JRC Scientific and Technical Reports

Emission Scenario Document for Product Type 4

Disinfectants used in food and feed areas

Drafted by Scientific Consulting Company (SCC) GmbH
Revised by the Biocides Technical Meeting
Endorsed by the Biocides Competent Authorities Meeting
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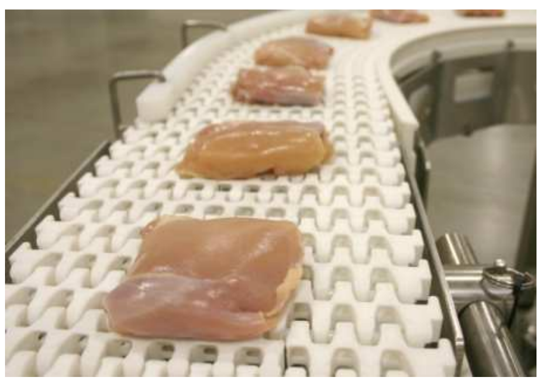

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The mission of the JRC-IHCP is to protect the interests and health of the consumer in the framework of EU legislation on chemicals, food, and consumer products by providing scientific and technical support including risk-benefit assessment and analysis 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 to the primary receiving environmental compartments of disinfectants, used in food and feed areas, such as food, drink and milk industries, slaughterhouses and butcheries, scale catering kitchens and canteens and milking parlour systems.

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 PT4 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 has 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).

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 ECB 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 revisions as detailed in this document include the following points:

- 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;
- Identifying gaps in knowledge and requirement for further research.

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1 INTRODUCTION

1.1 Background

Biocidal products of product type (PT) 4 are biocidal products used for disinfection of food and feed areas. This involves products used for the disinfection of equipment, containers, consumption utensils, surfaces or pipework associated with the production, transport, storage or consumption of food, feed or drink (including drinking water) for humans and animals.

According to Annex VI of the Biocidal Products 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 98/8/EC[1] 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 Biocides Directive (98/8/EC), 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.

1.2 Existing models and other ESD relevant sources of information

The following documents and existing models are the basis for the presented supplement to the ESD for PT 4:

- *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".*

[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

- *“Workshop on Emission Scenario Documents for PT 1, 2, 3, 4, 5, 6" - draft minutes of the workshop on the environmental assessment of PTs 1-6 in Arona, 11 March 2008.*

- *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)).*

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.

Picklists values and default parameters are to be adapted, when specific data is available, instead of a mandatory use of these values as defaults.

1.4 List of acronyms

Acronym	**Explanation**
BOD	Biological oxygen demand
CIP	Cleaning in place
COD	Chemical oxygen demand
DAF	Dissolved air flotation
ESD	Emission scenario document
FDM	Food, drink and milk industry
PEC	Predicted environmental concentration
SBR	Sequencing batch reactors
STP	Sewage treatment plant
VOC	Volatile organic compounds
Organisations:	
CCFRA	Camden & Chorleywood Food Research Association
HSE	Health and Safety Executive
IHO	Industrieverband Hygiene und Oberflächenschutz
IPPC	Integrated Pollution Prevention and Control

2 SELECTED USES OF DISINFECTANTS USED IN FOOD AND FEED AREAS (PT 4)

Biocides are used in the food and feed industry to reduce the level of potential food pathogens and to minimise the risks of food-borne diseases. Disinfectants are also applied in order to avoid spoilage and deterioration of food and feed and to extend their shelf-life.
Typically, disinfection is carried out on working areas (e.g. floors, walls, conveyor lines) as well as on food contact surfaces (e.g. pipelines, mixing and storage tanks associated with production). Disinfectants can also be used for aseptic packaging if disinfection with hot air or steam is not possible.

PT 4 can be divided into the following sub-product types:

- Disinfection in food, drink and milk industries (FDM) (see chapter 2.1)
- Disinfection in slaughterhouses and butcheries (see chapter 2.2)
- Disinfection in large scale catering kitchens and canteens (see chapter 2.2)
- Disinfection of milking parlour systems (see chapter 2.3)

This classification takes into account the size of surfaces to be disinfected (e.g. the scenario for slaughterhouses/butcheries is identical to the one for large scale catering kitchens/canteens with the exception of the default values for the surface areas to be treated), the nature of the equipment to be disinfected (e.g. cleaning in place of pipework compared to treatment of open surfaces) and the scale of the use (e.g. industrial scale application in food, drink and milk industry compared to very similar applications on a smaller scale in milking parlour systems).

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 in food, drink and milk industries (FDM)

2.1.1 Description of these use areas

According to EC (2006), the FDM sector is more diverse than many other industrial sectors in terms of size and nature of companies and the range of raw materials, products and processes.

All FDM production installations must comply with food safety standards and laws such as European Community Food Hygiene Regulations, including Regulation (EC) 852/2004, Regulation (EC) 853/2004 and Regulation (EC) 854/2004 and HACCP programs.
These regulations define the frequency of the applications and sometimes also the choice of products to be used. These requirements were considered in the development of the emission scenario document.

Typical working processes in the FDM sector comprise raw material reception and preparation, size reduction, mixing and forming, separation techniques, product processing technology, heat processing, concentration by heat, processing by removal of heat, post processing operations and utility processes.

According to Strauch (2002), disinfection in the FDM sector is typically performed by low and high pressure spraying, soaking and brushing, fogging, and CIP (Clean In Place = disinfectant is added to the circulating water) treatment of tools and machines. The advantage of CIP is that cleaning and disinfection of pipework, vessels and inner parts of machines can be performed without the need of disassemble them. CIP treatment can be used in two ways:

- Lost cleaning: the freshly prepared solution is only used for one single cleaning procedure and then poured into the sewage (e.g. when extremely dirty after one use and residual efficacy is no longer apparent).

- Stacked cleaning: the solution is stacked (stored) after use in a container until re-use. Since it is unavoidable that after each use the treatment solution is diluted by rinsing water, the recycled treatment solution plus rinsing water must be brought up to the required active substance concentration. This is done in an automated process by adding a concentrated product. The adjustment is based on the measurement of the electrical conductivity of the treatment solution for which a reference value is defined.

Cleaning gross contamination is always necessary before disinfection. This is done by physical means (scrubbing, pressure spraying, steaming). Furthermore, in order to ensure that food is not contaminated by biocides, all disinfected equipment is rinsed with water after application.

In-plant chlorination involves the addition of chlorine to the water supply of an entire food processing plant. After use, the treated water is discharged to the sewage system.

Disinfection of packaging material involves aseptic packaging, e.g. packaging materials are disinfected through immersion into a bath of 50 - 60℃ containing the disinfectant (Baumann, 2000) followed by drying of the disinfected packaging material with hot air. Therefore, environmental releases are primarily to air. If the contents of the bath are changed, most of it will be directed into the sewer system.

New technologies, which are currently finding their way into the food sector, are not considered in this ESD.

2.1.2 Biocidal active substances typically applied in this area

A survey conducted in 2001 by CCFRA on behalf of HSE (summarised in the TNsG for Human health exposure assessment) showed that the class of quaternary ammonium compounds (quats), alone or in combination with other agents, is the most common type of biocidal active substances in use. Alcohols and alcohol/quat combinations are usually supplied in ready for use trigger sprays or wipes. Hypochlorite is also often used, in most cases as foam. Peracetic acid preparations are mainly used for CIP applications and for spraying and fogging. Soaking of hoses was identified as a typical use for iodophors.
The amount of the disinfectants used depends on temperature and amount of organic soiling.

2.1.3 Environmental release pathway

The exposure of environmental compartments to biocides depends on the method of disinfection used. When disinfectants are applied by soaking, brushing or CIP, most of them end up in a sewage treatment plant. Depending on the nature of the premises and method of disinfection (i.e. non-contained disinfection processes/fumigation), there will be some potential for direct emissions to the air.

Typically, untreated FDM waste water is high in both COD and BOD. Levels can be 10 – 100 times higher than in domestic waste water. The suspended-solid concentrations vary from negligible to as high as 120000 mg/l. Untreated waste water from some sectors, e.g. meat, fish, dairy and vegetable oil production, contains high concentrations of fats, oil and greases.

Due to the high load of organic substance in the waste water of FDMs, the waste water is usually pre-treated before release to the environment.
Waste water treatment is an “end-of-pipe” treatment: water from different sources in a food processing plant is collected. This includes water from vehicles; equipment and installation cleaning, from washing of raw materials and waste water arising from e.g. evaporation or drying of foods. All these waste waters are collectively treated before discharge.

Typical annual waste water amounts from breweries, dairies and beverage industry are summarised in the following table:

Table 1: Mean annual waste water amount per plant (breweries, dairies, beverage processing plants) (IHO, 2006)

FOOD PROCESSING INDUSTRY	PLANT SIZE	MEAN ANNUAL WASTE WATER AMOUNT PER PLANT [$m^3.yr^{-1}$]
Brewery	Small	6,000
	Medium	35,000
	Large	150,000
Dairy	Small	140,000
	Medium	650,000
	Large	1,100,000
Beverage industry	Small	20,000
	Medium	400,000
	Large	1,500,000

According to the Environment Agency of England and Wales, 2000, the main options for discharging waste water from an installation are:

- to off-site STP without treatment;
- to off-site STP after partial treatment;
- to watercourse after full on-site STP;
- off-site re-use of certain waste water streams, e.g. as a feed stream in another industry, or for irrigation.

A summary of some methods used in different sectors is presented in the following table. Combinations of processes are frequently used to treat heavily polluted waste water.

Table 2: Pre-treatment techniques of waste water in the FDM sector (EC, 2006)

	Meat	Potato	Fruit and vegetable	Vegetable oil	Dairy	Starch	Confectionery	Sugar	Brewing	Malting	Soft alcoholic drinks	Distillery and spirit
Primary treatments												
Screening	Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes	Yes
Sedimentation		Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DAF	Yes	Yes		Yes	Yes	Yes	Yes				Yes	
Fat trap	Yes	Yes		Yes	Yes	Yes	Yes				Yes	
Centrifugation				Yes		Yes						
Flow and load equalisation	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Precipitation				Yes	Yes	Yes	Yes			Yes	Yes	
Neutralisation			Yes	Yes	Yes	Yes	Yes		Yes		Yes	Yes
Secondary treatments												
Aerobic treatment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Anaerobic treatment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Activated sludge	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Multistage activated sludge	Yes	Yes	Yes	Yes	Yes	Yes		Yes		Yes	Yes	Yes
SBR	Yes*		Yes*	Yes	Yes	Yes**		Yes	Yes	Yes	Yes	
Trickling filters	Yes	Yes	Yes			Yes***		Yes	Yes	Yes	Yes	
Aerobic lagoons		Yes	Yes		Yes	Yes***		Yes	Yes	Yes	Yes	Yes

Yes = treatment applied in that sector *Used in the Netherlands **Anaerobic batch reactors ***In connection with anaerobic treatment

DAF: Dissolved air flotation
SBR: Sequencing batch reactors

The FDM sector has implemented control techniques for air emission, which include process-integrated and end-of-pipe treatments in order to control or reduce emission of gases, odour / volatile organic compounds.

In the following table some widely used end-of-pipe air treatment techniques are summarised.

Table 3: End-of-pipe air treatment techniques (Willey, 2002)

Treatment process	
Solid and liquid pollutants	**Gaseous pollutants and odour/VOCs**
Dynamic separation	Absorption
Wet separation	Carbon adsorption
Electrostatic precipitation	Biological treatment
Filtration	Thermal treatment
Aerosol/droplet separation	Non-thermal plasma treatment
	Condensation
	Membrane separation

2.1.4 Emission scenarios

Two scenarios are presented in the following:

- One general scenario of Bakker which is a modified scenario for disinfecting milk extraction systems;
- One scenario developed on behalf of the IHO based on an industry survey. This survey showed that disinfection processes take place at numerous different points in a given plant and are released at the same release point. For this reason the entire plant is assessed.

A third scenario of Van der Poel (1999) which was included in the original AEAT report was moved to Annex I of this document after discussion during TM I 09 in Arona. This scenario shall be used only if the more specific scenarios described in 2.1.4.1 and 2.1.4.2 cannot be applied due to lack of data.

2.1.4.1 General scenario for drink and beverage industry, dairy industry, breweries *Bakker 2006*

Bakker (2006) modified the scenario for disinfecting milk extraction systems to provide a generalised scenario relevant to systems processing liquids in the food and feed area (e.g. for breweries, dairy industry, (soft)drink production, etc). In this model, distinction is made between the installation (process lines), mixing/processing tanks and storage tank.

Table 4: Scenario descriptions, parameters/variables and defaults for the disinfection of liquid processing (beverages, dairy, food)

Parameters	Nomenclature	Value	Unit	Origin
Input				
Concentration of active ingredient	*Cform*		$[g.l^{-1}]$	S
Volume of disinfectant used for cleaning of the installation, process lines	$Vform_{inst}$		[l]	S
Volume of disinfectant used for cleaning of the mixing tanks	$Vform_{mix}$		[l]	S
Volume of disinfectant used for cleaning of the storage tanks	$Vform_{tank}$		[l]	S
Fraction of the emission to waste water	F_{water}	1	[-]	D
Fraction of substance disintegrated during or after application (before release to the sewer system)	F_{dis}	0	[-]	D
Number of application per day	*Nappl*	-	$[d^{-1}]$	S
Number of days for the emission	*Temission*	365	[d]	D
Output				
Quantity of active ingredient used	*Qa.i.*		[g]	O
Emission to waste water	$Elocal_{water}$		$[kg.d^{-1}]$	O

Calculation

$$Qa.i. = Cform \cdot (Vform_{inst} + Vform_{mix} + Vform_{tank})$$

$$E_{local,\,water} = Qa.i. \cdot F_{water} \cdot (1 - F_{dis}) \cdot Nappl \;/\; (1{,}000 \cdot (365 / Temission))$$

2.1.4.2 Assessment of entire plants (e.g. breweries, dairies, beverage processing plants) *IHO (2006)*

This scenario has been developed on behalf of the industry group IHO (Industrie Verband Hygiene und Oberflächenschutz) and provides a methodology for estimating the releases of disinfectants from entire plants (e.g. breweries, dairies, beverage industry).

In the frame of the IHO project (2006), an industry survey was conducted including the creation of a questionnaire sent to several IHO members to be filled out and the inspection of a milk processing plant. The analysis of the questionnaires as well as the information collected during the inspection of the plant showed that disinfection takes place in several different units (e.g. CIP, disinfection of storage tanks by automated spraying/foaming, disinfection of surfaces, membrane filters or bottles etc.) partly simultaneously and often using the same disinfectant. Disinfection processes are highly automated. The size of CIP, other equipment or surfaces can vary considerably.
The waste water from the different plant units is collected in a collecting tank and the pH is adapted before release either to the public sewer system or to an onsite STP.

Based on the information collected, a scenario was developed which considers a model food processing plant as local point source. The release of disinfectants from this local point source covers all disinfection processes which take place in the model plant. The emission estimation is based on the annual tonnage of the active substance used in the model plant and on the annual waste-water amount discharged by this plant.

Data on the amount of disinfectant used per year, the number of disinfection days per year and the annual waste water amount per plant were collected in the frame of the industry survey for:

- dairies
- breweries
- beverage industry.

The survey showed that the annual amount of active substances used in dairies, breweries and beverage industry are within the same range. However, breweries have the lowest annual waste water release, thus representing a worst case with regard to biocide concentrations in the waste water. Since in addition, the data package collected on breweries is the most substantial one (comprising information on 50 breweries), it has been used for the definition of default values for the amount of biocidal products used per year in the local plant (*Qform*), the number of disinfection days per year (*Temission*) and for the capacity of an on-site STP (CAP_{STP}) taking into account the mean annual waste water amount of the breweries.
The number of disinfection days per year in breweries varies between 150 and 360 days. A mean value of 231 days was calculated (arithmetic mean, n = 50) and used as default value for *Temission*.

Concerning the STP to which the waste water is released, two cases have been distinguished:

- The waste water of the brewery is released to an **on-site STP** with a capacity of 112.7 m³/d which has been deduced as follows: The annual waste water amount in breweries varies between 3,500 and 510,100 m³ per year. A mean value of 41,128 m³ per year was calculated (arithmetic mean, n = 50) which corresponds to a daily capacity of a theoretical on-site STP of 112.7 m³ (mean annual waste water amount / 365 d).
  It was further assumed that the on-site treated waste water is directly released to surface water.

- The waste water is released to an **off-site STP** with the standard default values according to the TGD (daily capacity = 2000 m³).

The average annual amount of active substances (100%) used in a model plant (*Qai*) is provided for nine active substances in Table 7 below. These data have also been collected in the frame of the industry survey conducted for IHO (2006).

The default values provided for *Qai*, CAP_{STP} *and Temission* can be used if no other information is available. Wherever possible, actual data should preferably be used (i.e. annual tonnage of disinfectant and waste water amount) to describe the respective local scenario as realistically as possible.

The release of disinfectant to waste water (F_{water}) is by default 100% but can be reduced if data are available justifying such a reduction. Elimination (F_{elim}) of a substance during pre-treatment of the waste water before release to an on-site or off-site STP or 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 (e.g. data on on-site pre-treatment of waste water before release to the sewer system).

Table 5: Emission scenario for calculating the releases of disinfectants used in entire plants (e.g. breweries, dairies, beverage processing plants) (IHO 2006)

Parameters	Nomenclature	Value	Unit	Origin
Input				
Amount of biocidal active substance used per year in the local plant	*Qa.i.*		$[kg.yr^{-1}]$	P (Table 6)
Number of emission days per year	*Temission*	231	$[d.yr^{-1}]$	D
Fraction released to wastewater	F_{water}	1	[-]	D
Fraction of substance eliminated due to on-site pre-treatment of the plant waste water	F_{elim}	0	[-]	D
Fraction of substance disintegrated during or after application (before release to the sewer system)	F_{dis}	0	[-]	D
Capacity of the STP			$[m^3.d^{-1}]$	D
On-site STP	$CAP_{STP\_on\text{-}site}$	112.7		
Off-site STP (standard STP according to the TGD)	$CAP_{STP\_off\text{-}site}$	2000		
Dilution factor in surface water (standard default according to the TGD)	*DIL* [A)]	160	[-]	D
Output				
Effluent concentration of active substance in the effluent of the on-site STP	$C_{effluent}$		$[mg.l^{-1}]$	O
Influent concentration of active substance in the off-site STP	$C_{influent}$		$[mg.l^{-1}]$	O

Calculation

***On-site** treatment of waste water and direct release to surface water:*

$$C_{effluent}\ (PEC_{sw}) = (Qa.i.\ /\ Temission) \bullet 1{,}000 \bullet (1 - F_{dis}) \bullet (1 - F_{elim}) \bullet F_{water}\ /\ (CAP_{STP\_on\text{-}site} * DIL)$$

***Off-site** treatment of waste water:*

$$C_{influent} = (Qa.i.\ /\ Temission) \bullet 1{,}000 \bullet (1 - F_{dis}) \bullet (1 - F_{elim}) \bullet F_{water}\ /\ CAP_{STP\_off\text{-}site}$$

[A)] The dilution factor was calculated as follows: The effluent of a standard STP according to the TGD is 2,000 m³/d which is diluted 1:10 in a river in which complete mixing is assumed. The corresponding river flow rate according to equation 46 of the TGD is 18,000 m³/d. This river flow rate of a small river was assumed as river flow rate of the surface water receiving the effluent of an on-site STP of a brewery. The corresponding dilution factor is calculated according equation 46 of the TGD to be 160.7 (= (112.7 m³/d + 18,000 m³/d) / 112.7 m³/d = 160.7). The resulting dilution factor was conservatively rounded down to 160.

Table 6: Pick list for nine active substances: average annual consumption

per plant (standardized to the mean annual waste water amount)

Active substance	Average annual amount of active substance (100%) applied in breweries [kg.yr^{-1}]
Chlorine	228
Peracetic acid	407
QAV	24
Monobromacetic acid	362
Hydrogen peroxide	191
Propan-1-ol	143
Propan-2-ol	143
Glutardialdehyde	68
Polymers Biguanidhydrochlorid	121

2.2 Disinfection in large scale catering kitchens, canteens, slaughterhouses and butcheries

2.2.1 Description of these use areas

In **slaughterhouses and butcheries** disinfection measures are mainly surface treatments, while CIP is only used in exceptional cases. Application methods are spraying (low pressure and high pressure), foaming, soaking and manual brushing.
In meat processing areas psychrotolerant, qualitatively diverse flora occurs. Pathogenic micro-organisms, such as Listeria monocytogenes or salmonella must also be expected.

According to Strauch (2002), surfaces which come into contact with meat are disinfected in the first place. Strauch differentiates between heavily and less heavily soiled surfaces:

Heavily soiled surfaces:

- Reception area: daily disinfection of assembly line, walls and floors.
- Slaughter area: disinfection of machines, walls and floors.

Less soiled surfaces:

- Roasting room: disinfection of equipment, walls and floors.
- Conveyor belt cooling room : disinfection of walls, floors and conveyor.
- Disassembly room: disinfection of disassembly area, walls and floors.
- Storage area / Refrigerated areas: Disinfection of walls and floors once per week.

This differentiation is important because the level of soiling triggers the amount and frequency of disinfection treatments.
In the following, a typical disinfection plan is provided, describing procedures and the frequency of disinfections in meat processing:

Table 7: Disinfection plan for meat processing (Ernst GmbH and Enders, 2008)

Area to be disinfected	Disinfection procedure	Frequency of application
Receiving Department		
Floor, walls, doors, sinks	Spraying / foaming	Every fourth day
Hygiene sluice		
Shoe sole cleaner	Manual disinfection	Daily
Aprons	Manual disinfection	Daily
Slaughtering		
Doors, walls and floors	Spraying / foaming	After slaughtering
Machinery, small parts and equipment	Spraying / foaming	After slaughtering
Scrubbers and scalders	Spraying / foaming	After slaughtering
Production room		
Doors, walls and floors	Spraying / foaming	1 x per week
Equipment and machines	Spraying / foaming	If required
Plastic covers	Spraying / foaming	1 x per week
Cutting boards	Dipping	1 x per week
Sales and preparation room		
Doors, walls and shelves and floors	Spraying / foaming	1 x per week
Equipment and machinery	Spraying	After change of production / if required
Small parts	Spraying	After change of production / if required
Counters	Spraying	1 x per week
Coolers		
Doors, walls and floors	Spraying / foaming	1 x per week
Shelves	Spraying / foaming	1 x per week
Evaporators	Manual disinfection	1 x per week
Communal rooms		
Surfaces, showers and toilets, tables, sinks	Spraying	Daily, if requested

In **large scale catering kitchens and canteens** (e.g. in restaurants, hotels, houses for elderly and hospitals) disinfection is mainly performed by wiping, soaking or manual brushing. In the following, a typical disinfection plan describing the procedures and the frequency of disinfections are provided:

Table 8: Disinfection plan for a large scale catering kitchen (Orochemie, 2008)

Area to be disinfected	Disinfection procedure	Frequency of application
Work surfaces, counters, trolleys	Surface disinfection: Clean and disinfect, allow reaction time Quick disinfection: Rinse with tap water; either wet a cloth and wipe, or spray and wipe if needed; allow reaction time, rinse.	1-2 x per day and if required after contact with critical foods (meat, poultry, fish, eggs)
Cabinets, drawers, handles	Surface disinfection: Clean and disinfect, allow time to react Quick disinfection: Either wet a cloth and wipe, or spray and wipe if needed; allow reaction time, rinse.	1 x per week and if required Door handle: 1 x per day and if required
Floors	Clean and disinfect with a cleaning machine or appropriate wet-mop method, allow reaction time; use rubber scraper to remove excess disinfection solution, if necessary.	1-2 x per day and if required
Storage rooms and coolers, refrigerators	Clean and disinfect walls, floors and shelf surfaces; after waiting for reaction, rinse thoroughly with tap water.	1 x per week and if required
Tiled walls	Clean and disinfect, allow reaction time	1 x per week and if required
Sinks, drains	Thoroughly clean and disinfect, allow reaction time	1 x per day (evening)
Slicers	Disassemble machine, clean and disinfect, allow reaction time; rinse thoroughly with tap water before reassembly and use.	1-2 x per day and if required
Cutting boards	Surface disinfection: Depending on size, clean in dishwasher or with disinfection solution, allow reaction time, rinse with tap water Quick disinfection: Either wet a cloth and wipe, or spray and wipe if needed; allow reaction time, rinse with tap water	1 – 2 x per day; after contact with critical foods (meat, poultry, fish, eggs) after contact with critical foods (meat, poultry, fish, eggs)
Food containers	Surface disinfection: Depending on size, clean in dishwasher or with disinfection solution, allow reaction time, rinse with tap water Quick disinfection: Either wet a cloth and wipe, or spray and wipe if needed; allow reaction time, rinse with tap water	1 – 2 x per day; after contact with critical foods (meat, poultry, fish, eggs) after contact with critical foods (meat, poultry, fish, eggs)
Trash cans	Clean and disinfect, allow time to react	after each emptying

2.2.2 Biocidal active substances typically applied in this area

According to van Dokkum (1998) and Strauch (2002), the following biocidal active substances are applied in slaughterhouses, butcheries, large scale catering kitchens and canteens:

- Chlorine compounds (hypochloric acid and organic chlorine-releasing species);
- Iodine compounds (mainly iodophores);
- Aldehyde, e.g. glutar(di)aldegyde, glyoxal;
- Alcohols, e.g. ethanol;
- Organic and inorganic acids;
- Quaternary ammonium compounds;
- Alkylamine;
- Polymeric biguanides;
- Oxygen releasing substances, e.g. hydrogen peroxide, peracetic acid.

2.2.3 Environmental release pathways

Disinfectants are usually applied by spraying, foaming, soaking or brushing. The main fraction of the residues is released to the sewer system. As described in chapter 2.1.3 for the FDM sector, untreated waste water from slaughterhouses and butcheries has a high organic load and is usually pre-treated before release to the environment. The separation of fat in a precipitator is a standard treatment. Before release into the sewer system, the waste water is usually collected in tanks where the pH is adjusted to a neutral range.

Waste water from large scale catering kitchens and canteens is often diluted with other wastewater streams from the premise where the large scale catering or canteens are located and is usually not treated before release to the waste water system.

2.2.4 Emission scenarios

The scenario provided in the following estimates the emission from the disinfection of surfaces (floors, walls, working areas or other surfaces) in large scale catering kitchens, canteens and in meat processing facilities (slaughterhouses and butcheries).

The local emission is calculated based on the application rate of disinfectant per m² and the area of the treated surface. The surface area to be disinfected is largest in large scale catering kitchens and slaughterhouses and is therefore used as the basis for the emission scenario. Large scale catering kitchens and slaughterhouses are local point sources from which the disinfectant is emitted to the facility drain.

Since the size of surfaces to be disinfected ($AREA_{surface}$) and the frequency of disinfections (*Nappl*) in large scale catering kitchen as well as in slaughterhouses vary considerably, the following assumptions have been made in order to determine default values for $AREA_{surface}$ and *Nappl*:

- **$AREA_{surface}$ for slaughterhouses**

  The surface areas of slaughterhouses range from 1,000 m² (non industrial) to 10,000 m² (normal industrial slaughterhouses) (SCC, 2008). Recently constructed, centralised slaughterhouses can have a surface area of up to 20,000 m². These figures describe only the floor space of the slaughterhouses but not the surface area of the walls or working places, which are also disinfected. A value of 10,000 m² was defined as default value for $AREA_{surface}$ for the following reasons:

A floor area of 10,000 m² is in the upper value for a normal industrial slaughterhouse. This figure includes footways and traffic areas, which are not in contact with food or meat and which are therefore only cleaned but not disinfected. It is assumed that this area, which is not disinfected, is similar in size to the wall area plus working places, which are regularly disinfected but not included in the value of 10,000 m². Consequently, the default value of 10,000 m² would cover also walls and working places.

- **$AREA_{surface}$ for large-scale catering kitchens / canteens**

  In the following table the floor space of large scale catering kitchens as well as large canteens are provided:

Table 9: Examples for surface areas of large-scale catering kitchens / large canteens (Rohatsch et al., 2002)

Example	Surface area of large-scale catering kitchens / large canteens [m²]
1. Restaurants and hotels	
Robinson Club, Göhren-Lebbin, Germany	~ 200
Adlon Palais am Pariser Platz, Berlin, Germany	~ 390
BioParc, Dresden (Lingner Schloss), Germany	200
Hyatt Hotel Regency Soma Bay Resort, Egypt	190 (kitchen) 400 (storage, preparation)
Golden Arch Hotel Zürich Airport (Mc Donalds), Switzerland	101
2. Personnel catering	
Bürogebäude ENVIA, Leipzig-Markkleeberg, Germany	315
Casino Sender Freies Berlin (SFB), Germany	207
Personalrestaurant Bildungswerk Witten/Hattingen, Germany	~ 300
4. Catering for the elderly and handicapped	
Johannes von Gott Pflegezentrum, Krainbach, Austria	659
Malteser-Altenheim St. Hedwig, Duisburg, Germany	215
Seniorenheim Obergorbitz, Dresden, Germany	~ 750
ASB Alten- und Pflegeheim, Dresden, Germany	427
5. University canteens	
Technical University Chemnitz, Germany	990
Technical University Braunschweig, Germany	670
Mensa Werderstrasse Bremen, Germany	222

As can be seen in Table 9, surface areas of large catering kitchens and canteens vary between 101 and 990 m². Similar to the situation in slaughterhouses, these figures describe only the floor space while the surface area of walls and working places, which are also disinfected, are not included. On the other hand, aisles and other areas which are only cleaned but not disinfected are included in these values. However, in contrast to slaughterhouses, these areas are relatively small in comparison to the whole surface area and are therefore not further considered. In order to define a default value for $AREA_{surface}$ covering floor, walls and working places, the highest value for surface areas provided in Table 9 (= 990 m²) was conservatively doubled in order to cover the uncertainty with regard to wall surfaces and working places. The resulting rounded value of 2,000 m² was defined as default value for $AREA_{surface}$.

- ***Nappl* for slaughterhouses**

  Default values for number of disinfection events have been derived from the data provided in the disinfection plan for meat processing in Table 7 (see chapter 2.2.1). Since disinfection can take place from "once per week" to "after each use" depending on the surface to be disinfected, one disinfection per day can be considered as a reasonable default value.

- ***Nappl* for large-scale catering kitchens and canteens**

  Default values for number of disinfection events have been derived from the data provided in the disinfection plan for large scale catering kitchens in Table 8 (see chapter 2.2.1). Similar to the situation in slaughterhouses, disinfection can take place from "once per week" to "after each use" depending on the surface to be disinfected. Thus, one disinfection per day can be considered as a reasonable default value.

The default values provided for $AREA_{surface}$ and *Nappl* can be used if no other information is available. Wherever possible, actual data should preferably be used (i.e. label instructions on application frequency) to describe the respective scenario as realistically as possible.

The number of slaughterhouses or large scale kitchens/canteens feeding one STP was assumed to be one and was not included as separate parameter in the equation below. During the TM I 09 in Arona the question came up whether this would be an underestimation especially in case of the canteens. However, this is not the case: in Rohatsch et al., 2002, it is stated that large scale kitchens of rounded 1000 m² (floor area) have a catering capacity for 8,000 people.
For the derivation of $AREA_{surface}$ for large-scale kitchens and canteens a floor area of 990 m² was used as basis which consequently corresponds to a catering capacity for nearly 8,000 canteen users. The standard STP is fed by 10,000 inhabitants. Taking into account that not all of them eat in large scale canteens it is appropriate to assume that the standard STP according to TGD is fed by only one large scale canteen.

The release of disinfectant to waste water (F_{water}) is by default 100% but can be reduced if data are available justifying such a reduction. Elimination (F_{elim}) of a substance during pre-treatment of the waste water before release to an STP or 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 (e.g. data on on-site pre-treatment of waste water before release to the sewer system).

Table 10: Emission scenario for calculating the releases of disinfectants used in large scale catering kitchens, canteens, slaughterhouses and butcheries (IHO 2006)

Parameters	Nomenclature	Value	Unit	Origin
Input				
Application rate of the active substance	$Qa.i._{appl}$		[g.m^{-2}]	S
Surface area to be disinfected	$AREA_{surface}$			
Slaughterhouses		10,000	[m^{2}]	D
Large scale catering kitchens		2,000	[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 of substance eliminated due to on-site pre-treatment of waste water	F_{elim}	0	[-]	D
Fraction released to wastewater	F_{water}	1	[-]	D
Output				
Local release to waste water	$Elocal_{water}$		[kg.d^{-1}]	O
Calculation				
$Elocal_{water} = Qa.i._{appl} \cdot AREA_{surface} \cdot Nappl \cdot (1 - F_{dis}) \cdot (1 - F_{elim}) \cdot F_{water} / 1000$				

2.3 Disinfection of milking parlour systems

2.3.1 Description of these use areas

Disinfection of milking parlours is performed by CIP: the disinfectant is added to the circulating water and pumped through the equipment (including milking machine, pipe work and milk containers) after each milking event. The system is flushed with clean water after disinfection to remove any residues of the product.

This subcategory was included to cover the use of biocidal products on surfaces in contact with food in agriculture areas as identified by Lassen (2001).

2.3.2 Biocidal active substances typically applied in this area

According to Baumann et al (2000) and Lassen (2001), the following substances are typically applied for the disinfection of milking parlours:

- Hydroxides
- Peracetic acid

- Dioctyldimethyl ammonium chloride
- Sulphuric acid
- Sodium hydrogen sulphate
- Sodium hypochlorite and other chlorine compound
- Hydrogen peroxide
- Sodium dichloroisocyanurate
- Quaternary ammonium compounds

2.3.3 Environmental release pathways

Information provided by companies producing and selling disinfectants for milking parlours (SCC, 2008) showed that emission mainly occurs to the sewer system and not to the manure. The emission pathway depends on the size of the farm. In bigger farms, cows are milked in so-called milking carrousels which are usually located next to the stable and which are connected to the sewer system. In small farms, cows are milked in the stable using transportable milking equipment. In this case, emission occurs in modern farms to the sewer system, in older farms, without connection to the sewer system, to the manure. The tendency is definitely to separate the waste water stream coming from the milking parlours from the manure storage system since a certain amount of water is used for cleaning, disinfection and subsequent flushing of the milking equipment which leads to a high water contribution to the manure storage tank. Based on this information, it is assumed that the waste water from the milking parlour system is mainly released to the sewer system.

2.3.4 Emission scenarios

Baumann (2000) presented a scenario for disinfection of milking equipment relevant for dairies. This scenario was used as basis, some modifications were applied. As explained in chapter 2.3.3, it is assumed that the waste water from disinfection of the milking equipment is released to the sewer system and not to the manure as considered by Baumann.

The fraction released to waste water was considered to be 100% for a first tier calculation. If substance specific data are available (e.g. monitoring data), the fraction released to waste water can be reduced. 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 (e.g. data on on-site pre-treatment of waste water before release to the sewer system).

The default values from Baumann (2000) for the amount of disinfection used for cleaning the milk storage tank (45 l) and the milk installation (65 l) have been adopted. The milk installation is cleaned twice a day and the milk tank is cleaned once every three days. For the estimation of $Elocal_{water}$ only every third day is of interest because this third day presents the realistic worst case (both, milking installation and milking tank are cleaned). Therefore the amount of disinfectant was assumed to be 45 l/d for cleaning the milk storage tank and 130 l/d for cleaning the milking installation.

Emissions to air are considered negligible in this application.

Table 11: Scenario description, parameters/variables and default for the disinfection of milking parlour systems (adopted from Baumann, 2000)

Parameters	Nomenclature	Value	Unit	Origin
Input				
Concentration of active ingredient	*Cform*		$[g.l^{-1}]$	S
Amount of disinfectant used for cleaning of the milking installation	$Vform_{inst}$	130 (= 2 • *65)*	$[l.d^{-1}]$	D
Amount of disinfectant used for cleaning of the milk storage tank	$Vform_{tank}$	45	$[l.d^{-1}]$	D
Fraction of substance disintegrated during or after application (before release to the sewer system)	F_{dis}	0	[-]	D
Fraction of the emission to waste water	F_{water}	1	[-]	D
Output				
Quantity of active ingredient used	*Qa.i.*		$[g.d^{-1}]$	
Local emission to waste water	$Elocal_{water}$		$[kg.d^{-1}]$	

Model calculation

$$Qa.i. = Cform \cdot (Vform_{inst} + Vform_{tank})$$

$$Elocal_{water} = Qa.i. \cdot (1 - F_{dis}) \cdot F_{water} / 1000$$

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 4:

- In-plant chlorination and disinfection of packaging material have been identified by AEAT as relevant use in PT 4 but are not treated further in the following. If these are relevant applications, further research is needed for the development of respective scenarios.

- Concerning the general scenario provided by AEAT summaries now in chapter 2.1.4.1 (scenario form Bakker 2006): Default values for Vform and Nappl are missing. Further research is needed in order to define representative default values.

- Concerning disinfection of milking parlour: based on information provided in some questionnaires it was argued that the main emission pathway after disinfection of the milking parlour is to the sewer system. In the ESD for PT 18 it is stated that only the third flush of the milking parlour system is to the sewer system, previous flushes are to the slurry tank or to the manure. This situation needs clarification.

- A separate scenario for in field milking equipment is a field of further research.

- Emission scenarios based on tonnage are not included 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.

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Annex I

Additional scenario for disinfection in food, drink and milk industries (FDM): Van der Poel (1999)

Biocide application for disinfection of floors, walls and equipment within plants are similar to those described by Van der Poel (1999) for PT 2. The scenarios estimating emissions to sewer and air from the food and feed sector are summarised in Table 12 and Table 13. The scenario for air was adapted by including the standard default value for release to air. Due to the lack of specific release data covering emission to air in food and feed industry, the default value for Fair of 0.1 derived from the A-tables of the TGD (IC = 1: AGRICULTURAL INDUSTRY; Table A3.1 – Default emission factor to air) is proposed.

The release of disinfectant to waste water (F_{water}) is by default 100% but can be reduced if data are available justifying such a reduction.

Table 12: Releases to waste water from the food and feed sector

Parameters	Nomenclature	Value	Unit	Origin
Input				
Amount of water with active substance	Q_{water}		[l.d $^{-1}$]	S
Concentration at which active substance is used in water	C_{disinf}		[kg.l $^{-1}$]	S
Fraction released to waste water	F_{water}	1	[-]	D
Output				
Emission rate to waste water	$Elocal_{water}$		[kg.d $^{-1}$]	O
Calculation				
$Elocal_{water} = Q_{water} \cdot C_{disinf} \cdot F_{water}$				

Table 13: Releases to the air from the food and feed sector

Parameters	Nomenclature	Value	Unit	Origin
Input				
Amount of disinfectant with active substance	Q_{disinf}		[l.d $^{-1}$]	S
Concentration at which active substance is used in water	C_{disinf}		[kg.l $^{-1}$]	S
Fraction released to the air	F_{air}	0.1	[-]	D
Output				
Emission rate to air	$Elocal_{air}$		[kg.d $^{-1}$]	O
Calculation				
$Elocal_{air} = Q_{disinf} \cdot C_{disinf} \cdot F_{air}$				

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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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