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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 III:

Case study on PT 18: Insecticides

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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

[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.

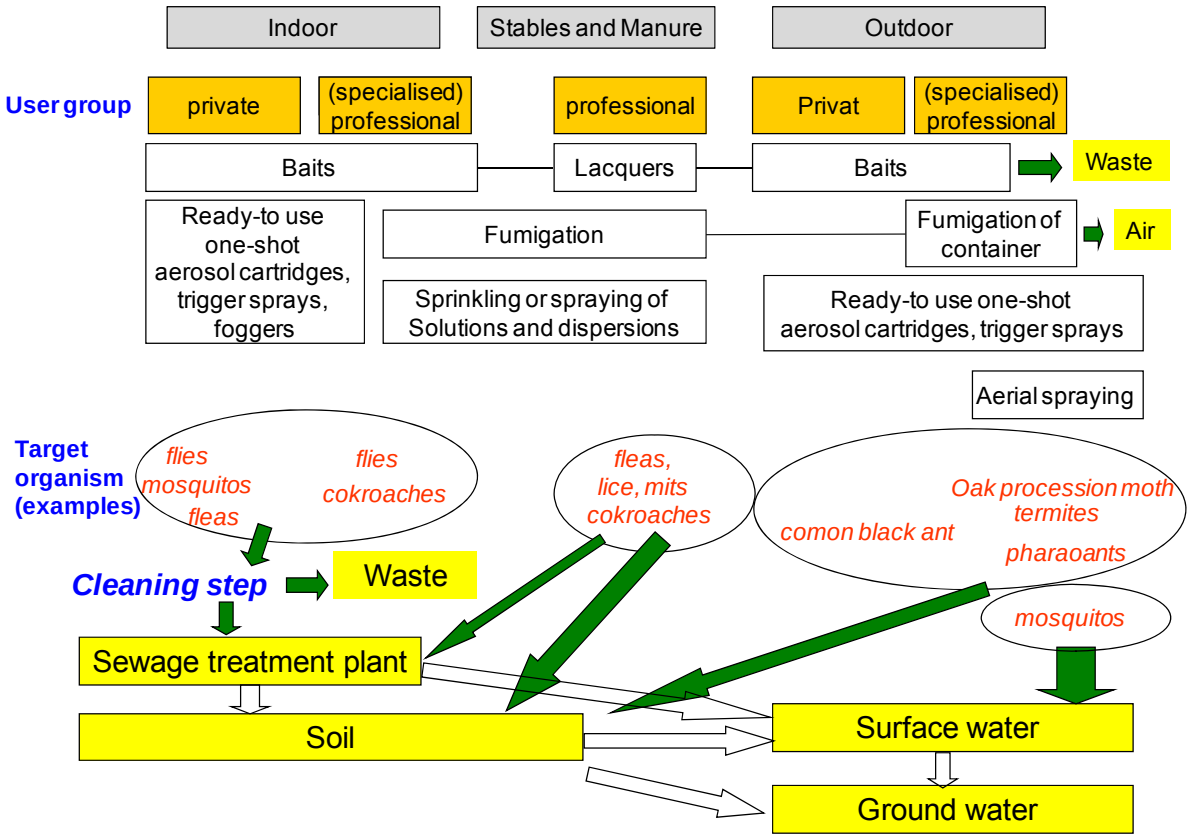

Figure III-1: Overview on the areas of application, the mode of application, important target organisms and the exposure routes of PT 18

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.

Outdoor

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

[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.

[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 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).

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[10] Personal communication of Dr. Norbert Becker, KABS, Germany

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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