JRC Scientific and Technical Reports

Emission Scenario Document for Product Type 2

Private and public health area disinfectants and other biocidal products

Drafted by Scientific Consulting Company (SCC) GmbH
Revised by the Biocides Technical Meeting
Endorsed by the Biocides Competent Authorities Meeting
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The mission of the JRC-IHCP is to protect the interests and health of the consumer in the framework of EU legislation on chemicals, food, and consumer products by providing scientific and technical support including risk-benefit assessment and analysis of traceability.

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EXECUTIVE SUMMARY

Following the entry into force of the Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market, all active substances in the European market have to be reviewed to ensure that under normal conditions of use they can be used without unacceptable risk for people, animals or the environment. Thus, in the frame of the review process, the risk assessment of each active substance plays a fundamental role and providing technical guidance to the assessments that must be performed ensures a correct and uniform implementation of the Directive for the different Member States.
According to Annex VI of Directive 98/8/EC the risk assessment shall cover the proposed normal use of the biocidal product together with a 'realistic worst case scenario'.

The aim of this Emission Scenario Document (ESD) is to set up methods for the estimation of the emission of disinfectants, used in the private and public health area, to the primary receiving environmental compartments.
For Product Type 2 (PT2) an ESD already existed, providing methods for the estimation of the emission of disinfectants used for sanitary purpose and for disinfectant used in the medical sector. The scope of the present ESD is to supplement the existing ESD by providing additional information and emission scenarios for disinfection of industrial areas, of air conditioning systems, of hospital waste and of chemical toilets.

The present ESD is intended to be used by Member States as a basis for assessing applications submitted with a view to include existing active substances used in PT2 in Annex I or IA of Directive 98/8/EC or for assessing applications for product authorisation. It can be a useful tool also for industry, when assessing requirements for a submission.

This ESD have been developed in the context of project FKZ 360 04 023 of the German Federal Environmental Agency (UBA), who contracted SCC GmbH for a first draft of the document. The first draft was then revised by the Biocides competence group of Chemical assessment and toxicology (CAT) Unit of the Institute for Health and Consumer Protection (IHCP) of the JRC, taking into account the comments of the Member States. The final version, approved by the Biocides Technical Meeting, was endorsed by the Biocides Competent Authority Meeting in May 2011.
The Biocides Technical Meeting and the Biocides Competent Authorities Meeting agreed in asking the JRC to publish the present Emission Scenario Document as a Scientific and Technical Report.

CONTEXT

This report have been developed in the context of the German Federal Environmental Agency (UBA) project entitled "Überarbeitung und Fertigstellung des Draft ESD für Desinfektionsmittel PT 2-4" (Revision and finalisation of the draft ESD for disinfectants in PT 2-4) and is a supplement to the already existing ESD for PT 2 [Emission Scenario Document for Product Type 2: Private and public health area disinfectants and other biocidal products (sanitary and medical sector)"] by van der Poel (2001). In 2006, the EU Commission initiated a project together with the former European Chemicals Bureau (ECB) to compile an emission scenario document for assessing active substances used as disinfectants in product types (PTs) 2 to 4 (concerning active substances on the third priority list, which are currently being evaluated) to extend the existing published ESDs. In January 2007, the project ended without the approval of the draft. As a result, the draft was not passed to the Biocides Competent Authority Meeting, so that the ESD was not approved at EU level.
Discussion on unanswered questions failed to reach a conclusion during the EU workshop on environmental assessment of disinfectants in Arona organised by the Commission services on 11 March 2008.
Therefore, the UBA contracted SCC GmbH on 17 November 2008 to review the present draft of the ESD taking into account the discussions in the ESD working group, the subsequent feedback from the member states, and the discussions at the technical meetings and the Arona workshop of 11 March 2008. In addition, shortcomings in both form and content needed to be corrected and missing data and scenarios to be added.
The results of the revision have been presented at the TM I 09 (Biocides Technical Meeting I of 2009) and discussed by the Member States; final alterations following comments made by the Member States after TM I 09 were incorporated. Thereafter the Technical Notes for Guidance were endorsed during the 34th CA meeting (Biocides Competent Authority meeting) for release for a 6-month consultation period of stakeholders. At the end of the consultation period, this ESD was revised on the basis of the comments received and the remaining issues were discussed at the first Biocides Technical Meeting of 2011 (chaired by the Biocides competence group of IHCP-JRC). Results of this discussion were incorporated in the final version.
The final version, approved by the Biocides Technical Meeting (chaired by the Biocides competence group of IHCP-JRC), was endorsed by the Biocides Competent Authority Meeting in May 2011.

The objectives of this document were the following:

- Removing formal shortcomings by harmonising the terminology with ESDs which have already been approved, also within the document, and improving legibility and clarity;
- Supplying missing notes for determining regulatory values;
- Incorporating the results of the discussions at the Arona workshop into the document;
- Compiling scenarios for known weaknesses in PT 2 (chemical toilets, air conditioning) on the basis of previously available preparatory work.
- Identifying gaps in knowledge and requirement for further research.

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1. INTRODUCTION

1.1. Background

Biocidal products of product type 2 are used for disinfecting air, surfaces, materials, equipment and furniture not used for direct food or feed contact in private, public and industrial areas (including hospitals) and cover also certain products used as algaecides, e.g. for use in swimming pools. Use areas include, *inter alia,* swimming pools, aquariums, bathing and other waters, air-conditioning systems, walls and floors in health- and other institutions, chemical toilets, waste water, hospital waste, soil and other substrates (e.g. in playgrounds).
According to Annex VI of Directive 98/8/EC[1] (the Directive) the risk assessment shall cover the proposed normal use of the biocidal product together with a 'realistic worst case scenario'. The aim of ESDs is to set up methods for the estimation of the emission of disinfectants to the primary receiving environmental compartments. The calculation of PEC values using environmental interactions, for example movement of emissions to secondary environmental compartments (e.g. from soil to ground water) is the result of fate and behaviour calculations and models and therefore considered to be outside the scope of this ESD. The Directive was adopted by the European Parliament and the Council in 1998. One objective of the Directive is to allow harmonisation of Member States' legislation concerning biocides. The Directive implements an authorisation process for biocidal products containing active substances listed in Annex I and IA. Active substances may be added to the Annexes after undergoing an assessment of risks to the users of the biocides, the general public and the environment. For the required environmental risk assessment, Environmental Emission Scenario Documents (ESDs) provide a tool for the assessment process, and a methodology for estimating the quantities of active substances which may be released to the environment during the various stages of a biocidal product's lifecycle. As specified in the requirements of the Directive, Member States may only authorise the placing on the market of biocidal products whose active ingredients are listed in Annex I (or Annex IA for low risk biocidal products) of the Directive. Substances can only be included in these annexes if thorough assessment of the risks establishes that, under normal conditions of use, they will not have unacceptable effects on public health or the environment. Providing technical guidance to the assessments that must be performed ensures a correct and uniform implementation of the Directive for the different Member States.

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[1] Directive 98/8/EC of the European Parliament and of the Council of 16 February 1998 concerning the placing of biocidal products on the market

1.2. Relevant sources of information

The following documents and existing models are the basis for the presented supplement to the ESD for PT 2:

- *AEAT (2007): "Service contract for the development of environmental emission scenarios for active agents used in certain biocidal products", draft final report to European Commission, Directorate General Environment*

- *ECB Document "Remaining Comments of the Member States and the Industry for the Finalisation of the AEAT Emission Scenario Document for PT 2-3-4"*

- *"Workshop on environmental risk assessment for Product Types 1 to 6 - Minutes of the workshop held in Arona on 11 March 2008*

- *EU TGD PART IV. IC-5 Personal/domestic and IC-6 Public domain. Assessment of the environmental release of soaps, fabric washing, dish cleaning and surface cleaning substances.*

- *Baumann et al. 2000, p.6 (Institute for Environmental Research (INFU), University of Dortmund, UBA Berlin: Gathering and review of Environmental Emission Scenarios for biocides (2000))*

- *Van der Poel and Bakker 2002, RIVM report 601 450 009. Emission Scenario Document for Biocides: Emission Scenarios for all 23 product types of EU Directive 98/8/EEC.*

- *Van der Poel 2001, RIVM report 601 450 008. Emission Scenario Document for Product Type 2: Private and public health area disinfectants and other biocidal products (sanitary and medical sector)*

- *Royal Haskoning (2003). Harmonisation of Environmental Emission Scenarios Biocides: PT 11 - Preservatives for liquid cooling systems. Report 4L1784.A0/R015*

1.3. Harmonised presentation

The emission scenarios are presented in text and tables in this report. In the tables, the input and output data and calculations are specified, and units according to (E)USES are used. The input and output data are divided into four groups:

S data Set	Parameter must be present in the input data set for the calculation to be executed (no method has been implemented in the system to estimate this parameter; no default value is set, data either to be supplied by the notifier or available in the literature).
D	Default Parameter has a standard value (most defaults can be changed by the user).
O	Output Parameter is the output from another calculation (most output parameters can be overwritten by the user with alternative data)

P Pick list	Parameter value can be chosen from a “pick list” of values

In this ESD four different sub-groups of PT 2 uses are covered. For three of them, only scenarios based on application data have been developed (see chapter 2.2 to 2.4), while for one sub-group (see chapter 2.1) for one use a scenario based on application data is provided and for another use both a tonnage based and a consumption based scenario are presented. The latter case follows the proposal of Van der Poel (2001) in his ESD for PT 2. Though it is desirable to have only one scenario, there may be circumstances for which two scenarios may be necessary or advisable. Appendix 1 of this document, which corresponds to Appendix 3 of the existing ESD for PT 2, gives a general explanation on the differences between the two types of emission scenarios and their respective advantages and disadvantages.

2. SELECTED USES OF DISINFECTANTS IN PRIVATE AND PUBLIC HEALTH AREAS (PT 2)

Product type 2 covers applications of biocides for the disinfection of air, surfaces, materials, equipment and furniture not used for direct food or feed contact in private, public and industrial areas, including hospitals. Disinfectants for food handling areas are covered by product type 4 and do not fall under the scope of this document. In the existing ESD for PT 2 (“Supplement to the methodology for risk evaluation of biocides; Emission Scenario Document for Product Type 2: Private and public health area disinfectants and other biocidal products (sanitary and medical sector)”) by van der Poel (2001), which was developed in the context of the EUBEES project, emission scenarios are provided for the following sub-groups of PT 2:

- Disinfectant used for sanitary purpose
- Disinfectant used in the medical sector for:
    - Disinfection of rooms, furniture and objects
    - Disinfection of instruments
    - Laundry disinfection

The scope of this document is to supplement the existing ESD for PT 2 by providing additional information and emission scenarios for the following sub-groups of PT 2 not yet covered:

- Disinfection of industrial areas (see chapter 2.1)
- Disinfection of air conditioning (see chapter 2.2)
- Disinfection of hospital waste (see chapter 2.3)
- Disinfection of chemical toilets (see chapter 2.4)

For several of the above mentioned applications in e.g. air conditioning systems and chemical toilets, the addition of a biocidal product to the system may have concomitant benefits in addition to human health protection e.g. control of odour or in-situ slimicidal or preservative effects to prevent build-up of fouling bacteria.

Under the Biocides Directive public health is considered to take priority over preservative uses. Thus, if a substance is applied in one of the applications listed above but has no impact on public health (e.g only to prevent the buildup of fouling bacteria), it does <u>not</u> fall within PT 2. In case of ambiguities, the Manual of Decision can be used as further guidance. As a general remark relevant to the application areas that follow, it is noted that active substances may react with other components during disinfection or in waste water and hence be degraded or deactivated. Therefore, a disintegration factor F_{dis} was taken into account in the scenario models. However, there are significant uncertainties in determining appropriate values for any disintegration factor. As a Tier 1 method, and to maintain a conservative approach to potential exposure, disintegration is not considered in the first instance and F_{dis} was set to 0. Where data is available to justify a change of the default value, this can be done.

2.1. Disinfection of industrial and institutional areas

2.1.1. Description of this use area

According to Gebel (2008), this use includes disinfection of walls, floors and other surfaces (e.g. large pieces of portable equipment and/or furniture) in the following main areas:

- **Industrial premises** dealing with packaging materials, biotechnology i.e. laboratories (yeast, proteins, enzymes), production of pharmaceutics, cosmetics and toiletries and production of computers
- **Institutional areas** such as public areas and transportation, schools, shops, gyms, hotels, offices
- **Primary health care areas / hospital sector** like hospitals, communal medical facilities, dental institutions, school clinics, kindergartens, nursing homes.

Surface disinfection in industrial, institutional and primary health care areas is usually done on a regular basis (daily) by using a ready-for-use product (e.g. wipe, trigger spray) or using a diluted concentrate which can be applied by scrubbing, mopping or wiping. The post-application includes either wiping the surfaces or letting them dry.

As a periodic treatment, fumigation involving the evaporation of a disinfection liquid in a room can also be applied, in most cases in hospitals. At present, there is no emission scenario available for this specific treatment. In the hospital sector disinfection follows specific hygienic requirements with regard to human health. According to Gebel (2008) and RKI (2003), disinfection in hospitals can be divided in the following processes: *Ongoing disinfection* during nursing and treatment of patients deals with a routinely performed disinfection of those surfaces in the vicinity of the patient which might be contaminated with pathogens. Surfaces which are not in the proximity of the patient, e.g the surface of walls more than 1.5 m above the floor as well as the ceiling are usually not a source of microorganisms and an infrequent cleaning of these surfaces is sufficient.

The *final disinfection* is the disinfection of an area or room that was used for the nursing or treatment of patients who suffered from infectious disease. Disinfection needs to be performed in a way which completely restrains any danger of infecting the next patient. The final disinfection reaches all those surfaces and objects that could have been contaminated with pathogens.

The *room disinfection* is defined as the complete and simultaneous disinfection of all surfaces and the air in a closed room, by vaporizing or atomizing an aqueous solution of formaldehyde (RKI, 2003). This is a large scale method regulated by local laws and is usually only conducted if a strong indication is given.

2.1.2. Biocidal active substances typically applied in these areas

The following active substances are typically applied in industrial premises and institutional areas (GUV R-209, 2001):

- Formaldehyde, glutar(di)aldehyd and other aldehydes or derivatives
- Phenol and phenol derivatives
- Quaternary ammonium compounds
- Biguanide
- Alkylamine / alkylamine derivatives
- Hypochlorite and other chlorine substances
- Alcohols
- Per compounds (e.g. peracetic acid or hydrogen peroxide)

Active substances specifically used for disinfection in hospitals, their use concentrations and typical contact times are summarised in the following table:

Table 1: List of RKI tested and approved substances for disinfectants (2003)

Active substance	In use dilution	Contact time
Phenol or Phenol derivatives	3 – 6 %	2 – 6 hours
Chlorine-organic substances or inorganic substances with active chlorine	2.5 – 3 %	2 hours
Per compounds	2 – 4 %	1 – 4 hours
Formaldehyde and/or other aldehydes or derivatives	3 – 10 %	4 – 6 hours

2.1.3. Environmental release pathways

Depending on the biocidal product, surfaces are either rinsed with water after disinfection (rinse-off products) or left for drying (non-rinse off products). The main emission pathway in industrial, institutional and health care areas is to the sewer system. However, depending on the nature of the premises and method of disinfection (i.e. non-contained disinfection processes / fumigation), there is some potential for direct emission to the air and to solid waste.

2.1.4. Emission scenarios

In the following, emission scenarios are provided for disinfection in **industrial premises** (chapter 2.1.4.1) and for disinfection in **institutional areas** (chapter 2.1.4.2).

Disinfection in **primary health care areas and hospital sector** are covered by the existing ESD for PT 2 by Van der Poel (2001) and are not repeated here again. Please refer to chapter 2.1 and chapter 3.3.1 of the RIVM report 601 450 008 (Van der Poel 2001), Emission Scenario Document for Product Type 2: Private and public health area disinfectants and other biocidal products (sanitary and medical sector).

2.1.4.1. Disinfection in industrial premises

Industrial premises such as biotechnology plants, production plants for pharmaceuticals, cosmetics or toiletries or production plants for computers are considered as local point sources which release their waste water to a local STP (Sewage Treatment Plant). Surfaces to be disinfected in such industrial premises can greatly vary. They can be surfaces of the rooms themselves (2 m² up to > 200 m²) such as floors, walls and ceilings, or smaller surfaces (< 2 m²) such as furniture, equipment, working places, isolator benches etc. The largest surface area to be disinfected in industrial premises was identified to be 1,000 m² (SCC, 2008).
Depending on the industry branch, working places may be disinfected after each use (this may result in several applications per day) or once per day, weekly or monthly, while floors, walls and ceilings are disinfected either daily, weekly or monthly. Application methods can be in all cases wiping, spraying or fogging (SCC, 2008).

Since disinfection in industrial premises is very inhomogeneous regarding the size of surfaces to be disinfected and the frequency of disinfections, the following assumptions have been made in order to determine default values for the frequency of applications (Nappl) and the surface area to be disinfected (*AREAsurface*):

Nappl: Since disinfection can take place from "after each use" to "monthly", one disinfection per day is considered a reasonable default value.

AREAsurface: The variation in the size of the surface area to be disinfected is quite high and depends on the nature and size of the industrial plant. Based on the above summarised information on sizes of treated surfaces (< 2 m² to 1,000 m²), it is assumed that a default surface area of 1,000 m² to be disinfected on a daily base in an industrial plant (including room floors and walls, furniture and working places) is a reasonable default value representing a worst case.

The scenario presented in Table 2 calculates the daily local emission of active substance to the facility drain based on the application rate of the disinfectant per m². Degradation of the substance during disinfection is not considered in a first tier release to waste water (*Fwater*) is therefore by default 100% but can be reduced if data are available justifying such a reduction.

The default values given in the Table 2 for *AREAsurface*, *Nappl, Fdis* and *Fwater* can be replaced with substance specific data if the application is restricted to smaller surfaces (wipe, trigger, sprays), or if a substance specific application scheme requires more frequent applications, or if data are available showing dissipation of the substances during disinfection.

Table 2: Emission scenario for calculating the releases of disinfectants used in industrial areas

Parameters	Nomenclature	Value	Unit	Origin
Input				
Application rate of biocidal product[A)]	*Vform*		$[l.m^{-2}]$	S
Concentration of active substance in the product	*Cform*		$[g.l^{-1}]$	S
Surface area to be disinfected	$AREA_{surface}$	1,000	$[m^2]$	D
Number of applications per day	*Nappl*	1	$[d^{-1}]$	D
Fraction of substance disintegrated during or after application (before release to the sewer system)	F_{dis}	0	[-]	D
Fraction released to wastewater	F_{water}	1	[-]	D
Output				
Local release to waste water (without pre-treatment)		$Elocal_{water}$	$[kg.d^{-1}]$	O
Calculation				
$Elocal_{water} = Vform \cdot Cform \cdot AREA_{surface} \cdot Nappl \cdot (1 - F_{dis}) \cdot F_{water} / 1000 Elocal_{water} = Vform \cdot Cform \cdot AREA_{surface} \cdot Nappl \cdot (1 - F_{dis}) \cdot F_{water} / 1000$				

[A)] Typical application rates for biocidal products found in the Internet (www.hygies.de) were 0.02 – 0.06 L/m², up to maximum 0.1 L in the pharmaceutical industry

2.1.4.2. Disinfection in institutional areas

In the existing ESD for PT 2, Van der Poel (2001) presents two emission scenarios for calculating the releases of disinfectants used in the sanitary sector. These “sanitary” scenarios are based on the scenario “Disinfection in accommodations” described by Luttik et al. (1993) which was designed for disinfectants used in accommodations for humans and for areas where food and drinks are prepared. Since the “sanitary” scenarios by Van der Poel (2001), covering both, private use (households) and public domain (institutional sector) are quite general in nature. They are also applicable to the use of disinfectants in institutional areas like public areas, schools, shops, gyms, hotels or offices. Some of the default values given by Van der Poel have been adapted to align the scenarios with this specific application area as further detailed in the specific scenario descriptions.

The first scenario (Table 3) is based on **annual tonnage** and follows the approach of the TGD for cleaning products in industrial category (IC) 5 (personal/domestic) at the stage of private use. Van der Poel (2001) assumed that the use of biocidal products is evenly distributed over a particular country and/or region. The release to waste water (F_{water}) is by default 100%. It can be reduced if data are available justifying such a reduction.

According to Van der Poel, releases take place to an STP. Therefore, the STP is viewed as the local main source (fed by 10,000 inhabitants producing 0.2 m³ waste water per person per day). The default fraction of 0.002 (*Fmainsource*) reflects the fraction of the total waste water in the region, received by a large STP and is calculated by dividing the number of inhabitants connected to one local STP by the number of inhabitants in the region, using the default as given in the TGD (10,000 / 20,000,000 = 0.0005) and applying a safety factor of 4 (0.0005 • 4 = 0.002). Under certain circumstances the use of an alternative safety factor for *Fmainsource* (HERA 2005) may be appropriate where this can be justified by the applicant.

The tonnage based scenario of Van der Poel (2001) was adapted as follows:

- It can be assumed that in institutional and private health care areas disinfection takes place only during the working week. *Temission* was adapted accordingly to 260 d, i.e. 5 days per week resulting, in (52 • 5 =) 260 working days per year.
- The factor F_{dis} describing the amount of substance disintegrated during or after application was included.

The adapted scenario is summarised in the following table:

Table 3: Emission scenario for calculating the releases of disinfectants used for sanitary purposes based on the annual tonnage applied (Van der Poel 2001).

Parameters	Nomenclature	Value	Unit	Origin
Input				
A) Relevant tonnage in the EU for this application	*TONNAGE* [A)]		$[t.yr^{-1}]$	S
Fraction for the region	$Fprodvol_{reg}$	0.1	[-]	D
B) Relevant tonnage in the region for this application	*TONNAGEreg* [A)]		$[t.yr^{-1}]$	S/O
A + B)				
Fraction of the main source (sewage treatment plant - STP)	$Fmainsource_4$ [B)]	0.002	[-]	D
Fraction of substance disintegrated during or after application (before release to the sewer system)	F_{dis}	0	[-]	D
Fraction released to wastewater	$F_4,water$ [B)]	1	[-]	D
Number of emission days for life cycle stage 4 (private use)	$Temission_4$ [B)]	260	$[d.yr^{-1}]$	D
Output				
Emission rate to wastewater	$Elocal_{4,water}$ [B)]		$[kg.d^{-1}]$	O
Intermediate calculation				

Parameters	Nomenclature	Value	Unit	Origin
B)				
Relevant tonnage in the region for this application				
$TONNAGEreg = Fprodvol_{reg} \cdot TONNAGE$			$[t.yr^{-1}]$	
End calculation				
A + B)				
$Elocal_{4,water} = TONNAGE_{reg} \cdot 1{,}000 \cdot Fmainsource_4 \cdot (1 - F_{dis}) \cdot F_{4,water} / Temission_4$				

[A)] In principle this should be $TONNAGE_k$ to identify usage in product *k* but this is not shown just as in the EUSES documentation.

[B)] The subscript "4" refers to the stage of private use in conformity with EUSES. The index has been included since this scenario reflects the original scenario of Van der Poel. The index is related to the tonnage based approach of release estimations where it defines the stage of life cycle, which is relevant for the choice of default values (see A&B tables of the TGD, 2003).

The second scenario (Table 4) is based on the **average consumption per capita** and uses post-consumer release predictions of the emission scenario document for soaps and detergents used in IC 5 (personal/domestic) and IC 6 (public domain) from the TGD (EC 2003). The emission scenario document gives an estimate of 100% release to waste water. The density of the product is assumed to be 1000 $kg.m^{-3}$.

The default values for daily consumption per capita in the original document (5 g product for general purpose and 2 g for lavatory disinfectants) are specific to detergents used for cleaning surfaces and lavatories. A statistical survey in Germany on the frequency of disinfectant applications in households in comparison to the use of cleaning agents shows that cleaning agents are used much more frequently than disinfectants (Statista, 2008):

Frequency of disinfectant applications:

daily:	1% of the surveyed households
several times per week:	3% of the surveyed households
once per week:	5% of the surveyed households

Frequency of detergents and cleaning agent applications:

daily:	8% of the surveyed households
several times per week:	38% of the surveyed households
once per week:	31% of the surveyed households

Based on this statistical survey it can be concluded that the default values for consumption of detergents/cleaning agents per capita of 5 g for “general purpose” and 2 g for “lavatory” cover as worst cases the daily per-capita amount of disinfectants used.
The following adjustment has been made as compared to the original scenario of Van der Poel (2001):

- The nomenclature was adapted to the most recent one as given in the EUSES 2.1 documentation.

- The factor F_{dis} describing the amount of substance disintegrated during or after application was included.

The adapted scenario is summarised in the following table:

Table 4: Emission scenario for calculating the releases of disinfectants used for sanitary purposes based on average consumption (Van der Poel 2001).

Parameters	Nomenclature	Value	Unit	Origin
Input				
Number of inhabitants feeding one STP	*Nlocal*	10,000	[cap]	D [A)]
Fraction released to wastewater	*F4,water* [B)]	1	[-]	D
Concentration of active substance in biocidal product	*Cform*		[kg.l^{-1}]	S
Consumption per capita				
General purpose (tiles, floors, sinks)	*Vform*	0.005	[l.cap^{-1}.d^{-1}]	D
Lavatory	*Vform*	0.002	[l.cap^{-1}.d^{-1}]	D
Fraction of substance disintegrated during or after application (before release to the sewer system)	F_{dis}	0	[-]	D
Penetration factor of disinfectant	*Fpenetr*	0.5	[-]	D
Output				
Emission rate to wastewater	$Elocal_{4,water}$ [B)]		[kg.d^{-1}]	O
Calculation				
$Elocal_{4,water} = Nlocal \cdot Vform \cdot Cform \cdot Fpenetr \cdot (1 - F_{dis}) \cdot F_{4,water}$				

A) Default number as used in the TGD and EUSES for the standard STP

B) The subscript "4" refers to the stage of private use in conformity with EUSES. The index has been included since this scenario reflects the original scenario of Van der Poel. The index is related to the consumption based approach of release estimations where it defines the stage of life cycle, which is relevant for the choice of default values (see A&B tables of the TGD, 2003)

Van der Poel (2001) provides a methodology to estimate which of the above described approaches, tonnage based or average consumption by inhabitant based, is more appropriate for the emission estimation: the break-even point – calculation. Further background information and explanations on the break-even point calculation are provided in Appendix 1 to this document (representing Appendix 3 by Van der Poel (2001)), a short description of the calculation is given in the following: *Break-even point:* Above a certain tonnage (i.e. the break-even point), the scenario based on tonnage is more appropriate, since the scenario based on consumption would underestimate the actual amount of disinfectant reaching one STP (see Appendix 1).

The break-even point can be calculated as follows:

$$TONNAGEreg = (Nlocal \cdot Vform \cdot Cform \cdot Fpenetr \cdot Temission) / (1{,}000 \cdot Fmainsource)$$

in which 1,000 is the conversion factor for tonnes to kilogram.

For the number of emission days, $Temission_4$ = 260 and the fraction *Fmainsource* for the model STP = 0.002, the break-even point can be written in the form:

$TONNAGEreg = 1.3 \cdot 10^6 \cdot Vform \cdot Cform \cdot Fpenetr$

With the default values for the consumption per capita and the penetration factor, this becomes:

$TONNAGEreg = 3.25 \cdot 10^3 \cdot Cform$ (sanitary purposes)
$TONNAGEreg = 1.3 \cdot 10^3 \cdot Cform$ (lavatory)

If for example, the concentration of the disinfectant $Cform = 10\ g.l^{-1}$ ($0.01\ kg.l^{-1}$), the break-even point will be reached at a regional tonnage of 32.5 $t.yr^{-1}$ for sanitary purposes and 13 $t.yr^{-1}$ for lavatory purposes. As *Cform* has to be supplied by the applicant, the tonnage at the break-even point can be estimated.

It was discussed during the Workshop on environmental risk assessment for PT 1 to 6 that both methods, tonnage based and average consumption by inhabitant based approach should be used in support of each other. Both approaches have their pros and cons and the RMS will use the tonnage approach to assess the validity of the average consumption approach and in particular the default values used in the models. The tonnage approach should be included in the risk assessment of relevant PTs but it is recognized that additional guidance is needed.

2.2. Disinfection of air conditioning systems

2.2.1. Description of this sub-product type

Disinfectants are added to air conditioning systems to prevent proliferation of micro-organisms and to prevent contamination of the cooling liquid and the air condition system with bacteria, inter alia to control *Legionella* species. The aims of air conditioning are: heating or cooling, wetting or dehumidification of air in buildings. The main components of an air conditioning system are a fan to circulate the air, a cold surface to cool and dehumidify air, a warm surface and a source of water vapour. Large systems are additionally equipped with tubes to distribute the air and collect it again.
According to Ihle (2006), the size and technique of the air conditioning systems can vary greatly depending on the size of the rooms which need to be air conditioned. The following systems can be distinguished:

- large (often centralised) air conditioning systems (e.g. in large buildings such as banks or offices) which regulate the room temperature and moisture throughout the year
- stand alone air conditioning unit (e.g. in households), which are in some cases used for cooling only and in other cases for both heating and cooling, depending on the season
- very small air conditioning systems e.g. in cars

In the following, the functioning of stand alone and central systems are shortly described (Padfield, 2000) in order to show which parts of the systems are susceptible for micro-organism infestation:

Standalone air conditioning unit:

The part of the system in the room, on the left, pulls air first over a cool surface and then over a warming surface. The part of the system on the right re-circulates the cooling fluid.

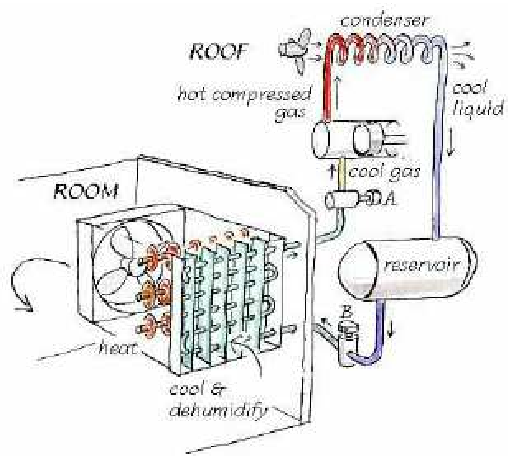

Figure 1: Stand alone air conditioning unit (Padfield, 2000).

The essential characteristic of cooling fluids (e.g. HCFC) is that they have a low boiling point at atmospheric pressure. The fluid passes from the reservoir through a valve B into the lower pressure within the cooling unit in the room. There the liquid evaporates, removing heat from the air. The boiling point is fixed by the constant pressure set by valve A. The vapour is then compressed and condensed back into a liquid which collects in the reservoir. (Padfield, 2000) The part of the air conditioning system susceptible for micro-organism infestation is the section responsible for cooling and dehumidifying since condense water can develop on the cooling surface which is usually collected in drainage pans (not shown in Figure 1) where the water is stagnant.

Large air conditioning systems (e.g. cooling chamber of central cooling systems) The cooling fluid in such a system is usually water, which is cooled by a refrigeration system (not shown in Figure 2) which works according to the same principle as explained for the stand alone air conditioning unit above. Air is circulated through ducts, and partly fresh air is added. A humidifier and various filters are also typical parts of a large system.

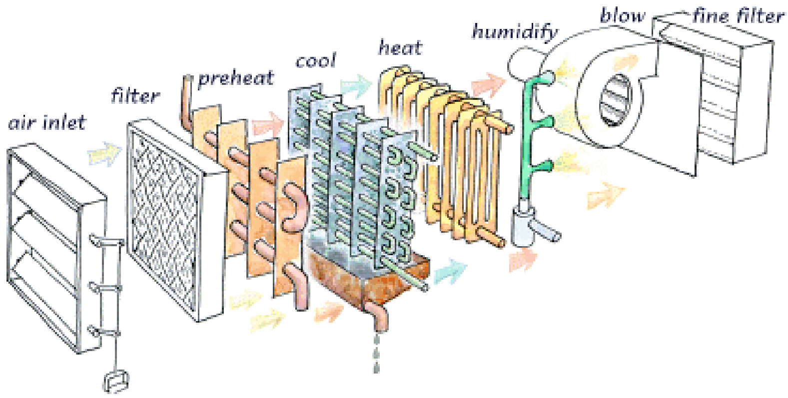

Figure 2. In large air conditioning systems chilled water is used to cool the air. Outside air is drawn in, filtered and heated before it passes through the main air conditioning devices (Padfield, 2000).

In large centralised systems, many variations on the basic design and of the cooling technique are possible. The following cooling technique exists:

- **Wetted media devices** utilise a porous substrate to provide an extended surface area for evaporation of water. Water is either circulated over the media or the media is rotated through a water bath. Since evaporation occurs from the surface of the media, water droplets are not produced. They use either once through potable building water or are equipped with a recirculating system including pump, automatic makeup water valve, a bleed-off/purge and a positive draining reservoir.

- **Air washers** utilise high-pressure nozzles to reduce water to small droplets for efficient evaporation. These systems have a chamber or casing containing one or more banks of spray nozzles and drift eliminators. Air washers contain a water sump for collecting and holding excess spray water. The eliminator section removes entrained droplets of water from the air. Air washers usually are equipped with a recirculating system including pump, automatic makeup water valve, a bleed-off/purge, and a positive draining reservoir. The water may be chilled for additional cooling and/or dehumidification.

- **Misters** produce an aerosol by use of ultrasonic device, spinning disks, or spray nozzles. Normally, these devices are supplied with fresh potable water directly from the building water system; however, some systems contain a reservoir.

According to Ihle (2006), the following parts of large centralised cooling systems are susceptible for micro-organism infestation:

1. The cooling section (e.g. air washer), where condense water is collected in drain pans.
2. The cooling water circuit of the air conditioning system, especially in the re-cooling equipment of the cooling water.
3. Humidity filters.

Biocides for disinfecting the air conditioning systems are mainly applied in large central units and only to a marginal extent in standalone units. Standalone air

conditioning units are rather cleaned (i.e. the condense water collection sump) than disinfected. Therefore, the focus in this ESD is on large (central) cooling systems.
According to Ihle (2006), biocides are mainly applied for the disinfection of the circulating cooling water (3) and of the moistened operating parts (1). The biocides are either applied to the collecting pan or to the circulating water. The application can be continuously or intermittently.

2.2.2. Biocides typically applied in this subgroup

The following biocidal active substances are used for the disinfection of air conditioning systems (Ihle, 2006):

- Chlorine and chlorinated compounds
- Hydrogen peroxide
- Organo-bromo compounds
- Aldehyde compounds

2.2.3. Environmental release pathways

The disinfectants can be released to the indoor air when the cooling water is vaporised. In addition, releases occur to the sewer system by blow down water, when systems are flushed or when condense water sumps are emptied.

2.2.4. Emission scenario for air conditioning

As concluded in chapter 2.2.1, disinfection of air conditioning systems typically takes place in large systems where biocides are automatically applied by a dosing unit to the circulating water and to moistened system parts. In the following chapters 2.2.4.1 and 2.2.4.2, scenarios for the emission pathways to air and waste water are given.

2.2.4.1. Emissions to the air

Biocides used in air conditioning systems can be released to air, when the cooling water is vaporised e.g in an air washer or mister. The emission scenario proposed by Van der Poel (1999) is followed to describe this emission pathway. However, the scenario was adapted by including a default value for *Fair*. The default value provided in the ESD for PT 11 for the fraction lost due to spray- and wind drift of 0.01 was used.

Table 5: Emission scenario for calculating the releases of disinfectants to air (Van der Poel, 1999, adapted)

Parameters	Nomenclature	Value	Unit	Origin
Input				
Amount of disinfectant with active substance	*Vform*		[l.d $^{-1}$]	S
Concentration of active substance in the product	*Cform*		[kg.l $^{-1}$]	S
Fraction released to the air	F_{air}	0.01	[-]	D
Output				
Emission rate to air	$Elocal_{air}$		[kg.d^{-1}]	O
Calculation				
$Elocal_{air} = Vform \bullet Cform \bullet F_{air}$				

2.2.4.2. Emissions to sewer system

Biocides used in air conditioning systems can also be released to the sewer system with the blow down water of a large central system. The existing scenarios for PT 11 (Liquid-cooling and processing preservatives- cooling systems) (Royal Haskoning 2003) have been adopted for the present ESD for PT 2 with only small amendments. In the ESD for PT 11 (Royal Haskoning 2003) the following types of cooling systems are described:

- **Once through cooling systems**: Surface water is pumped to the heat exchange module. There is no direct contact between the process stream and the cooling medium. The exchange of heat occurs through a separating wall. After heat exchange the water is discharged directly to the surface water as warmed-up water.

- **Open re-circulating cooling systems**: The cooling water circulates in an open loop. Water that has passed through the heat exchangers is returned to a cooling tower where the temperature is lowered by evaporative cooling. The cooled water is re-collected and re-circulated into the system. A certain amount of the cooling water is purged from the system (= blow down) to prevent scaling which is compensated by so called fresh “make-up” water.

- **Closed cooling systems**: The cooling water re-circulates in a closed loop and is not discharged after cooling. Processed heat is transferred to the cooling water in a heat exchanger and in a second heat exchanger the cooling water is cooled off by air or water. Residence time of the cooling water in closed cooling water systems can be up to 6 month.

When comparing the description of large (centralised) air conditioning systems by Padfield (2000) and Ihle (2006) (see chapter 2.2.1) with the descriptions of cooling systems in the ESD for PT 11, it becomes evident, that the large air conditioning units are comparable to open recirculating cooling systems: the cooling water is re-collected after heat exchange, cooled down and re-used for another cooling cycle. Also a certain blow down and make up of cooling water takes place in order to prevent salinisation of the air conditioning system.

The argument that the dimensions of most air conditioning systems might be smaller than those of open recirculating cooling system described in the ESD for PT 11 for e.g. power stations was followed up by performing a literature and internet search. No reliable values for the volume of water (V_{syst}), the blow down flow rate (*Qbld*) and for the recirculating cooling water flow rate (*Qcirc*) in the air conditioning system could be retrieved from the information obtained so that no direct comparison with the respective default values from the ESD for PT 11 was possible.

In a theoretical approach, it was attempted to deduce a default value at least for the recirculating cooling water flow rate (*Qcirc*) – the only parameter for which at least some information was found - to test the applicability of the default values of the ESD for PT 11. The recirculating cooling water flow rate (*Qcirc*) can be calculated from the air flow, which is indicated for most air conditioning systems. For air washers, the parameter water-air coefficient μ indicates how much water has to be sprayed hourly (most of it is recollected to be returned to the system) to reach a certain efficiency. The water-air coefficient μ is calculated by dividing the sprayed amount of water by the amount of air passing through and has usually a value between 0.3 and 0.4 (Ihle, 2006)

Taking into account the following examples of air flow volumes given for institutions in Switzerland (Basler, 1990) and assuming that air washers are used for cooling purposes, the corresponding recirculating cooling water flow was calculated backwards as follows:

Cooling water flow = air volume flow • μ (0.3 or 0.4):

Example	**Air volume flow [m³/h]**	**Calculated theoretical cooling water flow (μ = 0.3) [m³/h]**	**Calculated theoretical cooling water flow (μ = 0.4) [m³/h]**
Züricher Kantonalbank	2520	756	1008
Aargausche Kantonalbank	500	150	200
Banque de l'etat de Fribourg	6000	1800	2400
Ecole Polytechnique Fédérale de Lausanne	1200	360	480
Hasler AG	6720	2016	2688

This theoretical approach has the following weakness: the calculation is based on the coefficient μ for air washers. However, air washing is not necessarily the cooling technique applied in the examples from the table above. Nevertheless, the calculated values of the cooling water flow indicate that the cooling water flow in large (central) air conditioning systems is in the range of small (100 $m^3.h^{-1}$) and large (9000 $m^3.h^{-1}$) open recirculating cooling systems as described in the ESD for PT 11.

Descriptions of cooling systems provided by producers like e.g. Novatherm and the general descriptions given in Ihle (2006) show that the blow down flow rate (*Qbld*) is rather low in air conditioning systems (3 fold the evaporated amount, whereas the evaporated part is indicated to be only a very small percentage of the circulating water) and that the volume of water in the system (*Vsyst*) is rather in the range of small open recirculating cooling systems (300 m³) than of large ones (3000 m³) described in the ESD for PT 11. In the absence of any specific information on *Vsyst* and *Qbld* for large air conditioning systems, it is recommended as first tier to use the default values for small open recirculating cooling systems as given in the ESD for PT 11 for the time being.

The following alterations have been applied to adapt the ESD for PT 11 (open recirculating system, shock dosing and continuous dosing) for large air conditioning systems in PT 2:

- In contrast to the ESD for PT 11, it was assumed that the recirculating cooling water is cooled by a refrigeration system (as described in Padfield, 2000) and not by a cooling tower. Therefore, release to air and deposition to soil via a cooling tower is not considered.

- According to Ihle (2006), the amount of water lost due to evaporation is only a very low percentage of the circulating cooling water. Therefore, the parameter "fraction of water lost due to evaporation and drift" was not included in the calculation.

- The blow down water of the air conditioning system is released to the facility drain of the building. Thus, emission occurs via the sewer system to an STP.

- The emission estimation for PT 11 was revised in EUSES 2.1 (see EUSES 2.1 documentation). For this reason, the equations in Table 6 below reflect the revised equations from EUSES 2.1 and not the original ones from the ESD for PT 11.

Table 6. Emission scenario for air conditioning systems- shock dosing and continuous dosing (EUSES 2.1 background report, 2008).

Parameters	Nomenclature	Value	Unit	Origin
Input				
Amount of product used in shock dose treatment	$Qform_{event}$		[kg]	S
Amount of product used in continuous treatment	$Qform_{cont}$		[$kg.d^{-1}$]	S
Fraction of active substance in the product	*Fform*		[$kg.kg^{-1}$]	S
Volume of water in the air conditioning system	*Vsyst*	300	[m^3]	D*
Blow down flow rate	*Qbld*	48	[$m^3.d^{-1}$]	D*
Cooling water recirculation flow rate	*Qcirc*	2400	[$m^3.d^{-1}$]	D*
Degradation rate constant	*Kdeg*		[d^{-1}]	S
Number of emission days for one shock dosing	*Tshock*	$\leq$ Tint	[d]	D*
Number of emission days for repeated shock dosing	*Trep-shock*	300	[d]	D*
Number of emission days for continuous dosing	*Tcont*	300	[d]	D*
Time period between two emission events	*Tint*	1	[d]	D*
Output				
Number of dosing during the emission period	*n*		[-]	O
Hydraulic residence time	*HRT*		[d]	O
Overall rate constant for removal from the cooling system	*Ksyst*		[d^{-1}]	O
Concentration of active substance in the cooling water of the air conditioning system	*Cproc*		[$kg.m^{-3}$]	O
Concentration in blow down water	*Cbld*		[$kg.m^{-3}$]	O
Total release over time period T *(for shock dosing)* from one shock dosing event	$RELEASE_{shock,T}$		[kg]	O
Total release over time period T *(for repeated shock dosing)* from multiple shock dosing events	$RELEASE_{shock\text{-}int,T}$		[kg]	O
Total amount of substance released at continuous dosing after time period T *(for continuous dosing)*	$RELEASE_{cont,T}$		[$kg.d^{-1}$]	O
Local (average) emission to (waste) water	$Elocal_{water}$		[$kg.d^{-1}$]	O
Calculation				
$HRT = \frac{Vsyst}{Qbld}$ *eq. 310 of the EUSES background report (without emission to air)*				

Parameters	Nomenclature	Value	Unit	Origin
$Ksyst = \frac{Qbld}{Vsyst} + Kdeg$ *eq. 311 of the EUSES background report (without emission to air)*				
Shock dosing				
$Cproc = \frac{Qform_{event} \cdot Fform}{Vsyst}$ *eq. 312 of the EUSES background report*				
After one shock dose – discharge to sewer system				
$RELEASE_{shock,T} = Qbld \cdot Cproc \cdot \frac{1 - e^{-Ksyst \cdot Tshock}}{Ksyst}$ *eq. 315 of the EUSES background report (without cooling tower)*				
$Elocal = \frac{RELEASE_{shock,T}}{T_{shock}}$ *eq. 321 of the EUSES background report*				
After n dosings – discharge to sewer system				
$n = T_{rep\text{-}shock} / Tint$ *eq. 322 of the EUSES background report*				
$RELEASE_{shock-\text{int},T} = \sum_{i=1}^{n} Qbld \cdot Cproc \cdot \frac{(1 - \mathrm{e}^{-(\mathrm{Trep\text{-}shock} - (i-1) \cdot \mathrm{Tint}) \cdot \mathrm{Ksyst}})}{\mathrm{Ksyst}}$ eq. 325 of the EUSES background report (without cooling tower)				
$Elocal_{water} = \frac{RELEASE_{shock-\text{int},T}}{T_{rep-shock}}$ eq. 334 of the EUSES background report				
Continuous dosing				
$Cproc = \frac{Qform_{cont} \cdot Fform}{Vsyst}$ eq. 335 of the EUSES background report				
$Cbld = \frac{Cproc}{1 + Ksyst \cdot HRT}$ eq. 346 of the EUSES background report				
$RELEASE_{cont,T} = Cbld \cdot Qbld \cdot T_{continuous}$				
$Elocal_{water} = \frac{RELEASE_{cont,T}}{T_{continuous}}$				

***** Default values were taken from the EUSES 2.1 background report (page 146 to 147)

2.3. Disinfection of hospital waste

According to Bodenschatz (2005) and the EU Waste Catalogue (2002), hospital waste can be divided in the following waste groups and sub-groups labelled with a six-digit European waste codes:

Group A:

20 03 01 mixed municipal waste
15 01 XX packaging (including separately collected municipal packaging waste)
18 01 03* disinfected wastes whose collection and disposal is subject to special requirements in order to prevent infection
20 01 08 biodegradable kitchen and canteen waste

Group B:

18 01 04	wastes whose collection and disposal is not subject to special requirements in order to prevent infection (for example dressings, plaster casts, linen, disposable clothing, diapers)
18 01 01	sharps (except 18 01 03)

Group C:

18 01 03*	wastes whose collection and disposal is subject to special requirements in order to prevent infection

Group D:

18 01 06*	chemicals consisting of or containing dangerous substances
18 01 09	medicines other than those mentioned in 18 01 08
18 01 10*	amalgam waste from dental care

Group E:

18 01 02	body parts and organs including blood bags and blood preserves (except 18 01 03)

Hazardous waste:

18 01 08*	cytotoxic and cytostatic medicines

The disinfection of hospital waste is regulated by law in most of the EU countries, e.g. in Germany §10 of BSeuchG applies. By law only hospital waste of group C needs to be disinfected to prevent infection and the transmission of diseases. Hospital waste of group C is shredded to extent the surface before disinfection. There are different practices used across Europe for disinfection specifically for hospital waste treatment and disposal purposes. Chemical disinfection may occasionally be used in the disposal of clinical material or during bacterial contamination episodes (e.g. during the control of MRSA) but according to Bodenschatz (2008), autoclaving of clinical material is nowadays the main disinfection technique for clinical waste.

The disinfected waste is packed in special containers and then transported to an incinerator or landfill. For both waste treatment options, various specific legislation[2] is in place to prevent and control the release of pollutants into the environment. Since the use of biocides as disinfectant of hospital waste is not applied to a significant extent, the potential for any release of biocides into the environment from disposal of hospital waste is considered minimal, as disinfected waste is packed and incinerated, and does not require further consideration at the time being as emissions to the environment are considered to be limited. Therefore, an ESD covering biocides from hospital waste disposal sources is not needed.

[2] Including the Waste Incineration Directive 2000/76/EC, and Landfill of Waste Directive 99/31/EC.

2.4. Disinfection of chemical toilets

2.4.1. Description of this sub-product type

In chemical toilets, faeces are collected in tanks and sanitary additives containing biocides are added for disinfection and reduction of odour. Chemical toilets are installed on transport vehicles (aircrafts, long distant busses), at temporary sites (construction, camping, large events), or at other places without any possibility of a direct connection to the sewer system (parking lots). In addition, they are typically used in mobile vehicles and are found on boats, in recreational vehicles (RVs) or caravans.

Some of these systems (those used in airplanes, travel busses, caravans, trains and boats) are explained in more detail in Appendix 2 and in chapter 2.4.4 below (mobile toilets). In this chapter it is also explained in detail why the uses in airplanes, travel busses, caravans and trains are not considered in the emission scenario.
Cat litter products containing biocidal products fall within the PT 2 chemical toilet category. Used cat litter is assumed to enter the municipal solid waste (MSW) disposal pathway. Since the release of chemicals from MSW treatment processes (e.g. landfill, incineration) is controlled through other legislative mechanisms[3], the potential environmental releases of biocides from MSW do not require further consideration.

2.4.2. Biocides typically applied in this subgroup

Biocides used in sanitary additives for chemical toilets typically contain aldehydes (formaldehyde, glutaraldehyde) or cationic tensides (quaternary ammonia compounds) as active substances. The sanitary additives together with a certain amount of water (depending on the size of the respective tank) are filled into the sewage tank of the chemical toilet as so called pre-charge. The initial concentration of the sanitary additive varies between 0.01 - 2.0%.

2.4.3. Environmental release pathways

The sewage of chemical toilets, containing disinfectants, can be discharged directly to the sewer system (e.g. at airports) or is collected by professional operators (e.g. mobile toilets) and transferred to a municipal STP where the sewage is then disposed off by special receiving devices (Toi Toi & Dixi, 2008).

2.4.4. Emission scenario for chemical toilets

In **airports**, the highest amount of sewage from chemical toilets accumulates. At the Düsseldorf Airport, sewage amounts to approximately 60 m^3/d (Strauch 1993), whereas approximately 120 m^3 occur daily at the Frankfurt Airport (Fraport, 2008). Airports in Germany are usually located in the vicinity of large cities. Therefore, a uniform discharge of chemical toilet waste water into the sewage system is generally possible because of the strong dilution with communal sewer water (Bischofsberger, 1991). Special discharge agreements with the city STPs are in place which have much higher dimensions (they collect waste from >> 100.000 inhabitants) than the standard STP according to the TGD. The airport therefore represents a special situation for which no scenario was created. In order to be able to assess this situation in an ESD, additional information would need to be retrieved.

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3 Including the Waste Incineration Directive 2000/76/EC, and Landfill of Waste Directive 99/31/EC.

In German **trains** no sanitary additives are added anymore to the toilet (DB, 2008). The situation in other European countries is unclear; however, it seems to be the trend to avoid sanitary additives in train toilets also in other European countries. To verify this additional investigation in other countries would be needed. Comparing the size of the sewage tank of **caravans** (50 l), **travel busses** (60 l) or **mobile toilets** (200 – 320 l), mobile toilets have the highest tank volume. Since sanitary additives are added depending on the tanks size, mobile toilets represent a worst case. Mobile toilets are in use all over Europe and the content is usually discharged to local municipal STPs ($\geq$ 10,000 inhabitants). For this reason, they have been considered appropriate as basis for an emission scenario. It should be noted, that the specific information on mobile toilets presented in the following has been collected mainly in Germany and might represent only the situation there.

According to Strauch (1993), about 25,000 mobile toilets are in continuous use in the former West German states. Construction sites (70%) as well as large events are the main users of mobile toilets. These toilet cabins consist of a sewage tank above which the toilet unit is installed.

Before use, the toilets are filled with 20 l of sanitary additive, the so called pre-charge (*Vliquid*). Dosage parameters for disinfectants generally range between 0.5 and 2% of the pre-charge volume (i.e. maximum 0.4 l disinfectant per toilet filling = *Vform*). Depending on the type of the toilet cabin, the sewage tank of the mobile toilet can hold between 200 and 320 l sewage.

The sewage tanks are emptied on a weekly basis by special operates, pumping off the sewage into a tank wagon with a tank volume of 2 m³ (*Vtank*). The sewage tank of the mobile toilet are usually not full after one week, the German regulation ATV-M-20 provides an average filling content of 60 l on the day of discharge (*Vsewage*).

The subsequent disposal of the content of chemical toilets into communal sewage plants is regulated in Germany by regulation ATV-M 270. The content of the tank wagon is discharged into special openings at the STP under the supervision of plant personnel. It is a prerequisite that the STP has sufficient performance and capacity reserves. It is possible that scheduled delivery intervals are required. The minimum capacity of a sewage plant should be for 10,000 inhabitant equivalents.

According to the ATV-M-270, the nitrate concentration in mobile toilets contents is ten times higher than the nitrate content of normal sewage. For this reason, into a standard STP designed for 10.000 inhabitant equivalents, only 2 m³ per day of mobile toilet content are allowed to be discharged. Based on this information, the default value for the number of tank wagons discharging to one local STP (*Ntank)* was set to 1 since the volume of one tank wagon equals to 2 m³.

The release of disinfectant to the influent of the STP ($F_{influent}$) is by default 100% but can be reduced if data are available justifying such a reduction. Disintegration (F_{dis}) of a substance during or after application is by default 0 % but can be increased if respective data are available justifying this approach.

Table 7. Emission scenario for chemical toilets

Parameters	Nomenclature	Value	Unit	Origin
Input				
Amount of biocidal product per litre pre-charge liquid in a chemical toilet	*Vform*	0.02	$[l.l^{-1}]$	D
Fraction of active substance in the biocidal product	*Fform*		[-]	S
Density of the biocidal productA)	RHO_{form}		$[kg.l^{-1}]$	S
Volume of pre-charge liquid in the tank of a chemical toilet	*Vliquid*	20	[l]	D
Average amount of sewage in one mobile toilet before discharge (including pre-charge liquid)	*Vsewage*	60	[l]	D
Volume of the tank wagon collecting and discharging the sewage of chemical toilets	*Vtank*	2000	[l]	D
Number of tank wagons discharging to one local STP (standard size for 10.000 inhabitants)	*Ntank*	1	$[d^{-1}]$	D
Fraction of substance disintegrated during or after application (before release to the sewer system)	F_{dis}	0	[-]	D
Fraction of disinfectant released into the influent of the STP	$F_{influent}$	1	[-]	
Output				
Amount of active substance in one tank wagon	$Qa.i._{tank}$		[kg]	O
Local emission to STP from one tank wagon	$Elocal_{STP}$		$[kg.d^{-1}]$	O
Calculation				
$Qa.i.tank = Vform \bullet Fform \bullet RHO_{form} \bullet Vliquid \bullet (1-F_{dis}) \bullet Finfluent \bullet (Vtank / Vsewage)$				
$ElocalSTP = Qa.i._{tank} \bullet Ntank$				

A) range for RHO_{form}: 1.02 - 1.13 g/cm³ (n = 3)

3. FURTHER RESEARCH

One scope of the UBA project was to identify gaps in knowledge and requirements for further research. The following has been identified for PT 2:

- The scenario proposed by AEAT based on Van der Poel (2001) for "institutional areas" (Table 4) is based on the parameters "consumption per capita" and "the number of inhabitants feeding one STP". Further research to identify representative default values for "number of institution feeding one STP" and "consumption per institution" is needed in order to make the scenario more representative.

- The scenario for air conditioning system still lacks representative default values for the hydraulic retention time, volume of the system and blow down flow rate. Specific data have been provided by the Netherlands. Further research is needed in order to derive representative default values from e.g. these data.

- Default values for consumption of detergents/cleaning agents per capita as mentioned in 2.1.4.2 (disinfection of institutional areas) are partly based on a statistical survey in German households. It is questionable whether these values are representative for the use in institutional areas and further research on this issue is needed.

- In case that chemical toilets in airplanes or trains should also be considered relevant, further research for respective representative default values is needed.

- Disinfection of ion exchangers in cosmetic and pharmaceutical industry: no scenarios are currently available for these uses.

- The waste path is not covered in this ESD, reference is made to other legislation. Waste legislation usually works with sum parameters like DOC. In that legislation information about specific substances is not available. Consequently, hazardous properties of certain biocides are not taken into consideration. However, if a biocide is not degradable, it can have relevance for drainage from landfills or for waste incineration.

- Emission scenarios based on tonnage are not included for all sub scenarios since representative default values for $F_{mainsource}$ are not available. Further research is needed to define respective default values.

- The active substance in disinfectants if released to the facility drain usually passes the sewer system before release to the environment (STP) and can react there with organic matter, which is found abundantly in the sewer system. In such cases it is proposed to consider degradation in the sewer system (based on the defaults and equations given in the ESD for PT 5) as a higher Tier approach. The option for such a calculation step should be included in the ESD.

4. REFERENCES

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5. APPENDICES

Appendix 1: Differences between emission scenarios (Appendix 3 according to Van der Poel, 2001)

In general two types of emission scenarios may be distinguished, one based on the regional tonnage and the other on consumption.

1. Emission scenario based on tonnages

In general no regional tonnage will be known for an arbitrary substance. In that case the regional tonnage is derived from the EU tonnage by multiplication by 0.1 (10% rule). This is about twice the amount that may be expected on account of the fraction of inhabitants in the region of the EU (see 4). Such a situation will not be unlikely in most cases as it may be expected that the more densely populated areas will have more industrial activities than the rural areas.

For diffuse emissions caused by e.g. households the standard STP with 10,000 inhabitants feeding the system and an amount of 0.2 m wastewater per inhabitant per day is considered as a point source. If the use of a substance would be evenly distributed over the population (consumers) and STPs in a region and over the week, the fraction of this substance reaching the standard STP of EUSES would be *number of inhabitants connected to the STP (Nlocal) / number of inhabitants in the region (N)*. This means a fraction of 10,000 / 20 Mio. = 0.0005 with the defaults of EUSES. As the use of (formulation containing) substances never will be distributed evenly over the population and the week, a safety factor of four was assumed at the time. This means that the fraction of the main source = 0.002. This value is used in the emission tables of the TGD.

There may be applications where a point source is considered such as a hospital. In this report the fraction for the model hospital has been estimated to be 0.007. This fraction was calculated as from the average number of beds in a region per hospital and the total number of beds in that region (see Appendix 2).

2. Emission scenario based on the consumption

This type of emission scenario applies either the average consumption per inhabitant or the – estimated – use in process. An example of the average consumption is the use of soaps and detergents for cleaning and washing ($l.cap^{-1}.d^{-1}$ or $g.cap^{-1}.d^{-1}$). The emission scenario is simple and applies an emission factor, the concentration of the substance in the product (in this report a disinfectant for which the notifier has to specify the value) and the penetration factor (i.e. the fraction of the product on the market containing the specific substance).

For a point source like a hospital it may be also the use of this kind of products (usually known in $kg.y^{-1}$). The emission scenario is even more simple as there is no penetration factor needed. Only an emission factor and an amount of product used is needed besides the concentration of the substance in the product.

3. Tonnage versus Consumption

When a substance with diffuse emissions is assessed the scenarios based on the tonnage will produce emission directly related to the volume of the use. This is an advantage compared to scenarios that are based on consumption.
There are, however, also some disadvantages in using scenarios based on the tonnage; there is an uncertainty in the regional tonnage if this is not known and another uncertainty in the fraction reaching the standard STP. The use of average consumption has several disadvantages. First, there is no direct relation with the actual quantity of the disinfectant for the application in case of diffuse emissions. Second, the average consumptions are often not specifically for e.g. detergents with a biocide leading to an uncertainty and for many products no reliable data are known. Third, the average consumption in a region may be different form the EU average leading to an uncertainty (reason for the 'safety factor' of 4 applied to the STP calculations with tonnages).
Last but not least, the factor for the market penetration has a considerable uncertainty.
For point sources the main disadvantage is the fact that calculations of the consumption may have considerable uncertainties because of lacking data impelling detours to obtain estimates.

Because of the complete different character the two types of scenarios will provide outcomes which may be quite different. The emission factor and concentration of the substance in the product will be the same. For the diffuse emissions, i.e. emissions caused by use by the public at large, the scenario with the average consumption will give a fixed value whereas the scenario with the tonnage will give the emission as a linear relation to the quantity. It may be assumed that the tonnage scenario is more realistic as the consumption per habitant determines the tonnage.
For the point source there may be a situation that the use of the tonnage scenario is underestimating the emission. This is the case where the substance is not used in the product by all sources. For example, if we consider a cleaner with a disinfectant for sanitary purposes the various manufacturers of that product may apply different active substances. So, one hospital will apply the disinfectant assessed but another applies a different substance. The tonnage scenario, however, will distribute the whole amount over all hospitals so to say by using the fraction of its relative size (0.007). So, there will be a break-even point below which the consumption scenario will be better.

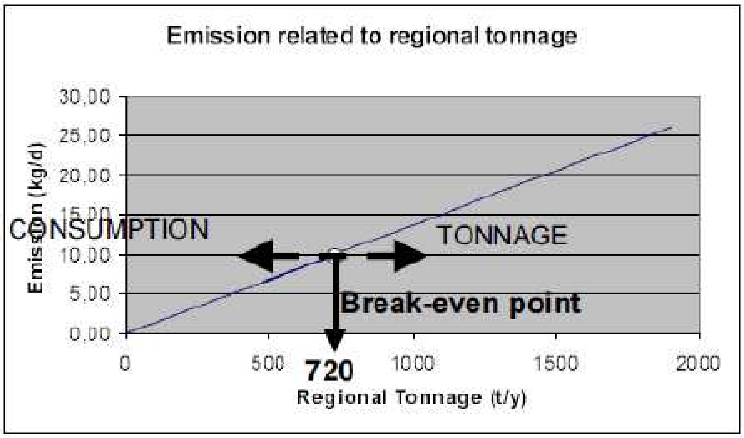
This is illustrated for a fictious situation with the following data (see also figure):

Emission factor (-)	1
Number of emission days (y^{-1})	365
Fraction of main point source (-)	0.005
Consumption point source ($kg.y^{-1}$)	3600

The emissions with the two scenarios are calculated as:

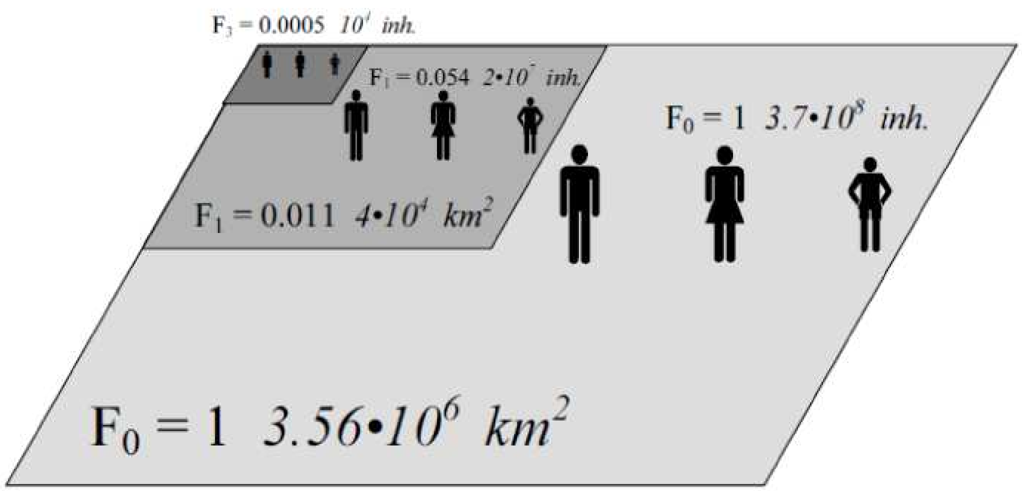
Tonnage: Emission = Tonnage • 103 • 0.005 • 1 / 365
Consumption: Emission = 3600 • 1 / 365 = 9.86 $kg.d^{-1}$

Break-even point: 9.86 = Tonnage • 103 • 0.005 • 1 / 365 - > □ Tonnage = 720 $t.y^{-1}$



4. Emission scenario based on the consumption

In the TGD the area of the region is 200 x 200 km^2, which is more densely populated than the average region of that size elsewhere in the EU (total area of the EU 3.56 • 10^6 km²). The number of inhabitants considered in the TGD is 2 • 10^7 in the region and 3.7 • 10^8 in the EU. So, the number of inhabitants per km² is 500 in the region and 104 in the EU. This means that the fraction of inhabitants in the region is 2 • 10^7 / 3.7 • 10^8 = 0.054 and the fraction of the regional area 4 • 10^4 / 3.56 • 10^6 = 0.011.



Appendix 2: Chemical toilet systems in airplanes, caravans, travel busses, trains and boats

Airplanes: Two different toilet systems are used in airplanes (Fraport, 2008)

1. Recirculation toilets: They are used mostly in older and smaller planes. This system consists of a collecting basin, in which the flushing water (about 20 to 40 l) plus sanitary additives (disinfection product) and the sewage water (faeces) are gathered together. During the flushing process a pump produces the necessary flushing pressure, whereby the flushing water from which the solid parts have previously been filtered out, reaches the toilet bowl. A single or double toilet unit is connected to this collective tank. With this type of system a centralized collection of sewage from the entire plane is not possible. A concentrate is either automatically dosed into toilet water before loading into the flush water reservoir, or poured manually into the reservoir. Unloading is a process of connecting pipe work from the vehicle to drains, or to a tank-wagon for remote disposal at a treatment works.

2. Vacuum toilets: In larger planes (>100 passengers) vacuum toilets have been increasingly used since the mid-80's. The amount of toilets per airplane depends on the plane size and/or the amount of passengers (ex. airbus A320 (107 to 202 passengers) maximum 4 toilets; airbus 340 (up to 380 passengers) maximum 12 toilets; airbus A380 (up to 555 passengers) maximum 25 toilets. The system of the vacuum toilets consists besides the toilet unit of a separate fresh water tank (flushing water) and a separate sewage water tank. Flushing occurs by sucking up the faeces and flushing with fresh water (about 0.2 l/per flushing). The difference in pressure between atmosphere and cabin (-0.3 to -0.6) is used for suction process. By low flying height a vacuum generator produces the necessary pressure difference.

   During the airplane servicing the faeces are disposed of at the respective airport of destination. For this the sewage tanks of the planes are emptied via special tank vehicles. Afterwards the tanks are flushed with fresh water and filled with flushing water containing disinfection products (about 5% of the tank contents = 20 – 40 l).

Travel busses and caravans: In travel busses chemical toilets as well as toilets with flushing water are used. In mobile homes however, chemical toilets are used almost exclusively. The tank size in mobile homes varies between 5 and 20 l. Before the toilets are used, sanitary additives are added in the collecting tanks. Depending on the travel distance, disposal of the sewage waste occurs at the respective destination. During the early 1990's special disposal facilities were built at camping and picnic areas, which were connected to the public canals. According to a survey performed by the German Camping Club, > 90% of all campsites offer disposal sites for portable / camper toilets. The excrement is then transported to sewage plants and properly disposed of (Bischofsberger, 1991).

Trains: For years the open toilet system (for ex. the drop chute toilet) was used on trains in Europe. Here the faeces were flushed (approx. 2-5 l water per flushing) through a soil pipe directly onto the rails. Since the early 1990's a closed pressure system (similar to airplanes) was constructed in the wagons. This system consists of fresh water for flushing, vacuum suction of faeces and the sewage water tank. During the flushing (approx. 1l water per flushing) the faeces are sucked-up and transported to the sewage water tank. Different toilet systems can be connected to the sewage water tank. According to the Federal Rail Office (2008) only a few trains of the Deutsche Bahn AG are still equipped with the drop-chute toilet.

Sanitary additives in flushing water or sewage tanks are not used by the Deutsche Bahn AG. In some European countries however, (for ex. France) sanitary additives are used. The sewage which comes from collecting tanks without sanitary additives corresponds in its composition to private sewage and can be transported to the public canals without prior treatment. The sewage from trains of the Deutsche Bahn AG is disposed of as described above. Chemically treated sewage may not be transported without prior treatment.

Ships/boats: The MARPOL (73/78) Agreement, enacted by IMO (International Maritime Organisation), is considered to be the most important international regulation for the protection of the ocean environment. The original treaties dated 1973 and 1978 have been modified over the years by periodical updates. Appendix IV of the MARPOL Agreement (27 September 2003) regulates the "prevention and pollution of waste water from crafts". According to this Agreement, dumping of waste water (treated or untreated) by crafts is prohibited.

In the recreational area Directive 2003/44/EC of the European Parliament and the amending Directive 94/25/EC of the Council of 16 June 2003 on the approximation of laws, regulations and administrative provisions of the Member States relating to recreational crafts apply. Thus all recreational crafts build after 2003, which have a toilet on board, have to be equipped with a waste water restraining system or rather holding tanks. Older and larger crafts (> 10 m) have to be upgraded. The tanks can be cleaned at respective suction devices at the harbors. These waste disposal facilities are either connected to the public canal system or the waste is collected and disposed by fuelling vehicles. The waste water from chemical toilets is either disposed at these suction devices or collected in separate special containers.

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Abstract
Following the entry into force of the Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market, all active substances in the European market have to be reviewed to ensure that under normal conditions of use they can be used without unacceptable risk for people, animals or the environment. Thus, in the frame of the review process, the risk assessment of each active substance plays a fundamental role and providing technical guidance to the assessments that must be performed ensures a correct and uniform implementation of the Directive for the different Member States.
According to Annex VI of Directive 98/8/EC the risk assessment shall cover the proposed normal use of the biocidal product together with a 'realistic worst case scenario'.
The aim of this Emission Scenario Document (ESD) is to set up methods for the estimation of the emission of disinfectants, used for the disinfection of vehicles used for animal transport, for veterinary hygiene and in hatcheries.
The present ESD is intended to be used by Member States as a basis for assessing applications submitted with a view to include existing active substances used in PT3 in Annex I or IA of Directive 98/8/EC or for assessing applications for product authorisation. It can be a useful tool also for Industry, when assessing requirements for a submission.
This ESD have been developed in the context of project FKZ 360 04 023 of the German Federal Environmental Agency (UBA), who contracted SCC GmbH for a first draft of the document. The first draft was then revised by the Biocides competence group of Chemical assessment and toxicology (CAT) Unit of the Institute for Health and Consumer Protection (IHCP) of the JRC, taking into account the comments of the Member States. The final version, approved by the Biocides Technical Meeting, was endorsed by the Biocides Competent Authority Meeting in May 2011.The Biocides Technical Meeting and the Biocides Competent Authorities Meeting agreed in asking the JRC to publish the present Emission Scenario Document as a Scientific and Technical Report.

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