noted that various training and/or certification schemes exist in many Member States for some product types and that there is a need for a minimum level of best practice harmonisation with regard to training requirements, at least for some PTs. There was a consensus that there is a need for a reporting obligation for Member States aimed at gathering data on the use of biocidal products.[59]

On 25 February 2010 a national workshop on sustainable use of biocides took place at the German Environmental Agency in Berlin with 30 participants from authorities, scientific institutes, NGOs and industry. Most experts agreed that provisions supporting the sustainable use of biocides would be useful. Here it became apparent that users of the biocidal products would prefer a separate Thematic Strategy for sustainable use of biocides, while the federal authorities favoured integration into the existing Thematic Strategy for pesticides. Some representatives of the federal states authorities suggested integrating aspects of sustainable use into the existing BPD (or future Regulation on biocidal products) without establishing a new framework directive (see 7.1).

Several RMM are currently being discussed by competent authorities (CAs). For example, the use of personal protective equipment (PPE) for reducing exposure and ensuring the safe use of the product are not considered acceptable for non-professional users.[60] While a few Member States completely forbid the spraying of wood preservatives by amateur users, most CAs suggest that spraying by non professional users should not be allowed if the exposure resulted in the need to use PPE.[61] It has also been proposed to restrict the use of anticoagulant rodenticides to professionals for resistance control, because many of them are classified as potential PBT/vPvB substances and have a high risk of primary and secondary poisoning for wildlife (birds and non-target mammals). However, at CA level this proposal was not accepted as an appropriate measure, considering the drawbacks for rodent control. In the inclusion Directives of these substances, the nominal concentration of the

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59 http://ec.europa.eu/environment/biocides/pdf/conclusions_workshop230408.pdf

60 Use of Personal Protective Equipment. 27th CA meeting, CA-May08-Doc.6.2

61 Spraying method of wood preservatives for amateur users. 26th CA meeting, CA-Sept07-Doc.5.3 – Final RISK MITIGATION MEASURES FOR ANTICOAGULANTS USED AS RODENTICIDES. CA-March07-Doc.6.3 final – revised after 25th CA meeting

active substance, the mode of application (no tracking powder, use of ready to use baits/ bait boxes etc.), and setting an upper limit to the package size have been described as suitable measures. Additionally, the restriction of products to specific areas (in and around buildings) and also restrictions of products to professionals or trained professionals only, should be considered in the framework of the national authorisation of rodenticidal biocidal products.

6 Summary of case studies on sustainable use of biocides

Chapter 6 gives a short summary of the results of the case studies documented in detail in Annex II, III, and IV.

6.1 Wood preservatives

Wood preservatives are used for both preventive and curative treatments of wood against insects or fungi. Preventive treatments are usually applied to wood at industrial treatment plants before the wood is put into service, whereas curative treatments are mostly applied to wood in-situ by professionals or amateurs. According to OECD (2003), in Germany about 95% of wood preservatives are applied in preventive treatment and about 5% in curative treatment. With regard to the mode of application, two principle different treatment techniques may be distinguished; namely deep penetrating and surface treatments. Deep penetrating treatments like vacuum-pressure or double vacuum are exclusively applied to wood in industrial treatment plants for preventive purposes. Surface treatments like spraying, dipping or brushing are applied both for preventive and curative purposes in all use sectors, i.e. industrial, professional and amateur users.

Emissions of wood preservatives and resulting exposure of the environment may occur during the application phase as well as during the storage and the service life of treated products. The route and degree of emission depend very much on the mode of application, the storage conditions of the treated wood and the use class. Whereas emissions to the environment are quite low for deep penetrating treatment techniques, surface treatments which are often performed in-situ (i.e. outdoors) may result in significant emissions. Leaching of wood preservatives during the storage of treated wood before use can be prevented efficiently by storing the treated wood in roof-covered and paved (= impermeable) areas. For most preserved wood, significant losses to the environment take place during the service life phase which can be very long (up to 50 years). With regard to the service life, five different use classes are distinguished which vary in terms of the exposure of the treated wood to the weather and the level of contact with ground or water.

Up to December 2010, 18 active substances of PT 8 have been included in Annex I or IA to Directive 98/8/EC. In the Inclusion Directives of these active substances, different risk mitigation measures are described which shall be considered during the authorisation of biocidal products containing theses active substances. The case study (see Annex II) shows that the measures proposed within Directive 2009/128/EC can in principle be transferred to biocides in order to promote the sustainable use of wood preservatives, but some adaptations are required. The service life stage has a specific importance both for human health and environmental risks. Indoor use of wood preservatives can be omitted by applying preventive constructional measures, such as covering the wood against insect infestations or open construction enabling visual control of the wood. As a general rule, habitable rooms with normal interior climate and protected from moisture do not need to be protected against wood fungi. Several RMM have been described in the Inclusion Directives and Assessment Reports / CARs for the active substances, among them restrictions to professional or industrial uses only, top coating for reducing leaching, storage of treated wood under cover and avoiding discharges to the sewer and surface water. To protect the aquatic (and the terrestrial) environment, the use of treated wood near water bodies or in protected areas could be restricted. There are training courses for the qualification and certification of professional users on a voluntary basis which could be made obligatory. Limitation of self-service systems (open shelves), including internet commerce, would be another option for improving advice on proper use given to consumers by qualified distributors. The equipment for industrial wood impregnation is partly subject to the Pressure Equipment Directive (97/23/EC) and the Machinery Directive 2006/42/EC, but a harmonisation of EU standards for all treatment processes (pressure and non-pressure treatment) is lacking. The development and harmonisation of Best Practice standards for wood impregnation would further support the sustainable use of wood preservatives.

Most wood preservatives will be authorised for specific use classes, depending on the subsequent situation of the wood (under cover, exposed to wetting, contact to soil etc.). The consequent labelling of treated wood, as envisaged in the current draft Biocides Regulation, is a prerequisite for preventing misuse, including the incineration of wood treated with wood preservatives.

6.2 Insecticides and products to control other arthropods

PT 18 refers to insecticides, acaricides and products to control other arthropods, but is often named “insecticides” for practical reasons. The respective biocidal products have a very wide use pattern and are used by specialised/trained professionals (e.g. pest controllers), professionals (e.g. farmers, cleaners), and consumers/private users. About 59 active substances are currently supported under the BPD, mainly pyrethroids. Many active substances among the organophosphates have been withdrawn, because of their risks, but a few (e.g. Dichlorvos) are available. Emissions to the environment mainly occur from cleaning and decontamination after indoor applications (mainly via sewage treatment plants), from releases of fumigants to the air, and from spreading of manure containing larvicides to soil. For mosquito control large scale aerial spraying/trickling is also performed, mainly with *Bacillus thuringiensis* toxins. The efficiency and proportionality of some indoor applications by consumers has been questioned and the promotion of risk awareness among consumers though public information campaigns is a promising tool. The possible development of resistance in the target organisms requires expert knowledge and training and certification of professional users is the most promising instrument supporting sustainable use. Similar to plant protection products, the application of IPM principles is a prerequisite and should be further developed by harmonisation of best practice standards. Numerous guidance documents on best practice describe appropriate use of insecticides and IPM principles. A European standard describing minimum requirements for professional pest control services is under development (CEPA activity).

Most instruments referred to in Directive 2009/128/EC on sustainable use of pesticides can be transferred to the biocidal insecticides, but some adaptations are required. In particular, indoor use of insecticides, which can be regarded as a “sensitive area” per se, needs special attention.

Several RMM for indoor use of insecticides have been proposed, such as their use in cracks and crevices or in concealed locations inaccessible to man and domestic animals to avoid secondary exposure. Other RMM concern the restriction of use in animal housings to those without a connection to the sewer system or direct release to surface water.

Self service purchase of insecticides from open shelves and through the internet could be restricted, especially for consumers, in the same way as it has already been implemented for plant protection products in Germany. Here, self-service purchase is prohibited, irrespective of the product’s classification.

6.3 Antifouling products

The case study on antifouling products (see Annex IV)) showed that the majority of antifouling products - about 95% of global demand - is used for protecting ship hulls from unwanted growth and settlement of fouling organisms e.g. bacteria, algae, and crustaceans. Currently, 10 substances are included in the review programme for the evaluation of existing biocidal active substances. The ban on organotin compounds by the International Convention on the Control of Harmful Antifouling Systems on Ships, developed by the International Maritime Convention Organisation (IMO), will end the use of organotin based antifouling products globally. Currently, biocide free alternatives like low-friction and ultra-smooth surfaces (e.g. coatings with nanoparticles, silicone, polytetrafluoroethylene) that inhibit the attachment of fouling organisms are available but still under further development, because of drawbacks in their use and application.

Two pathways are relevant to emissions of antifouling biocides from ship hulls into the environment: the use phase during service life and operations during application, maintenance & repair. It is estimated that 1/3 – 2/3 of the applied paint is released to the water during service life as an intended function of the antifouling paint. Negative effects arising from the inherent substance properties can be partly addressed in the authorisation process, by demanding risk reduction measures and specific restrictions on defined user groups. For example, criteria for the leaching rate of a biocide, the efficiency of a product and the risk assessment of metabolites could be defined and evaluated during the authorization procedure. In the frame of a Thematic Strategy, the focus could be on the promotion of low-risk products and biocide free alternatives.

Compared to the service life stage the phase of application, maintenance & repair leads to lower emissions into the environment but could be influenced by measures proposed within the Framework Directive 2009/128/EC. The case study shows that in principle some of the measures proposed there can be transferred to antifouling products. The main issues covered in a Thematic Strategy could be: a mandatory training programme for professional users who are involved in the application of antifouling products and the further development and implementation of “Best Practice” approaches that are already partly available. Also, harmonised EU standards on technical-organisationally measures (e.g. automatic spraying techniques, mixing) could be further developed. The scope of the Directive on Machinery 2006/42/EC to consider equipment for the application of pesticides could also be extended.

For non-professional users, awareness raising programmes seem most promising to contribute to sustainable use of biocides. Such programmes should inform about biocide free alternatives and, in case biocides cannot be avoided, which would be the less risky ones. In this context, a restriction for the sale of dangerous products through the internet or catalogues to amateurs could also be established.

Specific requirements e.g. hard ground, shrouding, waste water collection systems with filtering, waste equipment collection sites for marinas where application, maintenance & repair is allowed could be made mandatory within the framework of a Thematic Strategy. Also, the promotion of ecolabelled marinas could be supported to expand awareness.

To reduce emissions of antifouling biocides in sensitive areas e.g. lakes, coastal water bodies, the use of antifouling products could also be banned within the framework Directive.

The definition of harmonised indicators and the protection of non-target organisms from antifoulings and their metabolites are other important issues that could be addressed by a Thematic Strategy.

7 Summary of national workshops

7.1 Workshop on measures of sustainable use of biocides

On February 25th 2010 a national workshop on sustainable use of biocides took place at the German Environmental Agency in Berlin. Around 30 national experts participated. The objective of the workshop was to reflect the results of the study so far, to adjust the focus of the remaining work and to define the focus of the second workshop.

Most participants agreed that provisions for supporting the sustainable use of biocides would be useful. Plant protection products and biocides often contain the same active substances. Therefore, the approach followed in the project, to analyse the transferability of the measures of Directive 2009/128/EC to the biocide area and to add biocide-specific aspects, was considered a promising strategy. Some of the authorities involved in the sustainable use of plant protection products (Julius Kühn Institute) noted that the clear objectives of the Thematic Strategy were defined before the adoption of the Directive 2009/128/EC. First, the impacts of plant protection agents were identified (residues in food, in water) that were not addressed in the authorisation procedure. Only afterwards were measures taken to achieve the goals. Therefore, the question arises which are the main problems in the biocide area. The other participants stated that the poor availability of data (including consumption and monitoring data on biocides) hinders a definition of the objectives. Moreover, the interpretation of the limited data is difficult because the active substances of many biocides are also used for other purposes, such as plant protection products. One objective of a sustainable use strategy for biocides could therefore consist of improving the data bases.

Representatives of the pest control industry questioned the use of the term "sustainability" in this context. It was reported that pest controllers, when asked "What do you understand by the sustainable use of biocides" referred to “application of persistent active substances” and “repeated treatment”. It was therefore proposed to delete the term "sustainable" and speak only of "biocide use". The meaning of sustainability could be defined in a separate article. It was also discussed how the "minimum necessary" is to be defined. The Biocidal Products Directive requires in

Article 3 (7) that biocides should be properly used, whereby “the use of biocidal products is limited to the minimum necessary”. A quantifiable interpretation of this article is difficult because of the diversity of product types and use patterns. It should be taken into account that biocides are used for preventing infectious diseases or preserving materials and processes. Thus, one aspect of sustainable use is that sufficient active substances are available to counter the risk of resistance by frequent use and larger quantities of single biocides. It was discussed which aspects of sustainability could be considered in product authorisation, for example, in the form of RMM. Additionally, industry was worried about the impact of setting measures for sustainability after product authorisation such as use or sales restrictions.

With regard to the question of whether measures on sustainable use of biocides should be implemented by a specific directive on the sustainable use of biocides or should be included in existing policy, the following trends became apparent:

- Users of biocidal products preferred a separate Thematic Strategy for sustainable use of biocides. According to the users, national action plans for the sustainable use of plant protection products are not transferable to biocides, since there are too many differences from biocides. A flexible separate framework directive therefore seems appropriate to address sustainable use of biocides.

- The federal authorities (Bundesländer) favoured integration into the existing Thematic Strategy for pesticides. One advantage would be that any measures would be implemented faster than within a new Thematic Strategy. A specific timetable for including biocides into the existing Thematic Strategy should be included in the ongoing revision process of the Biocidal Products Directive.

- Some representatives of the federal states authorities suggested integrating aspects of sustainable use into the existing BPD (or future Regulation on biocidal products) without establishing a new framework directive.

There was agreement among participants that there is a need to prioritise measures and product types to be considered within a strategy on sustainable use of biocides. Here, the application forms (spray, bait), the application areas (indoor, outdoor) and the user category (professional, occupational, private) should be differentiated. The benefit of biocides on human health and material protection should by all means be considered when measures for sustainable use are discussed.

On the part of the chemical industry it was noted that Germany is quite well established when considering sustainable use of biocides, because there are already several regulations. The focus now is to start the authorisation procedure for biocidal products, thus new requirements for sustainable use are not acceptable for medium-sized companies. Because there are few monitoring data available for biocides - in contrast to plant protection products – it is too early to define measures, because it is not clear where the main problems lie.

In contrast, the authorities argued that while the BPD only governs the authorisation of biocidal products, the Thematic Strategy on sustainable use of pesticides concerns to the applicants of biocides and not the chemical industry. Sustainable use of biocides does not focus on individual products but considers more fundamental aspects such as how to decide whether and which application should be carried out. This does not depend on the authorisation of biocidal products but refers to the decision making of users. In fact, with respect to sustainable use of biocides, Germany is well positioned in many areas. But this was also true for plant protection products before the adoption of the Directive 2009/128/EC on the sustainable use pesticides. Nevertheless, the framework Directive is seen as progress, because the EU dimension is also taken into account. The existing structures and arrangements for sustainable use of biocides could be included in a national action plan.

7.2 Workshop on objectives of sustainable use of biocides

On February 2nd and 3rd 2011 a two-day-workshop was organised with different German authorities involved in the approval and surveillance of biocidal products. While the federal competent authorities are responsible for the authorisation process for active substances and biocidal products, market surveillance of biocidal products is carried out by the federal states (Bundesländer). The objectives of the workshop were to discuss open questions and the advantages/disadvantages of different options for implementing measures on the sustainable use of biocides. The workshop was aimed at supporting the development of a national position on sustainable use of biocides. In five sessions the identified impacts of biocides, the objectives of sustainable use, apparent conflicts in the protection goals, existing deficits in national legislation, and the different political options have been discussed.

According to the federal states, the surveillance of biocidal products on the market is difficult because there is little information on the application patterns of biocides. Surveillance of the proper use of biocides by private or non-trained professional users is difficult or even impossible. Only for specialised/trained professional users such as pest controllers can some inspections be carried out by local authorities. For consumers, no enforcement possibilities exist.

During market surveillance there still arise difficulties with the attribution of the product type and the differentiation from plant protection or medicinal products (dual use). The German register of existing biocidal products is not supervised because no national authorisation of biocidal products was previously in place. A positive list of biocidal products would facilitate their surveillance. However, this will improve with the implementation of the BPD. It seems that some professional applicants prepare their own biocides for immediate use without intending an authorisation, arguing that these are not placed on the market. It was suggested that all these conflicting cases and the respective decisions of authorities should be collected and made available to the authorities. In future, the authorities involved in market surveillance demand to be better informed concerning the actual decisions at the EU level (e.g. the manual of decisions, up to date biocidal substance and product lists).

The main objectives of sustainable use of biocides are the protection of the environment, especially of water bodies and soil, the preservation of biodiversity, the minimisation of hazards to human health and the avoidance of resistance development. The primary objectives of sustainable use should be to reduce risks. A reduction of the amount of biocides consumed is not the best indicator for sustainable use but could easily be calculated. The Framework Directive encourages MS to set quantitative objectives in their NAP, among them the amount of biocides used.

Obviously there are conflicts between the objectives of sustainable use (e.g. infection control through application of biocides might affect the environment; biodiversity in rain forests is endangered when durable tropical wood replaces wood from temperate latitudes protected with wood preservatives). The question is how to define and indicate a conflict of the objectives and which criteria should be applied for its quantification. Should conflicts of objectives be referred to as single cases (regional scale) or should these also be addressed on a global scale?

A distinction between individual and social, as well as of subjective and objective conflicts between objectives is required. Which objectives should have a greater emphasis? Has human health a greater importance than the environment and the environment a greater importance than costs?

A common approach to considering conflicts between the objectives in the biocide area is missing.

Biocides are often applied in the area of renewable raw materials such as wood and wool. A restriction for consumer use might cause consumers to use other materials for these purposes, such as plastic, concrete or aluminium, which might not be desirable in terms of sustainability. The labelling of materials treated with biocides, as foreseen in the future Biocides Regulation, is an important tool for consumers to have a sound basis for their purchasing decisions.

The issue of marketing statements which could encourage unnecessary use of biocides has also been discussed. As well as misleading labelling of biocidal products in respect of the risks to human health and the environment (which is not allowed according to Article 22 of the BPD), misleading statements on the reliability and proportionality of the applications proposed should also be considered. Article 62 of the draft Biocides Regulation will also prohibit misleading statements in respect of the efficacy of a biocidal product, but this only covers one part of reasonable use.

Preventive and alternative measures, such as constructional wood protection, may avoid conflicts between the objectives. Thus, alternatives should also be considered when weighting the objectives.

The main instruments for improving sustainable use mentioned at the workshop are improvement of education and training, advisory services and the quality of product information such as technical leaflets. Further on, the development of best practice documents for integrated pest control has been suggested. The risk awareness of the user is a very important issue. Sales restrictions via control of internet commerce and of self-service purchase of biocides have been referred to in this context. Low risk biocides as well as non-biocidal alternatives should be marketed with corresponding advertisement statements.

A general prohibition on consumer use of biocides was not considered appropriate but certain restrictions may be required. This should distinguish between reasonable and less reasonable applications of biocides. The need for and proportionality of biocide use should be considered (e.g. home disinfectants only to be applied in the presence of persons susceptible to infections but not for general disinfection purposes). The US EPA and OECD require that any pesticide must have a proven benefit. If there is no benefit, the pesticide is not needed.

Sound advisory services for consumers offered by the distributors would be helpful. Further restrictions of self-service purchase of biocides, as are already in place for plant protection products, could be envisaged.

With reference to the minimisation of biocides in sensitive areas, some examples such as the restriction of antifouling agents at the Lake Constance show that these restrictions are enforceable if supported by society.

With respect to the different options for implementing measures on sustainable use of biocides, it became clear that no short term solutions are foreseeable at the European level. The different approaches followed by MS demonstrate that harmonisation is required. Some MS such as Belgium have considered biocides in their NAP for sustainable use of pesticides. There is a need to distinguish which measures can be implemented at European level and which should be implemented on a national scale. The first risk reduction plan for plant protection products in Germany was outlined before the European Directive came into force. A survey of the experience and strategies of how other MS include biocides in their NAP should be carried out.

A prioritisation of product types on which implementation of measures on sustainable use should be focused has also been suggested. Different measures will probably be required for each PT. Further on, the different information requirements of the user groups (professional, specialised professional, and consumer) should also be considered. The hazards of the substances should also be considered, in order to prevent over-regulation. Thus the focus should be on distinct (active) substances and applications. The acceptability of measures to society should also be kept in mind. To date, the limited information available concerning the use phase hinders providing a sound basis for prioritisation. Often hot spots are only causally identified when it is too late for preventive measures. The inclusion of biocides within the scope of Regulation (EC) No 1185/2009 concerning statistics on pesticides and / or national provisions for collecting data on sales and consumption of biocides are recommended. This would also be the basis for establishing meaningful monitoring programs for biocides in environmental media. The development of monitoring programs is carried out by the German Federal Environment Agency but the implementation is done by the federal states. In the area of monitoring of pharmaceuticals in water bodies, co-operation between different authorities worked very well.

The authorities agreed that an action framework at the European level is required, even if this is a long term process. Considering the time frame required to implement the existing Directive on sustainable use of pesticides of about ten years, certain measures should be implemented earlier on a national level. All national measures should focus on identified impacts of biocide use and could then be included in the NAP. Later on, existing national measures could be implemented at a European level. It should be noted that any strategy for supporting sustainable use is not directly linked with the authorisation process but refers to additional measures for minimising exposure to biocides of humans and the environment during the use phase. A Framework Directive could also be established without defining a thematic strategy. First the objectives and instruments of sustainable use of biocides should be defined. In which regulatory framework these are implemented is of secondary concern.

The following next steps have been suggested by the authorities

- First, a problem analysis should be carried out. A systematic survey concerning the occurrence of biocides in different media (e.g. surface water, house dust) should be performed in order to collect any existing data. Because the monitoring and surveillance programs are carried out by the federal states, the data are widely distributed and there exists no detailed overview so far. Monitoring concepts and programs should be developed in order to identify the major impacts of biocides use and to identify the objectives of a thematic strategy for sustainable use of biocides and to define suitable indicators.
- Based on the results of the problem analysis, the objectives of a Thematic Strategy on sustainable use should be described.
- As a next step, definite proposals and modules for a Thematic Strategy, Framework Directive or a NAP should be elaborated for priority substances or biocides applications. The experience of other MS should be considered.
- The results shall be presented at a European level to experts. A European expert workshop on sustainable use of biocides is envisaged. The proposals and results shall support European activities concerning implementing measures for sustainable use of biocides.

8 Conclusions and recommendations

The Thematic Strategy on sustainable use of pesticides has so far been implemented only for plant protection products. No harmonised approach exists for minimising hazards and risks of biocides to human health and the environment during the use phase. In contrast to plant protection products, the use pattern of biocide is far more diverse, as reflected by the 23 different product types. The use of biocides in private homes is often more a response to lifestyle than to an objective need and the objectives may often be achieved by non-biocidal alternatives. Within the project the possibilities and requirements for transferring the measures of Framework Directive 2009/128/EC on sustainable use of pesticides to the biocide area have been analysed, with specific focus on wood preservatives, insecticides, and antifouling agents.

Several biocidal active substances, such as the fungicides Propiconazole, Tebuconazole, and Terbutryn as well as the herbicides Carbendazim and Diuron, are found in the outlet of STP and surface water and indicate that many biocides are not completely removed during wastewater treatment. Annex I of this report summarises the available literature data on the occurrence of biocides in the environment. Because reliable data on biocide consumption and use patterns are lacking, no prioritisation of the most relevant active substances to be included in monitoring programmes or in a risk minimising strategy is currently possible in Germany. Some MS provide statistics on biocides consumption and some monitoring programmes have been undertaken. These data could be evaluated first.

Sustainable use of biocides addresses the three pillars of social, environmental and economic sustainability. The social dimension refers to human health, general hygiene conditions in workplaces and residential areas. The environmental dimension refers to the protection of water resources, soil, non-target organisms and biodiversity. The economic dimension refers to the protection of commodities, materials, livestock breeding and industrial processes.

A systematic analysis of instruments for improving the sustainable use of pesticides described in Directive 2009/128/EC indicated that the structure of different instru-ments can be transferred to the biocide area, but some biocide specific adaptations are required. Unlike plant protection products, the intended use of some biocides is to be directly applied to water bodies. This includes e.g. larvicides in stables and manure, insecticides used for mosquito control or cooling water biocides. Further, disinfectants or preservatives are mainly released to municipal STPs before entering surface water. The behaviour of the active ingredients in STPs is therefore of particular concern. The focus on indoor use of biocides also distinguishes these from plant protection products. Another aspect is that, for some PTs, emissions during the service life of biocides exceed emission during the application phase. This includes e.g. wood preservatives, film preservatives, masonry preservatives, or antifouling agents.

The instruments described in the Thematic Strategy could be transferred as follows:

Education and training is of decisive importance for the sustainable use of biocides. There are several ongoing national activities for professional users established by professional associations and research institutes. CEPA took the initiative for the standardisation of pest control services on a European level. In other sectors, such as the application of antifouling paints, experts expressed concern about the lack of training activities. While education and training clearly need to be embedded in national (or local) engagement, a lack of exchange of knowledge and expertise among Member States is apparent.

Restrictions on sales of biocides could be adapted from those proposed for plant protection products. Some exemptions might apply for specific biocides where no risks have been identified. There also exist provisions for best practice on internet commerce but doubts remain whether these are followed. The establishment of strict rules on internet commerce and their surveillance is recommended.

The development and establishment of awareness programmes is an important instrument for supporting sustainable use of biocides, especially for consumers. There are national activities such as the German biocide portal www.biozid.info which could be further developed and translated to other languages. Providing information on safe use of biocides, preventive or non-chemical control measures to the general public is a suitable instrument for improving sustainable use of biocides.

The availability of appropriate equipment for the application of biocides is an important tool for minimising exposure and for targeted dosage of biocides. Initiatives for harmonisation and standardisation of the machinery for biocide application only exist in rudimentary form. The Directive on Machinery 2006/42/EC should be amended to include machinery and equipment for the application of biocides.

While Directive 2009/128/EC specifically cites aerial spraying as a mode of application to be restricted, this is of minor importance in the biocide area. However, the physical form of the biocide and the mode of application are indeed of major relevance. For example, spraying of insecticides indoors might cause higher exposure to humans and the environments than application in the form of baits. Therefore, this instrument should be amended to cover other modes of application of biocides.

Directive 2009/128/EC does not consider instruments for reduction of environmental emissions during service life. However, for biocides used for preservation of materials (PT 6-10) and antifouling agents (PT 21), a considerable proportion of total emissions arise during service life, through leaching from treated materials or the removal of coatings. Therefore, in contrast to plant protection products, the service life of biocidal products should be considered in detail in addition to the use phase.

Another aspect of Directive 2009/128/EC concerns provisions on informing persons who could be exposed via spray drift. Because biocides are often applied in the surroundings of human habitats, exposure of bystanders might be important (e.g. during pest control). In contrast to plant protection products, the problem of residential bystander exposure to biocides also arises. These are people exposed to the residues in the air and on surfaces in homes after biocide application.

Among specific measures to protect the aquatic environment and drinking water, the requirements of the Water Framework Directive as well as the concept of drinking water protection zones apply to both plant protection products and biocides. Additionally, measures might be envisaged where biocides are directly emitted to the environment, such as cooling water biocides. The identification of further priority substances and their monitoring in the environment is a prerequisite for setting environmental quality criteria.

The reduction of biocide use in specific areas, such as Natura 2000 sites, may be required for few applications such as wood preservatives. Several outdoor applications of biocides have been identified (e.g. PTs 2, 8, 10, 11, 14, 18, 21), but the prevalent use for most PTs is indoors. For insecticides, a user restriction could be envisaged in public areas such as school grounds and children's playgrounds (e.g. only specialist professional users to be allowed to work in these areas).

For handling of biocides and plant protection products the same safety measures apply in principle; these are e.g. determined by the classification and labelling of the preparations. The disposal of biocides residues and packages by municipal collection systems for hazardous substances should be facilitated. For some applications, the packages might be returned to the supplier, following the example of plant protection products. Due to the broader range of possible applications of biocides compared to plant protection products, however, it is questionable whether suitable collection systems could be established. In contrast to plant protection products, the removal (e.g. of antifouling paints) or the disposal of treated articles such as impregnated wood also has to be taken into consideration. For example, the incineration of treated wood under non-controlled conditions has been questioned. The labelling of treated articles is a prerequisite for this and directly relates to the use phase of biocides. Labelling of treated articles is considered in the proposal for a biocides regulation replacing Directive 98/8/EC.

Best practices in biocide application include the identification of a need (problem analysis, identification of pests), the examination of potential measures to control pests and the consideration of preventive and/or non-biocidal measures. Most of these elements can also be related to the IPM principles developed for plant protection products and pest control agents. Development and promotion of IPM guidance for pest control is considered one of the most promising instruments for the sustainable use of biocides. For the biocide sectors, the IPM principles may be adopted according to the requirements of each PT. For example, the concept of Hazard Analysis and Critical Control Points (HACCP) is applied as a preventive approach to food safety and also includes the principles of IPM. Several BREFs cover sectors where biocides are routinely applied (e.g. the BREFs on the Food, Drink and Milk Industries, the Tanning of Hides and Skins, or the BREF on Cooling Systems).

The case studies on sustainable use of wood preservatives, insecticides, and antifouling revealed that the structure of different instruments described in the Thematic Strategy, after their amendment as described above, could also be applied not only at the level of a specific PT, but also at the level of a specific biocides application or when indicated at the active substance specific level.

To date, there are no suitable indicators available for describing progress in the sustainable use of biocides. The reason is that only limited data on sales and consumption of biocides, the use pattern, poisoning cases and monitoring data in environmental media exist. The inclusion of biocides into the scope of the Regulation (EC) No 1185/2009 concerning statistics on pesticides, which so far only covers plant protection products, is recommended. These data are urgently needed for the development of suitable indicators and the definition of the objectives of sustainable use. Some MS have already started developing indicators of sustainable use of biocides on national level and these approaches should preferably be harmonised at EU level.

In some MS further national measurers have been implemented, especially the taxation of biocides according to the amount sold and to the intrinsic hazards.

In summary, an action framework on sustainable use of biocides on European level is recommended if it is designed in such a way that reduction of biocide use can be achieved. First, a problem analysis should be carried out by evaluating all available existing data and by establishing sound monitoring programmes for biocides. Then, the objectives and instruments of sustainable use of biocides should be defined. These measures could be implemented by establishing a new Thematic Strategy on biocides or by amending the existing one on pesticides. Because this is a long term process, certain measure should be implemented earlier at a national level. All national measures should focus on identified impacts of biocide use and should be included in a NAP. Later on, existing national measures could be integrated in a general strategy on sustainable use at European level.

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Thematic Strategy on Sustainable Use of Plant Protection Products – Prospects and Requirements for Transferring Proposals for Plant Protection Products to Biocides

Annex I:
Occurrence and impact of biocides in the environment
- Results of the Literature Research

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On behalf of the Federal Environmental Agency

Final Report

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Contents

0 Introduction

Biocides are intended to destroy, deter, render harmless, prevent the action of, or otherwise exert a controlling effect on any harmful organism by chemical or biological means (Article 2 (a) 98/8/EC). Due to these properties biocides pose potential hazards and risks to human health and the environment. The discussion on the effects of biocides began with a focus on human health impacts. The scandals surrounding the use of certain wood preservatives in the 70s and 80s as well as the discussion on pyrethroides for textile finishing and insect control in private households resulted in pressure for greater regulatory control of this sector. Consequently, active substances such as Pentachlorophenol and Lindane were removed from the market.

With regard to environmental impacts, concerns about the use of antifouling agents as ship hull coatings began to be debated in the early 1980s. In particular, the high ecotoxicity and endocrine effects of tributyltin compounds (e.g. the so-called imposex effects on snails) has resulted in a worldwide ban of these compounds.

Concerning the emission of biocides to the environment only limited reliable information is available to date and biocides are rarely considered in monitoring programmes. It is known that there are direct emissions to the environment (e.g. from cooling water biocides, swimming pool water, masonry preservatives, and antifouling agents). The majority of biocidal emissions are indirectly released via municipal sewage treatment plants (STP). Thus, for the risk assessment of biocides understanding their behaviour in STP (biodegradation, adsorption, and volatilisation) is a principle concern. However, risk assessment must also address the discharge of about 3-10% of the wastewater volume without treatment through the storm water overflow of the STP.

Given the known concerns, a systematic internet search and review of the literature on the occurrence and impacts of biocides in environmental media has been carried out. The object of this exercise was to identify problems which should be addressed when establishing measures on sustainable use of biocides. The results are presented in this Annex.

1 Data sources

Much information on the use of pesticides and to a lesser extent of biocides can be found in publicly available sources. The European Commission provides detailed information about the revision of the Biocidal Product Directive[1], the Thematic Strategy on Sustainable Use of Pesticides[2] and the revision of the Plant Protection Products Directive[3], including research projects, impact assessment studies, Emission Scenario Documents (ESDs)[4], workshops and stakeholder consultation protocols. The assessment reports of active substances included in Annex I or IA are available from the European Chemical Substances Information System (ESIS) and may contain some relevant information on sustainable use (e.g. data used for the exposure and environmental fate assessment, and recommendations about environmental protection measures)[5]. However, a systematic evaluation of all these data would go beyond the objectives and time budget of this study. Additionally, the contractors have direct access to discussion documents and meeting protocols from the competent authorities provided to them by the CIRCA Interest Group on Biocides. These documents are available to Competent Authorities and observers who have indicated a substantial interest in being kept informed.

In January 2009 a draft report of a study providing an "Assessment of different options to address risks from the use phase of biocides" was distributed (COWI, 2009). In addition, an assessment of the antibiotic resistance effects of biocides has recently been carried out by the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR, 2009).

The German Competent Authorities have initiated several research projects related to the implementation of the Biocidal Product Directive (ULIDAT data source, http://doku.uba.de/).

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1 http://ec.europa.eu/environment/biocides/revision.htm

2 http://ec.europa.eu/environment/ppps/home.htm

3 http://ec.europa.eu/food/plant/protection/evaluation/index_en.htm, http://www.efsa.europa.eu/EFSA/KeyTopics/efsa_locale-1178620753812_Pesticides.htm

4 http://ecb.jrc.ec.europa.eu/biocides/

5 http://ecb.jrc.ec.europa.eu/esis/

The German Federal Institute for Occupational Safety and Health (FIOSH) funded several research projects about occupational exposure to biocides (e.g. wood preservatives, insecticides, antifouling agents) which also provide useful information about the mode of application and resultant potential emissions to the environment (Bleck et al., 2008; Schneider et al., 2008).

A preliminary literature search was carried out using the databases Science Direct (www.sciencedirect.com), Medline (http://www.ncbi.nlm.nih.gov/sites/entrez), and ULIDAT ((http://doku.uba.de/), covering the period from 2000 to 2008. In addition, information was gathered from the websites of universities known to be involved in environmental research (e.g. the University of Frankfurt, http://www.bio.uni-frankfurt.de/ee/ecotox/publications/).

Monitoring data are available from river management organisations and water suppliers. The following websites have been consulted:

River Water Companies (RIWA)	http://www.riwa-rijn.org/riwa_en.html
International Association of Waterworks in the Rhine catchment area (AWR)	http://www.iawr.org
Internationale Kommission zum Schutz des Rheins (IKSR)	http://www.iksr.org
International Commission for the Protection of the Danube River (ICPDR)	www.icpdr.org
International Commission for the Protection of the Elbe River (ICPER)	www.ikse-mkol.org

The evaluation of monitoring data was limited to European water bodies.

2 Quantitative data and indicators for sustainable use

Statistical information on the volume and value of the pesticides market provided by EUROSTAT (and the "Statistische Bundesamt") generally do not distinguish between biocide and plant protection active substances. Rough estimates of the biocides market from several sources suggest that about 25% of the total pesticides market can be attributed to biocides (Gartiser et al., 2007). Some consumption estimates (disinfectants in hospitals, biocides in cooling water, disinfectants/bleaching agents/-preservatives in household cleaning products) are available from several research projects funded by the German Environmental Agency (Kahle et al. 2009). Furthermore, data on pest control biocides applied in private homes have been provided by industry associations. In 2007 the Industrie Verband Agrar (IVA) member companies sold about 20 t of pest control biocidal actives (mainly PT 18/19), 3 t of ant control actives and 10 t of rodenticidal actives (IVA, 2008). However, no data on specific active substances are available from this source.

The most detailed study on biocide consumption available in Europe is the Danish inventory of biocides which is based on information from the Danish Pesticide Statistics, the database of the Danish Product register, trade organisations, private companies, Statistics Denmark, and research institutions. In total 3,600 - 5,530 t of biocidal active substances were consumed in Denmark in 1998 (Lassen et al., 2001).

The Finnish register of chemical products (KETU) and the Nordic Substance Database have been used to establish a priority list of 77 chemicals including industrial chemicals, biocides and pesticides. For 17 priority biocides the use pattern, number of products and sales in 1999 have been assessed, Five of which (creosote oil, D-limone, hexachloroethane, naphthalene, and 1,4-dichlorobenzene) are also used as industrial chemicals. Two biocidal active substances (permethrin and deltamethrin) are used as agricultural pesticides, and one metal (copper) is used as biocide in disinfectants and wood preservatives. The biocides used in the greatest quantities were PAHs in Creosote oil (544 t per year), followed by the Phoxim used as insecticide and wood preservative (479 kg per year), and the insecticide Deltamethrin (301 kg per year). The consumption of the rodenticides Bromadiolone, Difenacoum and Brodifacoum was up to 7 kg per year (Koivisto 2001).

Among the scarce information available, the BIOMIK study on quaternary ammonium compounds calculated that the total consumption of alkylbenzyldimethylammonium-chloride (BAC) in Switzerland from biocidal applications was 90 t/a, and of dialkyldimethylammoniumchloride (DDAC) 30 t/a (Morf et al., 2007; Buser et al., 2009). Approximately, 11 t/a of BAC and DDAC are emitted to the environment (5 t/a to the aquatic environment) with the majority of BAC and DDAC emissions (>90%) being attributed to non-biocidal diffuse sources. In addition, data from Sweden show that about 77% of BAC consumption and 87% of DDAC are for non-biocidal purposes. The contribution of emissions from WWTPs (point source emissions) to the environment is only about one tenth of other emissions, and thus relatively low, compared to diffuse emissions (Morf et al., 2007; Buser et al., 2009).

It should be noted that while establishing the BPD there were proposals that the applicants should be required to report the amount of active substances produced. Furthermore, in the common core data set for active substances, the “likely tonnage to be placed on the market per year” is to be indicated (Annex IIA, 5.8). These data are confidential and are often not reported by applicants. However, an overall evaluation of existing data provided by the Commission has been carried out within the study “Assessment of different options to address risks from the use phase of biocides” (COWI, 2009). Here, an absolute minimum estimate of 400,000 t active substances production in the EU has been calculated.[6] Interestingly, within the majority of PTs relatively few substances (< 5) constitute significantly more than 50% of the total production/import tonnage registered. The manufacturing/import of substances for use as general disinfectants accounted for almost two thirds of the total tonnages for all 23 PTs while other PTs - especially 14, 15, 16, 17, 22 and 23 - are produced/imported in very low tonnages (< 25 t/a).

With regard to plant protection products, an EU regulation will soon provide for the gathering of statistics on the marketing and use of these products. Member States will be obliged to provide detailed statistics on sales, distribution and use. These data are intended to provide reliable data and indicators of the progress of improvements

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6 The order of magnitude of this estimate is quite well confirmed by extrapolating consumption data of the most comprehensive study on biocide consumption available for Denmark (Lassen et al. 2001). Here, total consumption of biocidal active substances was calculated as being 3,600 to 5,530 t/a. Comparing the population of Denmark (5.4 million) with that of the EU-27 (493 million) total consumption of biocides in the EU-27 can be extrapolated as being 329,000 to 505,000 t/a. However, the relative distribution of biocide tonnage on product types at EU level and in Denmark varies considerably.

resulting from the Thematic Strategy on Sustainable Use. The draft regulation concerning statistics on plant protection products includes reporting obligations for suppliers concerning the plant protection products that they place on the market. In addition, professional users will be required to keep records on the use of plant protection products in relevant areas (COM (2006) 778 final).

A reduction in the number of incidences of animals and humans being poisoned by biocidal products might be another indicator for sustainable use of biocides. Member States are obliged to collect information on such incidents in accordance with Article 23 of the BPD. These data are collected by the Commission and summarised in the composite reports (European Commission, 2008). However, only 16 out of 26 Member States have thus far submitted data, Germany being among those that have not submitted data. In total 15 539 cases of poisoning/exposure to active substances have been reported from 2003 to 2006 but in most cases it is not clear whether these are linked to biocidal products, plant protection products, detergents, or products containing dangerous chemical substances in general. Nevertheless, it was possible to note that the majority of these poisonings are related to the professional or household use of insecticides, rodenticides, disinfectants, repellents and wood preservatives. The active substances most frequently responsible for these incidents are Bromadiolone, Difenacoum, Permethrin, Alphachloralose, sodium hypochlorite, organophosphates, and carbamates (European Commission, 2008).

In Germany, the Federal Institute for Risk Assessment (BfR) is responsible for the evaluation cases of poisoning. In 2006, 6 cases of poisoning with wood presser-vatives, 4 cases with rodenticides and 30 cases with insecticides were reported. However, no unambiguous distinction is made between plant protection products and biocides; neither is there systematic collection of information on cases involving wildlife or domestic animals.

A research project funded by the German Environmental Agency investigated potential malpractice during the use phase of plant protection products, finding a high incidence of malpractice, especially during the application of plant protection products (Umweltbundesamt, 2006). In comparison, very little information has been collected on the details of malpractice during biocide application. However, for some PTs (PT 8, 18, 21) malpractice is documented in research projects of the German Federal

Institute for Occupational Safety and Health (BAuA), where the focus was on occupational exposure with no consideration of emissions to the environment.

3 Emissions to the environment

3.1 Emission routes

The COWI study from 2009 gives a qualitative overview of main emission routes for biocides and distinguishes between exposure to the environment during the application and the service-life phases. Disinfectants of PT 1, PT 2 and PT 4 are mainly discharged to municipal wastewater treatment plants (WWTPs) while disinfectants of PT 3 can also be emitted to soils or surface water with direct exposure of the environment in the use phase of biocides considered to be most significant for PT 7, PT 8, PT 10, PT 18 and PT 21. Direct non-target exposure of biota is mainly from the use of PT 14-19 and PT 23 (COWI, 2009). Cooling water biocides (PT 11) are emitted directly to surface water and indirectly discharged to WWTPs. Also slimicides (PT 12) and metal working fluids (PT 13) are mainly discharged to WWTPs, and waste disposal is considered to be the main emission route for embalming and taxidermist fluids (PT 22).

The SCENIHR study on the assessment of the antibiotic resistance effects of biocides identified the following applications as having emissions to the environment: disinfection of the outflow of WWTPs, cooling towers, antifouling agents, building materials, and antimicrobial surfaces (SCENIHR, 2009).

A literature survey on the occurrence of micro-pollutants, such as pesticides in municipal wastewater, and rough estimates of removal efficiency from physical sorption and vocalization parameters has been documented by van Beelen (2007). However, most pesticides mentioned belong to the chemical class of herbicides, such as Glyphosate (CAS 1071-83-6) or Mecoprop (CAS 93-65-2) which are not included in the Review Programme for biocides. The insect repellent Dietyltoluamide (DEET), which is regularly reported in WWTP effluents and surface water, was included in this analysis.

The sorption of organic substances on activated sludge plays an important role for removal efficiency. Substances with an octanol-water partition coefficient (log P_{OW}) below 2.5 are predicted to have low sorption potential with the consequence that, if they are not biodegradable, they will be released into surface water. In a review study on pollutants in urban wastewater and sewage sludge only a few biocides were included, notably Triclosan (Thornton et al., 2001).

The concentrations of pesticides (plant protection products and biocides) in the discharge to municipal sewage treatment plants and their elimination during the treatment was analysed by Singer et al. (2010, see table 1).

Table 1: Elimination of biocides in Sewage treatment plants

	Biocide or PPP *)	Primary effluent [ng/L]	Elimination [%]
Carbendazim	B, P (fungicide)	110 ± 30	36 ± 23
Diazinon	B (insecticide)	60 ± 10	48 ± 20
Diuron	B (herbicide)	60 ± 30	44 ± 47
Irgarol 1051	B (bactericide)	10 ± 4	52 ± 36
Isoproturon	B (herbicide)	90 ± 100	63 ± 36
Mecoprop	P (herbicide)	870 ± 590	-11 ± 109
Terbutryn	B (herbicide)	70 ± 20	72 ± 14

Data from Singer et al. (2010)
*) Diazonon, Diuron and Terbutryn formerly have been approved PPP

The results demonstrate that many biocides are not completely removed during wastewater treatment. Average eliminations may well be low, and usually below 50%, except for Isoproturon (mean elimination 63%) and Terbutryn (72%). Treated wastewater was identified as the major exposure route of the urban use biocides to the receiving river, although by-pass sewer overflows of untreated wastewater during rain events were also important. In the final effluent, Mecoprop was identified in the highest concentrations, with concentrations of 1-2 orders of magnitude higher than for other biocides and pesticides. For this active substance, the average concentrations in surface water ranged from below the limit of quantification (LOQ) to 520 ng/L. However, only the concentrations of Diazinon downstream the WWTP (20 ± 8.0 ng/L) were above the relevant threshold value for chronic effects of 3 ng/L (Singer et al. 2010).

Other studies also confirm that WWTPs are an important emission source for pesticides to surface water. In Switzerland about 20% of the total load of pesticides in surface water has been attributed to emission from WWTPs (Hanke et al., 2007). A systematic analysis of the importance of different emission sources of Pyrethroide insecticide to surface water (Sacramento-San Joaquin River, USA) revealed, that Pyrethroids passed through secondary treatment systems at municipal wastewater treatment facilities and were commonly found in the final effluent. Agricultural discharges in the study area only occasionally contained pyrethroids while discharges of the pyrethroid bifenthrin via urban storm water runoff was sufficient to cause water column toxicity in two urban streams when applying the amphipod, *Hyalella azteca* as test organism with 96 h exposure time. The maximum concentrations from the outflow of WWTP were as follows: Bifenthrin (29.8 ng/L), Cyfluthrin (17.8 ng/L), Cypermethrin (12.3 ng/L), Deltamethrin (3.5, ng/L), Esfenvalerate (4.3 ng/L), Fenpropathrin (6.1 ng/L) Lambda-cyhalothrin (6.2 ng/L), and Permethrin (45.8 ng/L) (Weston et al. 2010).

3.2 Monitoring substances of concern

With the exception of antifouling agents, monitoring data for biocides in the aquatic environment are currently very limited, with far more monitoring data available for other chemical categories such as plant protection products and pharmaceuticals. Available data are presented in chapter 4.2.3.

<u>Identification of main emission sources:</u>

One general problem of monitoring is the fact that chemical analyses do not distinguish between different sources of emissions to the environment, with many active substances being used both in plant protection and biocidal products. Furthermore, many chemicals such as food or cosmetic preservatives, bleaching agents, pharmaceuticals, and water treatment chemicals are also used as biocides (dual or multiple use). The main emission source is not always known and thus the contribution from biocidal uses alone is difficult to assess.

There is considerable overlap between biocidal and plant protection active substances. In this respect, a systematic analysis has revealed that 58 biocidal active substances within the Review Programme are also used in plant protection products, among them many insecticides (Annex 1). However, the contribution of biocides to the overall load of these actives is not known.

Another example of dual use is 2-Mercaptobenzothiazole (Benzothiazole-2-thiol CAS 149-30-4), which is a biocidal active substance (PT 2, 7, 9, 11-13) but which has its major use is as a vulcanization accelerator within the rubber industry. 2-Mercaptobenzothiazole has been identified as an environmental pollutant but has also been shown to be biodegradable (Gaja et al., 1997).

In a German study, the emission sources and pathways of copper, zinc and lead to water and soil were analysed, identifying traffic (vehicles), the building sector, water supply and other specific sources (e.g. galvanized products) as the main emission sources. In this respect, the contribution of copper and zinc containing biocides[7] was considered to be of minor importance (Hillenbrand et al., 2005). Recently, the application of copper as a plant protection product has been questioned and restricted by authorities for environmental reasons, especially for ecological viniculture, pomiculture and cultivation of other crops (Kühne et al., 2008).

A further example is sodium dimethyldithiocarbamate (CAS 128-04-1) which is a biocidal active substance supported for PT 9-12, a plant protection product and is also used as a wastewater treatment chemical for metal precipitation in presence of complexing agents. These organosulfides were identified as a source of algae ecotoxicity after biological treatment of wastewater from metal surface treatment industries (Gartiser et al., 2008). Dithiocarbamates, used as fungicides, herbicides, and as chelating agents to remove metals from industrial wastewater, have been reported to be contaminated with N-Nitrosodimethylamine (NDMA), a potential drinking water carcinogen (Mitch et al., 2003).

To summarise: attempts to combine the contributions of different emission sources from the uses of active substances covered by different regulatory regimes have identified high levels of uncertainty regarding the main areas of application relevant for environmental exposure. However, the concentration patterns for different compounds in surface water may identify the relevant sources of exposure. Within a study on the pesticide dynamics in surface water Wittmer et al. (2010) distinguished five types of concentration patterns:

a) compounds that showed elevated background concentrations throughout the year (e.g. diazinon >50 ng /L), indicating a constant household source;
b) compounds that showed elevated concentrations driven by rain events throughout the year (e.g. diuron 100–300 ng/L), indicating a constant urban outdoor source such as facades;

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[7] Examples are copper (PT 2, 4, 5, 11, 21), copper sulphate (PT 1, 2, 4), copper thiocyanate and dicopper oxide (both PT 21) as well as copper oxide and copper dihydroxide (both PT 8) and Zinc sulphide (PT 7, 9, 10).

c) compounds with seasonal peak concentrations driven by rain events from urban and agricultural areas (e.g. mecoprop 1600 ng/Land atrazine 2500 ng/L respectively);
d) compounds that showed unpredictably sharp peaks (e.g. atrazine 10,000 ng/L, diazinon 2500 ng/L), which were most probably due to improper handling or incorrect disposal of products; and finally,
e) compounds that were used in high amounts but were not detected in surface waters (e.g. isothiazolinones)

Among the substances included in the study the herbicides Isoproturon, Diazinon, Diuron, Terbtryn and the fungicide Carbendazim and 3-iodo-2-propynyl-butyl-carbamate also have a biocidal use (or dual use together with plant protection products) while Atrazine and Mecoprop are exclusively used for plant protection purposes.[8] A survey on the quantities of plant protection products used by farmers revealed the following order of consumption: Isoproturone > Glyphosate, Atrazin, and Terbuthylazin. Only minor amounts of other active substances such as Mecoprop and Diazinon had been used for plant protection purposes. Furthermore, flat roofs with bitumen felts treated with Mecoprop have been identified as the main source of this herbicide (Wittmer 2009).

The Swedish Environmental Protection Agency initiated a study concerning the emission, distribution and exposure of some major biocides. The study concluded that biocides do not seem to constitute a major problem in the Swedish environment. Even where some of these are frequently used close to important emission sources, the levels are usually well below risk levels. These results are probably due to a combination of low amounts used in relation to the size of the environmental compartments they are emitted to, and a generally high degree of (bio)degradability (Törneman et al. 2008, see table 2). In a previous monitoring study on biocides, including Bronopol, 4-Chloro-3-cresol, 2-Mercaptobenzothiazole, N-Didecyldimethyl-ammoniumchloride (DDMAC), Propinconazol, Resorcinol, 2-Thiocyanomethyl-thiobenzothiazol, Triclosan and several parabens, similar conclusions were drawn (Remberger et al. 2005).

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8 The concentration pattern for Mecoprop resembled on that of Diuron. The authors concluded that this would be an indication of constant sources from urban losses, most likely from building materials (facades, roofs). In this case this would have to be attributed to old sources because Mecoprop is not supported in the review programme for existing biocidal actives.

Table 2: Consumption of biocides and monitoring data in Sweden

Active substance consumption in Sweden	Main sources	Monitoring data
Tolylfluanide 143 [t/a]	Very common fungicide in a number of paint and wood oil products. All permits for agricultural use have been revoked.	Paint industry: Sediments of storm water manholes 0,26 - 0,85 mg/kg, Storage site for treated wood: Soil 0,3 mg/kg Not detected in the storm water, groundwater, untreated waste water, sludge from waste water treatment or soil samples collected at paint industries.
Chlorothalonil 1.3 [t/a]	Wood preservation products and, in other countries, boat paints. All permits for agricultural use have been revoked.	Not detected in any samples (limit of quantification in water 0.01 – 10 µg/L in soils and sediments 0.01 – 0.1 mg/kg). Has not been found within the Swedish regional aquatic monitoring of pesticides.
Diuron 6.8 [t/a]	Use as weed killer on railway embankments, roads, parking lots etc. (now discontinued). Main usage as a biocide in water based paints for exterior use and boat paints. Also included as a biocide in glues and lacquers used in the engineering industries.	Landfill leachate: 0.05 - 0.09 µg/L. Paint industry: Storm water 0.05 - 0.21 µg/L, groundwater 0.06 - 0.4 µg/L, inlet waste water treatment plant 32 µg/L. Storage for treated wood: Storm water sediment 0.0188 mg/kg. Background lake: Sediment 0.086 mg/kg. Regional monitoring of pesticides: Found in 0.2-1% of samples (median in surface water 0.0485 µg/l).
Cypermethrin 0.8 [t/a]	Insecticide for forestry uses (increased after storms when a large number of tress had to be stored). Also, biocidal use to combat and control ants in gardens and inside buildings.	Topsoil in proximity to storage sites for timber: 0.15 and 0.39 mg/kg. Storm water from detached houses: 0.1 and 0.45 µg/l. Not found in surface waters, ground waters and drinking waters.
Propiconazole 20 [t/a]	Fungicide in cereal crops and grass seed cultivations (e.g. golf courses) and paint and wood oil products for exterior use.	Paint industry: Storm water 0.67 - 85 µg/L, groundwater 0.28 - 7.9 µg/L, storm water manhole sediments 0.22 - 2.5 mg/kg, inlet waste water treatment plant 150 µg/L., sludge of waste water treatment plant 23 mg/kg. Storage for treated wood: Storm water manhole sediments 0.12 - 0.48 mg/kg, storm water 2.1 µg/L, soil 0.32 mg/kg. Regional monitoring of pesticides: Surface water 0.03 µg/l (median), 1 µg/l (maximum).
Kathon 25 [t/a]	Mixture of 2-methyl-3-isothiazolinone and 5-chloro-2-methyl-3-isothiazolinone. Preservatives used in aqueous-based industrial products (cleaning agents, cosmetics, toiletries, household products) as well as slimicides used in pulp and paper industries.	Not detected in any samples (limit of quantification in water 1 – 100 µg/L, in soils and sediments 0.05 – 0.1 mg/kg. German data suggest that isothiazolinone compounds were not found in effluent waters from the municipal wastewater treatment plants (Rafoth et al. 2007).

Data from Törneman et al. (2008)

<u>Comparison with existing list of priority substances:</u>

Annex X of the Water Framework Directive 2000/60/EC identifies priority substances for which a progressive reduction of emissions to water is intended. Among them are several biocides which a) are supported for Annex I inclusion (Isoproturon (PT 7, 9-12), Diuron (PT 7, 10), Naphthalene (PT19); b) have been withdrawn from the review programme (Chlorpyrifos, Lindane); or c) have been identified for potential biocidal purposes but have not been notified (Endosulfan, Hexachlorocyclohexane, Pentachlorophenol, Simazine, Trichloromethane). The overlap with plant protection active substances is evident. These priority substances are included in monitoring programmes and Directive 2008/105/EC describes environmental quality standards for the 33 priority substances /substance groups.

According to Brack et al. (2007, 2009) numerous studies did not demonstrate a clear cause–effect relationship between environmental concentrations of priority pollutants and ecotoxicological effects or ecological status at many sites under investigation. Thus, the limited number of chemicals on the priority pollutant list may not be the sole or major driving force for poor ecological status at many sites. As chemical analysis of pre-selected sets of toxicants often does not explain the ecotoxic effects of complex environmental samples, the authors propose a combined biological and chemical-analytical approach for the identification of newly emerging toxicants (Brack et al., 2007, 2009).

Under REACH, the first candidate list of Substances of Very High Concern (SVHCs) was published in October 2008 with 18 substances identified as SVHCs fulfilling the criteria set out in Article 57 (carcinogenic, mutagenic, reprotoxic cat. 1 or 2, PBT or vPvB or similar concern as endocrine disruptors). Currently 38 substances are identified as SVHCs. 11 of these substances are currently prioritised for evaluation in the authorisation process. Among these prioritised substances are several which have been identified as existing biocidal active substances: Diarsenic Pentaoxide, Dibutyl-phthalate (DBP), sodium dichromate and bis(tributyltin)-oxide (TBTO). Boric acid, and disodium tetraborate, anhydrous are supported in the Review Programme of the BPD.

Endocrine effects were considered by a German study on sustainable and pre-cautionary risk assessment and risk management of chemicals. Among the endocrine disruptors that should be given high priority in risk assessment about 20 biocidal active substances have been identified, among them Lindane and several tributyltin compounds used as antifouling agents (Gies et al., 2001). None of these substances are supported anymore in the BPD Review Programme.

Within the EU funded project "Source Control Option for Reducing Emissions of Priority Pollutants" (ScorePP), comprehensive and appropriate source control strategies to reduce priority pollutant emissions to urban waterways were analysed. The project focuses on the 33 priority pollutants initially identified in the Water Framework Directive (Seriki et al. 2008).

To summarise: the existing lists of priority substances do not specifically consider biocides and monitoring of these substances alone does not seem to be appropriate for the identification of failures in sustainable use of biocides. Furthermore, biocides included in these lists have mostly been banned and their occurrence in the environment is due to historic use only.

Prioritisation of biocidal active substances for environmental monitoring:

An analysis of extensive monitoring data of water suppliers in Europe revealed that (with the exception of Triclosan) biocides are rarely included in monitoring programmes. Among the pesticides most often detected are herbicides, with some of these herbicides, such as Atrazin, having been banned in Europe, indicating the historic pollution of soil deposits[9]. For the Danube catchment area arsenic, copper, zinc, chromium and their compounds have been identified as priority substances specific for the Danube, and biocides may contribute to emissions of these metals. The herbicides Isoproturon and Chlorotoluron, which are also used as algaecides in several PTs, have been analysed in more detail. The results suggest that agriculture is a major source of emissions (IKSR, 2005).

The COWI-study set out assumptions regarding the most important biocidal active substances within each PT in terms of annual production volume in the EU, as described in table 3.

After exclusion of readily biodegradable active substances (e.g. benzoic acid and sodium benzoate), oxidising agents (e.g. chlorine and hydrogen peroxide) and fumigants (e.g. ethylene oxide and trimagnesium phosphide), this list might provide a first indication of candidate active substances to be monitored in environmental samples.

[9] According to Hanke et al. (2007) Atrazin is still used in Switzerland where is belongs to the 20 most important pesticides.

Table 3: Most important biocidal active substances within each PT in terms of t/a. Substances listed alphabetically, not ranked (COWI, 2009)

PT	Main Group 1: Disinfectants and general biocidal products	PT	Main Group 3: Pest control
1	Benzoic acid, pentapotassium bis(peroxymonosulphate)-bis(sulphate), sodium benzoate, sodium hypochlorite	14	Bromadiolone, chloralose, chlorophacinone, coumatetralyl
2	Chlorine, ethylene oxide, hydrogen peroxide, sodium hypochlorite, symclosene, troclosene sodium	15	Chloralose
3	Chloroxylenol, cyanamide, formic acid, glutaral, hydrogen peroxide, sodium hypochlorite	16	-
4	Chlorine dioxide, hydrogen peroxide, L-(+)-lactic acid, peracetic acid, sodium hypochlorite	17	-
5	Biphenyl-2-ol, chlorine, chlorine dioxide, potassium permanganate, sodium hypochlorite	18	Cyanamide, dichlorvos, phenothrin, piperonylbutoxide, propoxur, pyrethrin and pyrethroids
		19	Ethyl-N-acetyl-N-butyl-beta-alaninate, methyl neodecanamide, naphthalene
	Main Group 2: Preservatives		**Main Group 4: Other biocidal products**
6	1,2-benzisothiazolone, bronopol, (ethylenedioxy)dimethanol, guazatine triacetate, isothiazolone mixture, L-(+)-lactic acid	20	Chlorine dioxide
7	Carbendazim, dichlofluanid, diuron, tolylfluanid, triclosan	21	4,5-dichloro-2-octyl-2H-isothiazol-3-one, diuron, zineb
8	Boric acid, copper oxide, didecylpolyoxethyl ammonium borate, disodium tetraborate, guazatine triacetate	22	2-butanone peroxide, dodecylguanadine monohydrochloride, methylene dithiocyanate
9	(Benzothiazol-2-ylthio)methyl isocyanate, 2-chloroacetamide, chlorocresol, diphenoxarsin-10-yl oxide, disodium tetraborate, ziram	23	Trimagnesium phosphide
10	2-chloroacetamide, 2-phenoxyethanol, pine extract		
11	Chlorine, chlorine dioxide, hydrogen peroxide, silver zeolite A, sodium hypochorite, tetrakis(hydroxymethyl)-phosphonium sulphate		
12	Bronopol, 2,2-dibromo-2-cyanoacetamide, hydrogen peroxide, glutaral, peracetic acid, sodium dimethyldithio-carbamate, sodium hypochlorite		
13	Boric acid, disodium tetraborate, (hexahydro-1,3,5-triazine-1,3,5-triyl)triethanol, trimethyl-1,3,5-triazine-1,3,5-triethanol		

Table 3 does not consider the current status of the review programme. For example, the wood preservative guazatine triacetate has not been approved for Annex I inclusion and therefore it should not have been used as a biocidal active substance since June 2008. In Switzerland the following candidate biocidal substances with relevance for surface water have been pre-selected within the BIOMIK project, based on consumption and degradability data (Knechtenhofer et al., 2007; Bürgi et al., 2009, see table 4)[10]:

Table 4: Candidate biocides for surface water monitoring in Switzerland

Name	CAS
Boric acid	10043-35-3
Carbendazim	10605-21-7
Dichlofluanid	1085-98-9
Glutaral	111-30-8
Copper oxide	1317-38-0
Diethylamine *(was not identified as biocidal active substance !)*	109-89-7
N,N-diethyl-m-toluamide	134-62-3
Pyrithione zinc	13463-41-7
1,2-benzisothiazol-3(2H)-one	2634-33-5
2-octyl-2H-isothiazol-3-one	26530-20-1
N'-tert-butyl-N-cyclopropyl-6-(methylthio)-1,3,5-triazine-2,4-diamine	28159-98-0
Diuron	330-54-1
Triclosan	3380-34-5
Formaldehyde	50-00-0
Bronopol	52-51-7
Permethrin	52645-53-1
3-iodo-2-propynyl butylcarbamate	55406-53-6
Diphenoxarsin-10-yl oxide	58-36-6
Propiconazole	60207-90-1
1,3-bis(hydroxymethyl)-5,5-dimethylimidazolidine-2,4-dione	6440-58-0
Quaternary ammonium compounds, benzyl-C12-18-alkyldimethyl, chlorides	68391-01-5
Terbutryn	886-50-0

In Switzerland, the total consumption of 277 different biocides has been estimated as being 7.500 t/a. More than 95% of this use is based on 30 active substances, of which seven are rapidly biodegradable (Bürgi et al., 2009).

The IKSR (Internationale Kommission zum Schutz des Rheins) publishes lists of chemical substances considered as being relevant for the Rhine River and several

[10] The criteria set by the group of experts for selecting these 22 substances as candidates for an extended assessment remain unclear as formaldehyde and glutaral should be biodegraded in WWTPs.

biocides supported in the Review Programme have been included in the list from 2007: Chlorocresol, Copper, Chlorotoluron, Dichlorvos, Diuron, Fenitrothion, Isoproturon, Monolinuron and Naphthalene (IKSR 2007, see also Annex III).

All these attempts to prioritise biocides as potential pollutants and to include some of them into monitoring programmes are based on expert knowledge rather than through the application of systematic methods. One option for improving the sustainable use of biocides could be to include typical biocidal actives which are emitted to the environment into respective monitoring lists. In order to prioritise potential biocidal pollutants for monitoring, emission data should be considered in conjunction with key properties of the substances, such as adsorption or biodegradation properties.

Götz et al. (2010) proposed a simple exposure based methodology for pre-selecting microcontaminants. This method is based on the annual consumption of the pollutants, physical–chemical properties and information about degradation and input dynamics. The method only requires the input of publicly available data on the chemicals' distribution behaviour between different environmental media, degradation data, and input dynamics. Ranking is based on a chemical's potential to occur in the water phase of surface waters. The three criteria used consist of (1) the chemical's distribution between media (water solubility, volatility or sorption), (2) the chemicals' biodegradation half-life in water, and (3) the input dynamics (continuous or repeated pulse input). The goal of this categorization methodology is to support the selection of compounds for water protection policy guidance and the identification of appropriate monitoring strategies. Table 5 shows the attribution of exposure categories to some biocides included in the study.

Table 5: Exposure categories of biocides from Götz et al. (2010)

	Exposure category	Water phase	Persistence	Input dynamics	Potential to occur in surface water	Monitoring data (av. conc. ng/L)
Carbendazim	III	≥ 10%	moderate	continuous	High	19
Diuron	IV	≥ 10%	moderate	complex	high	51
Terbutryn	IV	≥ 10%	moderate	complex	high	19
Irgarol	IV	≥ 10%	moderate	complex	high	5
Permethrin	V	≤ 10	not considered		moderate-low	not found

Most biocides attributed to isothiazolinones (e.g. octylisothiazolinone, benzisothiazolinone and chlormethylisothiazolinone) and quaternary ammonium compounds (e.g. benzyldimethyldodecylammonium-chloride and miristalkoniumchloride) have been attributed to exposure category III.

For biocidal applications with releases to municipal treatment plants this approach could be used to pre-select biocides to be included in monitoring programmes. However, data on total consumption of the active substances are required for this approach to become effective.

The need for improving the use of monitoring data in the exposure assessment of industrial chemicals has been challenged in an OECD workshop where it was recognized that the importance of monitoring data was proportional to the level of exposure assessment being performed (i.e., local, regional or continental). High priority was also given to improving accessibility to monitoring data. A number of recommendations regarding improvements to the design and performance of monitoring programmes were made, including calls for improved access to information on chemical emissions and for a dialogue between risk assessors and the monitoring community to be established (OECD 2000).

A strategy is being developed for the control of emissions of several pollutants detected in surface water of the river Rhine, including the bicoides Butylhydroxytoluene, Benzotriazole, Carbendazim, DEET, Mecoprop, and Triclosan (IKSR 2010).

Passive sampling

Passive sampling is a tool to monitor the presence and concentrations of micropollutants in the aquatic environment and has successfully been applied to the monitoring of biocides. The choice of the sampling material, the duration of integrative sampling, hydrophilic or hydrophobic properties of the micropollutants and the flow rate all have a significant influence on the results obtained (Vermeirssen et al. 2009).

3.3 Available data for each product type

As there is no systematic collection of data on the manufacture, consumption and occurrence of active substances (and their metabolites) in the environment, the following discussion sets out the data found in the literature research so far, arranged by PT. As well as quantitative data identified in the research, data found on relevant metabolites and degradation, usage in different applications (e.g. more than one PT or usage outside the scope of the BPD), and data on specific emission pathways is also considered.

PT 1: Human hygiene biocidal products

Triclosan and silver containing nanoparticles have been reported as biocidal active substances for hygienic purposes (Hund-Rinke et al., 2008). A Danish survey on the amounts of triclosan used as a preservative and antibacterial agent in cosmetics, cleaning materials, paint, textiles and plastic showed that in 2004 in total 1.8 t had been consumed, with cosmetics being by far the largest contributor to the amount of triclosan on the Danish market (99%). The largest amount of triclosan in cosmetics is found in products for dental hygiene, including tooth paste (Borling et al., 2006).

PT 2: Private area and public health area disinfectants and other biocidal products

The emission of disinfectants from hospitals into wastewater has been analysed by Gartiser et al. (2000). In summary, the average total consumption of active ingredients applied in hospitals for surface, instrument and skin/hand disinfection was found to be 27 g/(bed*day), with alcohols, which evaporate for the most part and therefore do not reach the sewer, representing the majority of emissions. Excluding alcohols, the consumption of active substances was 4.4 g/(bed*day), corresponding to a wastewater concentration of around 9 mg/l, with skin and hand disinfectants representing 10-15% of total consumption. in addition, the input of large kitchens and laundries to the consumption of biocides should not be ignored, as these uses contribute up to 99% of total loads of chlorine or peroxides, and up to 28% of total load of quaternary ammonium compounds (QACs). These data have been confirmed in a more wide ranging study including 27 German hospitals. Consumption data per bed and day and per nurse and day for particular categories of active ingredients corresponded quite well with the default values from the EU emission scenario documents (Tluczkiewicz et al. 2009).

Within a further German study on health risks from the daily use of biocide-containing products a market research was conducted and consumption estimates for washing and cleaning agents registered in Germany were analysed. The study revealed that total emissions of sodium hypochlorite, di- and tri-chloroisocyanuric acid and hydrogen peroxide from bleaching applications, are far greater than from their use for disinfection purposes. Also, the main emissions of isothiazolinones, benzoic acid, glutaraldehyde, 2-phenoxyethanol and triclosan are from preservative applications (see Annex 2). Typical important disinfectants are 2-propanol, alkyldimethylbenzyl ammonium chloride, gluataraldehyde, formaldehyde and hydrogen peroxide (Hahn et al., 2005).

Disinfectants/antiseptic agents have rarely been included in programmes monitoring hazardous substances in water. However, the following examples have been reported by Daughton et al. (1999, see table 6):

Table 6: Disinfectants/antiseptic identified in environmental samples in Germany

Active substance	PTs	CAS	Wastewater treatment plant monitorings
Biphenylol	1-4, 6, 7, 9, 10, 13	90-43-7	routinely found in both influents (up to 2.6 µg/L) and effluents (removal was extensive)
4-Chloro-3,5-xylenol (Chloroxylenol)	1-6 [1)]	88-04-0	occasionally found in both influents and effluents (< 0.1 µg/L)
Chlorophene	1-4, 6 [2)]	120-32-1	routinely found in both influents (up to 0.71 µg/L) and effluents
3,4,5,6-Tetrabromo-o-cresol	Not identified as existing active substance	576-55-6	found in both influents and effluents (<0.1 µg/l)
Triclosan	1-3, 7, 9, 11, 12	3380-34-5	0.05 – 0.15 µg/L in water

1) Not included in Annex I, COM Decision 2008/809/EC
2) Not included in Annex I for PT 1, 4, 6, COM Decision 2008/809/EC

Monitoring data from Austria show that QACs are effectively removed in municipal wastewater treatment plants. In the inflow DDAC-C10 and DDAC-C18, as well as BAC-C12 and BAC-C14, have been detected at the level of several µg/L. The total load of all QACs after treatment was considerably reduced and DDAC was rarely detected in the outflow of the WWTPs (Gans et al., 2005, see table 7).

Table 7: Monitoring of surface water and sediments by the Austrian Environmental Agency revealed the following concentrations (cited by Morf et al., 2007)

	Substance	CAS	Surface water µg/L	Sediment µg/kg
BAC-C12	Benzododecinium chloride (1)	139-07-1	0-1.9	3-3600
BAC-C14	Miristalkonium chloride (1)	139-08-2	0-0.5	0-1600
BAC-C16	Cetalkonium chloride (1)	122-18-9	0-0.1	1-350
BAC-C18	Benzyldimethyl(octadecyl)ammonium chloride (1)	122-19-0	0-0.1	0-290
DDAC-C10	Didecyldimethylammonium chloride	7173-51-5	0-1.5	0-510

(1) In the Review Programme of the Biocidal Product Directive these substances are covered by one entry: Quaternary ammonium compounds (benzylalkyldimethyl (alkyl from C8-C22, saturated and unsaturated, tallow alkyl, coco alkyl, and soya alkyl) chlorides, bromides, or hydroxides)/BKC.

From these data it is evident that, although low quantities of these QACs are detected in surface water, they are primarily adsorbed to sediments.

In a survey of 49 WWTPs in Germany, Biphenyl-2-ol (CAS 90-43-7, PT 1-4, 6, 7, 9, 10, 13) and Chlorophene (CAS 120-32-1, PT 1-4, 6) have been routinely found in both influents and effluents (up to 2.6 µg/L Biphenylol and up to 0.71 µg/L Chlorophene). The removal of chlorophene from the effluent was less extensive than for Biphenylol, with surface waters having concentrations similar to that of the effluents (Ternes et al., 1998).

The environmental impact of the increasing use of antibacterial silver used in medicinal products and products of everyday use has been assessed by Hund-Rinke et al. (2008). The preliminary risk assessment indicated that an environmental risk for the aquatic compartment and for sewage treatment plants can be considered as small, but cannot be totally excluded. For soil and sediment there is an indication of risk but current knowledge is limited on the concentration of silver ions in the environment, the influence of changing environmental conditions on silver and silver nanoparticles. Furthermore, washing machines containing silver electrodes are marketed which function as PT 2 biocides with silver released by electrolysis

(Samsung Electonics). General purpose and swimming water disinfectants may also contain silver in combination with sodium hydroxide (Sanosil).

PT 3: Veterinary hygiene biocidal products

Chemical disinfection of stables is routinely performed when animals are replaced. The main exposure route of these biocides is to liquid manure storage. The total amount of biocidal products used for this application in Germany was estimated as 860 t/a (about 60% for poultry farming and 40% for pig keeping). For cattle keeping, milking cleaners and disinfectants contribute to 22.000 t/a (Kaiser et al. 1998). The main disinfectants used are sodium hypochlorite, sodium dichloroisocyanuric acid (CAS 2782-57-2), sulphamidic acid (CAS 53429-14-6, only identified active substance), and several QACs (Didecyldimethylammonium chloride and benzalkonium chloride). In addition, about 250 t/a of Cyanamide (CAS 420-04-2, supported for PT 3 and 18) are used for liquid manure treatment to prevent the development of midge larvae. The emissions of disinfectants regarded as veterinary pharmaceuticals to liquid manure are also considered of major importance. Iodine-containing udder disinfectants (3.500 t/a) are also used, as well as copper sulphate, for prophylactic disinfection and protection of calves (1000 t/a) (Kaiser et al., 1998).

The German Environmental Agency funded a project to investigate the biodegradability of biocides in liquid manure (Kreuzig et al. 2010a, 2010b, see PT 18)

PT 4: Food and feed area disinfectants

A study of the German Environmental Agency on wastewater from bottle and tank cleaning processes provides a general overview of relevant processes and disinfectants applied. Wastewater pollution was assessed with bioassays (Pluta et al. 1997).

Currently a FIOSH project on human exposure to disinfectants applied to the food and feed areas is being planned (project number F 2034). The focus of this project will be on inhalation and dermal exposure. This project will also provide general data on the consumption of disinfectants.

PT 5: Drinking water disinfectants

Drinking water disinfection is based on oxidative biocides such as chlorine, sodium hypochlorite, calcium hypochlorite, chlorine dioxide, and ozone. In a German study on silver containing biocides, water treatment (including drinking water) has been identified as main source of silver emissions to WWTPs and the environment. This assumption is based on data from the Silver Institute which stated that in Europe 75% or 48,000 kg of biocidal use of silver in Europe is used for water treatment and ends up in WWTP. However, data might be overestimated, because legal requirements for drinking water treatment in Germany limit the concentration of silver in drinking water (Hund-Rinke et al., 2008).[11] A further biocidal use of silver is for the coating of terminal drinking water filters. This has been suggested as an appropriate method to protect immunocompromised patients from water-borne pathogens, such as Legionella (Vonberg et al., 2008).

PT: 6: In-can preservatives

A typical PT6 biocide which has often been analysed in wastewater and surface water is triclosan, a chlorinated biphenyl ether which is known to be highly toxic to aquatic organisms (Orvos et al. 2002; Singer et al., 2002; Thompson et al., 2005). The reason for the good data on triclosan emissions is that this substance is often analysed together with pharmaceuticals, because it is also used in medicinal personal care products (Paxeus, 2004; Thomas, 2004; Quintana, 2004; Bendz et al., 2005).

An analysis of plant protection products identified in ground and drinking water by drinking water suppliers indicated that the herbicides Diuron, Isoproturon and Chlorotoluron are among the 20 plant protection products most often detected in water samples (Sturm et al., 2007). In addition to their application as herbicides for plant protection purposes, these substances are also supported as biocides for PT 6 and 7 (and to a lesser extent for PT 9-13). However, the contribution of biocides to the total emissions of these contaminants remains unclear.

PT 7: Film preservatives

Among the biocides used in paints and plasters, Carbendazim, Diuron and Mecoprop[12] have often been detected in the different environmental compartments.

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[11] According to another study silver is mainly used for mobile drinking water purification and its permanent use for drinking water disinfection is restricted (Gartiser et al. 2005).

[12] The herbicide Mecoprop (CAS 93-65-2) has not been identified as a biocidal active substance and should not be used for that purpose.

All these substances are active ingredients in material protection products. Mecoprop used in bitumen sheets for roof waterproofing was investigated more specifically. Initial laboratory tests found leaching rates differing by a factor of 100 between different products (Burkhardt et al., 2007).

The leaching of four biocides (Diuron, Terbutryn, Cybutryn, Carbendazim) used in resin based facade coatings has been investigated by Burkhardt et al. (2009). Leaching from the facade was tested under UV-irradiation over 28 days using 80 irrigation intervals. This study found high initial concentrations followed by an exponential decrease. Rising temperature was found to increase the concentration of biocides in the runoff and the total losses were between 7% and 29% depending on the biocide. More than half of the losses occured within the first 15 min of runoff from a 60 min irrigation cycle. In the first litre of facade runoff 7 mg/L Diuron and 0.7 mg/L Carbendazim were detected. The authors further concluded that the modelling result for Cybutryn (28159-98-0, PT 7, 9, 10, 21) highlighted the high environmental risk to small surface waters from this substance. Diuron and Carbendazim are also used as pesticides and preservatives for other materials hence all pathways have to be evaluated in order to identify relevant sources and to protect soil and water receptors from these substances more efficiently (Burkhardt et al., 2009).

Terbutryn, a methylthiotriazines algicide and herbicide , is still supported as a biocidal active substance for PT 7, 9 and 10, while its approval as a plant protection agent in Germany was recalled in 1997 and in most other European countries in 2004. Despite its removal as a plant protection agent, monitoring programmes performed in 2005/2006 by the German Environmental Agency revealed that Terbutryn is detectable in most surface water samples in concentrations of up to 48 ng/L ((Kahle et al., 2009). In Bavaria in 2006 Terbutryn was detected in river water at maximum concentrations of 20 ng/L (Danube), 110 ng/L (Main) and 140 ng/L (Regnitz) (LfU Bayern, 2007, cited in Kahle et al. (2009). In the Elbe, 2.4 ng/L has been detected (Gerwinski, 2002).

The leaching rates of biocides from roof paints have been determined in laboratory experiments (application of paints to glass plates, drying for 24 h, dipping in synthetic rain water, exchanging of leaching solution every 24-72 h over 40 days). The release rates of Carbendazim and Terbutryn respectively were 12 mg/m^2 and 58 mg/m^2.In roof drain water concentrations of 9 mg/L and 1.5 mg/L of these biocides have been detected at low rain intensity (0.3 mm/h). This leaching study found that the concentrations of selected biocides may reach significant levels, especially after low intensity rainfall. Concentrations dropped with increasing time and rain intensity. No kinetics could be derived for methylisothiazoline-3-one and octyl-isothiazoline-3-ones as concentrations measured were below the detection limit which may have been caused by rapid biotic degradation and/or photodegradation (LUA NRW, 2005, Jungnickel et al., 2008).

PT 8: Wood preservatives

In Regulation 2032/2003 about 80 active substances were listed for PT 8, of which 41 active substances were included in the EU review programme for evaluation and possible inclusion in Annex I, IA or IB to Directive 98/8/EC[13].

In Germany, the total consumption of wood preservatives has been estimated to be approximately 29.000 – 31.000 t/a (Langer and Forst, 2001; OECD, 2003, cited in Gartiser et al., 2006). The consumption of wood preservatives in Germany can be divided into the following user sectors (see table 8):

Table 8: Consumption of Wood Preservatives in Germany (formulated products)

Application process	Amount [t/a]	[%]
Pressure treatment (water and solvent based, without tar oil)	2.000-2.200	7.0
Treatment in dipping/immersion plants	4.700-4.900	16.1
Tar oil; pressure and hot/cold dipping	5.000-6.000	18.3
Industrial/professional preventive treatment (injection, brushing) undercoating, varnishing, impregnation	12.400-12.600	41.8
Professional market undercoating, varnishing, painting	1.750	5.9
Do-it-yourself market undercoating, varnishing, painting	1.750	5,9
Professional curative treatment (injection, brushing)	1.750	5,0
SUM	29.000-31.000	100

Source: OECD Emission Scenario Document No. 2, Part I; ➔ http://www.oecd.org/dataoecd/60/11/2502747.pdf

13 Up to March 2009, 10 active substances of PT 8 have been included in Annex I or IA to Directive 98/8/EC: Clothianidin, Dichlofluanid, Etofenprox, IPBC, K-HDO, Propiconazole, Sulfuryl fluoride, Tebuconazole and Thiamethoxam

The above table shows that in Germany about 53% of wood preservatives are for professional applications, about 43% for industrial applications and about 6% for do-it-yourself applications. Table 8 also shows that about 95% of wood preservatives are applied in preventive treatment and only about 5% in curative treatment.

For Denmark, the total consumption of wood preservatives was quoted to range from 393 – 474 t/a (Lassen et al., 2001). COWI (2009) presents similar figures for the Danish consumption of wood preservatives: 377-453 t/a for vacuum and pressure applications and 16-21 t/a for for surface treatment, respectively.

Morf et al. (2007) present consumption data for wood preservatives in Switzerland where consumption is estimated to be approximately 1.098 t/a, corresponding to ca. 14.8% of total biocide consumption.

According to COWI (2009) the total annual tonnage for PT 8 in the EU amounts to 11.233 t/a, corresponding to 2.8% of the total tonnage for all PTs. This figure comprises the annual production/import volume for the active substances used in PT 8 in Europe and is based on data provided to the European Chemicals Bureau by companies as part of the notification procedure. (The lower figure compared to the consumption volume given for Germany in the OECD ESD of table 8 is due to COWI data being based on active substances tonnages while the OECD ESD estimates are based on formulated products.)

COWI (2009) further states that the use of wood preservatives is more important in cool and humid northern Europe than in the south. The most important active substances used in PT 8 in terms of production tonnage (1998-2001) are boric acid, cooper oxide, didecylpoly-oxethyl ammonium borate, disodium tetraborate and guazatine triacetate.

Exposure of the environment to PT 8 biocidal products may take place both in the application phase and in the service-life phase. This is particularly true for preservatives that are used both by professional and non-professional users for the surface treatment of wood which may be emitted to all environmental compartments (air, soil, water) and to WWTPs. In contrast, vacuum and pressure preservatives are mainly used by professional users in specialised plants so that exposure is limited to the air and WWTPs (COWI, 2009).

One possible emission pathway of biocides (including wood preservatives) into surface water may be rainwater discharges (in case of separate sewer systems) or storm water overflows. In both cases rainwater may be contaminated with biocidal active substances that are used in outdoor applications like fence poles, roofs or facades. However, knowledge about the quantities of biocide used for outdoor applications and leaching rates of the biocidal active substances is scarce, especially for wood preservatives.

Leaching rates for wood preservatives have been determined by Schoknecht et al. (2002, 2004) both in laboratory and outdoor experiments. Wooden poles treated with Propiconazol were exposed to rainfall and cumulated losses of Propiconazol were found to range between 100 mg/m² and 150 mg/m² within 200 days with rainfall of between 350 L/m² and 400 L/m². This loss corresponds to daily emission rates of 0.4 mg/m² for short poles with a smooth surface and of 0.7 mg/m² for longer poles with a rough surface. In the leaching tests a Propiconazol loss of 0.1 to 6.5 mg/m² per litre of rainwater was observed.

Leaching of wood preservatives may be particularly prevalent in wood impregnation plants which store treated wood in open storage areas, exposed to rainwater.

Copper containing preservatives have a market share of about 70% in pressure impregnation of wood, and consumption of between 70 t/a and 140 t/a copper containing wood preservatives has been calculated for Germany, with 3 t/a to 8 t/a being released through leaching, primarily to soil (Hillenbrand et al., 2005).

The leaching rate for wood preservatives depends mainly on the time required for the fixing process where the wood preservatives react with various constituents within the wood. During that period the risk of leaching by precipitation has to be minimised to ensure the efficacy of the preservation as well as to prevent emissions into the environment. Therefore, the German Umweltbundesamt funded a research project to determine the minimum fixing time for wood preservatives. This study found that the time necessary to reach a fixation level of 95% was typically between 2 and 14 days and depended on temperature and the active substance concerned. High air humidity increased the fixation time to upto 58 days (Schoknecht et al., 2003).

Direct emissions of wood preservatives to soil may also occur during the manual treatment (brushing) of fence poles. The fraction of product lost to the soil during application was determined to range from <.0.01% to 6% for Propiconazol and from 0.03% to 0.6% for Tolylfluanid. Here, the determining factors were wind speed, brushing speed and quantity of wood preservative applied per stroke of the brush (Uhlig et al., 2007; cited in Kahle et al. (2009).

Once the wood preservatives have dripped onto the soil they may be washed into surface water via run-off or they may leach further into the soil profile and ultimately enter the groundwater.

In surface water, a range of distribution processes between the water phase and the sediment take place the nature of which depend upon the physico-chemical properties of the active substances. For example, the wood preservative Permethrin tends to adsorb to sediments.

The active substances Propiconazol and Tebuconazol also used as wood preservatives have been detected in the effluent of WWTPs in Switzerland (Kahle et al., 2008, see PT 10). Propiconazol has also been included in groundwater monitoring programmes in Germany. In some groundwater samples Propiconazol was detected in concentrations upto <0.1 µg/L (and in 2 samples upto 0.1 µg/L and 1 µg/L, respectively). It was, however, not possible to allocate these values to specific emissions sources (Kahle et al., 2009).

Further monitoring data for wood preservatives were collected for the BIOMIK Project (Morf et al., 2007). In Canada, the QAC DDAC-C10 was detected in the Fraser River and downstream from four sawmills where the compound was used as wood preservative. DDAC-C10 concentrations in the sediment ranged from 0.52 mg/g to 1.26 mg/g dry weight with corresponding concentrations in the surface water of 446 µg/L close to the emission sources and <10 µg/L (LOQ) at a distance of 10 m from the emission source, respectively.

The insecticide Chlothianidin (CAS 210880-92-5), which has been included in Annex I of the BPD for PT 8 and is also supported for PT 3 and 18, was identified as the cause of a bee mortality incident which occurred in parts of South-West Germany in

April and May 2008 after maize seeds had been treated with Clothianidin (press release www.bvl.bund.de).

PT 9: Fibre, leather, rubber and polymerised materials preservatives

Some monitoring data are available for active substances used for PT 7, 10 or other PTs as well as being used for PT 9 purposes. However, no specific environmental emission data for PT 9 compounds have been found.

PT 10: Masonry preservatives

The occurrence and fate data for nine agricultural azole fungicides, some of them also used as biocides were studied for wastewater treatment plants (WWTPs) and lakes in Switzerland. The biocides Propiconazole (CAS 60207-90-1, PT 1, 2, 4, 7-10,12, 13, 20) and Tebuconazole (CAS 107534-96-3, PT 7-10) were consistently found in WWTP influents in concentrations of 1−30 ng/L. Loads determined in untreated and treated wastewater indicated that Propiconazole and Tebuconazole were largely unaffected by wastewater treatment. Incubation studies with activated sludge showed slow degradation and some sorption was observed for Tebuconazole and Propiconazole (degradation half-lives, 2−3 d). In lakes, Propiconazole and Tebuconazole were detected at low, nanogram-per-litre, levels. Per capita loads of Propiconazole and Tebuconazole in lakes suggested additional inputs; for example, from farm use or from urban rainwater runoff (Kahle et al., 2008). Furthermore, groundwater monitoring covering the federal states occasionally detected Propiconazol below 0.1 µg/L. The concentration of two samples was between 0.1 and 1 µg/L but the source of the contamination could not be identified (UBA-Grundwasser-Datenbank; Kahle et al., 2009).

Schoknecht et al. (2009) analysed the leaching behaviour of biocides used in facade coatings. These materials are increasingly used for textured coatings (renders) and paints for exterior façades where biocides are added to avoid the growth of fungi and algae on the surfaces of buildings, especially where effective thermal insulation prevents drying of the surface. The concentration of the active ingredients in the paints was around 1500 mg/kg and that in the render around 750 mg/kg.

In short-term immersion tests (Lab-ST) specimens with a coated surface area of 82.5 cm^2 were immersed in 200 mL of de-ionized water for 1 h. In the permanent immersion tests (Lab-PI) this procedure was prolonged for up to 29 days. In the irrigation experiments (Lab-IR) a coated surface area of 700 cm^2 was arranged on a 60° angled test assembly and irrigated with deionized water 10 times over 10 days (2.5 L/m^2 within 2 min of irrigation per day). Table 9 presents the main experimental results.

Table 9: Maximum concentration in the eluate and maximum emission rates of biocides from façade coatings

	Lab-ST		Lab-PI		Lab-IR	
	eluate mg/L	emission $mg/(m^2*d)$	eluate mg/L	emission $mg/(m^2*d)$	eluate mg/L	emission $mg/(m^2*d)$
1,2-benzoisothiazolin-3-one (BIT)	13.2	625	50.1	4651	24.5	58
2-n-octyl-4-isothiazolin-3-one (OIT)	38.	178	10.2	919	5.9	12
3-iodopropynylbutylcarbamate (IPBC)	1.2	57	4.4	244	2.3	6
Isoproturon	3.4	173	12.2	965	3.8	10
Diuron	2.3	111	6.7	570	3.3	8
Terbutryn	0.9	42	2.7	189	1.2	3
4,5-dichloro-2-n-octyl-4-isothiazolin-3-one (DCOIT)	0.2	8	0.5	26	0.3	0.8
Carbendazim	0.3	14	3.8	149	0.4	1
Irgarol	0.8	40	2.3	196	1.3	3

Lab-ST: short-term immersion tests, Lab-PI: permanent immersion test, Lab-IR: irrigation experiments

The active ingredients that were added to the renders and paints were all detectable in the eluates of the different leaching tests. Emissions mainly occur at the beginning of leaching periods.

PT 11: Preservatives for liquid-cooling and processing systems

In a German study typical biocide concentrations and emission have been estimated for cooling water based on data on the consumption of biocides for 180 plants. Principal loads were found to come from open recirculation cooling systems, even though only <10% of the plants using once-through cooling water used conditioning chemicals at all. Extrapolation of these data to the consumption data for Germany as a whole produced estimates of total loads of about 4.000 t/a oxidative and 125 t/a non-oxidative biocides (Gartiser et al., 2002, see Annex 4).

PT 12: Slimicides

Slimicides are used to protect industrial processes such as paper manufacturing or oil and gas production against fouling and in both cases application is limited to professional users. There is considerable overlap between the use of both oxidative and non-oxidative biocides for cooling water treatment (PT 12). Slimicides used for paper manufacturing are released to the wastewater which is biologically treated either on-site or in municipal treatment plants. Available data suggest that environmental impacts are mainly considered in respect of the optimization of processes and impacts on the WWTPs concerned (http://www.ptspaper.de).

PT 13: Metalworking-fluid preservatives

The fungicide Imazalil (CAS 35554-44-0), which is supported for PT 2-4, 13 and 20, has been detected in the outflow from some wastewater treatment plants in concentrations of up to 10 ng/L (Kahle et al., 2008).

PT 14: Rodenticides

Many anticoagulant rodenticides, such as Difenacoum, Difethialone, or Flocoumafen, are persistent, liable to bioaccumulation and toxic (PBT criteria), and therefore subject to a comparative risk assessment before their inclusion in this Annex is renewed. The main concern regarding rodenticides is primary and secondary poisoning of wildlife or other non-target organisms (household animals). No data are available on the occurrence of anticoagulants in environmental samples; however, several studies describe incidents of wildlife poisoning. For example, in a British study Difenacoum was detected in 20% of raptors (tawny owls) (Walker et al., 2008).

PT 15: Avicides

No biocidal products of this product type may be authorised for use in Germany (German Chemicals Act (ChemG)), as well as in several other Member States, such as Austria and Switzerland. However, avicides may be authorised for use in other Member States, such as Spain and the UK. Currently, only two active substances (Chloralose, CAS 5879-93-3 and carbon dioxide) are supported for use as an avicide (and as well for PT 14 and 23).

PT 16: Molluscicides

According to the Borderline-Documents of the Commission regarding biocides and plant protection products this PT concerns products used against snails to prevent human and animal disease transmission and products used against snails that clog water pipes, as opposed to products used against snails that cause harm to plants.

However, in a German study on human exposure with PT 16 biocides it was shown that occupational exposure to these biocidal products is practically non-existent, and that overlaps exist between PT 16 biocides and cooling water biocides (PT 11) (Schneider et al., 2008). Consequently, no active substance at all has been supported for this product type.

PT 17: Piscicides

No biocidal products of this product type can be authorised in Germany or in other Member State (see PT 15).

PT 18: Insecticides, acaricides and products to control other arthropods

The main emission sources of biocidal insecticides are animal housing and applications in and around buildings. The OECD has developed two emission scenario documents: a) Insecticides for Stables and Manure Storage Systems and b) Insecticides, Acaricides and Products to Control Other Arthropods for Household and Professional Uses.[14]

Agricultural insecticides may be used for both the application in animal housings and in manure storage systems (larvicides). Land application of manure to soil is considered the main emission route while some insecticide may also be emitted to sewers and WWTPs. Non-agriculture insecticides are generally used in or around buildings where the presence of insect pests is unwanted. Insecticides are applied in private houses but also in public buildings, such as hospitals, and professional buildings, such as restaurants.

For indoor application to surfaces, insecticides generally do not directly reach environmental compartments. However, surface cleaning will lead to releases either to wastewater or to general waste. Therefore, WWTPs are considered as one of the main receiving compartments.

With regards to outdoor application, consideration has been given to spraying, powder application and bait stations. The fate of the substance released to the environment depends upon where the treatment is undertaken, i.e. either in the countryside or urban environments. In urban environments rain water will wash

[14] http://www.olis.oecd.org/olis/2006doc.nsf/LinkTo/NT00000E62/$FILE/JT00197426.PDF
http://www.oecd.org/dataoecd/21/9/41030103.pdf

insecticides into the rain water/sewer system. For separate systems (rain water), it can be considered that no removal takes place at this point source. For mixed waste/rain water systems WWTPs will be the environmental compartment to be considered, followed by surface water or agricultural soil (from sludge application).

It has been suggested that veterinary drugs and biocides may be transformed in liquid manure reducing the total released to agriculture soils from manure application and storage (Montforts et al. (2004). A German research project developed a technical protocol for testing the behaviour of biocides in manure using standards with 10 % dry solids for bovine manure and 5 % dry solids for pig manure. These reference-manure samples were used for the degradability testing of the ^{14}C-labeled biocides Imazalil and Cyanamide. After a storage time of 177 days in the dark at 20°C no significant decrease of Imazalil concentration was observed. However, 77% - 90 % of the radioactivity initially applied remained in the extractable residues . In contrast, Cyanamid was significantly mineralised (16%) or bound to the dry solids and after 100 days the extractable residues accounted for 30% - 51% of the initial radioactivity (Kreuzig et al. 2010a, 2010b).

Monitoring data for pesticides from different water suppliers confirm that insecticides are rarely detected in surface water. (Herbicides are most often detected in concentrations above the drinking water limit value for pesticide residues of 0.1 µg/L).

WWTPs have been identified as important sources of pesticides emitted to the environment. However, these emissions cannot be attributed to biocides alone because malpractice during the application of plant protection products, such as losses during mixing and loading or the cleaning of equipment after treatment, is a major contributor to these emissions. The insecticides Diazinon and Primicarb used in households and gardens have been identified as a possible significant contributor to overall emissions to sewage (Balsiger, 2004).

In a study for the German FIOSH, mosquito control in the Upper-Rhine area via large-scale helicopter based application of *Bacillus thuringiensis* toxins has been analysed with a principle focus on human exposure. About 800 ha per day are treated with 8 t of ice granulate containing 80 kg active substance. Assuming 60 working days per year, the total amount of active substance applied to the environment comes to 10.8 t/a (Schneider et al., 2008). Another example for aerial spraying on a large scale from helicopters is the control of oak procession moths (*Thaumetopoea processionea*) whose fine hairs can cause allergic reactions to humans. The active substance used is generally Diflubenzuron (CAS 35367-38-5), at a dosage rate of 16 g active substance per hectare (=10^4 m^2). *Bacillus thuringiensis* toxins are used near bodies of water while Diflubenzuron must not be used within 100 m of such environments (Anonymous, 2008).

PT 19: Repellents and attractants

DEET (N,N-diethyl-m-toluamide, CAS 134-62-3, supported for PT 19 and 22) is one of the most important repellents against midges and has been detected in surface water all over the world. In the inflow and outflow of a WWTP in Hamburg concentrations of 210 ng/L and 130 ng/L, respectively, have been detected, indicating that DEET is not effectively removed during wastewater treatment (Weigel et al., 2004).

PT 20: Preservatives for food or feedstocks

The fungicide Imazalil is an example of a biocide used for PT 20 and other PTs (see PT13).

PT 21: Antifouling products

Antifouling products are used to treat vessels, other structures used in water, and aquaculture equipment, however the latter is not relevant to overall emissions. Globally about 95% of antifouling products are used for vessels (van de Plassche, 2004). In 2002 CEPE estimated the consumption of of marine paints and lacquers in the EU to be 9.540 t/a (www.cepe.org), but this volume covers all such products and not just antifouling products.

Organotins are the most widely used organometallic compounds with a worldwide production volume estimated at 50,000 tons. About 70% of the total amount is used as to produce PVC stabilizers, 23% is in agrochemicals and the rest is used in biocides for a wide range of applications (e.g. antifouling paints, wood and stone treatment, textile preservation, dispersion paints, industrial water systems), and as catalysts and reactants in chemical industry. In general the disubstituted organotins are used as PVC stabilizers and catalysts, and the trisubstituted organotins as biocides. Organotin compounds are released into the environment via several pathways, the most important of which are from agrochemicals, and antifouling paints, as well as from leaching from PVC (Baggenstoss, 2004).

A study of the Austrian Federal Environmental Agency revealed that the main sources of organotin compounds in the inland aquatic environment are antifouling coatings, plant protection products, wood preservatives, plastic stabilizers, textile impregnation, and disinfectants. The highest values were detected in sediments from surface water and sewage sludge. In surface water samples only some organotin compounds were occasionally detected (exception: monobuthyltin, a degradation product of tributyltin and stabilizer/catalyser of plastic which was detected at concentrations of up to 14 ng/L) (Sattelberger et al., 2002).

The International Convention on the Control of Harmful Antifouling Systems on Ships developed by the International Maritime Organisation (IMO) entered into force on 17 September 2008. This convention prohibits the use of harmful organotins in antifouling paints used on ships and will establish a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems. The application of antifouling systems containing Tributyltin is globally banned for all ships.

As there is a multiplicity of measured data on organotin compounds in the environment available trends are difficult to establish. Therefore, concentrations detected in specific compartments often can give only a rough picture of overall contamination. For example, a distinction can be made between the normal concentrations is sediments and concentrations at “hot spots” e. g. in harbours and industrial sites. Concentrations in suspended matter and sediments often correlate to the proportion of municipal wastewater in the respective water bodies. Concentrations in the free water bodies is always significantly lower than in corresponding sediments because of the high affinity of organotins to sediments (Klingmüller et al., 2003).

A study of the working group on pollution control of the river Elbe gathered analytical data for organotin compounds in sediments from the Elbe. Here, up to 300 µg/kg Tributyltin (calculated as tin) has been detected which could explain the recorded environmental effects from monitoring data (Arge Elbe, 2001).

With regards to the marine environment, OSPAR (2006) estimated the total losses of substances from antifouling coatings to the Greater North Sea in 2002 (before the ban of organotin containing antifouling coatings) to be 300 t/a (copper), 1800 t/a (zinc), 130 t/a (tributyltin) and 5 t/a (other biocides from antifouling coatings).

As a German bulletin concerning the use of antifouling paints states, the most used substance is copper, as metal powder and in different copper compounds. However, in many cases other organic substances like Triazine (e.g. Irgarol 1051), Zinc-compounds (e.g. Zinc-Pyrithion, Zinc-naphthenat), Methylurea compounds (e.g. Diuron), Dithiocarbamate (e.g. Zineb, Maneb) are also added to the antifouling product to enhance the coatings efficacy ("booster biocides") (Bayerisches Landesamt für Wasserwirtschaft, 2005; Readman et.al., 2002).

Currently, the 10 antifouling products included in Annex I for PT 21 are being evaluated, among them Tolylfluanid and Irgarol. Tolylfluanid, which is also being evaluated for its use under PT 7, 8 and 10, is degraded during drinking water ozonisation to N, N-Dimethylsulfamide (DMS), which is a precursor of the carcinogen N-Nitrosodimethylamine (NDMA). In Germany DMS has been detected in surface water (50 ng/L to 100 ng/L) and ground water (100 ng/L to 1000 ng/L) (Schmidt et al., 2008). The field use of Tolylfluanid containing PPPs is rising and since the 1980`s Irgarol (Cybutryne), (also PT 7, 9 and 10) has been used as a TBT substitute in vessel paint.

Extensive studies for the German UBA have shown that the negative environmental effect concentration of the active substance Cybutryne (Irgarol) found in mesocosm tests correlates to the real concentration measured in the environment (Kahle et al. 2009).

The usage of the new antifouling booster biocides Zinc pyrithione (ZnPT) and Copper pyrithione (CuPT) is increasing rapidly while problems continue with regards to the analysis of these substances (Raedman et al., 2002). These substances have been found to have very toxic effects on aquatic organisms, especially algae. When exposed to light in the water column they rapidly degrade to six main photodegradation products, the toxic effects of which are still under assessment (Onduka et al, 2007).

Zinc pyrithione (ZnPT) was examined by Grunnet and Dahllöft (2005), with regard to its fate in the marine environment (e.g. leaching from antifouling paints and the trans-chelation of ZnPT2 into CuPT2). This study produced a summary of how naturally occurring ligands and metals in seawater influence the stability of ZnPT2. The presence of free Cu^{2+}, which is present naturally in seawater, or as released from copper-containing paints, results in the partial trans-chelation of ZnPT2 into CuPT2. The complete trans-chelation of ZnPT2 into CuPT2 was observed when Cu^{2+} was present at an equimolar concentration in the absence of other "interfering" ligands When the leachate from antifouling paints containing both ZnPT2 and Cu_2O was analysed, CuPT2 was found, but no trace of ZnPT2. Photodegradation was low in natural waters and absent from 1 m or more below the surface. The results show that ZnPT2 has a low persistence in seawater when leached from antifouling paints. However, the more stable and toxic trans-chelation product CuPT2 has the potential to accumulate in the sediments and, therefore, should be included in both chemical analysis and risk assessment of ZnPT2 (Grunnet et al., 2005).

The environmental impacts of alternatives to the application of antifoulings have also been assessed. These products consist of a silicon resin matrix and may contain unbound silicon oils (1-10%). If these silicon oils leach out, they can have impacts on the marine environment: PDMS are generally persistent, they adsorb to suspended particulate matter and may sediment with them. Therefore, marine sediments are their ultimate sink. Furthermore, at high concentrations, an oil film may build up on sediments, and the infiltration of pores may inhibit pore water exchange, resulting in anoxic conditions with indirect effects on benthic communities. Non-eroding silicon-based coatings, which reduce fouling of ship hulls, do not bioaccumulate in marine organisms and have low direct toxicity for aquatic and benthic organisms. Metabolites, though formed at very low rates, are bioavailable, subject to long-range transport, bioaccumulate because of their small molecular size, transfer along trophic chains and have significant toxic potential. Therefore, such metabolites must be considered in silicon oil assessments. However, up to now considerable information gaps exist, preventing a sound assessment of potential impacts (Nendza, 2007).

For active substances used in antifouling products emissions from the treated surfaces (for example, ships' hulls or fish nets used in aquaculture) are critical to any robust exposure assessment. With regards to exposure assessment the review programme uses the OECD guidance entitled, “Emission Scenario Document on Antifouling Products” (OECD, 2005). A critical input parameter for estimating emissions is the leaching rate, which is part of the additional data set for this product type. Under the progress of the review programme the determination of the leaching rate was discussed several times in the Biocides Technical Meeting (TM). One crucial factor for estimating emissions in a statistical model is the total dry film thickness. It is essential that Member States always determine the number of coats required for each antifouling product plus the predicted dry film thickness of each coat in order to ensure that the total dry film thickness is used in the CEPE calculation method (for example, if a product must be applied as 3 coats of 150 µm per coat, then the total dry film thickness used in the CEPE model must be 450 µm). However, considering that most coating types work by erosion/polishing of the existing paint layer to expose new layers containing active substance, the UK believes that the assumption used in the CEPE model, that only 70% of active substance in the overall coating will be released over the lifetime of that coating could result in a considerable underestimate of overall emissions, as products would still be released until the very last layer was exposed. The potential release of biocide should be considered to be nearer to 100%, over the lifetime of the paint. However, from published literature it is evident that erosion on some parts of the hull occurs more slowly than other areas, and so not all of the active substance would be released at the end of the service life of the paint. Therefore, whilst the UK does not agree with the assumed loss of 70% of active substance, the UK also considers 100% loss to be unrealistic. Therefore, it could be suggested that the determination of leaching rate should be based upon an anticipated loss of 90% of active substance into the environment as a default value until data become available to support the use of a more definitive value (Andres et al., 2006).

Currently some Member States have specific national Regulations on antifouling products (Limnomar, 2004). For example, in Denmark antifouling paints containing Diuron or Irgarol are banned for vessels with lengths < 24 (www.mst.dk). Similar national provisions apply in Sweden (www.kemi.se), the Netherlands (www-ctb-wageningen.nl), and the UK (www.hse.gov.uk).

PT 22: Embalming and taxidermist fluids

About 25 active substances form different chemical classes are included in the Review Programme for this PT (QAC, aldehydes, DEET, anorganics etc.). However, no specific environmental data relating to this product type have been found.

PT 23: Control of other vertebrates

No biocidal products of this product type can be authorised in Germany or in any other Member State (see PT 15).

4 Further aspects of sustainable use

4.1 Human exposure

Compared to the situation for environmental concentrations, far more information is available on human exposure to biocides. Such information may be an indirect indicator of use patterns which result in emissions to the environment. In a German Environmental Survey of children, several biocides were analysed in the 63 µm dust fraction. Despite the fact that Pentachlorophenol (PCP), DDT and Lindane have been banned, they are still present in household dust samples. Chlorpyrifos and Methoxychlor were detected in 32% and 24% of samples, respectively; while Polychloro-2(chlormethylsulfonamid)-diphenylether and derivatives (PCSD/PCAD) were detected in 15% of household dust samples. Hexachlorobenzol and Propoxur were detectable in only 2% and 6% of samples respectively (Müssig-Zufika et al., 2008). In the same survey of children, PCP and other chlorophenols, as well as pyrethroid metabolites, were detected in urine samples where the PCP was mainly attributed to the historic use of this substance as a wood, textile and leather preservative (Becker et al., 2008).

A study on human exposure to pyrethroids used as insecticides for pest control and wool carpet preservation (private and occupational settings), concluded that, provided that best practices are applied, no evidence of risks to humans could be identified from biological monitoring (BMBF, IVA 2001). In another study, emissions of formaldehyde or formaldehyde releasing compounds as well as Isothiazolinones (2-Methyl-4-isothiazolin-3-one (MIT) and 5-Chlor-2-methyl-4-isothiazolinone (CIT)) from paints to air were investigated. One day after application the CIT concentration was determined to be between 15 and 85 µg/m³, with a corresponding MIT concentration of below 5 µg/m³. Both concentrations were observed to decline within seven days to below their respective detection limits (Horn et al., 2002).

In a US study, the persistence of organic wastewater contaminants in a conventional drinking-water treatment plant were assessed (Stackelberg et al., 2004). This study determined the occurrence and fate of 106 organic wastewater-related contaminants (including plant protection and biocidal active substances) during drinking water treatment. The study revealed that, among the active substances supported in the

Review programme, only DEET (PT 19) and Triclosan have been detected in stream and raw water samples, while Diazinon (CAS 333-41-5, PT 18), Dichlorvos (CAS 62-73-7, PT 18), and Limonene ((R)-p-mentha-1,8-diene, CAS 5989-27-5, PT 12) have not been found. In a further study, the occurrence and biodegradability of several antiseptics used in personal care products were analysed (Yu, 2006).However, the scope of this literature review is limited to European data.

4.2 Impacts on biodiversity, non-target organisms, and resistance

The BPD aims to ensure a high level of protection for humans, animals and the environment. It has however been suggested that the BPD should also include further objectives and prerequisites, such as biodiversity or (ground) water protection against metabolites, particularly with respect to the approval of active substances. While the impact of biocidal products on non-target organisms is assessed during the evaluation process, up to now biodiversity is not mentioned as a protection goal of the BPD. However, active plant protection substances whose use would result in unacceptable environmental effects, e.g. negative impacts on biodiversity, would not be allowed under the draft regulation to replace Directive 91/414EEC..

Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora includes provisions that require the maintenance or restoration of the natural habitats and populations of species of wild fauna and flora, including terrestrial or aquatic areas that contribute to ensuring biodiversity. In the context of Directive 92/43/EEC the use of biocides in general or of specific modes of application (such as spraying) in sensitive areas should be avoided.

Evidence of exposure of wildlife to biocides is scarce (with the exception of antifouling agents). One example is the detection of anticoagulant rodenticides such as Difenacoum in 20% of raptors (tawny owls) in Great Britain (Walker et al., 2008). Newspapers often report poisoning of domestic animals (especially dogs) through rodenticides (Mischke, 2004), but to our knowledge there is no systematic collation or analysis of such reports.

The Scientific Committee on Emerging and Newly Identified Health Risks has conducted an assessment of the potential impacts of biocide use on resistance of nosocomial, community-acquired and foodborne pathogens to antibiotics. This study concluded that some resistance mechanisms are common to both biocides and antibiotics. In particular, the use of triclosan, chlorhexidine, and quaternary ammonium compounds was linked to the development of resistance to antibiotics. To address these concerns an urgent need is identified for quantitative data on exposure to biocides, standards and methods to evaluate the ability to induce/select for resistance, and environmental studies on resistance and cross-resistance to antibiotics following use and misuse of biocides (SCENIHR, 2009).

4.3 Environmental benefits of biocide application

When considering a reduction in the risks to health and environment, the benefits from the use of biocides should be kept in mind. The COWI study concluded that the reduction of risks from the use of biocides should not be at the expense of a reduction of or change in use of biocides which could lead to new sorts of health and welfare problems. Only the problem of superfluous, thoughtless or misplaced use of biocides leading to unnecessary residual and waste products and thereby to unacceptable environmental and health problems, should be considered (COWI, 2009).

The benefits of biocide use are most often discussed in the context of the protection of human health from infectious diseases (Umweltbundesamt, 2006), but environmental benefits can also be postulated.

The economic, environmental and social benefits of plant protection products in agriculture have been assessed by Eyre Associates (2007), with the main emphasis on the economic aspects. The central assumption of the analysis was that the benefits can be deduced from a comparison of standard PPP application with integrated and organic systems. The environmental benefits of PPP have been attributed to land use i.e. based on estimates of the amount of extra land that would be needed to produce the same amount of each product after a complete switch to organic production and the potential increase of fertilisers. However, it is recognised that the drawbacks of the study include the limited data available as well as a considerable uncertainty about the reliability of assumptions. A similar approach might also be usefully adapted and applied to the estimation of the benefits from biocides, although this issue was not seen as a major goal of the project.

A critical review of the use, safety and benefits of microbiocides used in medical devices has been undertaken by Sattar (2006). The review focuses on suitable efficacy testing methods to allow for the selection of the best combination of microbiocides, mode of application and definition of the contact time etc.

The problem of the distribution of invasive animals and plants through ballast water from ships has been known for several decades and has led to the International Convention for the Control and Management of Ships' Ballast Water and Sediments, which was adopted in 2004. The use of biocides (in-situ generation or addition) to prevent or reduce this problem may therefore have benefits for biodiversity, benefits which may also apply to antifouling paints used to prevent marine organisms being transported attached to ships (IMO 2007).

5 Conclusions

The literature research indicated that quantitative data on the production and use of biocides, as well as monitoring data in the environment, which could be used as indicators for observing progress in sustainable use are scarce. The contribution of different emission sources from multiple uses of a range of active substances controlled under several regulatory structures has resulted in a high level of uncertainty about which application areas are most relevant when assessing impacts on the environment. Existing lists of priority substances do not specifically consider biocides, and systematic attempts to prioritise biocides as potential pollutants and to include some of them into monitoring programmes are missing.

The behaviour of biocides in WWTPs is considered as one important criterion for prioritizing active substances relevant for the environment. In this context it is interesting to note that the current strategy for the evaluation of plant protection products according to Directive 91/4134/EEC, based on consideration of the retention and binding of pesticide residues (bound and unextractable residues), has been questioned by experts. They argue that complete biodegradation (mineralization) should also be considered when evaluating active substances. To date a plant protection product which is more than 5% biodegraded in 100 days is accepted if less than 70% bound residues prevent leaching to water bodies (Stieber et al., 2007).

The COWI study concluded that only 105 of the 350 substances for review under the Biocidal Products Directive are classified as dangerous substances and are also included in Annex I to Directive 67/548/EEC (now included in Regulation (EC) No. 1272/2008). For the remaining 245 substances no information on inherent properties, classification and labelling is easily available[15]. These data gaps on active substances will be closed during the implementation of the BPD and following the submitting dossiers as required under Article 5.

The collection and analysis of data on the consumption and application of biocides and monitoring of these compounds in the environment would provide a method for

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[15] Not surprisingly the overall conclusion was that the majority of the active substances can be expected to be toxic or very toxic to aquatic life and that half of the substances are not easily biodegradable. Pest control active substances showed the highest degree of environmental toxicity.

identifying major impacts and for improving the sustainable use of biocides. Both the COWI and the SCENIHR studies concluded that environmental monitoring programmes for undesirable substances should include biocides (COWI 2009, SCNIHR 2009).

Available data from monitoring of biocides suggest that prioritisation of the active substances to be included in monitoring programmes should be carried out on a scientific basis, using consumption data and the intrinsic properties of the active substances such as adsorption behaviour, volatility and biodegradability.

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Annex 1: Comparison of BPD and PPP Review Programmes

Active substances included in the Review Programme of the BPD	
In or pending PPP Review	**Not in PPP Review**
Cyproconazole, Deltamethrin, Cypermethrin, Cyfluthrin, alpha-Cypermethrin, Flufenoxuron, Tebuconazole, Imidacloprid, Propiconazole, Imazalil, Pyriproxyfen, Difenacoum, Bromadiolone, Etofenprox, Aluminium phosphide, Bacillus thuringiensis, Benzoic acid, Captan, Carbendazim, Carbon dioxide, Chlorothalonil, Chlorotoluron, Copper dihydroxide, Copper oxide, Copper sulphate, Copper thiocyanate, Copper(II)carbonate copper(II) hydroxide (1:1), Cyanamide, Bifenthrin / Biphenate, Dazomet,Tolylfluanid, Didecyldimethylammonium chloride, Ethanol, Fenoxycarb, Fipronil, Fluometuron, Metam-sodium, Mixture alpha-cyano-3-phenoxybenzyl, Acetamiprid, Folpet, Chlorophenylaminocarbonyl-difluorobenzamide, N-cyclopropyl-1,3,5-triazine-2,4,6-triamine, Pyrethrins and Pyrethroids, Sodium hypochlorite, Spinosad, Sulphuryl difluoride, Terbuthylazine, Thiabendazole, Thiamethoxam, Thiram, Trimagnesium-diphosphide, Warfarin, Warfarin sodium, Ziram	Rotenone, Hexaflumuron, Difethialone, Chlorfenapyr, Brodifacoum, Hydramethylnon, Alkyl-benzyl-dimethylammonium chloride, Ammonium sulphate, Bacillus sphaericus, Bendiocarb, Boric acid, Bronopol, Chloralose, Chlorophacinone, Coumatetraly, Diazinon, Dichlofluanid, Dichlorophen, Dichlorvos, Disodium octaborate tetrahydrate, Diuron, Fenitrothion, Formaldehyde, Formic acid, Hydrogen peroxide, L-(+)-lactic acid, Methylene dithiocyanate, Flocoumafen, Monolinuron, Permethrin, Nabam, Naled, Nitrogen, Peracetic acid, Propoxur, Benzylalkyldimethyl (C8-C22)chlorides, bromides, or hydroxides), Azamethiphos, Silver nitrate, S-Methoprene, Sodium dimethylarsinate, Sodium dimethyldithiocarbamate, Terbutryn, Tetramethrin, Zineb
N=58	**N=44**

Annex 2: Consumption of selected biocidal substances used as washing and cleaning agents in Germany (year 2004)

substance	CAS	Disinfection				Bleaching				Preservation			
		CH	TH	FB	CS	CH	TH	FB	CS	CH	TH	FB	CS
		t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a
2-Propanol	67-63-0	254,4	0,0	5,2	2,8					0,5	0,0	0,0	0,6
sodium hypochlorite	7681-52-9	94,0	86,6	19,7	88,1	1934	251,9	54,8	389,0				
Alkyldimethylbenzyl ammonium chloride (QAV C12-C18)	68391-01-5	134,2	208,2	3,4	96,8					0,6	39,8	0,3	1,7
5-Chloro-2-methyl-4-isothiazolin-3-one / 2-Methyl-4-isothiazolin-3-one (mixture CMI/MI)	26172-55-4 / 2682-20-4	1,0	0,9	1,4	0,5					592,7	307,1	58,7	328,0
Benzoic acid (including benzoates)	65-5-0	1,4	6,6	1,6	1,4					96,5	27,4	4,3	13,8
Glutaraldehyde	111-30-8	13,3	0,0	1,0	50,0					69,2	85,3	4,6	0,4
Dichloroisocyanuric acid sodium salt	2893-78-9	2,4	0,0	0,0	5,0	22,4	0,0	0,0	5,6				
1,2-Benzisothiazolin-3-one	2634-33-5	0,1	0,0	0,0	0,0					81,2	156,2	27,2	7,0
2-Phenoxyethanol	122-99-6	7,8			0,0					7,8	1,2	51,3	0,2
2-chloroacetamide,	79-07-2	0,0	0,0	1,3	0,1					5,7	8,7	17,0	0,6
Formaldehyde	50-00-0	4,3	0,8	1,8	213,3					8,6	2,9	3,8	0,2
Trichloroisocyanuric acid	87-90-1	0,0	0,0	0,0	0,0	5,2	0,0	0,0	0,0				
H_2O_2	7722-84-1	2,9	0,0	0,0	177,5	34,4	2103	0,0	270,7				
Triclosan	3380-34-5	1,1	0,0	0,0	0,5					1,8	0,0	0,0	0,1
2-Bromo-2-nitro-1,3-propanediol (Bronopol)	52-51-7	0,0	0,0	0,6	0,0					338,8	46,8	3,1	3,0

CH: Cleaning in private homes
TH: Textile cleaning in private homes
FB: Floor cleaning (private homes and business)
CS: Cleaning of sanitary panels (private homes and business)

Annex 3: Comparison of biocidal active substances with the IKSR list of Rhine River relevant substances

Name	**CAS**	**PT*)**
1,4-dichlorobenzene	106-46-7	-
Copper	7440-50-8	2, 4, 5, 11, 21
Zinc	7440-66-6	-
Dibutyl phthalate	84-74-2	-
Bis(tributyltin) oxide	56-35-9	-
Chlorpyrifos	2921-88-2	-
Chlorotoluron	15545-48-9	6, 7, 9-13
Coumaphos	56-72-4	-
Dichlorvos	62-73-7	18
Dicofol	115-32-2	-
Dimethoate	60-51-5	-
Diuron	330-54-1	6, 7, 10
Endosulfan	115-29-7	-
Fenitrothion	122-14-5	18
Fenthion	55-38-9	
Hexachlorocyclohexane	608-73-1	-
Lindane	58-89-9	-
Isoproturon	34123-59-6	6, 7, 9-13
Malathion	121-75-5	-
Methoxychlor	72-43-5	-
Monolinuron	1746-81-2	2
Pentachlorophenol	87-86-5	-
Phoxim	14816-18-3	-
Simazine	122-34-9	-
Trichlorfon	52-68-6	-
Chlorocresol	59-50-7	1-4, 6, 9, 10, 13
Naphthalene	91-20-3	19

*) “-“: Identified active substances not included in the Review Programme

Source: http://www.iksr.org/uploads/media/Bericht_Nr._161d_01.pdf

Annex 4: Consumption of cooling water biocides in European countries (data in kg/a on a substance basis)

	Active substance	UK 1)	NL 1)	F	D 2)
	oxidative biocides				
Chlorine based	Chlorine				184.000
	Sodium hypochlorite	731.000	2.100.000	817.000	674.000
	Calcium hypochlorite				146.000
	Sodium dichlorisocyanuric acid	19.300			10.000
	Chlorodioxide	13.000			
Bromine based	Sodium bromide	356.000			
	1-Brom-3-chlor-5,5-dimethylhydantoin (BCDMH)	286.000			1.830.000
	Sodium hypobromite				44.000
	Ozone	0			3.000
	Hydrogen peroxide	910			1.180.000
	Potassium peroxymonobisulfate				11.000
	Peracetic acid	975			50.000
Total amount of oxidative biocides		1.407.185	2.100.000	817.000	4.132.000
	non-oxidative biocides				
QAV	Dimethylcocobenzyl-ammonium chloride	23.400			
	Benzylalkylammonium chloride	21.400			
	Total amount of QAV	71.152			64.100
Isothiazolinones	5-Chlor-2-methyl-4-isothiazolin-3-on	13.200			
	Total amount of Isothiazolinones	18.000	2.250		20.800
	halogenated Bisphenols (Dichlorophen, Fentichlor)	12.150			
	Thiocarbamate	56.800			
Others	Glutardialdehyde	56.400	15.000		
	Tetraalkylphosphoniumchloride	9.500			
	2,2-Dibromo-3-nitrilo-propionamid	17.200	10.000		19.800
	2-Bromo-2-nitropropan-1,3-diol				400
	S-Triazine				11.000
	Dodecylguanidinehydrochloride				6.900
	Methylenbisthiocyanate (MBT)	2.270			2.400
	ß-Bromo-ß-nitrostyrene	231			
	Fatty amines 3)			20.000	
	Others	4.412			
Total amount of non-oxidative biocides		248.115	27.250	20.000	125.400

Reference:

UK, **F**: IPPC Reference Document on the Application of BAT to Industrial Cooling Systems (11/2000)

NL: IKSR Synthesebericht Antifoulings und Kühlwassersysteme (Entwurf 15.11.2001)

D: This study (F+E 200 24 33, Januar 2001)
1) All cooling water systems
2) Only recirculation cooling systems, NaOCl is indicated as Cl_2
3) Consumption of fatty amines in a costal power plant

Source: Gartiser et al. (2002)

Environmental Research of the
Federal Ministry for the Environment,
Nature Conservation and Nuclear Safety

Research Project FKZ 3708 63 400

Thematic Strategy on Sustainable Use of Plant Protection Products – Prospects and Requirements for Transferring Proposals for Plant Protection Products to Biocides

Annex II:
Case study on PT 8: Wood Preservatives

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On behalf of the Federal Environmental Agency

Final Report

Freiburg, 30th August 2011

Contents

List of Abbreviations

CAR	Competent authority report
CCA	Copper chrome arsenate
ESD	Emission Scenario Document
DGfH	German Association for Wood Research (Deutsche Gesellschaft für Holzforschung e.V.)
DiBt	Deutsches Institut für Bautechnik
ESD	Emission Scenario Document
K-HDO	Cyclohexylhydroxydiazene 1-oxide, potassium salt
PT	Product type
RAL	Institut für Gütesicherung und Kennzeichnung eV
SDS	Safety data sheet
TRGS	Technical Rule for Hazardous Substances

1 Introduction

1.1 Target organisms

The Biocide Directive defines wood preservatives as “products used for the preservation of wood, from and including the saw-mill stage, or wood products by the control of wood-destroying or wood-disfiguring organisms.”

Wood preservatives are used for both preventive and curative treatments of wood in order to either prevent/retard the occurrence of biological degradation by wood-destroying or wood-disfiguring **fungi** and **insects** or to remedy already existing infestations of insects. Thus, depending on the target organisms, wood preservatives either act as fungicides or insecticides.

Table 1 gives on overview of the target organisms of preventive and curative treatments with wood preservatives.

Table 1 Target organisms of wood preservatives

Preventive treatments	**Fungi**		**Insects (wood boring & wood destroying)**
	Wood destroying fungi	**Wood discolouring fungi**	
	▪ *Basidiomycetes*; ▪ Rot *(Serpula lacrimans, Coniophora puteana, Antrodia vailantii / Antrodia sinuosa)* ▪ other	▪ Blue stain, ▪ Sap stain; ▪ Mould ▪ other	▪ larvae of the house longhorn beetle (*Hylotrupes bajulus*), ▪ Common house borer (*Anobium punctatum),* ▪ Powder-post beetles *(Lyctidae);* ▪ Termites (*Reticulitermes santonensis*) ▪ other
Curative treatments	**Insects (wood boring & wood destroying)**		
	▪ larvae of the house longhorn beetle (*Hylotrupes bajulus*); ▪ Termites (*Reticulitermes santonensis*)		

1.2 Use and user groups

Preventive treatments are usually applied to wood at industrial treatment plants before the wood is put into service whereas curative treatments are mostly applied to wood in-situ by professionals or amateurs. According to OECD (2003), in Germany about 95% of wood preservatives are applied in preventive treatment and about 5% in curative treatment.

Table 2 gives an overview of the typical wood preservative user groups.

Table 2 Wood preservatives user groups

User sector	Typical user
Industry	Sawmill, joinery, carpentry workers
Specifically trained professionals	Specifically trained and/or certified professionals (e.g. pest control technicians)
General public/amateurs	Non-trained applicators (using household wood preservatives)

1.3 Active substances

Regulation 2032/2003[1] listed about 80 active substances for PT 8, of which 41 active substances were included in the EU review programme to be evaluated with a view to their possible inclusion in Annex I, IA or IB to Directive 98/8/EC. Up to December 2010, 18 active substances of PT 8 have been included into Annex I or IA to Directive 98/8/EC (see Table 3). Depending on the target organisms, wood preservatives either act as insecticides or fungicides, with some of them being efficient against both insects and fungi.

Table 3 Active substances of PT 8 already included in Annex I, IA or IB to Directive 98/8/EC[2]

Substance	Insecticide	Fungicide
Boric acid	X	X
Boric oxide	X	X
Clothianidin	X	
Dazomet		X
Dichlofluanid		X
Disodium octaborate tetrahydrate	X	X
Disodium tetraborate	X	X

1 http://eur-lex.europa.eu/pri/en/oj/dat/2003/l_307/l_30720031124en00010096.pdf

2 http://ec.europa.eu/environment/biocides/annexi_and_ia.htm

Substance	Insecticide	Fungicide
Etofenprox	X	
Fenpropimorph		X
IPBC		X
K-HDO		X
Propiconazole		X
Sulfuryl fluoride	X	
Tebuconazole		X
Thiobendazole		X
Thiacloprid	X	
Thiamethoxam	X	
Tolylfluanid		X

In Germany, wood preservatives that are used for the preservation of construction timber need a special registration: the national technical approval or "Bau-aufsichtliche Zulassung". This technical approval is issued by the German Institute for Construction Techniques (Deutsches Institut für Bautechnik – DiBt). Approved wood preservatives are published in the "Directory of wood preservatives" ("Holzschutzmittelverzeichnis"; DiBt 2009).

The quality label RAL-GZ 830 (Version 04/2007) is assigned by the "Güte-gemeinschaft Holzschutzmittel" to those wood preservatives used for the presser-vation of non-construction timber that fulfil defined quality standards on biological efficacy, safety for human health and environmental compatibility (http://www.holz-schuetzen.de/).

1.4 Formulation types and mode of application

1.4.1 Formulation types

Wood preservative products are categorised by the type of formulation carrier. The OECD ESD (2003) distinguishes between four groups of formulation carriers, namely water, light organic solvent (white spirit type solvents), coal tar derivates and gases.

With reference to the first group – water based preservatives – a further distinction is made between non-fixating and fixating wood preservatives.[3]

Fixating wood preservatives are suitable for outdoor uses with direct contact to soil and/or water. In contrast, wood treated with non-fixating wood preservatives needs to be protected against weathering and is therefore only to be used indoors. Fixating wood preservatives contain components that support the fixation of the active ingredient to the wood. In order to ensure the proper fixation of the active ingredient of the wood preservatives, fixation times need to be maintained after the impregnation and before the actual use of the treated timber. After this fixation time, the treated timber can be exposed to weathering or be used in applications in contact with the ground or water.

Chromium has been extensively used as a fixative agent, especially in combination with copper and arsenic wood preservatives (copper chrome arsenate (CCA)). During this process the carcinogenic chromium (VI) is turned into chromium (III).There have been discussions in the EU regarding the use of chromium and its efficacy as wood preservative active agent. If chromium were to be considered as an active substance it could not be used in formulated biocidal products, because it would most likely fail the review for Annex I inclusion. Therefore, industry refers to its use as a fixative below its effective concentration as wood preservative.[4] This is an example of where the substance of concern is not the active substance but the fixative agent.

1.4.2 Mode of application

With regard to the mode of application, two main treatment techniques may be distinguished, namely deep penetrating and surface treatments. Each of these two treatment techniques covers several different possible preservation/application processes:

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[3] The ESD refers to fixation of the active substance by chemical or other means with the wood substrate. Fixation is a term originally used for chromium containing preservatives (OECD 2003).

[4] The guidance document agreed between the Commission services and the competent authorities of Member States on the role of chromium in wood preservation ENV.B.4/KB D(2005), Brussels, 4.07.2005 http://ec.europa.eu/environment/biocides/pdf/nfg_cr_040705.pdf

Penetrating application processes:

- Vacuum pressure
- Double vacuum, low pressure
- Injection

Surface treatments:

- Fumigation (indoor)
- Spraying, dipping, brushing, injection (indoor)
- Brushing, injection, wrapping, termite prevention = foundation treatment (outdoor)

Deep penetrating treatments like vacuum-pressure or double vacuum are exclusively applied to wood in industrial treatment plants for preventive purposes. Surface treatments like spraying, dipping or brushing are applied both for preventive and curative purposes in all use sectors, i.e. by industrial, professional and amateur users (see Table 4).

Table 4 Overview of application processes of wood preservatives (OECD 2003)

Type	User sector	Preservation process
Preventive	Industrial	Vacuum pressure & double vacuum process Vacuum (Automated) spraying / dipping Thermal impregnation
	Professional *in-situ* treatments	Spraying Injection Wrapping Brushing
	Amateurs	Brushing Spraying[5]
Curative	Professionals	Fumigation, injection, wrapping, spraying/ Brushing
	Amateurs	Spraying/

[5] In several countries (e.g. in Germany) spraying by amateurs is forbidden.

2 Possible emission routes and available ESD

The Thematic Strategy on the sustainable use of pesticides focuses on the reduction of risks during the use phase of the applied products.

With regard to the use phase of wood preservatives, it is necessary to differentiate between the application/treatment phase, the storage of treated timber and the service life phase.

Emissions of wood preservatives and resulting exposure to the environment may occur during the application phase, storage and the service life. The route and degree of emission depend very much on the specific application.

2.1 Emissions during the application/treatment phase

As described in section 1.4.2, wood can be treated using a deep penetration treatment process (for example vacuum pressure impregnation) or a superficial treatment process, which may be via dipping, spraying or brushing. The extent of emission during the application depends very much on the treatment technique.

Deep penetrating treatment techniques are usually carried out in industrial treatment plants. The wood is treated in a closed system and thus emissions to the environment are expected to be quite low: Emissions to soil and air may only occur in the case of accidental leakage or if safety standards are not followed. Discharges to waste water may take place by accidental spillage and during the cleaning of equipment and work clothes. According to COWI (2009), the total loss to waste and the environment during vacuum and pressure processes is estimated at < 5% of the biocides used.

The main surface treatments of timber include spraying, dipping/immersion or brushing. Surface treatments are often performed *in-situ* (i.e. outdoors) by both professional and amateur users. Wood preservatives may be released to soil or water if the treated wood is dripping, either during or shortly after application. In addition, spray applications may form aerosols causing emissions to the surroundings. Furthermore, cleaning machinery (immersion vessels), tools (brush, sprayer) and empty packages may lead to releases of wood preservative into the sewage system or even directly to the environmental compartments of soil and water.

2.2 Emissions during the storage of treated wood before use

In industrial treatment plants, freshly-treated wood is usually stored on-site before further processing takes place. Depending on the storage conditions, wood preservatives may be washed out of treated wood by precipitation, resulting in contamination of soil, groundwater and/or surface water.

In the first period following the preservation procedure, the biocidal active ingredients have to react with the wood constituents to be fixed in the wood. During that period, the risk of leaching by precipitation is highest and thus has to be minimised to ensure the efficacy of preservation as well as to prevent emissions into the environment.

Leaching can be efficiently prevented by storing the treated wood in roof-covered and paved (= impermeable) storage areas. Relevant risk mitigation measures are therefore specified in the Inclusion Directives of several active substances that have already been included in Annex I, IA or IB to Directive 98/8/EC (see section 3.1).

2.3 Emissions during the service life phase

The service life phase of treated timber can be very long; up to 50 years, depending on the specific application.

ISO (2007) defines five use classes that represent different service situations to which wood and wood-based products can be exposed. A description of the use classes with respective typical examples of end-uses and primary receiving environmental compartments is presented in Table 5. According to a presentation given by the European Wood Preservatives Manufacturers Group (EWPM) at a leaching workshop in Arona (2005), 70-80 % of the wood in use is in use/hazard class 3 (Plassche & Rasmussen, 2005).

For most preserved wood, the most significant losses to the environment take place during the service life phase, where the preserved wood is directly exposed to soil, water and/or weathering depending on the use class. According to COWI (2009), experiments have shown that about 25% of chromium, copper and arsenic will be washed out and released to the environment within 20-40 years of service life. The leaching rate decrease over time (Plassche & Rasmussen, 2005).

Table 5 Use classes of wood preservatives with typical examples

Use Class	**Description**	**Typical examples of timber end-use**	**Primary receiving environmental compartment**
1	Wood or wood-based product is under cover, fully protected from the weather and not exposed to wetting	All timbers in normal pitched roofs except valley gutters and tiling battens; floorboards, architraves and internal joinery timbers not built into solid external walls	Indoor/outdoor air *(emissions to outdoor air are considered negligible)*
2	Wood or wood-based product is under cover, fully protected from the weather but high environmental humidity can lead to occasional but not persistent wetting	Frame timbers in timber frame houses; timers in flat roofs	-
3	Wood or wood-based product is not covered and not in contact with the ground. It is either continually exposed to the weather or is protected from the weather but subject to frequent wetting	External joinery, bargeboards, fascias, valley gutter timbers. Fence rails, gates, deck boards, cladding. Noise barriers.	soil
4	Wood or wood-based product is in permanent contact with the ground or fresh water and thus is permanently exposed to wetting, divided into:		
4a	Wood in contact with the ground	Fence posts, gravel boards, transmission poles, playground equipment, motorway and highway fencing.	soil
4b	Wood in contact with fresh water	Lock gates and revetments. Cooling tower packing	freshwater
5	Situation in which wood or wood-based product is permanently exposed to salt water	Marine piling, jetties, dock gates	seawater

Figure 1 gives an overview of the main treatment types and processes for wood preservatives and includes potential emission routes to different environmental compartments.

In summary, with the exception of the industrial treatment in closed systems (e.g. vacuum and pressure treatments), many of these wood preservative applications are "open applications" with a potential risk of contaminating the environment.

2.4 Emission scenario documents (ESD)

The OECD Emission Scenario Document No. 2 Wood Preservatives Part 1-4 (OECD 2003) contains different emission scenarios for:

- Industrial preventive treatments to estimate emissions occurring during the industrial application phase;
- Service life of industrially pre-treated wood to estimate the emissions occurring during the service life phase, and
- Preventive and curative *in-situ* treatments by professionals and amateurs to estimate the emissions occurring during the application and the service life stage of the treated wood.

The existing emission scenarios provide guidance on how the emissions of active substances from wood preservatives to the environmental compartments of soil, water and air can be estimated.

Overview on the applications of wood preservatives and possible emission routes

Industrial preventive treatments

Deep penetrating treatments
Vacuum pressure,
Double vacuum pressure/
Low pressure

Surface treatments
Automated spraying
Immersion/dipping

On-site Storage

Professional and amateur in-situ treatments (preventive and curative)

Professionals
Fumigation (indoors)
Spraying (indoors)
Brushing (indoors/outdoors)
Injection (indoors/outdoors)
Wrapping (outdoors)
Termite prevention

Amateurs
Brushing

Service life of treated wood

Use classes:

UC1: wood under cover, fully protected, no wetting

UC2: wood under cover, fully protected, occasional wetting

UC3: wood not covered, no contact to ground, frequent wetting; e.g. fence, house, bridge

UC4: permanent contact with ground or fresh water, permanent wetting; e.g. fence post, jetty in lake

UC5: permanent contact with salt water, permanent wetting e.g. harbour wharf

≡ Almost closed systems
- Potential evaporation to air
- Potential emission via facility drain to STP

Emissions depend on storage conditions:
- Impermeable (paved) grounds with roof: No emissions
- Unpaved and uncovered storage area: Emissions to
  - soil due to leaching from treated wood via rainfall;
  - groundwater via leaching in soil
  - surface water via run-off

Emissions and receiving environmental compartments depend on application technique:
Fumigation: air
Spraying (indoor): emission negligible
Brushing: air, soil, surface water, groundwater
Injection: soil, groundwater
Wrapping: soil, groundwater
Termite prevention: air soil, groundwater

Emissions and primary receiving environmental compartment depend on use class:
UC1: no emissions
UC2: no emissions
UC3: soil
UC4: soil or freshwater
UC5: salt water

Figure 1: Overview of the main treatment types and processes of wood preservatives with respective potential emission routes to environmental compartments

3 Elements of sustainable use

3.1 Risk Mitigation Measures

Status

The Inclusion Directives for those active substances that have already been included in Annex I, IA or IB to Directive 98/8/EC, describe different risk mitigation measures which shall be considered during the authorisation of biocidal products containing theses active substances. Specific provisions for product authorisations, available so far, are summarised in Table 6.

Table 6 Provisions for product authorisations from the Inclusion Directives

Area	Risk mitigation measures	Active Substance
User restriction	Restriction of the use of the fumigant sulfuryl fluoride to **trained professionals**	Sulfuryl fluoride
	Restriction to industrial operators	K-HDO
Area of application	**Restriction of use** of K-HDO for the treatment of wood that may enter in direct contact with infants.	K-HDO
	Restriction of the use class for certain wood preservatives: No **in-situ treatment of wood** outdoors. *)	Boric acid Disodium tetrahydrate Propiconazole Tebuconazole Thiabendazole Thiamethoxam Tolylfluanid
	Restriction of the use class for certain wood preservatives for wood that will be in continuous contact with water or weathering allowed.*)	Boric acid Disodium tetrahydrate Propiconazole Clothianidin Tebuconazole Thiabendazole Thiamethoxam Tolylfluanid
	Restriction of in situ treatment of wooden structures near water, where direct losses to the aquatic compartment cannot be prevented, or for wood that will be in contact with surface water	Thiacloprid
Equipment	Restriction K-HDO as wood preservative to industrial use in **fully automated and closed equipment.** *)	K-HDO
Post application	**Storage** of timber freshly treated with wood preservatives under shelter or on impermeable hard standing to prevent direct losses to soil or water	IPBC Boric oxide Clothianidin Dichlofluanid Fenpropimorph Propinconazole Tebuconazole Thiabendazole Thiamethoxam Tolylfluanid
Disposal	**Collection** of any losses of wood preservative for reuse or disposal	Most wood preservatives

Area	Risk mitigation measures	Active Substance
Risk management measures	Use of appropriate **personal protective equipment** for reducing human exposure through industrial and/or professional use of certain wood preservatives	Most wood preservatives
	Appropriate risk mitigation measures for operators and bystanders exposed to the fumigants	Sulfuryl fluoride

*) Condition may be modified according to the outcome of a risk assessment

The use of a topcoat to reduce emissions of wood preservatives during their service life has been challenged in some draft CARs. However, the effectiveness of this RMM has been questioned because a top coat on construction timber will only be appropriate for a longer time span (3 to 5 years) if the wooden structure does not significantly change its dimensions. However, some deformation is inevitable if the wooden structure is permanently exposed to weathering and if no scheduled maintenance of the coating takes place (Fischer 2008).

In Germany, the technical standard DIN 68800 (Protection of timber, Part 1-5) regulates the appropriate and safe use of wood preservatives:

- DIN 68800-1: General specifications
- DIN 68800-2: Preventive constructional measures in buildings
- DIN 68800-3: Preventive chemical protection
- DIN 68800-4: Measures for the eradication of fungi and insects
- DIN 68800-5: Preventive chemical protection for wood based materials.

In addition, several technical rules (TRGS) exist, both for preventive treatments (TRGS 551 and 618) and curative treatments of wood (TRGS 512 and 523). For example, TRGS 523 contains special protective measures to be taken in connection with pest control activities (including curative treatments with wood preservatives) using substances or preparations that are highly toxic, toxic or otherwise hazardous to health.

On overview of existing standards, BAT and other relevant documents is given in Appendix 5.1.

Options

Further potential RMM to be applied for wood preservatives are; the limitation of package size (especially with regard to amateur users), use or user restrictions for certain modes of application, restriction to certain use classes and the collection of remnant packages by suppliers.

Harmonised standards and technical rules on the safe use of wood preservatives should be introduced at a European level.

The suitability and efficiency of RMM for biocidal products of PT 8 (and PT 18) have been evaluated in more detail within research project FKZ 3709 65 402.

3.2 Training

Status

According to the Inclusion Directive for the fumigant sulfuryl fluoride, Member States shall ensure that products containing this active substance may only be sold to and used by professionals trained to use them.[6]

In Germany, preventive and curative treatments via spraying and/or fumigation have to be undertaken by trained professionals, such as pest control technicians.[7]

The German Association for Wood Research (Deutsche Gesellschaft für Holzforschung e.V.) publishes numerous guidance documents which set out best practice for wood protection and biocide application.[8]

Furthermore, with regard to wood preservation in Germany, several training structures exist as part of the building protection industry:

The German Holz- und Bautenschutzverband e.V. offers a seminar / training course leading to the qualification of professional users. Successful participants in this course are awarded an expert knowledge certificate for wood preservation (“Sachkundenachweis Holzschutz”). The certificate confirms the qualification meets

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6 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:414:0078:0080:EN:PDF

7 During the 26th CA-Meeting it was agreed that the spraying method can be accepted for amateur users as long as no PPE is required.

8 http://www.dgfh.de/

the requirements of DIN 68800, part 4 and indicates that the owner has adequate scientific and technical knowledge in the preparation, guidance, execution and testing of wood preservation measures.[9]

In Germany, since 2007 the training requirements of a woodwork and building protector include a 3-year traineeship[10]. The occupational skills required include, inter alia:

- to detect and assess damage to woodwork and wooden construction elements;
- to complete preventive wood protection measures against animal (insects) and plant (fungal) pests which cause damage to wood;
- to detect and combat insects and fungi which cause damage to wood;
- to rectify damage to wood caused by animal and plant pests.

The German Technical Rule for Hazardous Substances (TRGS) 523 applies to pest control activities using substances and preparations that are highly toxic, toxic and/or hazardous to health inter alia in the area "preservation and protection of wood and buildings". Professionals who want to apply to the relevant authority for recognition in accordance with Section 4.3.2 of the TRGS 523 have to submit evidence of their knowledge (e.g. in form of certificates evidencing an examination or training course) and evidence on their on-the-job experience.[11]

In Sweden, there are requirements for professional users concerning the use of rodenticides (PT 14), wood preservatives (PT 8) and insecticides (part of PT 18), and training is part of a specific provision in the authorization (see Annex II to COWI).

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9 Ausbildungsbeirat Holzschutz am Bau (Hrg.). Handbuch zur Sachkundeausbildung Holzschutz am Bau Fragen und Antworten3. Auflage Stand Februar 2009

10 http://www.bibb.de/en/ausbildungsprofil_31944.htm

11 http://www.baua.de/en/Topics-from-A-to-Z/Hazardous-Substances/TRGS/pdf/TRGS-523.pdf?__blob=publicationFile&v=2

In France, there are voluntary standards for the training and certification of professional users:

- NFU 43500 standard (certificate) of good practice in the use of plant protection products or biocidal products, by professional users[12]
- CTB A+ certification of professional users of wood preservatives (PT08). This standard is awarded by companies on a voluntary basis and certified by the FCBA.[13]

In the USA, the state of Michigan offers an extensive manual/guide for commercial applicators of Category 7B pesticides for the control of "wood destroying pests" (Randall et al. 2000).

Options

Each improvement in the level of understanding of the users of wood preservatives, via for example training courses, other forms of education and the availability of best practice guidance documents, could be considered to support the sustainable use of wood preservatives.

The obligatory certification of workers at industrial treatment facilities and professional users of wood preservatives would be one option to increase the level of understanding of users. The development of harmonised guidance on best practice and suitable use instructions for applicants via the label or guidance documents, are further measures for improving sustainable use.

3.3 Requirements for sales of pesticides

Status

In Annex II of the COWI study, an overview is given of national qualification schemes for retailers/distributors of biocides, e.g.:

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[12] Norme NF U 43-500 sur les bonnes pratiques d'applications des produits phytosanitaires et biocides (Septembre 2006).

[13] http://www.ctbaplus.fr/ and http://www.fcba.fr/

- In Sweden, retailers need a certificate to sell products with certain hazardous properties and it is the retailer's responsibility to ensure that the buyer has the required qualifications such as a relevant certificate.
- In Finland, retailers/distributors and producers provide the national competent authorities once a year with data on the production, import/export and sales of biocidal products.
- In Germany, distributors or retailers selling biocidal products classified as toxic, very toxic or harmful (R40, R62, 63, 68) or oxidising or extremely flammable need a certificate of competence as required under the Chemikalien-Verbotsverordnung (ChemVerbotsV).

Biocidal products classified as very toxic or toxic should not be marketed via self-service systems, including from outlets with open shelves where products may be handled by the customer before purchase and internet commerce (Chemikalien-Verbotsverordnung, ChemVerbotsV). In Germany these methods are prohibited for the sale of plant protection products, irrespective of their classification, according to the plant protection law (Pflanzenschutzgesetz. PflSchG).

Nevertheless, many consumer biocides like wood preservatives are often displayed for sale on open shelves (self–service), or sold via the Internet where adequate use information, safety instructions and information on health and environmental risks are often not provided to customers.

Options

Requirements covering the sale of all biocidal products should be introduced which apply the requirements of the Directive on sustainable use of pesticides, including the prohibition of self-service sales of wood preservatives and provision for general information regarding the risks associated with the use of wood preservatives to be provided to customers by distributors, including information on hazards, exposure, proper storage, handling and application, and disposal.

3.4 Awareness programmes and information

Status

In Germany, a web-based information system for biocides (web portal combined with print media) has been established for the general public. The information system is available from the website, http://www.biozid.info/. This portal, developed and run by the Federal Environment Agency, aims to inform the general public about physical, chemical and other measures as alternatives to the use of biocidal products or which may minimize their use. On this website, particular emphasis is placed on describing preventive measures that may be applied to avoid the need to use biocides.

Furthermore, the Federal Ministry for Food, Agriculture and Consumer Protection (BMELV) published a "Practical Guide for Consumers on wood preservatives" in order to provide amateur (private) users with information on the safe use of wood preservatives (BMELV 2008).

Options

- Development of awareness programmes and practical guides for the general public on the risks of wood preservatives (and of biocides in general), as well as increasing awareness of the existence of these among their intended audience.
- Promotion of preventive (biocide-free) measures as alternatives to the use of chemical wood preservatives.
- Promotion of voluntary labelling (e.g. Blue Angel, EU Ecolabel).[14]

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[14] e.g. RAL-UZ 12a Schadstoffarme Lacke does exclude the use of preservatives for other purposes than in-can preservation http://www.blauer-engel.de/_downloads/vergabegrundlagen_de/UZ-012A.pdf

3.5 Certification and inspection of equipment in use

Status

Equipment used for wood preservation in industrial treatment plants has to fulfil certain requirements laid down in different EC Directives and technical standards.

For example, vessels for the pressure treatment of wood using water-soluble impregnating agents or coaltar oil (creosote) fall under the Pressure Equipment Directive (97/23/EC) and the Machinery Directive 2006/42/EC.

In many European countries (and elsewhere), wood treatment plants need to be authorised for operation by national authorities according to environmental laws or regulations which describe in detail the required design of a treatment plants.. In addition, industry associations have issued “Best Practice Guides for Treatment Plants” (see below DGfH Guides). According to OECD (2003) the status of these guides is voluntary in most countries but the guides are usually recognised and used by the authorities responsible for the authorisation of plants.

In Germany, the Deutsche Gesellschaft für Holzforschung e.V. (DGfH) published several Guides, called “DGfH-Merkblätter” which represent state-of-the-art guidance for wood treatment with preservatives and which form the basis for the approval of a new treatment plant, e.g. for pressure treatments, for (non-pressure) treatments in dipping/immersion plants and treatments with gas.[15] The DGfH Guides, as well as other existing technical standards, are listed in Appendix 5.1.

OECD (2003) states that the stringency and enforcement of the available regulations vary between different member countries. Even where regulations are in place, it is questionable whether or not older plants are in compliance with new and stricter regulations for their operation.

For details of the certification and inspection of spraying equipment please refer to the case study on PT 18 (insecticides).

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[15] The DGfH halted its activity for economic reasons and the future status of the guidance documents is unclear.

Options

Harmonised EU standards for all treatment processes (pressure and non-pressure treatment) could be further developed.

The scope of the Directive on Machinery 2006/42/EC for considering equipment used for the application of pesticides could be extended to cover equipment for the application of biocides.

3.6 Form of the biocide and mode of application

Status

The different modes of wood preservative application are divided into penetrating application processes (usually pressure applications) and superficial treatments in open tanks and impregnation facilities along with manual procedures such as, e.g. brushing or spraying (see chapter 1.4.2). These procedures must be assessed differently as far as their load on the environment is concerned (see chapter 2.1).

Deep penetrating treatments

With respect to environmental protection, pressure methods such as vacuum pressure treatments in closed facilities are considered to be the safest application methods. Furthermore, deep penetrating treatments of wood under pressure result in a better (i.e. deeper) penetration of the wood preservative into the wood thus reducing the leachability and emission from the wood during its service life.

The application of some wood preservatives such as K-HDO is restricted to industrial use in fully automated and closed equipments.

Surface treatments

Surface treatments are usually performed *in-situ* (i.e. outdoor) by both professional and amateur users. Wood preservatives may be released to soil or water if the treated wood drips preservative either during or shortly after application. In addition, spray applications may form aerosols causing emissions to the surroundings.

In several EU member states only trained professional users are permitted to spray wood preservatives and this must be undertaken in closed stationary treatment plants. Therefore, the question of whether and under which conditions the use of wood preservatives by spraying should be allowed for amateur users was discussed at the 26th CA Meeting[16]. This meeting decided that, at an EU level, amateur users could be allowed to apply spray wood preservatives, provided that no PPE is required. However, the exclusion of certain application methods, such as external treatment by spraying or brushing, has been proposed as a risk mitigation measure (Fischer et al. 2009).

For details of spray applications in general and fumigation in particular, please refer to the case study on PT18 (insecticides).

Options

Depending on the intended use class of treated wood, different levels of protection are required: in particular, to reduce the leachability of wood preservatives and to ensure their long term protection throughout their service life, wood to be used for applications likely to require contact with soil and/or water (use classes 3, 4 & 5) should only be treated by deep penetration processes (e.g. vacuum or pressure treatments).

Post-treatment conditions (storage of treated wood before use) should be regulated to ensure the sustainable use of biocides: In particular, intermediately after impregnation, wood must be stored on a paved and impermeable surface that is sufficiently protected from rain to prevent contamination of soil and ground water from any run off that may contain preservative.

In addition, harmonised minimum fixation times[17] after the treatment of wood (both by vacuum/pressure impregnation or dipping) should be specified at EU level (Schoknecht et al. 2003).

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[16] CA-Sept07-Doc.5.3 - Final Spraying method of wood preservatives for amateur users.

[17] In a certain period following the impregnation procedure the active ingredients of the wood preservatives have to react with the wood constituents to be fixed in the wood. During that period the risk of leaching by precipitation has to be minimised to ensure the efficacy of the preservation as well as to prevent emissions into the environment.

Although the restriction of spraying applications of wood preservatives to professional users has been rejected at the 26th competent authority meeting (see above), an EU wide regulation to restrict spray applications to (trained) professional users would be a preferable measure for the sustainable use of biocides. Furthermore, the application of wood preservatives by spraying should only be allowed in closed stationary systems.

3.7 Emissions during service life

Instruments for the reduction of environmental emissions during the service life are not considered in Directive 2009/128/EC on sustainable use of pesticides. However, a considerable proportion of total emissions of wood preservatives occur during the service life, through leaching from the treated timber (see chapter 2.3). Therefore, in contrast to plant protection products, the service life of biocidal products should be considered in detail in addition to the use phase.

Status

Provisions for the consideration of emissions from wood preservatives during the service life of wood within risk assessment are already part of the ESD for (OECD 2003). As consequence of the outcome of such risk assessments, the Inclusion Directives of several wood preservatives included in Annex I, IA or IB to Directive 98/8/EC contain restrictions concerning the *in-situ* treatment of wood outdoors or for wood that will be in continuous contact with water. These use restrictions prevent emissions of wood preservatives into water during the application phase and throughout the service life of treated wood (see chapter 3.1).

3.8 Specific measures to protect the aquatic environment

Emissions of preservatives to the aquatic environment may occur during the application, storage and service life of preserved wood (see chapter 2).

Status

In order to protect the aquatic environment, the Inclusion Directives for certain wood preservatives restrict the *in-situ* outdoor treatment of wood or of wood that will be in continuous contact with water (point 3.1). The same applies to *in-situ* treatments of wooden structures near water, where direct losses to the aquatic compartment cannot be prevented.

In addition, the Inclusion Directives for several wood preservatives that have been included in Annex I, IA or IB to Directive 98/8/EC require that freshly treated timber must be stored after treatment under shelter or on impermeable hard standing to prevent direct losses to soil or water, and that any losses must be collected for reuse or disposal.

Option

In line with Directive 2009/128/EC, preference should be given to biocides that are not classified as dangerous for the aquatic environment (pursuant to Directive 1999/45/EC) and do not contain priority hazardous substances, as set out in Article 16(3) of Directive 2000/60/EC. This applies in particular to the preservation of timber intended for use classes 4 & 5, where the treated wood will be in permanent contact with ground and/or fresh- and salt water (see chapter 2).

In-situ treatments of wooden structures in contact with or near water, where direct losses to the aquatic compartment cannot be prevented, should be restricted. Wooden structures that are intended to be in contact with water should preferably be treated using deep penetrating application techniques (e.g. vacuum or pressure treatments) to reduce the leaching potential of the wood preservatives concerned.

The requirement to store treated timber on sealed and covered surfaces should be a general prerequisite for all industrial wood preservatives to prevent leaching into soil, with subsequent contamination of groundwater, and run-off into surface water.

As a general rule for all biocides, unused products or surpluses should be disposed of properly and not washed down the drain.

3.9 Reduction of biocide use in sensitive areas

Status

For wood preservatives, several outdoor applications in sensitive areas can be identified, for example: fences, poles, railroad ties or other construction facilities (e.g. cabins, jetties) in areas used by the general public or by sensitive populations or in areas assigned to the conservation of wild birds, natural habitats and of wild fauna and flora.

As well as these outdoor applications indoor applications of wood preservatives may also be considered as uses within sensitive areas. For example, wooden roof timbers may be part of habitats used by wild animals such as bats and kestrels.

As a general rule, wood used within habitable rooms under normal conditions does not need to be protected against fungal attack. Furthermore, construction techniques, such as covering wood to protect it against insect infestation and open construction to allow visual inspection are described in DIN 68800-2.

The preventive protection for wood to be used for load-bearing and reinforcing timber construction elements is also regulated under German state building regulations. The protective measures to be taken (the wood preservative and the impregnation method to be used) are set out in detail in the German standard DIN 68 800, part 3 for preventive protection and in DIN 68 800, part 4 for curative measures. With regard to preventive protection measures, the construction supervisory authority should require that "a suitable procedure with the least environmental impact is to be given preference" when selecting impregnation procedures. In the case of control measures, part 4 of the standard explicitly stipulates that protected animals must be given special consideration: "In the case of timber construction elements, roof structures, etc. in which animals worthy of protection reside (e.g. bats, owls, kestrels, etc.), only those wood preservatives may be used that have been tested by a suitable testing office and their compatibility and suitability proved. These control measures may only take place at a time of year when these animals do not reside in these building elements."

Options

Measures that should be implemented to protect the aquatic (and the terrestrial) environment, which can be considered as sensitive areas per se, are described in section 3.8.

With regard to indoor applications, such as roof construction timbers, the controls described above concerning preventive protection and control measures must be followed.

3.10 Handling and storage of biocides and their packaging and remnants

Status

Handling

In Germany, under a voluntary agreement with industry, the packaging size for wood preservatives intended for non-professional use is limited to 750 mL.[18]

Disposal of remnants

Waste wood preservatives (remnants) fall under the Hazardous Waste Directive 2000/532/EC and have to be disposed of according to the following waste codes.

Waste Code	Type of waste
03 02	Wood preservation wastes
03 02 01*	Non-halogenated organic wood preservatives
03 02 02*	Organochlorinated wood preservatives
03 02 03*	Organometallic wood preservatives
03 02 04*	Inorganic wood preservatives

A significant amount of wood preservative enters the waste stream in the form of treated wood products and, in Germany the regulations covering the disposal of "used wood" (Altholzverordnung) include provisions for the recovery and disposal of wood treated with wood preservatives.

18 http://www.holzfragen.de/seiten/pop_biozide.html

Incineration of wood treated with wood preservatives

The incineration of wood has been questioned in some CARs. However, the substances of concern here are not limited to biocidal active substance and so focus on this life-cycle stage has been deferred to Member States' assessment at the product authorisation stage. For example it is known that about 5-10% of Chromium (III) used as a fixative for some wood preservatives is converted into Chromium (VI) during incineration.[19]

It should be noted that incineration of (treated) wood does not always occur under controlled conditions in licensed thermal treatment plants (as example suggested in the German regulations concerning "used wood"). For example, wood may be burned to heat private homes or in outdoor fires. The control of such incineration would require the preparation of guidance intended for non-professionals (the general public).

Options

- Limitation of packaging sizes and restriction of amateur use to ready-to-use products only.
- Instructions for non-professional concerning cleaning of treatment equipment (brush and container) following the application of wood preservatives.
- Instructions for non-professionals covering the disposal of treated wood, including guidance that such wood should only be burned in licensed incineration plants.

3.11 Integrated Pest Management

Status

Good practice in the application of biocides includes the identification of a need (problem analysis, identification of pests), the examination of potential measures to control pests, and the consideration of preventive and/or non-biocidal measures. All

[19] IPPC BREF Tanning of Hides and Skin draft 27. February 2009 , ftp://ftp.jrc.es/pub/eippcb/doc/tan_review_1D_pub.pdf

these elements are part of integrated pest management (IPM) approach, similar to that applied to the use of plant protection products. IPM integrates knowledge of pest biology, the environment and available technology, including the use of biocides.

Several studies and good practice (GP) guides are available describing integrated approaches to the reduction of the use and release of wood preservatives, e.g.:

- Description of the appropriate use and good practice during the use and disposal of biocidal products (Gartiser et al. 2005)
- Feasibility Study on the Support of the Information Requirement in Compliance with §22 ChemG on Alternative Measures for the Minimization of the Use of Biocides (Gartiser et al. 2006)
- Wood preservation: tips and information for correct handling of wood preservatives (Umweltbundesamt 2001)
- Practical Guide for Consumers on wood preservatives (BMELV 2008)

Gartiser et al. (2005 and 2006) describe inter alia elements of appropriate use and good practice during the use and disposal of wood preservatives. In this context they propose a uniform structure of GP reference documents (see Table 7). The proposed GP-structure reflects several elements of IPM principles such as the problem analysis and decision making process, the consideration of preventive and non-biocidal measures, as well as the controlling of success and documentation. The authors conclude that GP reference documents are not complete without references to legislation or other regulating documents, such as DIN-standards or information sheets from professional associations, which contain the basic information needed to implement GP. With regard to wood preservatives, the German technical standard DIN 68800 (Protection of timber, Part 1-5) includes provisions for the appropriate and safe use of wood preservatives (see chapter 3.1) and technical rules (TRGS) are available for both preventive treatments (TRGS 551 and 618) and curative treatments of wood (TRGS 512 and 523).

Table 7 shows the elements of good practice proposed by Gartiser et al. 2005 and names exemplarily elements of good practise or IPM principles for wood preservatives.

Table 7 Elements of good practice proposed by Gartiser et al. 2005

Step	Proposed general structure of Good Practice Documents	Good practice elements for wood preservatives
1	General principles and goals of the GP	
2	Description of the area of application	Preventive treatments; Curative treatments
3	Determination of the need for a biocide (problem analysis, definition of the goal)	Preventive treatments: Determination of the hazard and use class DIN 68800-3 and EN 335-1 and consequently determination of the preservation requirements (see Table 5). Curative treatments: Determination of the grade of infestation
4	Examination of the measures and decision making	Determination of measures to achieve the above goals
5	Prevention and non-biocidal measures	Preventive options: Preventive constructional measures in buildings according to DIN 68800-2; Selection of more resistant wood types; Depending on the intended use class, consideration of durability and treatability of different wood species according to EN 350-2; acetylation of wood etc. Curative treatments: Non-biocidal treatments like heat treatment
6 6.1 6.2 6.3 6.4 6.5 6.6	Proper use of biocidal products: Selection of low-risk products Minimising the amount of biocide used Licensing of equipment Applying risk management measures Controlling of success Waste disposal	Appropriate and safe use of wood preservatives according to technical standard DIN 68800ff. (Protection of timber, Part 1-5); Guidance documents for best practices of wood protection and biocide application (DGfH Merkblätter; see Appendix 5.1); Risk mitigation measures (see Table 6); Preference of deep penetrating treatments to reduce leaching; Application of special protective measures in connection with pest control activities for the use of highly toxic, toxic and health hazardous substances and preparations (TRGS 523); Collection of leachate/ run-off and recycling to prevent release, e.g. to the drains.
7	Documentation	Application of biocidal products for curative treatments has to be documented according to TRGS 523.
8	Storage and transport	Storage of treated timber on hard standing (impermeable ground) and under a roof.

Options

Further development of harmonised good practice documents and promotion of IPM guidance are considered to be the most promising measures for improving the sustainable use of wood preservatives.

Although promotion of efficient alternatives is already part of existing good practice guides (see above) it seems that more information (dissemination) is needed, especially for non-professional users.

Further measures for the application of IPM principles could include:

- Promotion of the use of ecolabelled products
- Substitution of, or at least a very strict use restriction on, very dangerous active substances

3.12 Indicators

Status

Reliable and up-to-date data on the production and consumption of wood preservatives (both on national and European level), are limited.

For Germany, the total consumption of wood preservatives is given in Lange (2001; cited in OECD 2003): According to these figures the total consumption in Germany was 29.000-31.000 tonnes (year not indicated). About 53 % of the preservatives were used in professional applications, about 41 % in industrial applications and about 6 % in do-it-yourself applications. About 95 % of the preservatives were applied in preventive treatment and about 5 % in curative treatment (OECD 2003).

A brief survey of the quantitative information on production volume contained in notification reports for biocides received by the European Chemicals Bureau was undertaken in July 2008 as part of the COWI report. Production tonnage data (1998-2001) were obtained for 65 % of the substances in PT8 and the total production volume of these substances was 11.233 tonnes. The tonnage of the five most important substances made up 93 % of the total. The PT 8 tonnage was 2.8 % of the total biocide tonnage (PT1-23).

In addition, COWI gives consumption data for Denmark: In 1998/1999 pressure and vacuum preservatives accounted for 9.1 % (377-453 tonnes) of the total consumption of biocidal active substances while preservatives for surface treatment accounted for 0.4 % (16-21 tonnes) (Lassen et al. 2001; cited in COWI 2009).

Options

Data on the manufacture and consumption of wood preservatives are needed for an evaluation of amounts used in the context of the sustainable use of biocides. Furthermore, data on the number of infestations with wood destroying insects and fungi, as well as the number of curative treatments, would be helpful for describing the problem.[20] Therefore, the inclusion of biocides into Regulation 1185/2009 concerning statistics on pesticides would be one option for gathering the required data on sales and consumption.

4 Example Outdoor brush coating of wooden structures

Use pattern	**Outdoor brush coating of wooden structures (e.g. fence or timber house)**
Target organisms	Wood destroying and discolouring fungi; wood destroying insects
User/applicator	Professionals and amateur users
Location	Outdoor; Use class 3 (outdoor application without contact to soil)
Active substances	Biocidal Product: Impranol-Holzschutzgrund; package 0,75-; 2,5-; 5- and 30-L Active substances: Tebuconazole: (0,60%) Dichlofluanid (0,55% Permethrin (0,15%)
Mode of application and dosage	Mixing: product is used undiluted Application: brushing, dipping at least 2 coats Dosage: 200-250 mL/m² in 2 coats Drying period: ca. 8 hours

20 For example, in Germany infestations with the wood-boring beetle *Hylotrupes bajulus* must be indicated to authorities in most federal states. ➔ http://www.holzfragen.de/seiten/recht.html

Use pattern	Outdoor brush coating of wooden structures (e.g. fence or timber house)
Main emission route	Brushing: (air)[21], soil, surface water, groundwater Waste from remnants, cleaning, used tools (e.g. brush) and gloves
Environmental behaviour	Tebuconazole is not readily biodegradable and has a low mobility potential. Dichlofluanid is inherently biodegradable. In biologically active soils it is rapidly degraded to DMSA (N,N-dimethyl-N'-phenylsulfamide). Dichlofluanid is extremely toxic to aquatic organisms but has a low toxicity to earthworms. DMSA shows a low aquatic toxicity.
Elements of sustainable use of biocides of PT 8	
Risk mitigation measures	Risk mitigation measures requested in the Inclusion Directives of the active substances Tebuconazole and Dichlofluanid: Use restrictions: - The inclusion document for Tebuconazole states that products with Tebuconazole as active substance cannot be authorised for the in situ treatment of wood outdoors or for wood that will be in continuous contact with water unless data are submitted to demonstrate that the product will meet the requirements of Article 5 and Annex VI, if necessary by the application of appropriate risk mitigation measures. - No in situ application by brush (professional or amateur) to wooden structures should be permitted where direct losses to the environmental compartment cannot be prevented. - Impregnated wood must not come in contact with food or feedstuffs. Risk management measures: - for painting (brush application) – suitable cotton coverall, protective -gloves and footwear are recommended.
Training	Status: Training of non-professional users (amateur users) is not foreseen. Product data sheets contain application recommendations and safety instructions. Reference to the Data Sheet "Merkblatt für den Umgang mit Holzschutzmitteln" is given in the product data sheet. Options Product data sheets should contain detailed application recommendations and safety instructions, especially for non-professional users (amateur users).
Requirements for sales	Status: Product must be classified and labelled properly. Product can be ordered from internet sale. A product data sheet containing application recommendations and basic safety instructions can be downloaded from the internet. Options: Information used by professional users as TRGS, UVV, SDS is not available to (and normally not understandable by) the non-professional user. Product

[21] The active substances have a low vapour pressure. Therefore, emissions to air are not relevant.

Use pattern	Outdoor brush coating of wooden structures (e.g. fence or timber house)
	information (like product data sheets) could be used for giving more (understandable) information to non-profession users including which important issues, risk and respective risk management measures the user should be aware of e.g. more detailed information of handling (e.g. instruction to cover the soil with tarpaulin during application). A harmonized format for this kind of product could be developed
Awareness programmes	Status: - Options - Publication of practical guides for amateur users
Certification and inspection of equipment in use	Status: Application with flat brush recommended. Options No certification/inspection of equipment required.
Form of the biocide and mode of application ➔ Emission during life cycle	Status: Outdoor application by brushing. As brushing is a surface treatment without deep penetration of the product / active substance into the wood, leaching out of the wood during the service life might be significant. Options: User instructions that outdoor applications in form of brushing should only be done during dry weather conditions to ensure minimum penetration and drying (= fixation) in order to minimise leaching
Specific measures to protect the aquatic environment	See also Risk Mitigation Measures. Status: - No in situ application by brush (professional or amateur) to wooden structures should be permitted where direct losses to the aquatic environment cannot be prevented. - Use restriction to use class 3: “wood not covered, no contact to ground (or fresh/salt water) - Product data sheet contains safety instructions with regard to the environment: “Do not let the product or its remnants get into surface waters, soil or waste water systems”. Options: - Use restrictions where direct losses to the aquatic environment cannot be prevented; a minimum distance from location of use to surface water could be introduced.
Reduction of pesticide use in sensitive areas	See specific measures to protect the aquatic environment.
Handling and storage of pesticides and their packaging and remnants	The waste packaging might be collected and returned to the supplier.
Integrated Pest Management	Proper use of the biocidal products: Selection of low-risk products or ecolabelled products; Minimising the amount of wood preservative used; Applying risk management measures; Appropriate cleaning of treatment equipment (brush and container) and waste disposal;
Indicators	Number of curative treatments.

5 Appendices

5.1 Overview on standards, BAT and other relevant documents

Standards	
DIN EN 84 (May 1997)	Wood preservatives- Accelerated ageing of treated wood prior to biological testing - Leaching procedure
DIN EN 335-1 (Oct. 2006) DIN EN 335-2, (Oct. 2006) DIN EN 335-3, (Sept. 1995)	Dauerhaftigkeit von Holz und Holzprodukten; Definition der Gefährdungsklassen für einen biologischen Befall; neue Bezeichnung: Dauerhaftigkeit von Holz und Holzprodukten -Definition der Gebrauchsklassen Teil 1: Allgemeines, Teil 2: Anwendung bei Vollholz, Teil 3: Anwendung bei Holzwerkstoffen
DIN 68800-1 (Nov. 2009) DIN 68800-2 (Nov. 2009) DIN 68800-3 (Nov. 2009) DIN 68800-4 (Nov. 2009)	Holzschutz - Teil 1: Allgemeines Holzschutz - Teil 2: Vorbeugende bauliche Maßnahmen im Hochbau Holzschutz – Teil 3: Vorbeugender Schutz von Holz mit Holzschutzmitteln Holzschutz - Teil 4: Bekämpfungs- und Sanierungsmaßnahmen gegen Holz zerstörende Pilze und Insekten
DIN 68800-5 (Mai 1978)	Holzschutz im Hochbau -Vorbeugender chemischer Schutz von Holzwerkstoffen
DIN EN 599-1 (Oct. 2009)	Dauerhaftigkeit von Holz und Holzprodukten - Wirksamkeit von Holzschutzmitteln wie sie durch biologische Prüfungen ermittelt wird - Teil 1: Spezifikation entsprechend der Gebrauchsklasse
DIN EN 599-2 (Aug. 1995)	Dauerhaftigkeit von Holz und Holzprodukten - Anforderungen an Holzschutzmittel wie sie durch biologische Prüfungen ermittelt werden - Teil 2: Klassifikation und Kennzeichnung
DIN EN 350-1 (Okt. 1994) DIN EN 350-2 (Okt. 1994)	Dauerhaftigkeit von Holz und Holzprodukten -Natürliche Dauerhaftigkeit von Vollholz - Teil 1: Grundsätze für die Prüfung und Klassifikation der natürlichen Dauerhaftigkeit von Holz. Teil 2: Leitfaden für die natürliche Dauerhaftigkeit und Tränkbarkeit von ausgewählten Holzarten von besonderer Bedeutung in Europa.
DIN EN 460 (Okt. 1994)	Dauerhaftigkeit von Holz und Holzprodukten -Natürliche Dauerhaftigkeit von Vollholz -Leitfaden für die Anforderungen an die Dauerhaftigkeit von Holz für die Anwendung in den Gefährdungsklassen
DIN EN 13991 (Nov. 2003)	Derivate der Kohlenpyrolyse -Öle aus Steinkohlenteer: Kreosot - Anforderungen und Prüfverfahren
Vornorm DIN CEN/TS 15003 (Juni 2005)	Dauerhaftigkeit von Holz und Holzprodukten -Kriterien für Heißluftverfahren zur Bekämpfung von holzzerstörenden Organismen
BS 5268-5 (Sept. 1989)	Verwendung von Holz im Bauwesen -Leitfaden für die Schutzbehandlung von Bauholz
ISO 21887 (2007)	Durability of wood and wood-based products -- Use classes
BAT	
BREF „Surface Treatment using Organic Solvents“ (Aug. 2007)	Chapter 18: Wood Preservation
Technical rules	
TRGS 512	Begasungen (Juni 2004)
TRGS 523	Schädlingsbekämpfung mit sehr giftigen, giftigen und gesundheitsschädlichen Stoffen und Zubereitungen (Nov. 2003) - “Pest control using highly toxic, toxic and health hazardous substances and preparations”
TRGS 618	Ersatzstoffe und Verwendungsbeschränkungen für Chrom(VI)-haltige Holzschutzmittel (Dezember 1997)

TRGS 551	Teer und andere Pyrolyseprodukte aus organischem Material (Juni 2003)
BGVV	Vom Umgang mit Holzschutzmitteln – Eine Informationsschrift (1997)
BMVEL (Referat 532)	Verbraucherleitfaden Holzschutzmittel (2003)
HBG (BGI 736)	Holzschutzmittel – Handhabung und sicheres Arbeiten (1999)
Bayer. Staatsministerium für Gesundheit, Ernährung und Verbraucherschutz	Gesundheitsgefahren und Schutzmaßnahmen beim betrieblichen Einsatz von wasserlöslichen Holzschutzmittel (2001)
Bayerisches Landesamt für Wasserwirtschaft	Wasserwirtschaftliche Anforderungen Holzimprägnieranlagen (Merkblatt Nr. 3.3./3, 1995)
BBA-Merkblatt Nr. 22	Vorsichtsmaßnahmen bei der Anwendung von Methylbromid (Brommethan) zur Schädlingsbekämpfung in Räumen, Fahrzeugen, Begasungsanlagen oder unter gasdichten Planen (1989)
BBA-Merkblatt Nr. 71	Drucktest zur Bestimmung der Begasungsfähigkeit von Gebäuden, Kammern oder abgeplanten Gütern bei der Schädlingsbekämpfung (1993)
BIA-Empfehlung Nr. 1023	Einsatz von Bis-(N-Cycohexyldiazeniumdioxy)-Kupfer-(Cu-HDO)-haltigen Holzschutzmitteln
UK Process Guidance Note NIPG 6/3 (Version 2, Oct. 2004)	Chemical Treatment of Timber and Wood Based Products
Codes of Practice (Merkblätter)	
DGfH.Merkblatt	Verfahren zur Behandlung von Holz mit Holzschutzmitteln Teil 1: Druckverfahren (1991)
DGfH.Merkblatt	Verfahren zur Behandlung von Holz mit Holzschutzmitteln Teil 2: Nichtdruckverfahren (1991)
DGfH.Merkblatt	Sicherer Betrieb von Kesseldruckanlagen mit aromatischen Imprägnierölen (1990)
DGfH.Merkblatt	Sicherer Betrieb von Kesseldruckanlagen mit wasserlöslichen Imprägnierölen (1990)
DGfH.Merkblatt	Sicherer Betrieb von Nichtdruckanlagen mit wasserlöslichen Imprägnierölen (1990)
DGfH.Merkblatt	Sonderverfahren zur Behandlung von Gefahrenstellen (3/2003)
DGfH.Merkblatt	Schutz von Holzwerkstoffen (ohne Jahresangabe)
DGfH.Merkblatt	Leitlinie für die holzschutzmittelverarbeitenden Betriebe bei Umweltfragen (1991)
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Research Project FKZ 3708 63 400

Thematic Strategy on Sustainable Use of Plant Protection Products – Prospects and Requirements for Transferring Proposals for Plant Protection Products to Biocides

Annex III:
Case study on PT 18: Insecticides

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On behalf of the Federal Environmental Agency

Final Report

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Contents

1 Introduction

1.1 Target organisms

The product type PT 18 refers to insecticides, acaricides and products to control other arthropods. Biocidal products of PT 18 are used in many different applications and against many target organisms:

Indoor application:

Cockroaches prefer warm conditions as found in kitchens and/or food processing facilities and are important vectors for various diseases. Among the ants the Pharaoh ant has invaded buildings in temperate climate of Europe. The Common black ant nests in gardens, under paving stones, in foundations or occasionally within buildings. Fleas feed on the blood of animals (e.g. cats, rodents) and humans. Among the flies the housefly is the most representative and is a vector of e.g. enteric diseases such as gastro enteritis. Female Mosquitoes feed on the blood of humans and other animals. Wasps and hornets build nests in soil and tree cavities as well as inside buildings. Hornets and other species are protected animals in many regions of the EU. Spiders and dust mites belong to the arachnid group. Bed bugs feed on blood and establish themselves in cracks, crevices, headboards, bed frames, mattresses, behind wall-mounted picture and other furniture. Termites are social insects, living in colonies underground, in wood or in nests.

Outdoor application:

Large or local scale mosquito control through the treatment of water bodies with larvicides and the control of the Oak procession moths have been identified as outdoor applications of insecticides. Both are combated with manual sprayers and aerial spraying. The control of Oak procession moths resembles to plant protection but has been attributed to biocides because they are primarily treated for heath hazard reasons as their hairs may cause skin irritation and asthma.

On principle, protected animals such as bees, hornets and other wasps must not be combated with biocides.

Special applications

For the control of foreign pests and alien species spray application and fumigation of reservoirs is very common. For example some countries oblige airlines to apply insecticides (mainly pyrethroids) during the flight on certain routes based on the WHO recommendations on the disinsecting of aircraft (in-flight spraying or space spraying). The German authorities recommend applying short term insecticides beforehand into the empty cabin to minimize exposure to passengers (BfR 2005). The fumigation of ship (import) containers through Methylbromide (in Europe not allowed anymore), Sulfurylfluoride or hydrogen phosphide might lead to high exposure to work people when these containers are opened (BfR 2009). These applications are rather discussed from a human health perspective than from an environmental point of view (e.g. Faulde, M. 2003).

Stables and Manure

Insecticides used in animal housing and manure storage systems are closely linked to veterinary hygiene biocidal products (PT 3)[1]. Products used for the control of external parasites are medicinal products. On farms, one main problem encountered is flies. There are several species of manure-breeding flies, which can become a serious problem and may be controlled by larvicides and/or adulticides. The house fly is one of the predominant species that breed in fresh manure, decaying silage, spilled feeds, bedding and other decaying organic matter. The other insects and arthropods, which may cause serious problems, are e.g. bloodsucking flies, lice, mites (acarids), louse flies, fleas, and cattle crubs. Especially poultry is susceptible to bloodsucking parasites.

1.2 Use and User groups

Household insecticides and insecticides used in public/commercial/industrial buildings may be applied by non-trained applicators (both private and professional). Professional user such as house caretakers, building cleaning professionals, or farmers may have some background on pest control from their professional education. Specifically trained professionals and/or certified professionals are used to apply insecticides routinely. To this group belong pest control technicians and

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[1] Although PT 3 belongs to the main group of disinfectants which does not cover insecticides.

applicators which should receive regularly further training. It should be mentioned, that the ESDs do not refer to "specifically trained professional" while some inclusion directives (e.g. on fumigants) and the respective "specific provisions" for active substances in Annex I do. The distinct user groups are discussed more in detail in chapter 3.2 on training.

1.3 Active substances

So far only few insecticides have been included in Annex I of the BPD such as Indoxacarb, Spinosad, Metofluthrin, Nitrogen, Phosphide releasing compounds, and Sulfuryl fluoride. The draft assessment reports of several other active substances are currently being discussed among Member States. According to the progress of the Review Programme for the evaluation of existing active substances the following active substances have been included in the Review Programme in 2009 (CA-Sept09-Doc.8.1).[2] The prevalence of pyrethroides is evident.

Table III-1: Active substances of PT18 being evaluated in the Review Programme

Substance group	**Substances**
Organophosphate	Azamethiphos, Diazinon, Dichlorvos, Naled
Neonicotinoid	Acetamiprid, Clothianidin, Imidacloprid
Triazine	Cyromazine
Pyrrole	Chlorfenapyr
Benzoylurea	Diflubenzuron, Flufenoxuron, Hexaflumuron, Triflumuron
Carbamate	Bendiocarb
Microbial	Bacillus sphaericus strain 2362, BTI strain AM65-52, BTI strain SA3A, Spinosad
Botanical	Abamectin, Margosa extract, Chrysanthemum cinerariaefolium, ext., Geraniol
Pyrethroide	alpha-Cypermethrin, Bifenthrin / Biphenate, Cyfluthrin, Cypermethrin, Cyphenothrin, d-Allethrin, Deltamethrin, d-Phenothrin, d-Tetramethrin, Empenthrin, Esbiothrin, Esfenvalerate, Etofenprox, Imiprothrin, Lambda cyhalothrinm, Permethrin, Prallethrin, Pyrethrins and Pyrethroids, Tetramethrin, Transfluthrin (n= 20)
Insect Growth Regulator	S-Methoprene (Insect Growth Regulator)
Organoarsenic compound	Sodium Cacodylate
Inorganic solids	Cyanamide, Silicium dioxide / Kieselguhr, Silicon dioxide – amorphous
Inorganic solids, gas releasing	Aluminium phosphide, Magnesium Phosphide
Inorganic gas	Carbon dioxide, Hydrogen cyanide, Nitrogen, Sulfuryl fluoride
Unclassified	Decanoic acid, Fipronil, Octanoic acid, Pyriproxyfen, Thiamethoxam
Synergist	Piperonyl butoxide / PBO
Total active substances	n=59

[2] The active substances supported are subject to continuing chances in the progress of the Review Programme.

1.4 Formulation types and mode of application

Insecticides affect their target organisms by ingestion, by inhalation or by contact with the active substance. Most insecticides act by contact. Even in the case of a space spray or self-pressurised aerosols the principle action is by direct contact. The form of the biocidal product to be marketed may be a gas, a liquid (emulsifiable or microencapsulated liquids, lacquers) or a solid. Among the gases are carbon dioxide, nitrogen, hydrogen cyanide, and sulphuryl difluoride. Other biocides such as aluminium phosphide or trimagnesium diphosphide release phosphine gas when these become in contact with moisture. Liquids are mainly applied to surfaces by spraying, atomization and hot atomization. Solids might be used in smoke generator (combustion), as contact powders or wettable powders, as water dispersible granules or as baits. Powders should be applied to inaccessible areas where they are not likely to be removed during cleaning or blown about.

For pest control measures ordered by authorities in Germany only approved biocidal products and pest control methods shall be used according to § 18 of the Infection Protection Act (Infektionsschutzgesetz-IfSG). These were evaluated and included to a list of the Federal Office for Consumer Protection and Food Safety (BVL 2008). Basis for the inclusion of biocidal products and methods is the proof of efficacy in accordance with the eradication principle and also an evaluation of effects on the environment and on human health. The list refers to the preparation of working solutions, the dosage and the duration of application. Additional instructions are given for main applications. For example the spraying distance, the area (e.g. barrier band) or hot spots to be treated, the preparation of efficient baiting campaigns. The list distinguishes between contact poisons with and without long-term effects, stomach insecticides, medicinal products or pharmaceuticals against head louse, biocides for expulsion of hidden pests, treatment without insecticides and the equipment (in combination with certain products).

Sprayers

Aerosol dispensers are hand-held self-pressurised ready to use products which disperse by a propellant such as butane.

Trigger spray (manual sprayer) are hand-held products which disperse through mechanically induced pressure.

One-shot aerosol cartridges are self-pressurised aerosols often called “foggers” or “fumigators” designed to release their entire contents as a fog for space treatments.

All these sprayers may be applied by both professional and non-professional user. Additionally, the professional use of knapsack sprayers as well as compressed air sprayers is very common.

In relation to the use of a one-shot aerosol cartridges (total release foggers) a study on occupational exposure of insecticides applied for pest control questioned, whether such products containing very toxic active substances can be handled safely without appropriate training and, generally, without the use of personal protective equipment (Schneider et al. 2008).

Dusters

Dusters are ready-to-use products which distribute powder insecticides through a shaker or rotary pumps. In wet areas also wettable powders are used which are not inactivated by water.

Diffusers and smoke generators

Diffusers are essentially used by the general public and consist of a reservoir (e.g. impregnated paper or stick pack) from which the insecticide (usually pyrethroids) evaporates passively or via electric vaporizing heaters. Smoke generators such as coils consist of a mixture of the insecticide with a combustible filler and produce when ignited sub-micron particles.

The German Federal Institute for Risk Assessment (BfR) objects to the use of diffusers with Dichlorvos in food product markets or other places accessible to the public because of possible chronic intoxication (BfR without year).

Foggers

Most fogging devices are exclusively applied by professional user and produce fine insecticide droplets (5 to 30 µm) which are suspended into air for air space treatments. For cold fogging the formulation is introduced in a variable airflow generated by a turbine. For hot fogging a heating cartridge is added which increases the rate of volatilization of the fogger liquid by achieving temperatures ranges of 60°C to 80°C. Compared to cold fogging, hot fogging generates smaller particles, which remain longer in the air.

Fogging of stables is only allowed when the animals were removed. Here also special mist blowers are used which also are applied for plant protection products.

The WHO defines a fog (synonym aerosol) as a space spray with mean droplets <50 µm diameter, while a mist is a spray in which the droplets have a mean diameter between 50 µm and 100 µm (WHO 2006).

One shot fogging cartridges are also available for consumer use.

Springling

For animal breeding in stables sprinkling of granules to the floor where organic substrate (e.g. manure, bedding material, and spilled feed) is present is very common. But also spraying of solutions and dispersions on the floor or on the walls and ceiling is applied.

Smearing

Smearing, for example with a brush ("brushing"), is usually carried out on those places of stables where flies use to stay, e.g. on window sills, ceiling, roof beams, lamp shades, etc. In some cases the insecticide is mixed with substances attracting the insects.

Gel applicators and baits

Insecticide gels often are mixed with a food attractant or a pheromone and are applied in the area of the track of crawling insects, e.g. cockroaches, ants. They are usually applied as ready-to-use products with an applicator gun or in sealed systems such as baits stations. Also ready-to-use baits which consist of blocks or granulates are marketed. They are also called chemical traps in contrast to physical traps where an attractant is combined with glues or high frequency coils or UV.

Importance of different modes of application

Few data is available on the importance of the different modes of application. Often professional pest control operators refer to Integrated Pest Management and modern application techniques such as baits which have replaced many spray applications.

However from product data bases it becomes clear that most insecticide biocidal products are designed for spray applications: Eickmann et al. (2006) collected 185 biocidal products for professional use of PT 18 of which 84% were applied by spraying. In another market survey 389 products for professional use of insecticides were compiled. Here 85% of all insecticidal products were applied by spraying (Schneider et al. 2008). A market survey of biocidal products for consumer use in Germany revealed that from 158 insecticidal products 46% are applied by spraying (Hahn et al. 2005). It should be noted that an evaluation of products on the market does not consider the market share of single products. Thus, these surveys only give an indication about the importance of their mode of application and the active substances used.

2 Possible emission routes and available ESD

Two ESDs are available for insecticides, acaricides and products to control other arthropods for household and professional uses (OECD 2008) and for Insecticides for stables and manure storage systems (OECD 2006). Other documents on human health exposure provide further background information. For example the exposure of consumer may be calculated by the CONSExpo Pest control product fact sheet. Here, also estimates about the frequency of spray applications of insecticides by consumers are given: 9 times per person per year (Bremmer et al. 2006).

Insecticides may be used indoors (within buildings), outdoors (around buildings and beyond), in sewer systems, in food storage systems and for veterinary purposes. Figure III-1 gives an overview on the areas of application, the mode of application, the most important target organisms and the exposure routes.

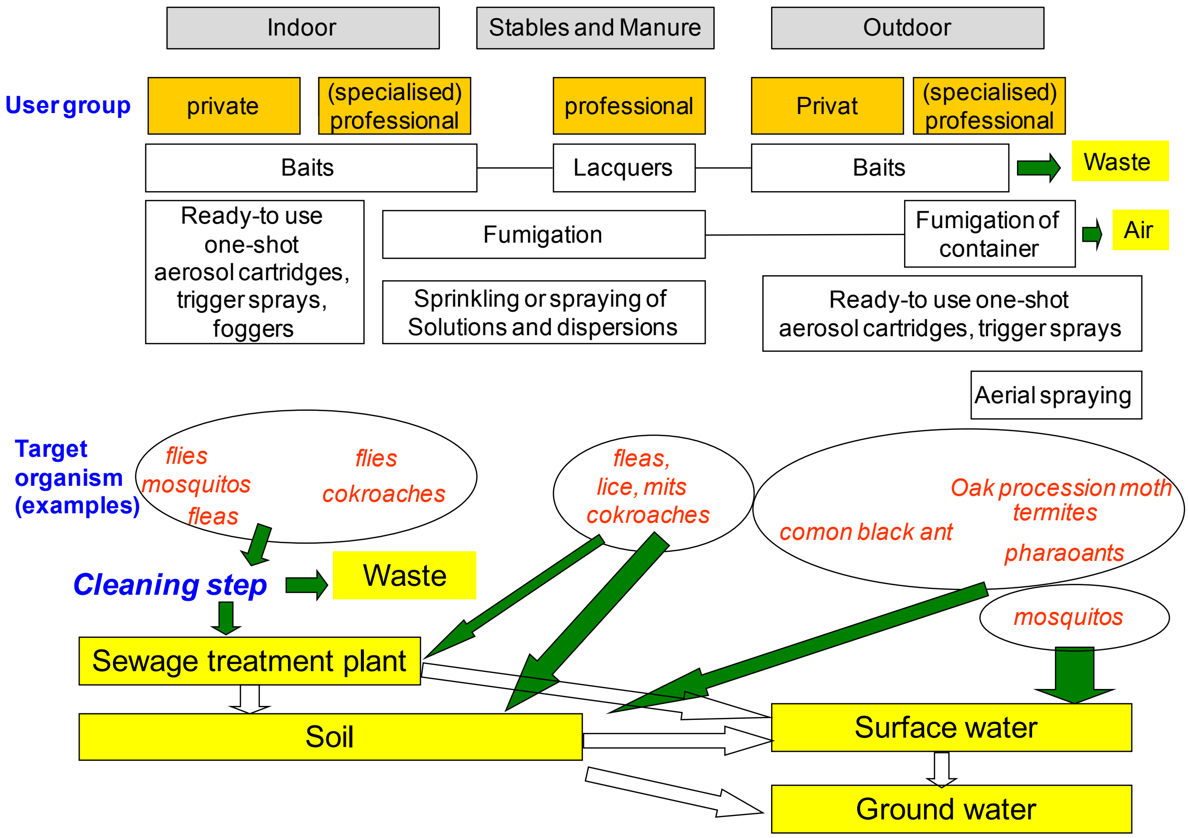

Figure III-1: Overview on the areas of application, the mode of application, important target organisms and the exposure routes of PT 18

Household and professional uses

Indoor

A survey of household insecticides in Germany revealed that these are used in the form of bait boxes, strips/stickers, powders or liquid preparations to control crawling insects and in the form of sprays and evaporators to control flying insects. The most commonly used active substances belong to the categories of pyrethroids (e.g. prallethrin) and organophosphates (e.g. dichlorvos and phoxim). To control ectoparasites on pets, mainly pyrethroids are used (e.g. in impregnated collars, sprays, powders and shampoos). Some of these products may also be attributed to veterinary medicinal products or PT 19 (if they have a repellent activity without killing effects). The evaluation of calculated exposures (screening) and of toxicity data resulted in the conclusion that risks for users from spray applications for crack and crevice treatment of the organophosphate chlorpyrifos (which meanwhile has been removed from the market) was substantially higher than that for the pyrethroid prallethrin (in terms of Margins of Exposure, MOE) (Hahn et al. 2005).

Insecticides may be marketed as ready-for-use products or as concentrates. The application of concentrates requires a dilution step (mixing) and/or a loading step (filling of the equipment. Insecticides applied indoor reach the treated surfaces, the walls and the floor but will generally not reach directly the environmental surface water (including sediments), groundwater, soil and air. Therefore, indoor receiving materials are considered as “intermediate compartments”. The cleaning step after application leads to releases either to wastes (dry cleaning methods) or to waste water (wet cleaning methods). Therefore sewage treatment plants (STP) are considered being one of the main “receiving compartment”. The “final” environmental compartments are surface water, the groundwater (e.g. through sewage sludge from STP), the soil (from sludge application) and the outdoor air. If needed the mixing / loading step for the preparation of working solutions might result in additional exposure to the environment.

The cleaning (or decontamination) of surfaces after application of insecticides has been challenged as measure to minimise the toxicological risks of an exposure of human beings and non-target animals. In Germany, the technical rule TRGS 523 requires that after pest control measures the accessibility of treated areas must be approved by the operator after considering measures such as continuous aeration, removal of bait residues or cleaning.

Practical experiments showed that the decontamination success depends largely on the formulation of the insecticide used and on the removal technique applied. The highest reduction in insecticide residues was achieved for micro-encapsulated formulations. High-pressure extraction was the most effective technique for the removal of insecticides residues from non-porous, waterproof surfaces. The decontamination result is influenced primarily by the surface structure of the target material, the type of insecticidal formulation applied and the procedure used to remove insecticide residues (Winter et al. 1999, 2000). It should be noted that from an environmental point of view the cleaning step may result to emissions to the environment. In some (draft) CARs for actice substances (e.g. Fipronil) the RMS suggested to restrict the application area indoors to cracks and crevices treatment inaccessible to man and domestic animals, because the risk assessment showed risks for surface water when a cleaning step was applied.

Another emission route is the “decontamination” of textiles such as protective clothes after application by washing and the release of contaminants to the wastewater.

<u>Outdoor</u>

The main scenario for outdoor control of flying and crawling insects is the spray or powder application around the building (perimeter treatment). Powders are used as insecticidal barrier against crawling insects to avoid the infestation of the buildings. Secondary poisoning of non-target animals (i.e. birds or mammals) consuming contaminated insects or taking their food, e.g. grass or seeds, in the treated area is a major concern. Insecticides applied outdoor reach the environmental compartments either directly (e.g. spray application) or indirectly (spillage during preparation or from e.g. bait stations). Additional releases to the environment occur when contaminated insects do not die immediately and carry the active substance to the surrounding area.

The fate of the substance released depends on the location of the treated structures. In rural areas, releases will end up on unpaved soil. The relevant environmental compartments are soil and groundwater. Large scale mosquito control with larvicides and targeted treatment spots (e.g. termites bait stations) also result in direct release to the environment.

In urban environments, the ground surface mainly consists of non permeable substrates and residues of insecticides are washed out with rain to the rain water/sewer system. Depending on whether separated or mixed sewer systems for rainwater and wastewater exist the primary compartments are surface water or sewage treatment plants (and successively surface water, soil from the application of sewage sludge and groundwater as “final” environmental compartments).

In Germany, the technical rule TRGS 523 requires that the working solutions or baits should be prepared preferably outdoors from the respective concentrates. This principle, which follows a human health point of view, might cause environmental exposure, if spillage of biocides occurs or if residues are emitted to rain runoff.

Stables and Manure

Animal housing

The use instructions for the application of insecticides such as smearing of walls and ceiling or spraying to the floor as well as interval for repetition and need for ventilation after application for treatment of animal housing facilities influence the fraction of the biocide reaching the manure storage system and the fraction emitted directly to the air.

Manure storage

Insecticides applied as a larvicide at manure storage systems end up completely in the manure. For the emissions the way of application e.g. sprinkling or spraying of the insecticide to manure is not important. The degradation during the manure storage time before land application might be taken into account.[3] Next to liquid manure (slurry), effluents from dry manure storage, wet precipitation, cleaning water from milking systems or stable cleaning might enter wet storage tanks (liquid waste, slurry). Dry storage systems (manure heap or manure pit) and in some cases parts of the liquid waste may also be discharged to the sewer. Direct release to the sewer is not allowed in most member states. Solid or dry manures are normally stored on

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[3] A technical protocol for determining the transformation of biocides in liquid manures has been developed in a German research project (Kreuzig et al. 2010).

impermeable concrete floors which often are connected to an effluent tank to store the liquid fraction separately. For the application of wet or dry manure as a fertiliser to agricultural soil many countries have legislation setting standards for the maximum amount of phosphate and/or nitrogen per area which determines also the release of insecticides to soil. After application to agricultural soils leaching of insecticides to surface and ground water may occur.

3 Elements of sustainable use for PT 18

3.1 Risk mitigation measures

Status

The TRGS 512 “Fumigation” describes the personal protection equipment to be used when applying fumigants. For hydrogen cyanide and phosphine releasing compounds air-purifying filters may be used, for sulfuryl fluoride atmosphere-supplying respirators are required which are independent from the air surrounding the user.

The inclusion Directives for insecticidal active substances and the draft CARs refer to user restriction for fumigants to specifically trained professionals while applying appropriate personal and respiratory protective equipment. Phosphine releasing compounds may only be applied by professionals in the form of ready-for-use products. The use of applicators may be a measure to reduce risks.

Additional RMM are the information of potential bystander and the removal of food before application, the keeping of waiting periods which ensure compliance with the Maximum Residue levels (MRLs) on food and feed allowed and the proper disposal of unused products.

The minimisation of exposure of insecticides to humans, to non-target species and to the aquatic environment has been challenged. For example products shall be positioned away from external drains and unused products shall be disposed properly and not washed down the drain.

Options

The (draft) CARs also describe restriction of the application areas such as only indoor use in crack and crevices or in concealed locations inaccessible to man and domestic animals for avoiding secondary exposure. Other RMM concern the restriction of use in animal housings to those without an effluent to the sewer system or direct release to surface water. Further potential RMM to be applied for insecticides are the limitation of the package size, the application of baits, the limitation of maximum concentration, use or user restrictions for spray or other modes of applications, and the recollection of remnant packages by the supplier.

The evaluation of RMM risk mitigation measures for biocidal products of PT 18 (and PT 8) has been evaluated more in detail within another research project (Gartiser et al. 2011).

3.2 Training

Status

According to the inclusion Directives of fumigants (e.g. sulfuryl fluoride) and fumigant releasing compounds (phosphide) only specifically trained professionals are allowed use these active substances.

According to the COWI-study several MS have established mandatory certification schemes for pest control operators (including PT 18 applications with insecticides): In Belgium pest control operators must be registered and must hold a certificate of professional qualifications. In Germany requirements exist for the qualification of professional users for PT 14-19 in accordance with the Hazardous Substances Ordinance and the Technical Rule TRGS 523. TRGS 523 only applies for curative pest control, preventive measures are not addressed. Fumigation may only be performed with official permission. In Hungary, for professional users of PT 14, 18 and 19 certification is mandatory. Also in Lithuania, in The Netherlands, Romania, The Slovak Republic, Spain, and Sweden there are requirements for training and certification of professional users for PT 18. Moreover, very toxic or toxic substances as well as CMR substances of category 1 and 2 are often only allowed to be used by authorised professional users. Other Member States such as France and the United Kingdom have voluntary certification schemes.

In Germany four user categories applying insecticides are distinguished:

a) Specialized professional user

In Germany, about 1000 companies offer pest control services. Since 2004, a three-year recognized occupational education to professional pest controllers exist. The curricular of the professional education of pest controllers includes the following items:[4]

Safety and occupational health, relevant laws, information sources, operational procedures, use and maintenance of equipment, handling and use of hazardous chemicals and pest control agents, risk mitigation measures to avoid exposure of operators, bystanders, and of the environment, the monitoring of pests, planning and realisation of pest control measures, consultancy of customers, quality assurance.

Before 2004 the qualification “pest control operator” was obtained by advanced training of people from other professions. All pest control operators automatically are considered as possessing expert knowledge according to Annex III No. 3 of the Ordinance on Hazardous Substances. Pest controller may be examined by the IHK (IHK: Chamber of Industry and Commerce).[5] Some companies also have a certified quality management according to DIN EN ISO 9001.

Also building cleaning operators receive a two or three-year education with contents of pest control. These are considered competent in pest control after additional training. After this training, the operators may carry out simple pest control measures and can acquire expertise or sub-competence with relatively little effort.

For some applications such as fumigations according to the Technical Rule TRGS 512 the successful participation of training courses is required for acquire the necessary competence and certification. The basic course for fumigation takes 5 to 9 days depending on the fumigants included.

The German Pest Operator Association (Deutscher Schädlingsbekämpfer-Verband e.V., DSV) offers training and education measures of their members and also develops technical standards for pest control (TRNS).[6]

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4 http://www.gesetze-im-internet.de/bundesrecht/sch_dlbekausbv/gesamt.pdf

5 http://svv.ihk.de

6 http://www.dsvonline.de

The Confederation of European Pest Control Association (CEPA) in 2008 published the Roma Protocol, a commitment to develop professional standards for the European pest management industry. A certification system for companies or individuals and the development of common criteria concerning the quality of services through participating in the work of CEN (European Committee for Standardisation) started in December 2010. For the maintenance of authorisation training and periodic updating in technical, commercial, administration and customer services is required (CEPA 2008). According to CEPA in total around 38.000 persons are employed in about 6.800 companies engaged in pest control in Europe achieving a total turnover of 1.501 million EUR. Rodent control and insect control are the most important segments, representing 78% of the turnover of all activities (CEPA 2003).

The work proposal by CEPA will not look at details of pest control but at the services offered and performed by pest controllers (qualification thereof). The time frame for standard development is three years from the date of the acceptance of the proposal by the CEN Members.[7]

b) Non specialised professional user

This user group may occasionally be asked to carry out pest control measures within their routine work as employees in public institutions, the food industry, public institutions such as schools or hospitals, building caretakers, facility manager and similar services. These users are only allowed to have access to substances and preparations classified under the Hazardous Substances Ordinance as very toxic, toxic or containing CMR substances, if they prove to hold expert knowledge.

c) Farmers

Farmers often acquire appropriate training including pest control measures (diploma in agriculture, agricultural engineer, agricultural master) or by additional training on crop protection. Farmers usually do not perceive differences between plant protection products and biocidal products. Biocidal products are routinely applied in the agricultural environment including animal breeding. The expertise of farmers and their awareness of hazards of biocidal products are likely to vary widely.

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[7] Personal communication of Ms Andrea Gulacsi, CEN - European Committee for Standardization from 13.10.09

d) Non-professional amateurs applying pesticides in their home

Amateur users must not have access to biocidal products classified as very toxic or toxic or containing CMR substances according to the Hazardous Substances Ordinance.

Option

From an environmental point of view the user restriction could also include substances which fulfil the criteria for being persistent, bio-accumulative and toxic (PBT) or very persistent and very bio-accumulative (vPvB). Further on substances which have endocrine-disrupting properties or developmental, neurotoxic, or immunotoxic effects might be subjected to user restrictions.[8]

Each improvement of training and qualification supports sustainable use of insecticides. The obligatory certification of all professional users of insecticides (including non specialised professional users and farmers) would be one option. The development of harmonised guidance on best practices and suitable use instructions for applicants via the label or guidance documents are further measures for improving sustainable use.

3.3 Requirements for sales of pesticides

Status

In Annex II of the COWI an overview on national qualification schemes for sellers and retailers is given. In Belgium, Malta and in Malta Slovak Republic training is required for seller and retailers. In Germany, Spain and Sweden retailers need a certificate to sell products with certain hazardous properties.

In Germany distributors or retailers selling biocide products classified as toxic, very toxic or harmful (R40, R62, R63, R68) or oxidising or extremely flammable need a certificate (expert knowledge) according to the Chemikalien-Verbotsverordnung (ChemVerbotsV).

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[8] According to the proposal for a Biocides Regulation (version from 14 December 2010) the Council of the European Union recommends that also biocidal products containing substance with PBT, vPvB, and endocrine properties (among others) should not be authorised for use by the general public.

Biocidal products classified as very toxic or toxic should not be marketed through self-service systems from open shelves, including internet commerce (Chemikalien-Verbotsverordnung, ChemVerbotsV). In Germany self-service of plant protection products is prohibited irrespective of their classification according to the plant protection law (Pflanzenschutzgesetz, PflSchG).

Options

Requirements for sales of biocides following as envisages in the Directive of sustainable use of pesticides.

3.4 Awareness programmes and information to the public

Status

Insecticides certainly belong to those biocidal products for which communication of risks is required. Many experts note that self-treatment for pest control often is improperly applied followed by further spread of pests or development of resistance and that expert knowledge is required for effective pest control. In Germany a web-based information system (web portal combined with print media) has been established for the general public (www.biozid-portal.de). The special portal developed and run by the Federal Environment Agency (www.biozid.info) is a part of the information system and aims providing information to the general public about physical, chemical and other measures as alternatives for the use of biocidal products or for minimization of their use, the focus laying on the description of preventive measures.

he Urban Pest Advisory Service (UPAS) of Zurich initiated a project to advise people on the correct use of insecticide sprays in households and to reduce unnecessary applications. In their advisory work they often met people who try to get rid of insects or mites indoors with an insecticide spray, often without even knowing the species. When they were told that a professional pest control operator (PCO) is needed, people often worry about the poison this action will involve. Despite this fear they do not consider that their own use of insecticide sprays could be more harmful for their health. An information leaflet called “The reasonable handling of insecticide sprays” has been published for the public. People are advised that in many cases there are better alternatives to spraying. Harmless insects coming in from outdoors could for example be excluded with window fly screens. Spraying will not stop more insects from coming in. In the case of cockroach, pharaoh ant or bed bug infestation, sprays cannot solve the problem, so a pest control operator is needed. When pets are infested with ectoparasites (mainly fleas), veterinarians often recommend one-shot aerosols to customers which cover all surfaces with insecticide and are often overdosed or applied in the wrong locations. Instead a pest control operator is the better choice in houses with flea infestations (Landau-Lüscher 2008).

In Belgium a Federal programme for reducing the use of both agricultural pesticides and biocides has been established since 2005 with the objective to reduce the environmental impact of pesticides for agricultural use by 25% in 2010 and to achieve a 50% reduction in other sectors on which approved pesticides and permitted biocides have an impact. The aim of this programme is not to reduce the use of pesticides and biocides, but rather to reduce the risks to health and the environment caused by their use. This aim is expressed through risk indicators. Since 2006 this programme is financed by contributions (taxation) of the products following the polluter pays principle. These contributions take into account the amounts sold and the scores attributed on the basis of the risk phrases.[9]

Options

Development and realization of awareness programmes. Making accessible all relevant information about the prevention of pests, minimisation of risks, and alternative non-biocidal pest control measures. Intensification of information exchange of authorities and pest controller. Interchange of authorities with other experts on a European level.

3.5 Certification and inspection of equipment in use

Status

In Germany plant protection products must be applied properly and for their intended use with inspected equipment. The manufacturer, distributor or importer of new types of plant protection equipment must confirm compliance with the requirements by

[9] The Belgium approach should also be described in the main report on task 2 and 3. https://portal.health.fgov.be/pls/portal/PORTAL.wwv_media.show?p_id=954218&p_settingssetid=1&p_settingssiteid=56&p_siteid=56&p_type=basetext&p_textid=8552411

submitting a declaration, including the relevant documentation. The declaration procedure is obligatory for all plant protection equipment. Plant protection equipment must not be sold in Germany if it has not been listed in the plant protection equipment list at the BBA. In addition, there is a voluntary approval procedure which includes a practical inspection of the equipment in use. There is also the European Network for Testing Agricultural Machines (ENTAM), a network of European inspection centres for agricultural machines and equipment which carries out inspections at test benches and grants mutual recognition with regard to inspection reports. Additionally the SPISE Working Group (Standardised Procedure for the Inspection of Sprayers in Europe) was established during in 2004 and is working on further steps for the harmonisation and mutual acceptance of equipment inspections. A constant exchange of information should be made possible between the working group and consultations going on between the EC and MS on improving the sustainability of plant protection (http://www.jki.bund.de). Equipment for pest control is only covered if the equipment is used for both plant protection and biocidal products.

The technical rule TRGS 523 on pest control requires that the equipment for application of pest control agents such as spraying or fogging equipment may only be applied according to the operating instructions of the supplier and must be checked for functional and safety efficiency at least once a year. It refers also to the technical rule for liquid sprayers (UVV 3.11 "Flüssigkeitsstrahler") of the accident prevention & insurance associations, which meanwhile was suspended. This technical rule applied to both liquid sprayers with more than 25 bar operation pressure and for those with less than 25 bar, if used for the application of hazardous substances. However, mainly mechanical safety measures are described.

Only few harmonised standards exist for crop protection equipment. Some of the equipment is also used for biocides (e.g. ISO 19932 part 1 and 2: knapsack sprayers). Some pest control measures are approved according to § 18 of the Infection Protection Act and require a combination of a specific biocidal product with the respective equipment, that means that they are assessed in conjunction (BVL 2008).

The producer of spraying and fogging equipment for pest control refer to equipment standards of the WHO (1990, 2006) and the ISO standards on “safety of machinery” (Technical Committee 199, http://www.iso.org).

For spraying of insecticides often hand-held ultra low volume (ULV) sprayers are used. Here, droplet size is controlled by an atomiser disk driven by an electric motor and thermal fogger generators. Compared to conventional sprayers ULV Sprayers produce smaller droplets in the range of 20-75 µm which cover a larger target area compared to conventional sprayers (Koch et al. 2004). As a result the overall consumption of the active substances is minimized. Droplet size and volume flow is controlled by the nozzle size, the viscosity of liquid and atomiser discs, rotating nozzles or other mechanically devices. Some sprayers define their droplet size so that the droplets are no respirable (> 35 µm). From an environmental point of view ULV sprayers should be preferred compared to conventional or low volume sprayers because the overall amount which might be released to the environment is minimized.

While Directive 2009/127/EC from 21 October 2009 on machinery for pesticide application requires, that the equipment for application of plant protection have to be inspected (with possible exemptions of hand-held equipment) no general certification of equipment for the application of insecticides in pest control exists.

Options

With an amendment of Directive on machinery 2006/42/EC for considering equipment for the application of pesticides, the scope of the Directive could be enlarged to cover equipment for the application of biocides (with exemptions for those with minor importance). Initiatives for harmonisation and standardisation of the equipment for biocide application could be supported. The inspection and certification of biocide equipment could also be established via national rules.

3.6 Mode of application

Status

Aerial spraying

Aerial application of biocides has been identified for large scale application of *Bacillus thuringensis* toxins (among other biocides such as Diflubenzuron) for mosquito control and the control of oak procession moths. The insecticides are sprayed or trickled as granulate.

Spaying

The spraying equipment for applying insecticides in pest control usually is the same as used for plant protection products. The parameters determining inhalation and dermal exposure when applying spraying of insecticides have been determined by simulation measurements in model rooms. Field measurements at selected workplaces showed that the distribution of particle diameters is the most relevant parameter for human exposure. Additionally exposure significantly depends on the workplace operation such as the direction of spraying: Overhead applications cause far higher human exposure than applications directed towards the bottom. Dermal exposure through high pressure spraying equipment (often applied in stables) is higher than through low pressure spraying equipment as usually applied indoors for pest control (Koch et al. 2004). Whether the choice of the equipment also determines exposure to the environment has not been analysed.

Fumigation

Many Member States require that fumigants should only be applied by professionals. In Germany the technical rule TRGS 512 "Fumigations" (2008) describes the requirements for fumigation with Hydrogen cyanide, Phosphine releasing compounds (Aluminium phosphide, Magnesium phosphide) and Sulfuryl fluoride. The possibility that imported products might be fumigated with other gases such as in the meantime banned Methyl bromide should be kept in mind. Only competent operators holding a certificate of authorities are allowed to carry out fumigations. For Phosphine releasing compounds portioned ready–for-use-products may also be applied by assistants who have been instructed by competent operators. For soil fumigation (a plant protection application) ready-for-use products releasing less than 15 g Phosphine do not require an authorisation of operators. Before fumigation an evaluation of possible alternatives such as treatment with heat, Carbon dioxide or Nitrogen has to be performed as part of a substitution check. The proof of air tightness and the identification of potential leakages to adjoining buildings and the presence of bats or birds in the roof structure have to be checked before the gas is released. The object fumigated may only be accessible to the public after the concentration of the fumigant has been declined below the detection limits (hydrogen cyanide 2 ppm, Phosphine 0.01 ppm, Sulfuryl fluoride 1 ppm, see TRGS 512).

Options

The existing national standards could be adapted harmonised on a European level. The translation of technical rules such as TRGS 512 is an important step to harmonisation. The restriction of spray applications or on-shot foggers to non-professional users would be an option for improving sustainable use. The use of water soluble packages by professional users for preparing working solutions from concentrates could reduce human and environmental exposure during mixing and loading and enable correct dosage of solutions.

3.7 Emission during service life

The emission of insecticides during the service life is not as relevant as for preservatives. Remnant efficiency of surfaces/lacquers treated with long term insecticides could be considered as “service life”. These are partly covered with the discussion on decontamination and cleaning (see chapter 2).

3.8 Specific measures to protect the aquatic environment

Status

The Water Framework Directive (WFD) 2000/60/EC sets environmental standards for priority substances, but no insecticides have been included. The establishment of drinking water protection zones for pesticides applies for both plant protection products and biocidals products. The restriction of the use area indoors to crack and crevices treatment inaccessible to cleaning has been mentioned in some CARs as RMM. Also the minimisation of the potential exposure of humans, of non-target species and of the aquatic environment by avoiding drainage and runoff of biocides as well as s by ensuring proper disposal of unused products has been challenged.

Options

The few examples of direct applications to water bodies (e.g. mosquito control and liquid manure) should be carefully examined. For indoor treatment the conflicting recommendation concerning the cleaning of surfaces from a human health and environmental point of view should be examined by European experts. The inclusion of biocidal insecticides and their metabolites in monitoring programmes would be a further option for better assessing environmental exposure.

3.9 Reduction of pesticide use in sensitive areas

Status

It has been reported that *Bacillus thuringensis* toxins for mosquito control may be applied in natural habitats for wild fauna and flora after approval by local authorities.[10]

Residential exposure to insecticides post-application is an important issue from a human health point of view. Therefore private homes could be considered as a “sensitive area” per se. For example metabolites of Pyrethroides resulting from pest control uses, preservation of wool carpets, or ant-flea treatment of pets are routinely found in the urine of private home habitants (reference values for selected metabolites are in the range of 1-2 µg/L, Anonymous 2005). Similarly several reference values have been established for Organophosphate metabolites in urine, mainly resulting from food intake but also from pest control measures (range between 16-160 µg/L, Anonymous 2003). Krieger et al. (2001) analysed different exposure sources of Chlorpyrifos pesticides used indoors via fogger, spray and crack-and-crevice treatments. The persistence of total residue on carpet was substantially higher than the residues transferable to man. Exposure estimates from monitoring results with urine were substantial lower than the predictions from modelling exposure. However, environmental exposure after cleaning measures is not discussed.

In the German Environmental Survey of Children, several biocides have been analysed in the 63 µm dust fraction. Despite the fact that Pentachlorophenol (PCP), DDT and Lindane have been banned, they are still present in house dust samples of households. Chlorpyrifos and Methoxychlor were quantifiable in 32% and 24% of the samples, respectively. The insecticides Polychloro-2(chlormethylsulfonamid)-diphenylether and derivatives (PCSD and PCAD, components of wool preservative Eulan) were detected in 15% of the house dust samples. Hexachlorobenzol and Propoxur were quantifiable in only 2% and 6% of the samples, respectively (Müssig-Zufika et al., 2008). PCP and other Chlorophenols as well as Pyrethroid metabolites

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[10] Personal communication of Dr. Norbert Becker, KABS, Germany

have also been detected in urine samples. PCP mainly has been attributed to former applications as a wood, textile and leather preservative (Becker et al., 2008).

A study on the exposure of humans to Pyrethroids used as insecticides for pest control and wool carpet preservation in private and occupational rooms concluded that no evidence of risks for humans can be derived from biological monitoring provided that best practices are applied (BMBF, IVA 2001).

However, it should be noted that all these studies aim on the evaluation of potential risks for human health. Environmental aspects would have to be considered when decontamination and cleaning of surfaces leads to releases to the soil or water compartments e.g. via wastewater and landfill of sewage sludge (see chapter 2).

Options

For the protection of surface water, soil and Natura 2000 habitats a general prohibition of the application of insecticides in sensitive areas could be declared.

As aerial spraying of biocides is actually used to control mosquitoes and oak procession moths it is appropriate to consider a prohibition on aerial spraying of biocides. Applications with lower environmental concern, such as the use of *Bacillus thuringiensis* toxins, might be exempted from a general prohibition.

In private homes the application by consumers in their homes and residential exposure of bystander to insecticides should be discussed. This might lead to user restrictions if proper use of insecticides by consumers can not be guarantied.

3.10 Handling and storage of pesticides and their packaging and remnants

Status

For consumer use exclusively “ready for use” insecticides are marketed. Empty packages and remains should be delivered to existing municipal collection systems for hazardous substances. Empty packages are not routinely collected and returned to the supplier.

The TRGS 512 gives detailed rules for the disposal of packages from fumigation. Small-scale materials including contaminated packages of phosphine releasing compounds may be separately collected and disposed via municipal hazardous waste collection. Compressed gas container are returned to the supplier and re-used. The procedure for decontamination of phosphine releasing compounds by water in open containers positioned outdoor for 12 hours is also described. The equipment should be cleaned after application and hereby residues of the working solutions and flushing liquids must not be emitted to water bodies but must be collected and disposed according to the waste laws.

TRGS 523 on pest control describes general rules for storage of pest control agents, which should not endanger human health, the environment. Any misuse should be avoided by suitable precautionary measures. For storage of more than 50 kg pest control agents classified as toxic or very toxic additional TRGS 514 on storage of toxic and very toxic compounds applies which describes further requirements for the construction of stock facilities such as the protection from floodwater, housebreaking, fire-protection etc. as well as surface requirements of the floors, which must retain liquids in pans and must be impermeable and not connected to sewers.

Options

Te use of appropriate sizes of packages and the limitation of concentrations of the active ingredients are instruments for reducing hazardous wastes. As a general principle concentrates should not be used by amateurs. The establishment of a collection and recycling system similar to that for plant production products should be discussed for larger packages from professional uses.

3.11 Integrated Pest Management

Status

Several (national and international) guidance documents concerning the pest control and including IPM principles exist:

- WHO 2008 Public Health Significance of Urban Pests (Bonnefoy et al 2008)
- Handbuch für den Schädlingsbekämpfer (Bodenschatz 2009)
- Malis Handbook of Pest Control (Malis et al. 2004)
- Complete Guide to Pest Control with and without chemicals (Ware, G. W. 2005)
- Pesticide Applicator Core Training Manual - Certification, Recertification and Registered Technician Training - Part A: Required reading for: Private pesticide applicators, Commercial pesticide applicators, Registered technicians

- Healthy Hospitals - Controlling Pests Without Harmful Pesticides (Owens 2003)
- Health and Safety Agency for Northern Ireland (1995). The safe use of pesticides for non-agricultural purposes. Approved Code of Practice.

CEPA started an initiative for standardisation pest controlling services under CEN (see also chapter 3.2).

Some case studies exist where cost and efficiency of IPM measures are compared to conventional treatment (Miller et al., 2004, Wang et al., 2005). Generally, the cost of IPM treatment was higher compared to the conventional treatment at the beginning of the treatment, but comparable after some months. Efficiency on cockroach control was always best when applying IPM (for more details see chapter 6.4).

While general principals on IPM rules can be described, such as the need of monitoring, it seems that sound IPM measures have to be developed pest specifically. This is comparable to IPM in the agricultural sector which considers specific crops.

Options

Applying IPM principles is a promising tool for improving sustainable use of insecticides. The promotion of initiatives on IPM (e.g. of CEPA), the request to include IPM principles in standard development, and the establishment of an EU expert group developing common standards would be options to support IPM development.

The substitution of very dangerous active substances such as CMR or PBT substances would be one option for improving sustainable use. The evaluation of risks during the review programme on existing biocidal active substances already led to the removal of many priority substances from the market. Flufenoxuron is an example which due to its PBT/vPvB properties will not be included in Annex I of the Biocidal Product Directive according to the suggestions of the RMS (draft CAR report on Flufenoxuron). Depending on the progress of the review programme further PBT substances or candidates for comparative risk assessment might be identified. To date only active substances for which risks have been identified are subject to a comparative assessment. During the decision making for the pest control method to be applied substitution of hazardous active substances by less hazardous ones is a general principle for ensuring safety at working places. However, operators need instruments and background information as a decision tool.

3.12 Indicators

Status

Few data on total amount of household pest control agents exists but practically no data on professional uses of insecticides is available In 2007 the Industrie Verband Agrar (IVA) member companies sold about 20 t pest control biocidal actives (mainly PT 18/19) and 3 t ant control actives (IVA, 2008). However, no data for specific active substances is available from this source. From the COWI-report it is known that Cyanamide, Dichlorvos, Phenothrin, Piperonylbutoxide, Propoxur, Pyrethrin and Pyrethroids are the most important insecticides used in Europe. However no data on consumption of active substances/biocidal products is available for Germany and the most other Member States (Belgium, Finland, Romania, and Sweden collect data on an annual basis). Slovenia and Spain collected data from producers, retailers and professional users of T, T+ and CMR 1 and 2 substances (COWI 2009). However, it remains unclear whether these data are published.

Options

The data gap on the use of biocides has been complained from many researchers. The inclusion of biocides into the Regulation (EG) No 1185/2009 concerning statistics on pesticides would be an option for gathering data on sales and consumption and on typical applications and use patterns. These data could serve as a baseline for a future evaluation of the progress on sustainable use of biocides.

In Germany, according to TRGS 523 pest control operators must hold a register of all pest control products with their classification, amount, and area to be used. These data is only provided to authorities on request but not routinely collected for statistical evaluation. However, they are available on principle.

4 Examples

4.1 Control of cockroaches by spraying and bait applications

Location	Indoors in kitchens and/or food processing facilities
Target organisms	Cockroaches cause serous food contamination and disease transmission as well allergens and need to be controlled. Originating from Africa they are now cosmopolitan pests. From around 3500 species worldwide the German cockroach (*Blattella germanica*), the Oriental cockroach *(Blatta orientalis*), the Brownbanded cockroach (*Supella longipalpa*) and the American cockroach (*Periplaneta Americana*) are the most often referred ones.
User/applicator	Professional user including pest control operators
Active substances	Biocidal products: **Biocidal Product 1** Fipronil (0.05%) in 35 g cartridge, application as ready-for-use-bait. **Biocidal Product 2** Hydramethylnon (2.15%) in 30 g cartridge, application as ready-for-use-bait. **Biocidal Product 3** Natural Pyrethrines (5.4 g/L) and Permethrin (214 g/L) as concentrate for spray application after dilution **Biocidal Product 4** d-Phenothrin (10%) as emulsified concentrate for spray application after dilution Human exposure when applying these products was estimated by Schneider et al. (2008).
Mode of application and dosage	**Gel baits** Application of bait gels is performed via specific bait guns. Dosage Biocidal Product 1: up to 3 x 0.03 g/ m^2 depending on species present and level of infestation. A spot of gel 3-4 mm in diameter weighs approximately 0.03 g. Dosage Biocidal Product 2: 0.25 – 1 (g/m^2). A 100 mm strip of 2 mm in diameter weighs approximately 0.25 g. **Spray application follows two steps:** Mixing and loading: 40 mL Bioicdal Product 3 are diluted with water in a knapsack sprayer to 5 litres (0.8%) 7,5 mL Biocidal Product 4 are diluted with water to 0,5 L in a handheld trigger spray Application 5 litres diluted Bioicdal Product 3 are applied to 100 m^2 surface (50-10 mL / m2 depending on the). The scatter band of the spray application ion floors and walls is about 1 m. 0.5 litre Bioicdal Product 3 is applied on about 20 m of door frames or similar localisations. For preventing insects from entering from outside, spray barrier strips 10 cm wide at doors, windows etc are recommended (from instructions of a comparable product with pyrethroide alphacypermethrin).
Frequency	Gel Baits: Bioicdal Product 1: Gel baits will remain pliable and palatable to cockroaches, usually up to 12 weeks. Where infestations are high inspect the baits four weeks after treatment and replace as necessary. Spray application: Permethrin has remnant efficiency over 2-3 months.

Main emission route	Wastewater after wet cleaning
Other uses	
Environmental Behaviour	Still being under evaluation
Available Best Practices Standards	No specific guidance documents on cockroach control found, but included in IPM documents on general pest control.
Elements of sustainable use of biocides of PT 18	
Risk mitigation measures	Gel baits: No special measures for handling are necessary provided the product is used correctly. When using, do not eat, drink or smoke. Do not spray insecticides on or around bait gels or place it on recently treated surfaces, as this may discourage cockroaches from feeding on it.
Training	Only applied by professional users according to the product instructions
Requirements for sales of pesticides	Only to be sold to professional users.
Awareness programmes	
Certification and inspection of equipment in use	Not important for bait cartridges and hand held trigger spray. Certification of Knapsack sprayers could be required. In Germany some (few) knapsack sprayers used for both plant protection and pest control purposes have a GS-certificate ("Geprüfte Sicherheit" ="Tested Safety". ➔ http://www.praevention.lsv.de/lbg/struktur/fach_inh.htm Several standards for knapsack sprayers exist: ISO 19932-1:2006: Equipment for crop protection -- Knapsack sprayers -- Part 1: Requirements and test methods ISO 19932-2:2006 Equipment for crop protection -- Knapsack sprayers -- Part 2: Performance limits ISO 10625:2005 Equipment for crop protection -- Sprayer nozzles -- Colour coding for identification ISO 4254-6:2009 Agricultural machinery -- Safety -- Part 6: Sprayers and liquid fertilizer distributors
Form of the biocide and mode of application	Applications of insecticides to cracks and crevices as gels baits, dusts and liquid spray are effective against cockroaches which prefer to hide in small dark spaces. Baits should be placed in the vicinity of: corners, cracks and crevices, voids, service-ducts, lift shafts, equipment and furniture e.g. counters, refrigerators, cookers, sinks, baths, and around sensitive situations e.g. electrical, electronic and mechanical equipment. General surface treatments by spraying can be targeted to baseboards and bands in the corners (e.g. each 1 m of wall and floor) as well as to electric and warm water lines and tubes.
Emission during service life	For baits and spray application emission to the environment is possible via cleaning and decontamination. According to the product instructions of Biocidal Product 3 only surfaces which might come in contact with food or feed should be decontaminated via an alkaline purifier followed by a neutral water purifier applied e.g. via high pressure cleaners.
Specific measures to protect the aquatic environment	Do not allow contamination of public drains or surface or ground waters. Prevent product from entering water courses or the ground. Bait gels should not be applied where it will become submersed or likely to be removed by routine cleaning.
Reduction of pesticide use in	Only use indoors. Residence rooms, hospitals, schools, kitchens, etc. might be considered as sensitive area per se from a human health point of view.

sensitive areas	
Handling and storage of pesticides and their packaging and remnants	Gel Baits: Clear spillage immediately while wearing protective clothing. Contain spillage, sweep or shovel up, collect contaminated material and place in a marked container for disposal. Keep dry and frostproof in a suitable pesticide store. Keep only in original container. Keep away from heat and protect from sunlight. Store separately from food, drink and animal feed. Spray application No special measures for handling necessary provided the product is used correctly. When using do not eat, drink or smoke. Keep dry and frostproof in a suitable pesticide store. Store separately from food, drink and animal feed.
Integrated Pest Management	Conventional treatment consists in the preventive and reactive application of insecticides with sprays and dust. Basic IPM programmes to control cockroaches were initiated in the 1980s. With IPM the amount of insecticides can be reduced by 90% compared to conventional treatments. The removal of debris, harbourage sites and food sources is one prerequisite in cockroach control programmes. The identity of the pest species and the locations with pest infestation must be known. One main potential for reducing the amount of insecticides is to identify areas that do not need to be treated. Careful monitoring with cockroach traps using attractants or pheromones is used for determining the level of infestation. However, traps alone do not effectively control cockroaches, especially German cockroaches. Additionally non-spray chemical treatments using baits result in reductions in the numbers of cockroaches. Indeed the development of baits has revolutionized cockroach control, especially against the German cockroach. Alternative strategies consist in non-chemical treatment with heat. Most household insect pests are extremely sensitive to high temperatures. At 52ºC, a 30-minute exposure kills 100% of adult male German cockroaches. In field studies, it was possible to control German cockroaches by heating foodhandling areas in buildings to 46ºC for 45 minutes. The housing technology and design has a major influence on the prevalence of cockroaches infesting structures. The elimination of harbourages such as ventilation systems, false ceilings, wall coverings, central heating, and sewage pipes with warm conditions is the primary goal of so-called built-in pest control. By incorporating habitat removal, granular and gel bait treatments, and some spot sprays, greater than 80% reductions were achieved with less total insecticide used, compared with conventional perimeter sprays.(Bonnefoy et al. 2008). Some case studies exist where cost and efficiency of IPM measures are compared to conventional treatment. Miller et al. (2004) analysed the IPM effectiveness for the control of German cockroach (Blattella germanica) in a public housing environment. The "traditional" treatment for German cockroaches consisted of monthly baseboard and crack and crevice treatment with a conventional biocide by using spray and dust formulation insecticides. The IPM treatment involved initial vacuuming of apartments followed by monthly or quarterly applications of baits and insect growth regulator devices. At the beginning of the study the cost of the IPM treatment was significantly higher than the traditional treatment, but after 4 months the cost was comparable, because many of the IPM apartments could be moved to a quarterly treatment schedule. In addition, the IPM treatment was also more effective than the conventional treatment as was shown by monitoring of the remaining cockroach population by trapping. Wang et al. (2005) realised a comparative study on the cost and effectiveness of a building-wide cockroach integrated pest management (IPM) program compared with bait alone treatment in public housing. In the IPM group, cockroaches were flushed and vacuumed and sticky traps were placed to monitor and reduce cockroach numbers. Educational materials were delivered

	to the residents; and only afterwards bait gels were applied to kill cockroaches. IPM resulted in significantly greater trap catch reduction than the bait alone treatment. IPM resulted in a more sustainable method of population reduction. The cumulative cost of IPM was significantly higher than that of the bait treatment at the beginning but declined to equal levels as for the bait alone strategy after 29 weeks. The authors expect that IPM will provide better control at similar cost compared with bait alone treatment.
Substitution of very dangerous active substances	Not identified

Conclusion

Cockroaches are one of the most significant pests found in apartments, homes, foodhandling establishments, hospitals and health care facilities worldwide. Additionally sensitization of habitants in an urban environment to cockroaches and their and their faeces (next to those of dust mites) has been identified a major cause of asthma.

Some cockroaches (including the German cockroach) have developed resistance to many of the organophosphates, carbamates and pyrethroids extensively used against them (Bonnefoy et al. 2008).

4.2 Disinfestations of insects from emptied food processing structures and storage areas through fumigation

Location	Emptied food processing facilities (buildings, silos, mills, containers) including processing of cereals (e.g. breakfast cereal), flour and semolina based products (e.g. biscuits, cakes, pasta), chocolate confectionary, dried fruit and tree nuts. Fumigation of structures is considered to be worst-case in terms of the amount of Sulfuryl fluoride used and greater difficulty to seal compared to other fumigation scenarios (e.g. container fumigation).
Target organisms	Foodstuff moths such as the flour moth, mill moth, dried fruit moth. Beetles such as the rust red flour beetle, confused flour beetle, saw toothed grain beetle, warehouse beetle, leather beetle.
User/applicator	Qualified professional user
Active substances	The Biocidal Product has a purity of 99.8% sulfuryl fluoride.[11] The Biocidal product is a mixture of approx. 98 % of hydrogen cyanide with stabilizing additives.[12]
Mode of application and dosage	Sulfuryl fluoride is a colourless gas with a boiling point of -54 °C. The gas is introduced from gas cylinders via an introduction tube (minimum burst pressure 35 bar) into large open spaces. The maximum concentration is 128 g/m^3 and the maximum target dosage for is 1500 $g.h/m^3$. The dosage is dependent on the pest species, the life stage and the temperature. Increasing the temperature reduces the dosage required for all pest life stages. A computer programme (Fumiguide) has been developed to be used for the coordination of

[11] http://www.dowagro.com, data also refer to the draft CAR Sulfuryl fluoride, PT 18 from 20 February 2009 published at http://circa.europa.eu.

[12] Data for Hydrogen cyanide refer tot he draft CAR from December 2007 (published at http://circa.europa.eu). HCN is still under evaluation and thus conclusions might be revised after discussion at technical meetings.

	fumigant rates with the parameters of temperature, pest, exposure period and fumigant loss rate (measured as half-loss-time) (draft CAR Sulfuryl fluoride, PT 18 (Insecticide), 20 February 2009). Hydrogen cyanide (HCN) dosage for full efficacy is 10 g/m3, i.e. 1 kg per 100m3. The Biocidal product (stabilized liquid hydrogen cyanide) is mixture of approx. 98 % of hydrogen supplied completely soaked into a porous material in 1.5 kg gas-tight steel cans.
Frequency	Once; repeated application only needed if reinfestation occurs.
Main emission route	Sulfuryl fluoride is released to the environment after treatment when the sealed structure is vented. The ESD estimates that, after application, 97.9 % of the fumigant is released to the air compartment within one day.
Other uses	Both fumigants are also used for PT 8 , HCM also for PT 14.
Environmental behaviour	Sulfuryl fluoride is expected to remain primarily in the air phase due to its very high vapour pressure and relatively moderate water solubility (1.04 g/l). Atmospheric lifetime for sulfuryl fluoride was estimated as being 5 to 14 years. Photolysis is not expected to be a significant contributor to the degradation of sulfuryl fluoride in the troposphere. Hydrolysis in ocean waters is of major importance. Sulfuryl fluoride is not directly released to the aquatic environment or soil and will therefore not directly impact these compartments. No risks to aquatic organisms are expected from the hydrolysis products of sulfuryl fluoride accumulating in water over ten years . The global warming potential of sulfuryl fluoride (compared to CO_2) is considerable, but the substance has no potential to deplete stratospheric ozone. Due to the global warming potential, a monitoring programme for sulfuryl fluoride in remote tropospheric air is required for product authorisation, as stated in the specific provisions of Annex I. The half-life of HCN in the atmosphere is about 1-3 years, but HCN is ubiquitous, formed by natural organisms and by volcanic activity as well as anthropogenically from the exhaust gases of automobiles.
Available Best Practices Standards	TRGS 512 “Fumigations”
Elements of sustainable use of biocides of PT 18	
Risk mitigation measures	Exposure of the applicator is considered to be negligible as the applicator should not be present during the fumigation and operators should use self-contained breathing apparatus (SCBA). To minimize the amount of fumigants required in buildings, the total air volume to be exposed may be reduced by using so-called big air balloons. Wear positive pressure self-contained breathing apparatus and protective clothing, do not wear gloves or rubber boots when introducing the gas For most devices there is latency between the action and the release of the product. Appropriate measures to protect fumigators and bystanders during fumigation and venting of treated buildings or other enclosures must be taken. Labels and/or safety-data sheets of products shall indicate that, prior to fumigation of any enclosure, all food items must be removed. Surveillance of the concentrations of sulfuryl fluoride outside the fumigated. structure, by use of monitoring equipment, is a prerequisite to ensure safe level of exposure for both operators and bystanders. Wash all protective cloths after use. The product label of Sulfuryl fluoride states that no contamination of surface water or ditches with the chemical or used container should occur. The concentration of Sulfuryl fluoride in remote tropospheric air shall be monitored and Member States shall ensure that reports of the monitoring are submitted by authorisation holders directly to the Commission every fifth year.
Training	Only allowed to be applied by authorised professional users
Requirements for sales of pesticides	Sulfuryl fluoride and HCN should not be sold nor provided to unauthorised persons, including among professional users.
Awareness programmes	
Certification and	Yes: Gas steel cylinders are routinely checked for air tightness, TRGS 512

inspection of equipment in use	requires regularly inspections of the equipment.
Form of the biocide and mode of application	The gases are usually provided in steel cylinders as a liquefied gas under pressure.
Emission during service life	Not relevant
Specific measures to protect the aquatic environment	HCN should not be released through ventilation after fumigation when it is raining, because the wash out could cause water pollution.
Reduction of pesticide use in sensitive areas	Prevent access of livestock, pets, and other non-target mammals (e.g. bats) and birds to buildings under fumigation and ventilation.
Handling and storage of pesticides and their packaging and remnants	HCN is extremely flammable while sulfuryl fluoride is non-flammable, non-explosive and has no oxidizing properties. Use of protective equipment.
Integrated Pest Management	Fumigation with Sulfuryl fluoride used as PT18 is for non-food applications. All food items have to be kept in air-tight sealed packages or must be removed from the premises to be fumigated. The structure has to be made as gas tight as possible by sealing all openings (e.g. windows, doors). Not to be applied when temperature at the site of the pest activity is below 10 °C. Also HCN should not be applied below 10°C and it should be ensured that it is not washed down by rain, especially in the final phase of ventilation. Hydrogen cyanide has a higher density than air. Residual concentration of hydrogen cyanide is reached under normal meteorological conditions 24-72 hours after the beginning of ventilation. The fumigated structure must be properly ventilated before re-entry without PPE. Before re-entry, the local air concentration of sulfuryl fluoride or HCN must be ≤ 3 mg/m^3.
Substitution of very dangerous active substances	Carbon dioxide and Nitrogen are suffocating inert gases used for pest control which could be used as substitutes.

Conclusion:

Sulfuryl fluoride is increasingly used as fumigant due to the phasing out of Methyl bromide, which depletes the stratospheric ozone layer, under the Montreal Protocol. The global warming potential of Sulfuryl fluoride is considerable. Thus the concentration in remote tropospheric air shall monitored by applicants for product authorisation. Mitigation Measures refer to human exposure of operators and bystanders. Hydrogen cyanide (HCN) is a classical fumigant, the application of which is limited due to its high solubility in water and its extreme flammability. Because hydrogen cyanide is miscible with water, wash out with rain must be avoided.

5 Appendices

5.1 Overview on standards, BAT and other relevant documents

Standards	
DIN 10523 (Juli 2005)	Lebensmittelhygiene – Schädlingsbekämpfung im Lebensmittelbereich
ISO 6322-3 (Juli 1999)	Storage of cereals and pulses -- Part 3: Control of attack by pests
Technical rules of authorities	
TRGS 512 (Nov- 2008)	Fumigations
TRGS 523 (Nov. 2003)	Schädlingsbekämpfung mit sehr giftigen, giftigen und gesundheitsschädlichen Stoffen und Zubereitungen
BBA-Merkblatt Nr. 22 (1989)	Vorsichtsmaßnahmen bei der Anwendung von Methylbromid (Brommethan) zur Schädlingsbekämpfung in Räumen, Fahrzeugen, Begasungsanlagen oder unter gasdichten Planen
BBA-Merkblatt Nr. 71 (1993)	Drucktest zur Bestimmung der Begasungsfähigkeit von Gebäuden, Kammern oder abgeplanten Gütern bei der Schädlingsbekämpfung
Guidance documents of professional associations	
TRNS Teil 1 (14.07.2005)	Technische Regeln und Normen der Schädlingsbekämpfung Gesundheits- und Vorratsschutz (G+V) sowie Materialschutz im Gesundheits- und Vorratsschutz (M/G+V)

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Thematic Strategy on Sustainable Use of Plant Protection Products – Prospects and Requirements for Transferring Proposals for Plant Protection Products to Biocides

Annex IV:
Case study on PT 21: Antifouling products

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On behalf of the Federal Environmental Agency

Final Report

Freiburg, 30th August 2011

Contents

List of Abbreviations

ACP	Advisory Committee on Pesticides
AFP	Antifouling Product
ANZECC	Australian and New Zealand Environment Conservation Council
BAT	Best Available Techniques
BCF	British Coatings Federation Ltd
BPD	Biocidal Products Directive
BUWAL	Bundesamt für Umwelt, Wald und Landschaft (Swiss Agency for the Environment, Forests and Landscape)
CEPE	European Committee for Paints and Inks
COWI	Consultancy within Engineering, Environmental Science and Economics
CPD	Controlled depletion polymer
DCOIT	4,5-dichloro-2-octyl-2H-isothiazol-3-one
DDT	Dichlordiphenyltrichlorethan
DIN	Deutsche Institut für Normung; German Institute for Standardization
Diuron	3-(3,4-Dichlorphenyl)-1,1-dimethylharnstoff
DIY	Do It Yourself
DK	Kingdom of Denmark
DMS	*N,N*-Dimethylsulfamide
EC_{50}	half maximal effective concentration
ECI	European Copper Institute
ESD	Emission Scenario Document
ESIS	European chemical Substances Information System
EU	European Union
FIN	Republic of Finland
FR-coating	Foul release coating
GNF	Global Nature Fund
GUV	Deutsche Gesetzliche Unfallversicherung
HPW	High pressure water washing
HSE	Health and Safety Executive
HVLP	High Volume Low Pressure- Technique
IMO	International Maritime Organisation
IPPIC	International Paint and Ink Council
Irgarol®	2-Methylthio-4-*tert*-butylamino- 6-cyclopropylamino-*s*-triazin
ISO	International Organization for Standardization
LimnoMar	Labor für Limnische, Marine Forschung und Vergleichende Pathologie; Laboratory for Freshwater, Marine Research and Comparative Pathology
M&R	Maintenance & Repair
MAMPEC	Marine Antifoulant Model to Predict Environmental Concentrations
MS	Member State
MSCA	Member States Competent Authorities

MSDS	Material Safety Data Sheet
N	Dangerous for the environment
NDMA	*N*-Nitrosodimethylamine
NL	Kingdom of the Netherlands
OECD	Organisation for economic Co-operation and Development
OSPAR	Oslo-and Paris-Conventions
PBT	Persistant, Bioaccumulative, Toxic
PDMS	Poly dimethyl siloxane
PPP	Plant Protection Products
PT 21	Product Type 21
QWASI	Quantitative Water, Air and Soil Interaction
R	Risk Statement
RA	Risk assessments
REACH	Regulation (EC) No 1907/2006 on the Registration, Evaluation, Authorization and Restriction of Chemicals
REMA	Regulatory Environmental Modelling of antifouling
RMM	Risk Mitigation/Management Measure
SDS	Safety Data Sheet
SE	Kingdom of Sweden
SED	Solvent Emission Directive (1999/13/EC)
SME	Small and medium enterprises
SPC	Self-Polishing Coating
STP	Sewage Treatment Plant
T	toxic
T^+	very toxic
TBT	Tributyltin Compounds
Teflon®	Polytetrafluorethene
TH	Technische Hochschule
TOT	Triorganotin
TRGS	Technische Regeln für Gefahrstoffe Technical Rules for Hazardous Substances
UBA	Umweltbundesamt; Federal Environment Agency, Germany
UK	United Kingdom of Great Britain and Northern Ireland
UV	Ultraviolet
UVV	Unfallverhütungsvorschriften
VDL/DSV	Verband der deutschen Lackindustrie
VOC	Volatile Organic Compounds
vPvB	very persistant very bioaccumulative
WFD	Water Framework Directive
WWF	World Wide Fund For Nature
WWT	Waste Water Treatment
WWTP	Waste Water Treatment Plant
Xn	Harmful
Zineb	zinc ethane-1,2-diylbis(dithiocarbamate)

1 Introduction

1.1 Target organisms

Micro- and macro organisms settle on surfaces placed in salt and fresh water within a short time. The type and intensity of fouling depends on different environmental factors e.g. temperature, salinity, nutrient supply and light. Fouling is more rapid in salt water because of the diversity of organisms. Up to 150 kg of organisms can settle on one m² surface area within six months (Peters et al. 2002, UBA, 2007). Fouling in general is unwanted e.g. as increased flow resistance on ships leads to an increase of fuel consumption – the frictional resistance can raise fuel consumption by up to 40% and this will result in increased bunker costs, expenses due to lost earnings or time delay; also, manoeuvrability is decreased and the possibility of premature corrosion is increased. Another negative effect is the potential for transmigration of species (UBA, 2007). Therefore, antifouling products are used to prevent surfaces from unwanted growth and settlement of fouling organisms. Target organisms are all microbes and higher forms of plant or animal species, micro- and macro organism (bacteria, algae and crustaceans) in sea water and fresh water that may possibly settle on ship hulls and other surfaces.

1.2 Use and user groups

The highest amount of antifouling product (AFP) is used for ship hulls (commercial and pleasure). The worldwide demand for this use is estimated at 95% of the total demand. Other uses are aquaculture equipment (e.g. fish nets), pipelines, and harbour and offshore constructions.

The use of AFP in offshore construction, e.g. drilling platforms, is considered as the most important after the use on ship hulls, approximately 2.5 % of the total global demand (van de Plassche et al., 2004; OECD 2005). Nevertheless, the use of AFP in German coastal waters may be less, because the life span of underwater constructions is much longer than the period over which release of an antifouling paint could guarantee a fouling free surface[1].

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[1] Personal communication B. Waterman, limnomar, 7.12.2009 and HSE corrosion protection – offshore technology report 2001/011

The application of AFP and paints for ship hulls takes place in ship building yards and maintenance and repair yards. For the latter, yards for commercial and for pleasure boats can be distinguished. Professional application on vessels of > 25 m and < 25 m length is carried out by both trained and untrained workers. The treatment of vessels < 25 m is mainly done by untrained professional users and amateurs. Yacht building and repair ranges in scale from craftsmen to large manufacturers and approximately 98% of these businesses are small and medium enterprises (SME). While in new construction the coating is generally agreed between shipyard and customer, in maintenance and repair yards the customer has more influence on coating choice and may purchase the coatings directly (UBA, 2007).

For other uses, AFP are mainly used by specifically trained amateurs.

1.3 Active substances

The Biocidal Products Directive defines PT 21 as “Products used to control the growth and settlement of fouling organisms (microbes and higher forms of plant or animal species) on vessels, aquaculture equipment or other structures used in water.”

Currently the 5th EU review programme contains 10 substances, organic and inorganic (metal-based), some of these are also used as PPP e.g. Tolylfluanid and copper thiocyanate. The most important substances in terms of production tonnage were DCOIT (4,5-dichloro-2-octyl-2H-isothiazol-3-one), Diuron[2], and Zineb (Kjolholt 2008 cited in COWI, 2009). Diuron is not longer included in the review programme for use in PT 21. Another important boosting antifouling agent is Irgarol 1051, which is used to supplement copper based paints (Gardinali et al. 2004). Irgarol 1051 was detected in surface waters from South Florida (Miami region). Table 1 gives an overview of active substance included in the 5th review programme and the classification found in the ESIS data base or self-classification by manufacturers.

2 For Diuron a notification is only planned for PT 7 and 10.

Table 1: Substances included in the 5th review programme

Substance group	**Substances**	**Classification**
Organic	**Tolyfluanid** (dichloro-N-[(dimethylamino)sulphonyl]fluoro-N-(p-tolyl)methanesulphenamide, EC Nr: 211-986-9)	very toxic T+, R26, dangerous for the environment N, R 50
	Dichlofluanid (EC Nr: 214-118-7)	harmful Xn, dangerous for the environment N, R50
	Cybutryne/ Irgarol (N'-tert-butyl-N-cyclopropyl-6-(methylthio)-1,3,5-triazine-2,4-diamine), (EC Nr: 248-872-3,)	not classified in ESIS database (self classification: R 43, N ; R 50/53)
	DCOIT (4,5-dichloro-2-octyl-2H-isothiazol-3-one) (EC Nr: 264-843-8)	not classified in ESIS (self classification: Xn; R21/22, C; R34, Xi; R37, R43 N; R50)
Inorganic (metal based)	**Copper** (EC Nr: 231-159-6)	not classified in ESIS
	Dicopper oxide (EC Nr: 215-270-7)	harmful Xn, dangerous for the environment N, R50-53
	Copper thiocyanate (EC Nr: 214-183-1	not classified in ESIS (self classification: Xn; R20/21/22 R32 N; R50/53)
	Copperpyrithione Bis(1-hydroxy-1H-pyridine-2-thionato-O,S)copper (EC Nr: 238-984-0,)	not classified (self classification: T+; R26 Xn; R22 Xi; R41, R38 N; R50)
	Zineb (EC Nr: 235-180)	irritant Xi
	Zinc Pyrithione (EC Nr: 236-671-3)	not classified in ESIS (self classification: T, R23/24/25)

Organotin compounds for antifouling have been restricted by Commission Directives 1999/51/EC and 2002/62/EC. The International Convention on the Control of Harmful Antifouling Systems on Ships, developed by the International Maritime Convention Organisation (IMO), entered into force on 17 September 2007 and will end the use of organotin compounds globally. Nevertheless, sealed organotin antifouling paints and other antifouling substances no longer used in the EU can still be found on ship hulls and can be released during maintenance and repair and metal recycling.

AFP based on copper contain it at up to 50% w/w as the main biocide (UBA, 2007). Copper-containing AFP is designed to leach out copper ions at a concentration at the surface of the vessel that repels organisms from attaching to the ship hull. Copper prevents barnacles, mussels, shells, weed and similar organisms (macro-fouling) from settling. Micro-fouling formed on the surface may promote macro fouling. Therefore, co-biocides are added such as Irgarol and Zineb (International Council of Marine Industry Associations, 2006). Other forms of biocidal products to be considered are substances used as booster biocides and co-biocides that intensify the effect.

For aquaculture equipment, copper is the most used product among OECD member countries. While in the UK and FIN cuprous oxide is used, in Spain chromium oxide is used (OECD 2005).

For the use of antifouling substances, a differentiation between vessels of > 25 m and < 25 m has been made as MS have different permits for use on yachts < 25 m, according to restrictions for triorganotin-containing paints (Readman et al. 2002 cited in COWI, 2009).

A study of AFP used in freshwater along the UK coastline was carried out in 2001 to target future monitoring (HSE, 2001). The study referred to initial reviews of the environmental effects of Triorganotin compounds (TOTs) following the restrictions already placed upon the use of TOTs on boats > 25 m long. As a result, it was considered that additional restrictions were likely to be placed upon the future use of TOTs. The Advisory Committee on Pesticides (ACP) was concerned that, if further restrictions were placed on TOTs, the main alternatives, which were copper compounds and organic biocides or combination of them, would be used much more widely. The study also referred to another review of copper compounds undertaken by HSE, which indicated that the restriction of use of TOTs would not result in an increase in the environmental concentration of copper that would pose a higher risk than TOTs (HSE, 2001). The copper review also highlighted a new concern; the use of biocides added to copper products to boost their effectiveness against copper-tolerant algae, known as booster biocides, is likely to increase following TOT restrictions. As a result, a review of booster biocides was carried out in 2000, which led to the use of two booster biocides (Diuron and Irgarol 1051) being revoked (HSE 2001). The aims of the survey were to:

- highlight locations with the highest boating densities, to help target questionnaires and future monitoring
- establish boating patterns in freshwaters (seasonal variability in pleasure vs. commercial craft, moorings vs. day trippers) to confirm highest boating densities
- establish the extent of usage of AFPs in freshwaters in order to find out whether an additional risk assessment and/or monitoring would be necessary
- collect the information needed to develop a new risk assessment strategy for 'lake' systems, including average boat size, and quantity/frequency of use of AFPs
- to identify the main AFPs used in freshwaters and hence the chemicals that may need to be monitored for.

In general antifouling coatings can be divided into eroding and non-eroding coatings (Table 2, Mukherjee, A., 2009, Waterman et al., 2004).

Table 2: Characteristics of different antifouling coatings

Coating	Characteristics
Non-eroding coating	
1) Insoluble matrix coating	Also called: contact leaching or continuous contact paint The polymer matrix (e.g. vinyl, epoxy acrylic, chlorinated rubber polymers) is insoluble, it does not erode after immersion in water, the biocide diffuses out of the polymer matrix into water, over a period of time the release rate falls below the level required to prevent fouling These coatings have a lifetime of 12 to 18 (up to 24) months and are difficult to recoat
Eroding coating	
2) Soluble matrix paint	Also called: conventional antifouling system, controlled depletion polymer (CDP) In this paint the active substance is physically dispersed in the matrix which is usually natural resin based. The active substance is incorporated into a binder mixture of gum rosin and plasticizer which can dissolve into water. Once the paint is in contact with water the rosin dissolves and the biocide can migrate to the surface. The soluble matrix paint does not loose antifouling efficiency as a function of time; the coating has a life time of about 12-18 months.
3) Self-polishing copolymer	This kind of antifouling paint is usually based on acrylic polymers. The biocide is incorporated into a soluble paint matrix. On immersion into seawater, the soluble pigment particles dissolve and leave behind the insoluble biocide-copolymer and backbone polymer matrix. This matrix is hydrophobic and therefore water can only fill the pores left free by the pigment. When the vessel is in movement the chemical binding between biocide-copolymer and backbone polymer is released and the surface is polished by depleting of the topmost layer. This permits a slow and controlled leaching rate. Under stationary conditions there is renewal of the paint layer. Typically, the polishing rate is between 5 µm and 20 µm per month. The polishing rate and the release of biocide can be altered to suit different applications like vessel speed, water routes. The efficiency can be increased by adding booster

Coating	Characteristics
	biocides. The life span is about 3 to 5 years and it is not necessary to remove old paint before the application of new paint.
4) Foul release coating	Does not prevent fouling but reduces the attachment strength of (micro)organisms. FR-coatings have restricted applications since they are only effective at high relatively speed (Dafforn et al. 2011).

Research and development on biocide free alternatives is still ongoing (Bergenthal, 1999; Waterman et al. 1999, 2003; WWF, 2002). There are biocide free antifouling coatings already available which act by their specially designed surfaces (low-friction and ultra-smooth) that inhibit the attachment of fouling organisms. Non-eroding and eroding coatings can also be distinguished here (Table 3).

Table 3: Characteristics non-biocidal antifouling coatings

Coating	Characteristic
Non-eroding coating	
1) Non-stick coating	These coatings are silicone- (poly-dimethyl siloxane PDMS) or Teflon®-based. They have extremely low surface energy, low micro-roughness, high elastic modules and low glass transition temperature. They are used on high speed and high activity vessels like passenger vessels, container vessels. Disadvantage of these coatings are their high costs, difficult application procedures, low resistance to abrasion and an average speed of 20 knots is needed. The life span is up to 5 years. Silicon-free non sticking coatings have only a low efficiency.
Eroding coatings	
2) self-polishing and ablative systems	These coatings perform similarly to biocide containing self-polishing coatings but use non-toxic compounds

Other kinds of biocide free anti-fouling systems include coatings containing nano-particles that reduce friction. According to a recent study by the German UBA (UBA 2010, Watermann et al. 2010), no information about the nature of the nano-particles is made available in the Technical Data Sheets or Safety and Health Data Sheets of the products. The study concludes that, due to the lack of proven efficiency, nanotechnology based antifouling systems and the additional use of biocides without declaration on leisure boats and on the professional market cannot be regarded as alternatives to antifouling systems which do not use nanotechnology.

1.4 Formulation types and mode of application

Antifouling substances used for ship hulls are often added to liquid paints. But AFP are also offered stand-alone and have to be mixed with paints and thinners before application.

Concerning different forms of application, the following sectors and user groups have to be distinguished:

- New building commercial ships: only professional users
- New building pleasure craft: only professional users
- Maintenance and repair – commercial ships: professional users
- Maintenance and repair – pleasure craft: professional and non-professional users

Sprayers: Paints used with airless spray guns normally consist of high amounts of solvents, whereas paints used by rolling and brushing are more viscous. Air spray application is not allowed according to the former TRGS 516 on antifouling paints and airless spray guns are normally used by professional users only.

Brushing and rolling: Non – professional users mainly use brush and roll techniques; professionals may also use a combination of these, together with spraying applications.

Other uses – Dipping: Fish nets are mainly dipped into the AFP.

2 Possible emission routes and available ESD

2.1 Antifouling products used on ship hulls

2.1.1 Emission during service life

The AFP on vessels continuously release to the water during service life. Therefore, this is expected to be the main environmental emission route. It is estimated that 1/3 – 2/3 of the applied paint is released to the water during use (Madsen at al. 1998 cited in Cowi 2009). According to a calculation method developed by CEPE, around 70% of the AFP is released during service life while 30% is retained in the paint film at the end of its specified lifetime (OECD 2005). This method is based on a mass-balance calculation with a default of 30% retention and therefore may not be a realistic worst-case approach[3]. Current laboratory methods are likely to over-estimate the leaching rate but can be used in a precautionary approach for environmental risk assessment. With regard to risk assessment, considering that most coatings work by erosion/polishing of the existing paint layer, the potential release of biocide over lifetime would be closer to 100%. Therefore, representatives of Members State Competent Authorities welcomed a proposal presented at a workshop for technical experts evaluating active substances that the anticipated loss of 90% should be used as a default unless alternative data are available. The CEPE mass-balance method will be used in the Review Program as the method to determine the steady state leaching rate (MSCA, 2007).

During the service life stage, AFP leach continuously, directly into surface water (marine or fresh water). Substances can adsorb to particle matter and subsequently settle in the sediment. Released to water, degradation (hydrolysis, photolysis), volatilisation to air and hydrodynamic transport have to be considered in the assessment of substances.

According to estimates by OSPAR, quite a substantial proportion (around 14 to 19 %) of all copper and all zinc entering the Greater North Sea are losses from antifouling coatings and ship anodes. It is expected that this ratio will increase with the substitution of TBT as an antifouling agent by copper-based paints (OSPAR, 2006).

Other emissions enter the environment (air, water, soil) through maintenance and repair and subsequent application (see next chapter).

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3 In 2006 a workshop on the harmonisation of leaching rate determination for AFP was held, concluding that the standardised laboratory methods overestimate the leaching rate compared to the situation under field steady state conditions. The application of the CEPE mass-balance method in the Review Program has been accepted while the anticipated loss of the active substance to the environment in the CEPE mass-balance method was set at 90%. Because the mass-balance method may still overestimate leaching rates, compared to data from the U.S. Navy, a correction factor of 2.9 may be applied to the PEC/PNEC risk quotient in a second tier assessment based on a weight of evidence approach.

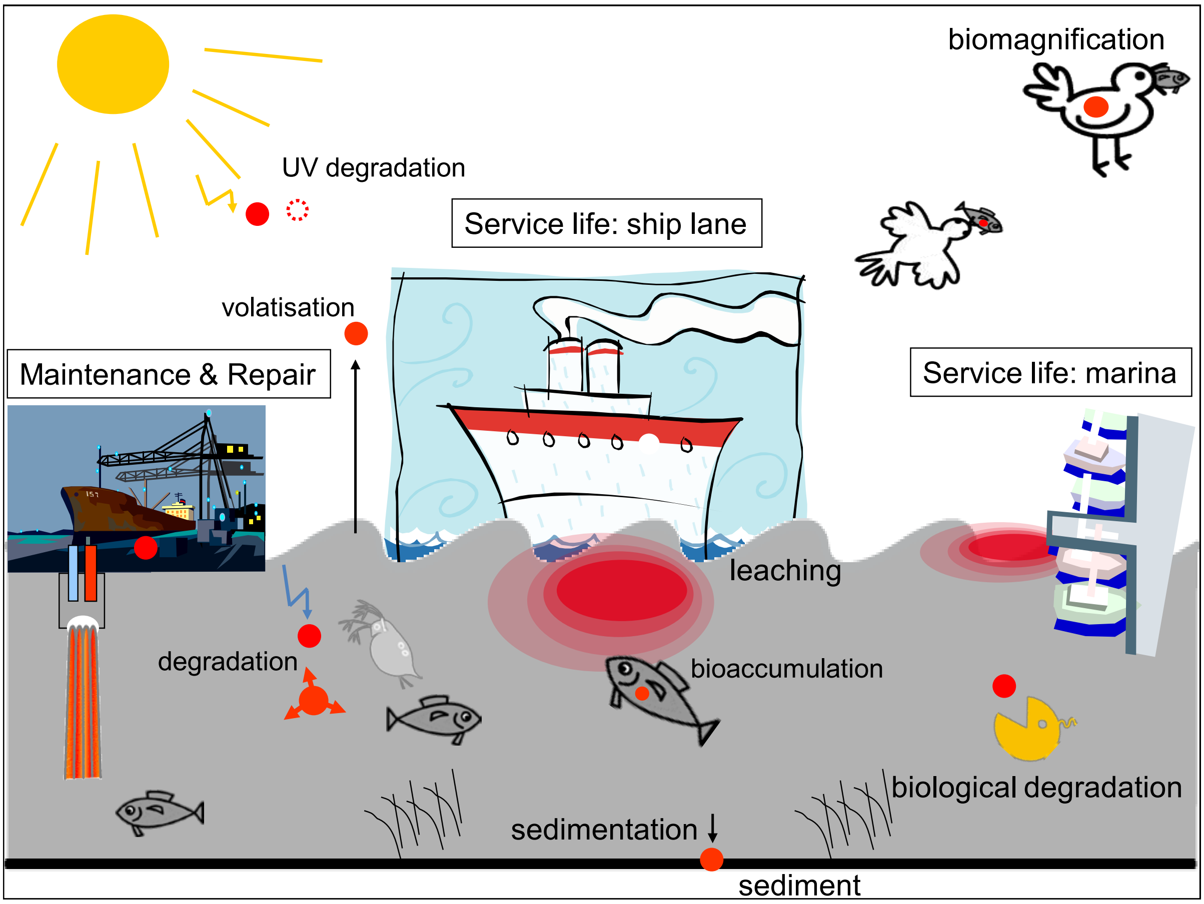

Figure 1: emission, fate and behaviour of AFP[4]

2.1.2 Emission during application of AFP

With regard to emissions from application, there is a difference between

1. new build ships and maintenance & repair (M&R); and also between
2. commercial boats and pleasure boats.

In the new building of ships, the abrasion of old exhausted paint is not necessary and work is mainly done indoors or in closed systems.

Possible emissions to the environment from shipyards and boatyards have to be considered. While several shipyards work with closed systems to prevent antifouling paints from entering the environment, other yards work in highly exposed environments (OECD 2005).

[4] modified and added to according to: presentation of Namekawa, Arch Chemicals, 19 June 2007, Developing an ISO Risk Assessment Standard for Antifouling Coatings

New build commercial/pleasure ship, professional users

During the application phase, emissions can take place during the different working steps. In each working step different emission routes can occur, depending on the location:

- **mixing, stirring and loading** (automatically or manually), and spillage: Water, soil
- **drying** on open air (mainly solvents, fewer antifouling substances): Air, water, soil
- **application** with airless spray gun because of overspray (max 30% of input material, UBA, 2007): Air, water and soil

The location where application takes place is important for the possible emission routes. A differentiation between the following places has to be made (van de Plassche et al. 2004; OECD 2005):

1. **Dock**
   a. on block painting cell: no significant emission, possibly via STP
   b. on block, open air: direct emission into surface water (river, harbour)
   c. Exposed floating dock, marine lift (open air, hard standing area, un-covered, graving dock (open air, hard standing area, covered: Emission: directly into surface water (river, harbour)
2. **Slipway**, open air, hard standing area near or above water surface: directly into surface water, indirectly by leaching into water and soil (ground water).
3. **boat yard – outdoor**, hard standing area, compact earth, not near surface water, temporary covering: Soil, water via STP
4. **boat yard – indoor** hard standing area: no significant emission directly, potential emission to water via STP

2.1.3 Emission during Maintenance & Repair (M&R) of ship hulls

2.1.3.1 Application

The application of AFP during M&R includes three steps:

- **cleaning of the surface**: mainly done with high pressure water washing (HPW) at up to 6 bar that removes the leached layer from exhausted paint but has a minor influence on old paint. For pleasure boats, the leached layer typically represents 20% of the paint film originally applied, containing a fraction of 5% of the original concentration of active ingredient.

- **removal of old paint and preparation of surface**: abrasive blasting (re-blasting, spot blasting) or hydro blasting or abrasive water treatment; non-professional users mainly use manual abrasive techniques. Abrasion in combination with high pressure water washing will remove 30% of the paint film containing the leached layer plus an additional layer containing a fraction of 30% of the original concentration of active ingredient.

- **application of new coating:** selection of an appropriate product, application of subsurface coating if necessary, if old TBT-coating exists, sealing is required; application with airless spray guns, brushing and rolling.

Depending on the condition of the surface, the damaged areas are cleaned and recoated or the paint is completely removed from the hull for repainting. A complete removal is also necessary if a different kind of coating is applied (e.g. a silicone coat on a SPC).

2.1.3.2 Removal

There are three principal methods for the removal of antifouling systems (IMO, 2008):

1. scraping: sanding, grinding, or scraping by hand to scrape off the paint

2. blasting: grit blasting /dry blasting, wet blasting

3. water blasting washing (low, medium, high pressure)

The possible emission routes from maintenance and repair (removal of old paint and application of new paint) also depend on the place where the work is done e.g. a factory work room or roofed area with hard standing or dockyard in contact with or near to surface water (dry docking in graving or floating docks). Table 4 gives an overview on the characteristics of removal of AFP.

Table 4: Characteristics of removal of antifouling coatings

Removal by actor	Work place characteristics	Technique	Emission route
Commercial ship, professional user	Exposed floating dock or marine lift (open air, hard standing area) or graving dock (open air, hard standing area)	Surface preparation with high pressure water washing (HPW) or abrasive blasting (re-blasting, spot blasting) or hydro blasting or abrasive water treatment	surface water (river, harbour), waste water (and disposal as waste after waste water treatment, filtering)
Pleasure ship, professional user	Repair shop in boat yard (hard standing area or compacted earth) or boat yard (hard standing area)	Surface preparation with HPW, abrasion	soil, waste water
Pleasure ship, non-professional user	Semi-closed to closed room or open air (compacted earth, washing area) or open air (hard standing area)	HPW	soil, waste water

The collected waste water should be adequately treated (e.g. by ultrafiltration, adsorption, electrochemical or biological treatment, solvent extraction, photodegradation (Pangam, 2009). No information is available on whether this recommendation is followed in practice.

Figure 2 gives an overview of the main exposure routes to environmental compartments.

General overview on the application of antifoulings on ship hulls and possible emission routes

Application incl. mixing/stirring + drying, storage | **Removal** | **Service life** | **Waste**

•**New building**
commercial ships + pleasure crafts
(only professional user)
•Application: Airless spraying guns

•**Maintenance and repair**:
•commercial ships (professional user)
•pleasure crafts (professional and non-professional user)
•Removal, washing:
- •High pressure water washing and brush (HPW)
- •Abrasion (entire ship hull, spot blasting) by dry sandblasting or wet sanding (sand washing)

•Application:
- •Airless spraying gun
- •Brush and roller
- •Combination of both techniques

= Dockyards (indoor (painting cells) and outdoor (hard standing)
➢emission:
- ➢directly in dockside and sourrounding to water and soil by drift of aerosol and
- ➢indirectly by dried paint on dock walls to air and water by leaching
- ➢emission into surface water small

= slipway (outdoor, open ait)
➢emission: directly by drift of aerosol possible in dockside and sourrounding (water and soil) and indirectly by dried paint on dock walls (leaching)
➢Potential emission to surface water

Service life

•**Shipping lanes**
•**Open Sea**
•**Commercial harbour**
•**Estuarine and coastal marina**
•**Marinas in lakes**

= surface water
➢ direct emission:
leaching rate 90% of applied antifouling

Waste

•**Disposal of**
- •Solid waste from application
- •Paint residues in cans
- •Sludge from STP
- •Fibre glass reinfordced plastic hulls on landfills

•**Waste water discharge - Waste Water Treatment (WWT)**

= via landfill
= via waste water collection system
➢Potential emission to soil,
➢Emission to water low (to moderate)

Figure 2: General overview on the application of AFP and emission routes from ship hulls of PT 21

2.2 Other uses: fish nets

The application of AFP to fish nets is normally done by immersing the nets directly into the container filled with antifouling paint. After immersing the nets are hanged up for drying. This is only allowed in authorised shipyards with waste water collection systems and normally done by professional users. The cleaning occurs by high pressure hosing and flushing. It is assumed that nearly 100% of the AFP is released into water during service life. There are no specific requirements for the waste treatment of fish nets. Disposal to landfill is expected.

Overview on the application of antifoulings in other uses (fish nets) and possible emission routes

Application

•Immersing of nets directly into paint
•drying

= authorised dockyards
➢ potential emission into sourrounding (dropping, spill) → soil
➢Potential emission via STP

Storage and Handling

Removal / Cleaning

1. high pressure washing
2. Flushing
3. Large scale washing machines

= authorised dockyards
➢ potential emission into sourrounding (dropping, spill) → soil
➢Potential emission into water via STP

= other places
➢ potential emission into sourrounding (dropping, spill) → soil

Figure 3: General overview on the application of AFP and emission routes from fish nets

3 Elements of sustainable use

3.1 Risk Mitigation Measures

Status

In the framework of the BPD, no risk assessments (RA) of AFP have been carried out so far.

For copper a voluntary risk assessment was carried out by the European Copper Institute (ECI[5]). It covers copper and dicopper oxide but no specific risk mitigation measures are described.

Only few existing standards refer to specific uses of AFP. The international standard ISO/NP 13073-1[6] on risk assessment is still under development.

The former TRGS 516 "Application and removal of antifouling" has been withdrawn and partly implemented in the new TRGS 401 "hazard by dermal contact – evaluation, assessment, measures" but TRGS 516 can be used for further hazard assessment concerning AFP in case antifouling-specific measures are needed. Therefore, air spray application is not allowed. For airless spraying, workers must keep a distance of 15 m from ship surface (see also chapter 3.5). The HSE document recommends that, if work is done on a movable platform, it should be done from bottom to top.

Technical rule TRGS 516 contains general provisions on risk mitigation measures to minimise overspray and emissions to the environment:

Application:

- In general, application must not lead to negative effects on the environment, releases into soil or water should be avoided: therefore, preference for brushing or rolling and coverage of the work place, and use of screens on windy sites is recommended

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5 http://www.eurocopper.org/kupfer/copper-ra.html

6 ISO/NP 13073-1: Ships and marine technology – Risk Assessment on anti-fouling systems on ships – Part 1: Marine environmental risk assessment method of active substances used for anti-fouling systems on ships

- max. wind speed is defined:
    - max. wind speed of 13.8 m/s (6 Beaufort) in inner dock yard
    - max. Wind speed of 5.4 m/s (3 Beaufort) above dock yard in open fields, and in case the paint dries slowly – stop work; work must be done at lower wind speeds
- selection of less emissive forms of application e.g. proper spray nozzle, spray angle 90°, distance appr. 0.2 – 0.3 m
- application is only allowed where paint particles can be collected, wash off of particles into water has to be prevented e.g. by relevant techniques
- leftovers (paint, solvents) have to be re-used or handled according to waste legislation

Maintenance and repair

As the removal of exhausted and old paint is necessary before new paint is applied, abrasive techniques are usual. TRGS 516 recommends using suction head blasting (closed system), high pressure water blasting and wet air pressure blasting. If needed, a screen should be placed in the main wind direction to avoid emission into air and water and to allow collection of particles. Dry air pressure techniques are only allowed where other techniques are not technically feasible. In this case, the work place should be covered and/or properly housed. Further abrasive techniques are only allowed where leftovers can be collected and wash off avoided by collection systems. Waste water has to be collected and cleaned or disposed of properly.

As work is often done outdoors and near surface water, housing to reduce air movement and the installation of local exhaustion ventilation is part of BAT to reduce emissions into the environment by driftage into air (Rentz, 2002). The use of high pressure abrasion is only applicable where there is a waste water treatment plant. Nevertheless, dockyards have to be cleaned before the dock is flooded again.

(See also chapter 3.11 on integrated antifouling control measures.)

Another possible pathway is the cleaning of ship hulls: here, mechanical measures used in a dock yard or below the waterline in specific locations in a harbour or marina can be optimised to reduce the emission of antifouling biocides. While costs for underwater cleaning are lower, emissions into water are much higher and it is therefore not often carried out (Kätscher, 1999). In addition, the risk of releasing foreign species into the water increases and underwater cleaning is therefore forbidden or should be avoided in some countries (Anzecc, 1997). Efficient cleaning is particularly important for biocide free coatings of ship hulls (Hornemann, 2003).

Options

As for many substances, data for the assessment of the environmental risks are not sufficient but data gaps will be filled during the authorisation process. However, a further comparative assessment of AFP during service life is not foreseen.[7] A user may therefore not be able to decide which product is the lower risk product, as many other technical details e.g. the matrix surface and use of the ship in salt water or fresh water, high or low speed, also have to be considered.

Here a need for further action is seen in assessing active substances, research and development and subsequently promoting low risk and biocide free products. A feasibility study for a new eco-label for biocide-free AFP has still not been implemented (Watermann et al. 2004). Currently, different methods are being assessed that allow a more controlled release of AFP, such as self eroding of hard antifouling products, encapsulation of active substances / reservoir membranes. Research & development in this field could be supported under a Thematic Strategy.

3.2 Training

Status

In Germany, training for professional workers is done during professional training (e.g. ship building industry, painter skills). The use of AFP may be only one part of training in the handling of dangerous substances and mixtures e.g. paints and varnishes.

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7 The draft Biocides Regulation currently being discussed includes measures for comparative risk assessments at the product level.

In general, only professional users (painters and ship building craftsman) are trained, but in many cases untrained staff are engaged in ship yards (Bleck et. al, 2005; 2008). Maintenance and repair in particular is carried out by specialised corrosion companies but, because of the hard work and the low pay in this sector, untrained workers are often engaged part time.[8]

Pleasure boats are often treated and painted by the untrained ship owner (consumer) unless the owner pays professional boat repair shops. Training for non-professional user (owners of small vessels) is not usual.

Staff working on commercial ships only rarely come into contact with antifouling products.

The former TRGS 516 requires that at least one skilled person has to be employed who supervises the work. As antifouling paints are often hazardous mixtures, relevant operation instructions have to be provided and the workers have to be instructed at least once a year. The instructions have to be repeated in each new work place.

Options

A mandatory training programme for professional users who are involved in the application of AFP could be established. Because of the international trade in ships and diverse workplaces, EU wide harmonisation should be explored.

For paints sold to the general public, suitable use instructions for untrained applicants could be made mandatory.

3.3 Requirements for sales of pesticides

Status:

In general, products for professional use applied to new build ships and used in larger ship repair dockyards are sold directly by the manufacturer of the AFP. Other products in smaller packages are also sold by manufacturers, retail (DIY) or by distributors directly but also via the internet and mail-order catalogues.

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[8] However, it should be noted that the majority of ship repairs are carried out in Asia and the Middle East (see ESD for PT 21, van de Plassche et al. 2004, p. 41).

In general, sale of products classified as very toxic, toxic or harmful is not allowed to the general public, but only to professional users (REACH, Annex XVII).

Specific requirements apply to AFP on commercial ships – often the decision is made by ship owners according to the specific needs arising from the system used by the ship builders.

AFP which have to be mixed (e.g. copper powder and paint, for example the product “international V 17m”) which are used in small ship yards (Bleck et al., 2005) are also available to the general public via the internet. From the information given on the internet, it is often hard to find information on the classification of the mixture and the ingredients.

Options

Currently, antifouling paints are often not clearly labelled as a biocidal product, as some of the substances are not yet classified (which is not allowed according to the Biozid-Meldeverordnung). Often advertising includes antifouling characteristics but non-trained users in particular have difficulty in identifying and assessing the ingredients.

Restrictions on the sale of dangerous products to amateurs via the internet or mail-order catalogues could be established. Specific information for amateurs on how to choose the optimal product for their purpose is lacking and should be developed. Only ready to use products should be available for non-trained users.

In general, requirements for sales of all biocides as foreseen in the Directive on Sustainable Use of Pesticides should be implemented.

3.4 Awareness programmes

Status

Non-Professional users (normally the owner of the boat) often select an AFP based on information from other owners or manufacturers about efficiency in the specific area, and carry out the application themselves. For users of pleasure boats, the aesthetic factor plays a major role in decision making. Often industry provides information on its products[9].

Small marinas often have separate places for cleaning and repair where waste water and old paint is collected, treated and then disposed of according to the relevant (local) regulations. Currently, amateurs are unaware of those requirements, e.g. that there is special disposal of paint scrapings, as a survey in the UK shows (HSE, 2001). There are also initiatives like “Green Blue” in UK, supported by the British Marine Federation and the Royal Yachting Association, which aims to raise general awareness on potential environmental impacts and how to avoid them and provides more readily available information about environmental impacts e.g. leaflets like “Antifouling and the marine environment” that explicitly addresses users of pleasure boats.

The label “Blue Flag (Hafen Blaue Flagge)” requires that the manager of the harbour/marina must prove that he offers up to three environmental training activities for users and members carried out within the Blue Flag season.

Support and information in deciding on the correct product can be provided, e.g. the test-kit developed by LimnoMar which indicates which product is suitable for the antifouling in the particular area.

In Germany, a booklet is available that gives easy to understand information about fouling and the use of anti fouling paints (Bewuchs-Atlas e.V. Hamburg, 2010). In the main part AFP are listed according to the following 5 categories:

- Biocide-free antifouling coatings
- Biocide-free - technical / mechanical systems
- Nano particle coatings
- Biocide-containing coatings
- Biocide-containing technical systems

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9 International Yacht Paint, 2009: Anstrichfibel für Yachten; http://iyp.yachtpaint.com/germany/

The description of each product contains e.g. information about water type, possibility of self-application, durability.

The website www.bewuchs-atlas.de addresses professional and private user of AFP and offers various information on fouling and antifouling systems. The website http://www.biozid.info/ also offers information on biocides and alternatives, but the part on AFP is still under development.

Options

Promotion of alternatives (no use of antifouling products and only mechanical treatment without chemicals, biocide-free products, and promotion of new surface materials) should be further strengthened and assessed.

Voluntary labelling (e. g. Blue Angel, EU Flower) of low risk and biocide-free products could be developed and promoted.

Promotion of “eco-labelled” marinas e.g. Deutscher Segler Verband (DGU: “Blue Flag – Hafen Blaue Flagge”) could enhance awareness amongst the general public.

3.5 Certification and inspection of equipment in use

Status

As antifouling paints are often added to solvent-containing paints, requirements exist with regard to explosion protection. Here several standards exist (see table in appendix).

Only airless spray guns are allowed which generally have a pressure of 160 to 200 bar, nozzle diameter in a range of 0.65-0.79 mm. It is assumed that airless-spray with these high pressures generate a significant overspray (Koch et al. 2004) up to max. 30% of the material (UBA, 2007).

As air spray guns are not allowed, the former TRGS 516 recommends that workers should remain a distance of 15 m from ship surface and the use of spraying nozzles at an optimal application angle to avoid overspray. The HSE (2001) also recommends the selection of appropriate spraying nozzles and the adjustment of spraying pressure to minimise overspray and dust. HVLP-spray guns are recommended.

Options

Harmonised EU standards on technical-organisational measures (e.g. automatic spraying techniques, mixing) could be further developed. The scope of the Directive on machinery 2006/42/EC could be extended to include equipment for the application of pesticides.

3.6 Form of the biocide and mode of application

Status

Spraying of antifouling paints on ship hulls is normally done by professional users in dock yards.

One study showed the only impact on the environment while spraying was that the sprayer with the lowest exposure to airborne copper worked in strong winds, the wind blowing the paint overspray away from his breathing zone. The effect of the wind on exposure, however, varied depending on the direction of the wind in relation to the direction of spray and the position of the spray operator (HSE, 730/15). The overspray is directly released to the environment. In practice, problems arise if the ship is bigger than the dock, buildings and cranes constrain the construction of screens or housing.

Certain amounts of old and exhausted paint may also be emitted during repair and application.

Options

Setting of strict requirements for use: e.g. spraying to be allowed only by trained professionals.

Specifications for maintenance and repair (removal and waste treatment of old coatings and waste water) can be further regulated.

Especially with regard to waste water and waste collection, specific requirements (e.g. closed systems) could be developed – here interfaces with waste regulation are obvious.

The efficiency of risk management measures could be defined by relevant standards – harmonised tests are needed.

3.7 Specific measures to protect the aquatic environment

Status

Currently among the substances included in the ongoing review programme, only few active substances (dicopper oxide, dichlofluanid, tolyfluanid, Irgarol, copper thiocyanate, and Copperpyrithione) are classified as dangerous for the environment (see table 1). No environmental classification exists for copper, Zineb and Zinc pyrithione. This information gap will be closed during the authorisation process.

As the leaching rate determines the emission of antifouling agents from the surface of a ship's hull to the environment, which in turn depends e.g. on the formulation of the biocidal product and the surface to be protected, the determination of leaching rates under realistic environmental conditions is one prerequisite for the identification of less risky AFP.

Provisions for the treatment of ship hulls in freshwater bodies exist in some MS e.g. in DK, NL, UK, SE (COWI, 2009). There are also regional restrictions in German Bundesländer e.g. for Lake Constance, the Wakenitz and the Ratzeburger See in Schleswig-Holstein. Also, the Swiss BUWAL (Bundesamt für Umwelt, Wald und Landschaft), as riparian of Lake Constance, published a list of permitted antifouling products (BUWAL, 2003).

The leaflet "Use of antifouling paints on vessels" from the Bavarian Environment Agency (Leaflet 4.5/16, 1 July 2005) contains a list of recommended coatings (silicone, teflon® hard coatings and hydro viscose coating) and less recommended products based on copper but without booster biocides. With regard to silicone, it has to be considered that this kind of coating shows some drawbacks: it is comparatively costly and the coating is quite sensitive, it is not practical for all ships. Further, unbound silicone oils can leach out and can have impacts on marine environments because they are persistent, adsorb to suspended particulate matter and may settle into sediment, and if films build up on sediments, pore water exchange may be inhibited (Nendza, 2007).

Options

The release of antifouling agents to water prevents ship hulls from fouling. In this sense, direct emission to water is the intended function of an AFP during service life. Hence almost the whole amount of antifouling substance added to ship hulls will end up in water and will subsequently be degraded and/or adsorbed to sediment[10]. In this sense the reduction of the total amount of antifouling agent used will be the first approach towards a sustainable use of AFP. However, fouling, especially on commercial ships, will lead to higher fuel consumption (IPPIC, 2009) and this has to be taken into account in a thematic strategy on sustainable use. So, a balance has to be found here, especially as commercial shipping is a global business and needs international coordination[11].

Another point that has to be kept in mind is that antifouling coatings limit invasions of foreign organisms. Hull fouling transported by global vessel traffic is an important pathway for the spread of non-indigenous marine species into local regions. The risk through detachment and dispersal of viable material and subsequent spreading could be managed by removal of the vessel to land for de-fouling in dry-docks. In-water cleaning is often used for small vessels and large vessels outside their dry-docking schedule (Hopkins & Forrest, 2008). But in-water cleaning is restricted in some countries e.g. New Zealand, Australia (ANZECC, 1997) - see also chapter 3.11 on Integrated Pest Management.

Nevertheless, the inclusion of AFP and their metabolites in monitoring programmes at EU level and the development of international Risk Assessment Standards would be an option for a better environmental exposure assessment.

With regard to inherent substance properties which are subject to the authorisation process, the fate and behaviour of the substance and the formation of metabolites after release in particular have to be assessed. A recent study on the “acute toxicity of pyrithione photodegradation products to some marine organisms” (Onduka et al.

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[10] The COWI study also mentioned that the release of up to 90% of the AFP applied to ship hull will not necessarily occur, as a Danish study showed that the release of organotin from Danish vessels to the inner Danish Waters accounts for 12-35% (Lassen et al. cited in COWI, 2009).

[11] In general R&M of commercial ship can be done all over the world, sot where a ship is treated and how it is done will be a decision based on the costs and the relevant provisions of the country

2007) suggests the necessity of risk assessments not only for the pyrithiones but also their photodegradation products.

A restriction on PBT, vPvB substances for AFP should be assessed at EU level.

More concrete local measure can be found with regard to application and M&R. Extension of specific provisions for the treatment of ships in freshwater bodies should be considered, e.g. no treatment of ship hulls below the water surface. Also, strict regulations for the treatment of waste, waste water collection and sewage treatment plants – STP - from maintenance and repair could be established.

Further the use of AFP for aquaculture could be restricted and specific requirements for off-shore constructions should be developed, but there is also need for more data gathering and this could be done AT EU expert level.

Models should be further developed and used for the identification of (regional, local) areas to be protected. There are models developed by HSE like REMA[12] (Regulatory Environmental Modelling of antifouling - for marinas and estuaries) and QWASI[13] (Quantitative Water, Air and Soil Interaction - for a quantitative assessment of the interaction of water, air and sediment), and MAMPEC[14] (Marine Antifoulant Model to Predict Environmental Concentrations).

3.8 Emission during service life

Status

There are two situations that lead to an emission during service life: continuous leaching into water bodies during operation as a main pathway and emissions during M&R as a minor pathway.

The efficiency of an AFP depends on the inherent properties and is one important criterion for the selection of an AFP (Daehne, 2008). As a result, an important amount of antifouling agent is released directly into surface water during service life - emission can be seen as a function of the biocide. As about 70-90% of the AFP is

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[12] http://www.hse.gov.uk/biocides/bpd/environmentalexposure.htm

[13] http://ecb.jrc.ec.europa.eu/biocides/

[14] http://www.antifoulingpaint.com/downloads/mampec.asp

released during the service life, it is seen as the main source directly into the aquatic environment and this is hard to control through sustainable use. Nevertheless, maximum leaching rates of antifouling substances are already defined in some standards.

Depending on the different types of antifouling coatings, maximum periods of service are expected (CEPE cited in HSE, 2002).

Type of coating	Soluble matrix	Insoluble matrix	TBT self polishing co-polymer	TBT-free self polishing
Maximum period of service	18 months	24 months	5 years	5 years

Considering the release of up to 30% residual AFP during M&R and the washing of ship hulls,[15] a release directly in to water is also possible. This is a lower total release compared to the release during continuous leaching, but it is of regional relevance e.g. in harbours or in marinas. Emissions during M&R can be controlled by reduction measures (see chapter 3.11 on Integrated Pest Management).

Options

As the main pathway is continuous leaching, a requirement for improvement of ideal leaching rates of AFP can be seen as an option under a Thematic Strategy. In this framework e.g. maximum leaching rates can be defined in national action plans for specific water bodies.

An option for reduction of the use of antifouling coatings seems to be to clean the hulls of pleasure boats by mechanical measures e.g. by brushing or scrubbing or high-pressure cleaning (Hornemann, 2003) used in a closed system with water collection. A requirement to provide the necessary infrastructure in marinas can be a measure within a thematic strategy.

Additionally, the use of FR-coatings as biocide free alternative coatings would be an option. But there are still limited possible applications (high speed vessels) and further research is necessary.

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[15] www.globalnature.org, http://www.uft.uni-bremen.de/chemie/ranke/docs/Vorstudie_AF_Zus_UFT_marum.pdf

3.9 Reduction of pesticide use in sensitive areas

Status

A survey on the acute toxicity of zinc pyrithione and copper pyrithione, used as booster biocides, and their six main photodegradation products to three marine organisms representing three trophic levels (algae, crustacean, and a fish) showed that risk assessment is needed not only for the pyrithiones but also for their photodegradation products (Onduka et al, 2007).

Provisions to prevent non-target organisms need to be defined. A study on the toxicity of antifouling paint to non-target organisms on three trophic levels

- bacteria *Vibrio fischeri*,
- red macroalgae *Ceramium tenuicorne* and
- crustacean *Nitocra Spinipes*

from Ytreberg 2009 showed that the release rate of Cu was highest for ship paints (from ships > 12 m), at 3.2−3.7 μg cm^{-2} $day^{-1,}$ compared to chemically-acting pleasure boat paints (< 12 m) (0.7−1.0 μg cm^{-2} day^{-1}). The physically-acting paints released significantly more Zn (4.8−8.1 μg cm^{-2} day^{-1}) than the chemically-acting pleasure boat paints (1.8−2.9 μg cm^{-2} day^{-1}) and the ship paints (0.7−2.2 μg cm^{-2} day^{-1}). The macroalga, Ceramium tenuicorne, was the most sensitive species tested for both Cu (EC_{50} = 6.4 μg L^{-1}) and Zn (EC_{50} = 25.4 μg L^{-1}). Further, it was shown that the active substances were responsible for the observed toxicity for the ship paints, but Zn and other substances leached from the pleasure boat paints, and in particular the physically-active paint, could also be responsible for the toxicity (see also Karlsson et al. 2010).

The leaflet “Use of antifouling paints on vessels” from the Bavarian Environment Agency (Leaflet 4.5/16, 1 July 2005) recommends owners of pleasure boats to survey if an antifouling paint is really needed. For example, if the boat is used often or only used in freshwater and mechanically cleaned several times, an AFP may be not necessary. In case an AFP is needed, biocide free coatings are recommended. If these are not applicable, copper based coatings should be selected. Of these, copper powder should be preferred to copper oxide. Additional booster biocides are not recommended to be used.

Options

Surface water, soil and groundwater can be regarded as sensitive areas *per se* – therefore specific RMM (e.g. no removal or washing in surface water where collection is not possible, cleaning and M&R only on hard standing or with permanent cover, closed systems and treatment for waste water) should be implemented to prevent emissions into these compartments.

The development and application of further ecotoxicity tests with representative marine organisms from different trophic levels, e.g. bacterium *Vibrio fischeri*, the red macroalga *Ceramium tenuicorne* and harpactacoid copepod *Nitocra spinipes*, which can be used for risk assessment (Ytreberg et al. 2009) should be encouraged.

3.10 Handling and storage of pesticides and their packaging and residues

Status

For the coating of ships, the coating material is generally supplied in 20 litres buckets although 100 litre re-useable containers are used for large applications. The implementation of the Solvent Emission Directive (SED 1999/13/EC)[16] leads to the situation that buckets used in larger docks are taken back by the formulator.

Antifouling paints have to be stored properly (TRGS 516) and only competent staff are allowed to handle them. Residues (and solvents) must not be mixed and disposal has to be carried out according to the relevant legislation, waste has to be handled in line with the local waste legislation (see also Chapter 3.1).

Options

Limitations on package sizes and only ready to use products for amateurs could be implemented.

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[16] COUNCIL DIRECTIVE 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations

Establishment of a collection and recycling system similar to that for PPP could be useful for professional use. In Germany the collection of residues could also be carried out at special collection sites.

3.11 Integrated antifouling control measures

Status

Good / best practice on AFP is not yet available but is covered in BAT for surface treatment and coating (UBA, 2007).

Several guidance documents concerning best management practice also exist

- IMO: Draft Guidance on best Management Practices for removal of Anti-Fouling Coatings from Ships, including TBT hull paints – submitted by the United Kingdom, 21 July 2008
- HSE: Health and Safety Executive: Safe use of tin-free, marine anti-fouling coatings. Information document HSE 730/15
- ANZECC: Code of Practice for Antifouling and in-water hull cleaning and main using
- British Coatings Federation Ltd (BCF): Safe use of antifouling coatings
- VDL/DSV: Unterwasseranstriche – So wenig Antifouling wie nötig = so viel Umweltschutz wie möglich
- CEPE: Personal health protection during application of antifouling paints and Guidance on the Safe Application of Yacht Coatings – Personal and Environmental Protection - Do's and Don'ts

The IMO submitted draft guidance on Best Management Practices for Removal of antifouling coatings from ships, including TBT hull paints (IMO, 2008) as the implementation of sound practices can reduce the release into the environment. It includes two main methods:

- Source-control methods: e.g. vessel covering, sweeping, covering waste piles, and bermed storage for waste and paints

- Collection, filtration and treatment methods e.g. hull wash water settling tanks, and filter.

Basic facility requirements for the removal of AFP are

- Good housekeeping practices: thorough record-keeping, securing of materials and equipment, instructions of workers together with clear frame work for safe operations and responsibilities, and clear code of practice.
- Facility design: at a minimum all facilities should have an impermeable floor or work surface for dry paint removal and cleaning after work, waste water collection and containment system, suitable air cleaning system
- Facility staff: designated staff with responsibilities for waste, waste water
- Collection of waste: separate storage, properly labelled
- Waste water collection: collection should be done separate from non-contaminated water, settlement of particles should be allowed by containers left standing
- Handling of waste water: separation of particles from water and proper disposal
- Discharge water: a certain particle load may be allowed e.g. 100 mg/L, pH should be between 6.5 and 9; discharge into sensitive marinas should be avoided

Example Code of Practice:

The ANZECC code of practice aims to identify best practices for the application, use, removal and disposal of antifouling paints and is targeted at owners and operators of boats of all sizes, whether for recreation or commercial uses, and providers of boat-cleaning facilities. It proposes measures which should be taken to minimize the release of AFP to the surrounding environment. It includes some similar measures to those already described in TRGS 516. Although some of the mentioned practices are forbidden in Germany, they could be still allowed in other MS. In the following only measures are mentioned which have not already be mentioned elsewhere in the text:

General provisions:

- Excessive abrasion or hosing on the boat should be avoided
- M&R of all vessels should be conducted at an appropriate facility, either above the tidal zone, or in a dry dock, no removal of antifouling products should be undertaken while the vessel is in the water, on beaches or below the high tide limit.

- Scrapings and debris should be collected for disposal and stored in sealed containers until removed by licensed waste disposal contractors (or as otherwise specified by regulatory agencies).

Provisions for facilities:

- Where large vessels (>25 m) exclusively or predominantly operate in confined waterways, bays, rivers or estuaries (e.g. ferries, barges fishing boats, work vessels, privately-owned pleasure craft), they may be a significant source of toxic substances in the locality. The relevant State agency may prohibit use of particular antifoulants on such vessels (e.g. those containing tributyltin). Therefore, operators and those responsible for vessel maintenance should check with the relevant State agency before applying antifoulants.
- Development of a uniform licensing procedure for such facilities:
    - New dry docks, slipways and hardstands - no water should run off work areas without treatment to remove toxic substances, turbidity and discolouration. New facilities should be designed and managed so as to allow for eventual disposal to sewer of treated waste water and first-flush runoff.
    - Existing dry docks, slipways and hardstands - measures should be adopted to minimize water runoff and certain potentially toxic, turbid or discoloured discharges. Bunds may be used on sealed concrete. Sumps may be used to contain waste water and spillages. Straw bales and woven fibre material may be used to retain suspended solids. Existing facilities should plan for upgrading to allow for eventual disposal to sewer of waste water and first flush runoff

Techniques for Pollution Abatement

- Preparation areas should be bunded to ensure accidental spillage cannot escape to water.
- Spillage should be treated with a suitable absorbent and disposed of as a controlled waste.
- All plant and equipment from work areas should be subject to regular preventative maintenance programs to ensure optimum performance.
- Preparation of all antifoulants should take place in areas protected from traffic, with overhead cover.
- Site operators should assume any removed coating is contaminated with biocides and dispose of in accordance with requirements of local environmental and/or waste disposal authorities.
- Measures must be undertaken to contain wash waters and to segregate wash water from non-contaminated flows.
- Established written operational procedures should exist.

Specific Requirements During Application - All Vessels

- Cleaning using water is preferred to chemicals, high pressure liquid cleaners that operate with detergents, solvents, caustic or acid should only be used if a system exists for collection of waste waters.

- Low pressure, high volume spray guns are preferred over high pressure guns.
- Efficient use of all antifouling paints, during their application, should ensure that total losses due to all causes do not exceed 30% of the coating to be applied to the substrate.
- Consideration should be given to:
    - maximising coating transfer efficiency during application;
    - blowing back hose lines to the pump on completion of work;
    - using returnable bulk containers;
    - careful planning of coating operations to minimise coating residues and losses;
    - application during optimal weather conditions, if possible.

Removal of paint

- Removal processes on small craft (<25 m) should use the best available techniques that do not entail excessive cost.
- Use of tarpaulin and sheeting would allow cheap collection of wastes for offsite disposal, No removal while the vessel is in the water, on beaches or in the intertidal zone – only at appropriately equipped and approved facilities.
- Old antifouling coatings are not to be burnt off, Biological materials (marine biota) should be disposed of as solid waste in accordance with local requirements e.g. to landfill.
- Where antifouling paints have been removed from old vessels (greater than 10 years old), it should be assumed that the paint residue contains tributyltin, unless test results prove otherwise … the paint residue should be disposed of at the approved local landfill facility. Antifoulants removed from vessels constructed before the 1970's may contain a variety of extremely hazardous chemicals, including substances like arsenic, mercury and DDT, and should be disposed of at a local approved landfill facility in which leachates are contained.

Releases to Air

- Wet abrasion is preferable to dry abrasion - Use of wet methods controls particulate emission to air but generally creates high volumes of liquid waste. Ultra high pressure water blasting, with lower volumes of liquid waste, is likely to become widely available in the future.
- Vacuum blasting, or containment blasting, with reusable abrasives and separation equipment is the current best option for removal of used antifouling coatings.

If vacuum or containment blasting is employed emission targets should be as follows:-

- if operating without wet particulate arrest, exhaust emissions of 35 mg/m³ should be targeted;
- if operating with wet particulate arrest, exhaust emissions of 20 mg/m³ should be targeted.

The "Best Practice Advice Flyer" from The Green Blue[17] summarises the similar measures appropriate for non-professional users.

[17] http://www.thegreenblue.org.uk/publications/Antifouling.pdf

Topside and antifouling paints and varnish including used brushes, solvents, rollers and trays are hazardous waste and should be disposed of accordingly.
The key is to prevent anti-foulant from unnecessarily entering the water. Skirt the hull when scrubbing down or painting the hull and use a tarpaulin to catch the flakes and drips. Don't leave a coloured patch under your boat!
If washing off on a slipway, use a device such as loop of rope to trap any paint particulates and then sweep up and dispose as hazardous waste.
Look into alternative hull paints, such as hard vinyl, silicone or Teflon®, which are suitable for in-water hull cleaning systems.
Dust from sanding paint and antifouling coatings is toxic. Using a dustless vacuum sander will also protect your health.
If you use scrubbing piles, only scrub off the fouling and not residue paint – be careful not to let old or new paint enter the water.
Select a marina, club or boatyard which has a closed loop scrub-down facility which collects residues and wash down.
Select the right type of antifouling paint for your craft and boat usage – take advice from your chandlery. Use water-based paints where possible or low VOC (Volatile Organic Compounds) paints.
Apply the right amount of antifouling paint required and do not spill it – when applying use a sheet to collect drips.

The international label "Blue Flag" (http://www.blueflag.org, www.blaue-flagge.de) requests that advice on the handling of water, waste and energy, the use of environmental friendly products and health and safety issues is offered by the site operator. Further, sufficient and appropriately labelled and separated containers for the storage of contaminated waste (paint, solvents, removed paint, AFP, batteries…) have to be offered. In 2004, 123 pleasure boat marinas were certified in Germany, in 2009 650 marinas worldwide were awarded the label.

Criteria were developed for the award of "Environmentally Sound Ship" but these mainly cover emissions resulting from operation of ships (Bornemann et al. 1999).

Several standards for the application, removal and determination of the leaching rate exist, they are not always specific for antifoulants but they have relevance for the use of AFP e.g. DIN EN ISO 15181-2[18]: (see also table in Annex 6).

[18] Beschichtungsstoffe – Bestimmung der Auswaschrate von Bioziden aus Antifouling-Beschichtungen

However, with regard to the global ship traffic in several fields on the use of AFP the need for an international harmonisation is demanded by different organisations besides IMO. So some organisation want the ISO to be responsible for the development e.g. of standards on risk assessment standard for antifouling coatings and respective methods (Namekawa, 2007).

There is no information about examples of good practice for the use of antifoulants for fish nets or offshore constructions.

Options

Because many applications are carried out outdoors, every measure that encloses the working area would reduce emissions e.g. covering, sealing the ground, exhaust ventilation, waste water collection and treatment.

Promotion of efficient alternatives (e.g. biocide-free - silicon based, encapsulated substances with optimised leaching) is already part of good practice but it seems that more information is needed, especially for non-professional users.

Research and development activities and promotion of alternatives are still needed and may be a measure for sustainable use of biocides.

Integrated Pest Management should also include biosecurity risks from ship hull fouling releasing non-indigenous pest into recipient regions. These risks arise not only from releasing adult or planktonic life stages, but also through dispersal of fragments of some species e.g. sponges, bryozoans which can spread in recipient regions. Assuming suitable environmental conditions for the organisms, e.g. salinity, temperature, the risk is likely to increase with the residence time of a vessel in a recipient region. Compared to no management and possible release of fouling organisms, the in-water hull cleaning through mechanical removal of fouling may pose less risk but this depends on the method. Regular defouling in dry dock and retaining of foulants by filters and containment tanks with a subsequent reapplication of antifouling paint may be the most efficient method for preventing settlement of non-indigenous organisms (Hopkins & Forrest, 2008; IPPIC, 2009). Invasive species can be a threat to fishery and aquaculture (IPPIC, 2009). Summarising, a balanced weighting of the conflicting objectives is required in the context of a sustainability framework.

3.12 Indicators

Status

Reliable and up-to-date data on the manufacture and consumption of antifouling substances are hard to find. From the COWI report it is known that, from 1998-2001, the total production volume for 60% of the substances in PT 21 was 668 tonnes and the three most important substances made up 88% of the total. However, one of the most important substances, dicopper oxide, is not included.

It is also known that a large share of antifouling paints is imported (Koch et. al).

Some AFP, especially the use of Pyrithionate, are relatively new; more research is needed to identify relevant metabolites and their environmental fate (Onduka et. al, 2007; Ranke et al. 2002).

There is almost no information available on the use of AFP in other uses e.g. offshore and harbour construction, fish nets.

Options

Data on manufacture and consumption of AFP is needed for the evaluation of amounts used in the context of sustainable use of biocides. Therefore, the inclusion of biocides into regulation 1185/2009/EC concerning statistics on pesticides would be an appropriate option for gathering data.

Relevant metabolites should be identified and used as indicators in monitoring programmes, not only in the framework of the WFD but possibly also for the marine environment. Sediment as sink for antifouling substances should be included in monitoring programmes.

Data on other uses (fish nets, offshore constructions, harbour construction) is missing and should also be collected.

4 Example: Application of antifouling paint on pleasure boat

Use pattern	Application on pleasure boat
Target organism	Micro- and macro organism, in fresh water (lakes), brackish water, salt water (e.g. North sea, Baltic Sea)
User/applicator	Owner of the boat, non-professional
Location	Small marina, open air (compacted earth, some covering)
Active substance	Biocidal product: Solid antifoulant[19], package: 750ml or 2.5l Liquid paint: Tolylfluanid 1-2.5%, copper 25-50% (mixture is classified as dangerous: harmful Xn, dangerous for the environment N) Mixture contains also other substances which are classified as dangerous
Mode of application and dosage	Stirring before and while using <u>Application:</u> rolling, brushing <u>Mixing:</u> product is used undiluted – "ready-to-use" <u>Application:</u> airless spraying (air spraying not allowed) <u>Mixing:</u> depending on temperature up to 5% solvent is allowed No abrasion is needed before application if similar self-polishing coating is already on boat Drying time: Dust dry: 0.5 hour Rain safe: 1 hour Water safe: 4 hours <u>Dosage:</u> new coating: 2 coatings, repair: 1 coating theoretical application rate: 10 m²/L Average thickness of layer: 100 µm wet and 10 µm dry
Main emission route	Rolling brushing, airless spray → air, **soil**, potential to water via WWTP or STP Waste from residues, cleaning, used tools (e.g. stirring tool, brush), gloves
Environmental behaviour	Tolylfluanid degrades to *N, N*-Dimethylsulfamide (DMS), which is a precursor of the carcinogen *N*-Nitrosodimethylamine (NDMA) during drinking water ozonisation. In Germany DMS has been detected in surface water (50 ng/L to 100 ng/L) and ground water (100 ng/L to 1000 ng/L) (Schmidt et al., 2008).
Training	<u>Status:</u> Training for non-professional workers (owner of the boat) is not foreseen <u>Options:</u> Training could be an additional topic in lessons for awarding boat certificates, for further measure see awareness programme

[19] The product name has been made anonymous.

Requirements for sales of pesticides	Status: Product must be classified and labelled properly, no advertising phrases that play down the risks are allowed. The product can be ordered through internet sale, no further advice is required by any regulation, a Safety Data Sheet (SDS) and a Material Safety Data Sheet (MSDS) are normally also available by download from the internet but non-professional users are not able to understand SDS, so the product information is the basis for adequate application Options: Information used by professional users as TRGS, UVV, SDS is not available (and normally not understandable) for non-professional users. Product information (or MSDS) could be used for giving more (understandable) information for non-professional users e.g. which important issues, risk and respective risk management measures the user should be aware of e.g. more detailed information on handling, requirements for working place (covering, hard standing area, information on waste handling). A harmonized format for this kind of product could be developed.
Awareness programmes	Status: In some cases AFP are not necessary for pleasure boats. Some marinas have relevant facilities for application, maintenance & repair, waste handling and trained persons who are responsible for compliance with existing regulation Options: Information for non-professional users on the availability of alternatives and the effects and risks of antifouling products could be made publicly available, Obligation to have a trained person in marinas Promotion of “eco-labelled” marinas (“Blaue Flagge”)
Certification and inspection of equipment in use	Status: No certification scheme for equipment in use Options: In this case further need for certification of equipment,
Information to the public	The web-based information system of the German Federal Environment Agency provides useful information (www.biozide.info)
Form of the biocide and mode of application ➔ Emission during life cycle	Status: Paint is a insoluble matrix coating that releases the biocide tolylfluanid and copper by diffusion, the release is high in the beginning and decreases with time, copper reacts to copper carbonate which is insoluble Options: Promotion of biocides where leaching rates are controlled better
Specific measures to protect the aquatic environment	Status: Paint is not allowed to enter the surface water, waste, waste water must be collected and is not allowed to enter the water body. Options: A minimum distance from location of use and surface water could be introduced Restriction on use of any AFP for pleasure boats under a certain size e.g. < 25 m

Reduction of pesticide use in sensitive areas ➔ protection of non-target organisms ➔ surface water ➔ soil	<u>Status:</u> <u>Options:</u> RMM e.g. covering, working only on hard standing, could be compulsory as a minimum requirement Restriction on use of AFP in specified areas e.g. lakes
Handling and storage of pesticides and their packaging and residues	<u>Status:</u> Information on handling and storage is given on product information <u>Options:</u> Limitation on packaging size for amateurs Special information for waste disposal on packaging – waste collection of empty containers and unused residues Maybe spray cans for non-professional user could be an alternative packaging because stirring and refilling, cleaning can be avoided but drawbacks may be from the aspects of occupational health
Integrated Pest Management	<u>Status:</u> <u>good / best practice</u> First of all checking if antifouling coating is necessary at all; maybe cleaning at regular intervals is sufficient Checking if alternatives (e.g. silicon based) are applicable is part of good practice but non-professional users are seldom aware of it <u>Options:</u> Promotion of efficient alternatives (e.g. biocide-free - silicon based, encapsulated substances with optimised leaching, cleaning) Information on use
Indicators	<u>Status:</u> Leaching during service life is the main emission route, but a significant amount of substance can also be emitted to the environment during application, mixing& stirring <u>Options:</u> As there is no data on consumption, collection on this is needed, also monitoring programmes in marinas (coastal areas, lakes and rivers) should reflect the use of AFP in this area and include the substances themselves and the relevant metabolites It could also be checked if research on emissions to soil and groundwater bodies is useful and needed

Conclusion

The service life of AFP is the service life stage, with the main emissions into the environment. Leaching from the ship hull can be seen as an intended function of the AFP. The consequences could be partly subject to the authorization process. For example, criteria for the leaching rate of a product, the efficiency and the risk assessment of metabolites could be defined and evaluated in the authorization procedure. In the framework of a Thematic Strategy, the focus could be on the promotion of low-risks products or biocide free alternatives.

The maintenance & repair phase is the other relevant path of emissions into the environment, even though minor in magnitude. However, this phase can be influenced by measures laid down in a Thematic Strategy.

The use of antifouling products by non-professional amateurs offers the following exemplary measures of sustainable use (not complete):

- Collection of data about consumption of AFP by amateurs
- Training and awareness raising of this group of users on
  - Information as a basis on decision making whether an AFP is necessary at all and, if it cannot be avoided, which one would be the one with the lowest risk → development of a guidance that reflects the crucial information
  - Training for environmentally sound handling, storage, application and waste handling → as part of “boat pilot permission” or in the framework of the promotion of “eco labelled” marinas
- Restriction of sale to amateurs → no sale of products classified dangerous for the environment by internet sale or catalogues
- Restriction of application, M&R only in yards equipped with appropriate surrounding (hard ground, covering), waste water collection system with filtering, waste collection sites
- Restriction of AFP in sensitive areas e.g. lakes

5 Appendices

5.1 Overview on standards, BAT and other relevant documents

Best Available Practices	Not yet available for AFP,, partly covered in BAT for surface treatment and coating: Bericht über Beste Verfügbare Techniken (BVT) im Bereich der Lack- und Klebstoffverarbeitung in Deutschland -Teilband I: Lackverarbeitung- Deutsch-Französisches Institut für Umweltforschung (DFIU) und Universität Karlsruhe (TH), August 2002 European Commission: Best Available Techniques on Surface Treatment using Organic Solvents. August 2007
Standards	Several Codes of practice for application and removal of antifouling coatings from different sources (also non-EU) available but no elaborated standards
Standards	
ISO/DIS 13073-1	Risk assessment on anti-fouling systems on ships - Part 1: Marine environmental risk assessment method of biocidally active substances used for anti-fouling systems on ships
ISO/CD 13073-2	Risk assessment on anti-fouling systems on ships - Part 2: Marine environmental risk assessment method for anti-fouling systems on ships using biocidally active substances
ISO/WD 13073-3	Risk assessment on anti-fouling systems on ships - Part 3: Human health risk assessment for the application and removal of anti-fouling systems
DIN EN 1829-1, (Norm-Entwurf)	Hochdruckreiniger – Hochdruckwasserstrahlmaschinen – Sicherheitstechnische Anforderungen – Teil 1: Allgemeine Beschreibung; Deutsche Fassung prEN 1829-1:2007
DIN EN 1829-2 (2008-06)	Hochdruckwasserstrahlmaschinen – Sicherheitstechnische Anforderungen - Teil 2: Schläuche, Schlauchleitungen und Verbindungselemente; Deutsche Fassung EN 1829-2:2008
DIN 24375, Ausgabe: 1981-06	Oberflächentechnik; Flachstrahl-Düsen für luftlos zerstäubende Spritzpistolen; Maße, Prüfung, Kennzeichnung
DIN 55945 2007-03	Lacke und Anstrichstoffe – Fachausdrücke und Definitionen für Beschichtungsstoffe und Beschichtungen
DIN EN 13966-1, Ausgabe: 2007-11	Bestimmung des Auftragswirkungsgrades von Spritz- und Sprühgeräten für Beschichtungsstoffe – Teil 1: Flächenbeschichtung; Deutsche Fassung EN 13966-1:2003
DIN EN ISO 10890 (Entwurf , 2009-08)	Beschichtungsstoffe - Modell für die Biozid-Auswaschrate von Antifouling-Beschichtungen durch Berechnung der Mengenbilanz (ISO/DIS 10890.2:2009); Deutsche Fassung prEN ISO 10890.2:2009
DIN EN ISO 15181-1 (2007-10)	Beschichtungsstoffe - Bestimmung der Auswaschrate von Bioziden aus Antifouling-Beschichtungen - Teil 1: Allgemeines Verfahren zur Extraktion von Bioziden (ISO 15181-1:2007); Deutsche Fassung EN ISO 15181-1:2007
DIN EN ISO 15181-2 (2007-10)	Beschichtungsstoffe - Bestimmung der Auswaschrate von Bioziden aus Antifouling-Beschichtungen - Teil 2: Bestimmung der Kupferionen-Konzentration im Extrakt und Berechnung der Auswaschrate (ISO 15181-2:2007); Deutsche Fassung EN ISO 15181-2:2007
DIN EN ISO 15181-3 (2007-10)	Beschichtungsstoffe - Bestimmung der Auswaschrate von Bioziden aus Antifouling-Beschichtungen - Teil 3: Berechnung der Auswaschrate von Zink-Ethylenbis(dithiocarbamat) (Zineb) durch Bestimmung der Konzentration von Ethylenthioharnstoff im Extrakt (ISO 15181-3:2007); Deutsche Fassung EN ISO 15181-3:2007
DIN EN ISO 15181-4 (2009-02)	Beschichtungsstoffe - Bestimmung der Auswaschrate von Bioziden aus Antifouling-Beschichtungen - Teil 4: Bestimmung der Konzentration von Pyridintriphenylboran (PTPB) im Extrakt und Berechnung der Auswaschrate (ISO 15181-4:2008); Deutsche Fassung EN ISO 15181-4:2008

DIN EN ISO 15181-5 (2008-09)	Beschichtungsstoffe - Bestimmung der Auswaschrate von Bioziden aus Antifouling-Beschichtungen - Teil 5: Berechung der Auswaschrate von Tolylfluanid und Dichlofluanid durch Bestimmung der Konzentration von Dimethyltolylsulfamid (DMST) und Dimethylphenylsulfamid (DMSA) im Extrakt (ISO 15181-5:2008); Deutsche Fassung EN ISO 15181-5:2008

Authorities and employers mutual insurance association	
TRGS 401	Gefährdung durch Hautkontakt - Ermittlung, Beurteilung, Maßnahme Ausgabe: Juni 2008 (replaces TRGS 516) The TRGS 150 und 531 have been integrated into the new TRGS 401. In individual cases the previous TRGS can be used further on as auxiliary means for the assessment of working place safety while applying antifoulants.
TRGS 516	Antifoulingfarben (has been withdrawn). Can partly be used according to the VCI for antifoulant applications but is not available online any longer.
GUV-V D25	(VBG 23) Verarbeiten von Beschichtungsstoffen (außer Kraft gesetzt infolge des Inkrafttretens der Betriebssicherheitsverordnung BetrSichV)
GUV-V C28	(VBG 34) Schiffbau
GUV-V D26	(VBG 48) Strahlarbeiten
GUV-V D15	(VBG 87) Arbeiten mit Flüssigstrahler
GUV-V	(VBG 119) Gesundheitsgefährlicher mineralischer Staub (außer Kraft ersetzt durch (BGI 5047))
BGI 5047	Mineralischer Staub
GUV-V C21	Hafenarbeit
BGR 217	BG-Regel: Umgang mit mineralischem Staub, zurückgezogen
BGI 639	Merkblatt: Maler- und Lackierarbeiten
BGI 557	Merkblatt: Lackierer
BGI 740	BG-Information: Lackierräume und –einrichtungen – bauliche Einrichtungen, Brand- und Explosionsschutz, Betrieb
BGI 536	Merkblatt: Gefährliche chemische Stoffe, zurückgezogen
BGI 621	Merkblatt: Lösemittel
BGI 546	Sicherheitslehrbrief Umgang mit Gefahrstoffen (bisher ZH 1/93) Vereinigung der Metall-Berufsgenossenschaften 2001
BGI 595	Merkblatt reizende Stoffe / ätzende Stoffe
VDMA	Diverse 'Einheitsblätter' zu Anforderungen, Prüfmethoden, Sicherheit etc. von Geräten
STG	Diverse Richtlinien zu Korrosionsschutz sowie ein 'Datenblatt für Beschichtungsstoffe', Druckwasserstrahlen. Antifouling kommt in den Datenblättern nicht vor.

5.2 Literature

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