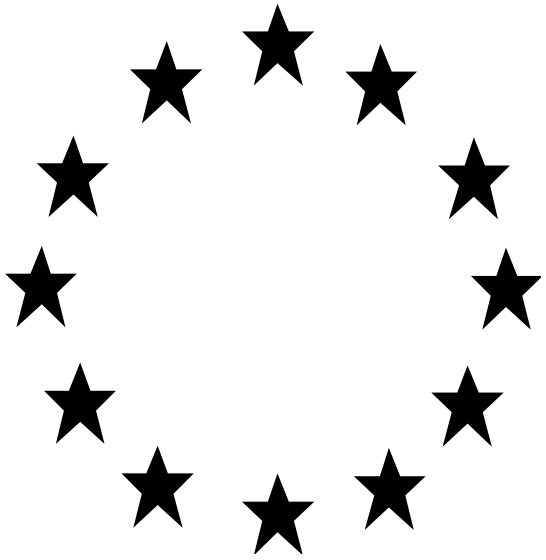


Draft Assessment Report (DAR)

- public version -

Initial risk assessment provided by the rapporteur Member State the Netherlands for the existing active substance

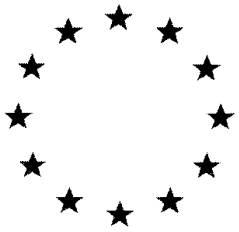
SODIUM HYPOCHLORITE

of the fourth stage of the review programme referred to in Article 8(2) of Council Directive 91/414/EEC

Volume 1

February 2009

European Commission



SODIUM HYPOCHLORITE

VOLUME 1

Rapporteur Member State: The Netherlands

May 2008

Draft Assessment Report and Proposed Decision of the Netherlands prepared in the context of the possible inclusion of sodium hypochlorite in Annex I of Council Directive 91/414/EEC

CONTENTS

LEVEL 1

SODIUM HYPOCHLORITE

STATEMENT OF THE SUBJECT MATTER AND PURPOSE OF THE MONOGRAPH

1 Statement of subject matter and purpose for which the monograph was prepared

1.1 Purpose for which the monograph was prepared

This monograph on the active substance sodium hypochlorite has been prepared to support the inclusion in Annex I of the Directive 91/414/EEC.

1.2 Summary and assessment of information relating to the collective provision of dossiers

Not applicable, because only one dossier for sodium hypochlorite was submitted.

1.3 Identity of the active substance (Annex IIA 1)

1.3.1 Name and address of applicant(s) for inclusion of the active substance in Annex I (Annex IIA 1.1)

Vivian Powell
Horticultural Development Council
c/o Stockbridge Technology Centre Ltd,
Cawood, Selby,
North YorkshireYO8 3TZ
United Kingdom

1.3.2 Common name and synonyms (Annex IIA 1.3)

Sodium hypochlorite is produced as an aqueous solution. In diluted form also known as (liquid) bleach. Synonyms are sodium oxychloride or soda bleach.

1.3.3 Chemical name (Annex IIA 1.4)

Sodium hypochlorite.

1.3.4 Manufacturer's development code number (Annex IIA 1.5)

Not applicable.

1.3.5 CAS, EEC and CIPAC numbers (Annex IIA 1.6)

The following data refers to sodium hypochlorite as either the solid or the aqueous solution:

CAS	: 7681-52-9
EEC	: 231-668-3
Annex I index number	: 017-011-00-1
CIPAC	: not available
UN/NA Number	: 1791
RTECS Number	: NH3486300

Sodium hypochlorite is only produced as an aqueous solution. However for clarity the following data is added here. For sodium hypochlorite as a solid hydrate additional CAS numbers exist:

Sodium hypochlorite heptahydrate	CAS No.: 64131-03-9
Sodium hypochlorite hydrate (2:5)	CAS No.: 55248-17-4
Sodium hypochlorite pentahydrate	CAS No.: 10022-70-5

1.3.6 Molecular and structural formulae, molecular mass (Annex IIA 1.7)

Molecular formulae	: NaClO
Structural formulae	: $Na^+ – ClO^-$
Molecular mass	: 74.44

1.3.7 Manufacturer or manufacturers of the active substance (Annex IIA 1.2)

Sodium hypochlorite is a basic chemical manufactured by several companies. It is commercially available from many sources and in many concentrations. See also confidential information (Volume 4, Annex C).

1.3.8 Method or methods of manufacture (Annex IIA 1.8)

See confidential information (Volume 4, Annex C).

1.3.9 Specification of purity of the active substance (Annex IIA 1.9)

The content of a sodium hypochlorite solution is expressed either as sodium hypochlorite or as *available* chlorine. In many countries the national law uses available chlorine, therefore the concentrations in this DAR are expressed as available chlorine (in %w/w) (this is also what the methods under B5 measures). According to the RAR (RAR, 2007), the term active chlorine is used for the combination of HOCl + Cl_2 + N-chloroamide (in practice only HOCl + Cl_2) and the term available chlorine is used for the combination of HOCl + Cl_2 + CLO^-. Free chlorine is the same as active chlorine.

The undissociated hypochlorous acid acts as a disinfectant (WHO, unknown; Russell, 1999).

The terms active an available are not consequently used in literature and should be used carefully.
The content as available chlorine is calculate with the following formula:

[Available chlorine] (as g/L Cl_2) = [NaClO] (g/L) * Mw(CL_2) / Mw(NaClO) = [NaClO] (g/L) * 0.953
[Available chlorine] (as %w/w Cl_2) = [A.C.] (as g/L Cl_2) / (10 * density (g/ml))

The content of a typical TK of sodium hypochlorite is 10 – 12% w/w available chlorine.

Expression	**Definition**	**Contains**
Active chlorine	chlorine in its disinfecting form	$HOCl + Cl_2$
Free chorine	*Identical to active chlorine*	*Identical to active chlorine*
Available chlorine	chlorine in its disinfecting form, including the hypochlorite ion	$HOCl + Cl_2 + CLO^-$
Total (available) chlorine	*available chlorine + chloroamines*	*available chlorine + chloroamines*
Bound chlorine	chlorine bound to amines (chloroamines)	$NR_2Cl + NRCl_2 + NCL_3$

1.3.10 Identity of isomers, impurities and additives (Annex IIA 1.10)

See confidential information (Volume 4, Annex C, C.1.2.1).

1.3.11 Analytical profile of batches (Annex IIA 1.11)

See confidential information (Volume 4, Annex C)

1.4 Identity of the plant protection product(s) (IIIA 1)

No Annex III dossier was submitted. The plant protection product is the same as the active substance.

1.4.1 Current, former and proposed trade names and development code numbers (Annex IIIA 1.3)

Not relevant.

1.4.2 Manufacturer or manufacturers of the plant protection product (Annex IIIA 1.2)

Not relevant.

1.4.3 Type of the preparation and code (Annex IIIA 1.5)

SL – Soluble concentrate: A clear to opalescent liquid to be applied as a solution of the active ingredient after dilution in water. The liquid may contain water-insoluble formulants.

1.4.4 Function (Annex IIIA 1.6)

Disinfectant.

1.4.5 Composition of the preparation (IIIA 1.4)

The plant protection product is the same as the active substance.

1.5 Uses of the plant protection product(s) (Annex IIA 3.2 to 3.4; Annex IIIA 3.1 to 3.7, and 11.1)

1.5.1 Field of use (Annex IIA 3.3; Annex IIIA 3.1)

Horticulture.
For application to mushroom crops for the control of Bacterial Blotch

1.5.2 Effects on harmful organisms (Annex IIA 3.2; Annex IIIA 3.2)

Chlorine kills pathogens such as bacteria and viruses by breaking the chemical bonds in their molecules. Disinfectants that are used for this purpose consist of chlorine compounds which can exchange atoms with other compounds, such as enzymes in bacteria and other cells. When enzymes come in contact with chlorine, one or more of the hydrogen atoms in the molecule are replaced by chlorine. This causes the entire molecule to change shape or fall apart. When enzymes do not function properly, a cell or bacterium will die. (www.lenntech.com)

Bacterial blotch is caused by *Pseudomonas tolaasii,* which is known to occur frequently in peat and chalk as a natural inhabitant. At certain times of the year, in particular in the spring and autumn, epidemics of bacterial blotch occur. This disease results in brown staining of the mushroom caps which are either heavily downgraded (light infections) or unsaleable. Although *Pseudomonas tolaasii* is omnipresent in mushroom composts, it is important to keep levels below the threshold levels that result in spoilage symptoms. Mushroom growers have used sodium hypochlorite for many years in order to control bacterial blotch, which is effective on the cap tissue of the mushroom by reducing the level of blotch organisms that are present.

1.5.3 Information on authorisations in EU Member States (Annex IIIA 11.1)

Products based on sodium hypochlorite have been authorized in various EU Member States for a large number of years for disinfection purposes both as biocides as well as plant protection products.

1.5.4 Summary of intended uses (Annex IIA 3.4; Annex IIIA 3.3 to 3.7)

See table 1.5.4-1.

Table 1.5.4-1 Summary of representative uses evaluated (sodium hypochlorite)

Crop and/ or situation (a)	Member State or Country	Product name	F G or I (b)	Pests or Group of pests controlled (c)	Preparation		Application				Application rate per treatment (for explanation see the text in front of this section)			PHI (days) (m)	Remarks
					Type (d-f)	Conc. of as (i)	method kind (f-h)	growth stage & season (j)	number (max) (k)	interval between applications (min)	g as/hL min – max (l)	water L/ha min – max	g as/ha min – max (l)		
Mushrooms	EU	Sodium hypochlorite	I	Bacterial blotch caused by Pseudomonas tolaasii	SL	10 – 12% available chlorine	In irrigation water applied by watering tree	From appearance of mushrooms on beds until mushrooms are pea size	40[A]	1 day	31.5 NaClO ≈ 30 g available Cl_2	10,000	3150 NaClO ≈ 3000 g available Cl_2	1[B]	[A] 40 applications per year (assuming 10 cultivation cycles per year and 3-4 applications per cycle) [B] A PHI of 1 day was proposed by the notifier. However, in practice the PHI will be longer.

(a) For crops, the EU and Codex classifications (both) should be taken into account; where relevant, the use situation should be described (e.g. fumigation of a structure)
(b) Outdoor or field use (F), greenhouse application (G) or indoor application (I)
(c) *e.g.* biting and suckling insects, soil born insects, foliar fungi, weeds
(d) *e.g.* wettable powder (WP), emulsifiable concentrate (EC), granule (GR)
(e) GCPF Codes - GIFAP Technical Monograph No 2, 1989
(f) All abbreviations used must be explained
(g) Method, e.g. high volume spraying, low volume spraying, spreading, dusting, drench
(h) Kind, *e.g.* overall, broadcast, aerial spraying, row, individual plant, between the plant- type of equipment used must be indicated
(i) g/kg or g/L. Normally the rate should be given for the active substance (according to ISO) and not for the variant in order to compare the rate for same active substances used in different variants (e.g. fluoroxypyr). **In certain cases, where only one variant is synthesised, it is more appropriate to give the rate for the variant (e.g. benthiavalicarb-isopropyl).**
(j) Growth stage at last treatment (BBCH Monograph, Growth Stages of Plants, 1997, Blackwell, ISBN 3-8263-3152-4), including where relevant, information on season at time of application
(k) Indicate the minimum and maximum number of application possible under practical conditions of use
(l) The values should be given in g or kg whatever gives the more manageable number (e.g. 200 kg/ha instead of 200 000 g/ha or 12.5 g/ha instead of 0.0125 kg/ha
(m) PHI - minimum pre-harvest interval

LEVEL 2

SODIUM HYPOCHLORITE

OVERALL CONCLUSIONS

2 Reasoned statement of the overall conclusions drawn by the Rapporteur Member State

2.1 Identity, physical and chemical properties, details of uses, further information, and proposed classification and labelling

2.1.1 Identity

Sodium hypochlorite is produced as a liquid with 10-12% available chlorine (Cl_2). The content of the solution is expressed as available chlorine as in solution several compounds are formed and the equilibrium is dependent on pH and temperature. All points are addressed.

2.1.2 Physical and chemical properties

Active substance:

Sodium hypochlorite reacts with a variety of compounds. It will not evaporate from water. The 10 – 12% solution is instable and will slowly decompose. Stability is dependent on concentration available chlorine, pH, temperature and other storage condition. All points are addressed.

Plant protection product:

The plant protection product is the same as the active substance. All points are addressed.

2.1.3 Details of uses and further information

Sodium hypochlorite is used on a large scale in a wide range of non crop protection situations. For example in agriculture (dairy hygiene), chemical industries, paint- and lime industries, food industries, glass industries, paper industries, pharmaceutical industries, synthetics industries and waste disposal industries. In the textile industry sodium hypochlorite is used to bleach textile. It is sometimes added to industrial waste water to reduce odours. Hypochlorite neutralizes sulphur hydrogen gas (SH) and ammonia (NH3). It is also used to detoxify cyanide baths in metal industries. Hypochlorite can be used to prevent algae and shellfish growth in cooling towers. In water treatment, hypochlorite is used to disinfect water. In households, hypochlorite is used frequently for the purification and disinfection of the house and is applied in swimming pools for water disinfection and oxidation.

In mushroom cultivation sodium hypochlorite is applied in aqueous solution using a concentration of 300 ppm available chlorine (300 mg/litre free available chlorine).
Concentrate is diluted using a diluter or large volume tank & pump. Chlorinated water is applied with a watering tree (a movable tube based irrigation system). The volume applied would depend upon water requirement but would generally not exceed 1 litre per m2 of bed surface. (Compost depth is about 9/10 inches (up to 30 cm) with about 2 inch (5 cm) depth of casing on top).

A mushroom farm has several growing rooms. A growing room is a closed room with two racks, carrying about 5 shelves with growing beds, one above the other, see pictures below. In each growing room, the cultivation of mushrooms is in a different stage of the cultivation process.

Water is essential for mushroom growing. Watering is possible from both sides of the bed as well as from just one side. Sodium hypochlorite can be added to the water used to irrigate the mushroom crop. The sodium hypochlorite treated water is applied to mushrooms with a watering tree (See below).

Since the cultivation of mushrooms can differ between the member states (e.g. longer cultivation cycle), it is described in detail below what the assumptions have been for the risk assessment in the DAR (using as worst-case scenario the manual application with a watering tree).

The harvesting period in the cultivation of mushrooms is called flush. The first harvest is the first flush, starting about 14-18 days after casing. A farmer will harvest 2-3 flushes per growing room per cultivation

cycle of about 5 weeks. At the end of a cultivation cycle, the growing room is steamed for 8 hours at about 70 °C and emptied. On average there are about 10 cultivation cycles a year.
The decision to water is usually based on the casing moisture. Especially after casing as much water as possible will be added to the growing beds. Farmers try not to water mushrooms any larger than pea size i.e. they water in between flushes on 2-4 consecutive days and then go without for 7/8 days until the flush has been picked off. Sodium hypochlorite can be added to the irrigation water from appearance of mushrooms on the beds until the mushrooms are pea size. Sodium hypochlorite will not be applied before the first flush ('problems' with Pseudomonas depend on e.g. temperature and humidity and application of sodium hypochlorite will not be necessary in each cultivation cycle and therefore sodium hypochlorite is not applied preventatively). Sodium hypochlorite can be applied between the first and second flush (the third flush will result in a significantly lower amount of mushrooms/m^2 than the first and second flush. Pseudomonas will grow there where the mushrooms touch each other and this will happen infrequently during the third flush). This means that as worst-case, sodium hypochlorite can be applied 3-4 times per cultivation cycle. A mushroom farm has several growing rooms, each in a different stage of the cultivation process, and there are about 10 cultivation cycles a year in a growing room.

Sodium hypochlorite is stated to be quickly inactivated once it makes contact with the highly organic casing layer.

2.1.4 Classification and labelling

Classification and labelling for the active substance

Physical chemical properties

Hazard symbol:	none
Indication of danger:	none
Risk phrases:	R31 "Contact with acids liberates toxic gas"
Safety phrases:	none

Justification for the proposal: identical to the ECB classification.

Human health effects

Hazard symbol	: C
Indication of danger	: corrosive
Risk phrases	: R34 "Causes burns"
Safety phrases	: S1/2 "Keep locked up and out of the reach of children"
	: S26 "In case of contact with eyes, rinse immediately with plenty of water and seek medical advice"
	: S28 "After contact with skin, wash immediately with plenty of water"
	: S36/37/39 "Wear suitable protective clothing, gloves and eye/face protection"

: S45 "In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible)"

Justification for the proposal:

The proposal is based on the RAR for sodium hypochlorite, and is identical to the ECB classification, 29th ATP (However, several additional safety phrases are proposed. ECB classification: S1/2, S28 and S45).

Specific limits:

Concentration ≥ 10% : C R34

Concentration ≥ 5% and < 10% : Xi R36/38

The C&L Technical Group at the 15-18 March 2005 Meeting, decided to maintain the above classification.

Theoretically pure sodium hypochlorite should be classified as "harmful for ingestion" (Xn, R22) on the basis of the oral LD_{50} data. This classification does not apply to solutions as their concentration is always below 25%.

Ecotoxicological effects

Hazard symbol:	N	
Indication of danger:	"Dangerous for the environment"	
Risk phrases:	R50	"Very toxic to aquatic organisms"
	R53	"May cause long-term adverse effects in the aquatic environment"
Safety phrases:	S29	"Do not empty into drains"
	S56	"Dispose of this material and its container to hazardous or special waste collection point"
	S60	"This material and its container must be disposed of as hazardous waste"
	S61	"Avoid release to the environment. Refer to special instructions/Safety data sheet"

Justification for the proposal:

In acute toxicity tests with sodium hypochlorite in fish, Daphnia magna and algae, the lowest LC/EC50 values were 0.090, 0.005 and >0.06 mg/L (TRC). Sodium hypochlorite is not readily biodegradable. It is proposed, that on the basis of its acute toxicity sodium hypochlorite should be categorised as "Dangerous for the environment" (N), "Very toxic to aquatic organisms" (R50) and "May cause long-term adverse effects in the aquatic environment" (R53).

It is recommended that the active substance also carries the following 'S' safety phrases:

S29 Do not empty into drains

S56 Dispose of this material and its container to hazardous or special waste collection point

S60 This material and its container must be disposed of as hazardous waste

S61 Avoid release to the environment. Refer to special instructions/Safety data sheet

Classification and labelling for the plant protection product

The plant protection product is the same as the active substance (aqueous sodium hypochlorite solution containing 10 – 12% w/w available chlorine).

2.2 Methods of analysis

2.2.1 Analytical methods for analysis of the active substance as manufactured

It is possible to determine the concentration on sodium hypochlorite in the technical material and formulation by measurement of the available chlorine content, in combination with the sodium content.

2.2.2 Analytical methods for formulation analysis

Not relevant, the plant protection product is the same as the active substance.

2.2.3 Analytical methods for residue analysis

No methods are required for plant or animal products as there is no residue definition. Also a method for soil is not required. As the active substance is not classified as (very) toxic, no methods are required for body fluids or tissues.

For water the content of hypochlorite can be determined using ISO method 7393:1985 (parts 1 to 3), which determines the total available chlorine content.

No residue definition for air is proposed. However, the content of chlorine in air can be determined with NIOSH method, no 6011.

2.3 Impact on human and animal health

2.3.1 Effects having relevance to human and animal health arising from exposure to the active substance or to impurities contained in the active substance or to their transformation products

The data/studies/evaluations with regard toxicology and metabolism presented in this DAR are taken from the RAR (Risk Assessment Report) for sodium hypchlorite (November 2007), which was written by Italy under the Existing Substances Regulation. For this DAR, the references referred to in the RAR have not been individually evaluated by the RMS, neither were the references submitted by the notifier.

Sodium hypochlorite (NaClO) is produced as an aqueous solution containing 10 – 12% w/w available chlorine. In diluted form it is also known as bleach or soda bleach. Household bleaches usually contain about 5% sodium hypochlorite (about pH 11, irritant), and more concentrated bleaches contain 10-15% sodium hypochlorite (about pH 13, corrosive).

Sodium hypochlorite has a long history of use in the home for both bleaching of textiles and cleaning and disinfection of household surfaces. It is increasingly used in a very wide range of formulations for household, institutional or industrial applications.

A sodium hypochlorite solution contains three chemical species, in equilibrium with each other: chlorine (Cl_2), hypochlorous acid (HOCl), and hypochlorite ion (ClO^-). Their concentration depends on the pH of the solution (see B.2.1.18). As a consequence, different concentration units are found in literature to measure the species present in a hypochlorite solution. The pH of commercial solutions is above 11 and the only species effectively present is ClO^-. In this DAR, the units used in the original studies will be reported in the description of the studies. For the purpose of Risk Characterisation, available chlorine unit will be used, since it covers all the different pH situations of the hypochlorite solution.

Toxicokinetics

Animal data suggest that after exposure via oral route, HOCl is absorbed and excreted mainly through urine as chloride (36.43% of the administered dose after 96h); a lesser extent of $HO^{36}Cl$-derived radioactivity not necessarily associated with absorption was detectable in the faeces 96h after exposure (14.8%). Plasma levels peaked after 4 hours. Elimination half-life was 88.5 hours.
Although this will be an underestimation, oral absorption is at least 40% (rounded value) based on urinary excretion only, as the RAR-summary did not quantify the amount recovered from tissues, organs and residual carcass.
Once in the body, HOCL is not enzymatically metabolised and it reacts directly with organic molecules to form some organochlorinated compounds, characterised by their own toxicity.
Human data are very scant and indirect. Absorption is suggested by some transient and not severe systemic symptoms following ingestion, although the possibility they are secondary to a local effect could not be ruled out with certainty.

Toxicodynamics

Acute toxicity

The acute toxicity of marketed hypochlorite solutions by the oral route is low. The LD_{50} values for solutions containing active chlorine concentrations up to 12.5% are greater than 5.8 g/kg bw. The data for dermal acute toxicity as well as inhalation toxicity indicate a low level of toxicity for these routes of

administration. Therefore, sodium hypochlorite does not need to be classified for acute oral, dermal, and inhalation toxicology.

A considerable number of skin and eye irritation tests were performed with various sodium hypochlorite solutions. Depending on the concentration, sodium hypochlorite solutions appeared to be irritating to skin and eyes or even corrosive. Despite some difficulties in interpreting the older animal data, the overall evaluation of both animal and human data supports the current EU classification as irritant above 5% (R36/38) and as corrosive above 10% (R34).

Based on the systematic animal and human study data as well as on the scarcity of alleged sensitisation cases reported from the market (also taking into account that in the past hypochlorite solutions were associated with skin sensitisation owing to the presence of chromium salts) it is concluded that sodium hypochlorite does not pose a skin sensitisation hazard.

Subacute and subchronic toxicity

No standard 28-day or 90-day repeated dose toxicity studies on sodium hypochlorite in animals by the oral route have been reported. However, the data available from non-standard studies are sufficient to derive a NOAEL for sodium hypochlorite by this route of exposure. The dermal exposure studies reflect the reversible irritant effects of sodium hypochlorite at the doses tested.

Oral

No systemic effects have been observed in any of the studies reported. A general decrease of body weight or body weight gain was usually observed following treatment with the highest doses used, most probably due to a secondary effect linked to low water consumption.

In male and female rats treated with 0.2% and 0.4% of sodium hypochlorite in drinking water for 13 weeks, a decrease in body weight and in specific organ weights, associated with some biochemical changes, were reported. A NOAEL of 0.1% of sodium hypochlorite (950 mg/L available chlorine or 47.5 mg/kg bw/d) can be derived.

Dermal

Daily exposure of mice to 0.1% sodium hypochlorite solution for 10 minutes on four consecutive days caused an increase in epidermal thickness.

No effects were observed in the dermal studies except for specific skin toxicity in guinea pigs (marginally lowered *in vitro* basal cell viability) of uncertain toxicological relevance at 0.5% sodium hypochlorite solution which is related to the acute irritant effects of the substance. In the same study, epidermal hyperplasia was observed following 14 days exposure (8 hours/day) to 0.1% sodium hypochlorite solution, but not following one, four or seven days of exposure. Exposure to 0.5% sodium hypochlorite solution for 8 hours/day for seven or fourteen days caused significant epidermal hyperplasia, but not after 1 or 4 days.

No effects were observed after exposure of guinea pigs to 0.125% sodium hypochlorite solution for up to 8 weeks.

The NOAEL for repeated dermal exposure to sodium hypochlorite solution is related to its cytotoxicity/ irritating properties and is dependant on the concentration of the applied solution. Therefore, irritation can be seen as a threshold for dermal toxicity. No dermal toxicity will occur at concentrations of sodium hypochlorite solution that do not cause irritation, either after single or repeated exposure.

A study in mice suggests that ten minutes exposure to 0.1% sodium hypochlorite solution for four days causes an increase in epidermal thickness. However, inconsistencies in the reporting of the study suggest that the finding might be unreliable.

Taking all of these comments into account, it is concluded from the available animal data (which is unreliable and might not adequately reflect human experience) that a very conservative NOAEL for repeated effects following dermal exposure to sodium hypochlorite solution is 0.1%.

There is no information on systemic toxicity following dermal application route. Fully dissociated in water, and immediate oxidising organic molecules, sodium hypochlorite is not expected to pass the skin to become systemic available. The amount of chlorinated substances passing the skin depends on the amount of mobile organochlorine substances being formed on and in the skin.

Genotoxicity

Sodium hypochlorite has been studied in a fairly extensive range of mutagenicity assays, both *in vitro* and *in vivo*. There are deficiencies in the conduct and/or reporting of most of the studies.
The positive results produced in bacteria assays and the induction of chromosome aberrations (including gaps) and SCE in mammalian cells suggest, even if mammalian cell gene mutation studies are lacking, that sodium hypochlorite may exert an *in vitro* genotoxic activity.
Sodium hypochlorite was without effect in a well-conducted mouse micronucleus assay suggesting that sodium hypochlorite is not genotoxic *in vivo*.
The available data are not conclusive with respect to genotoxicity. However, since sodium hypochlorite has shown lack of carcinogenicity effects (see B.6.5), no additional testing is required.

Long term toxicity

In long term carcinogenicity studies, sodium hypochlorite administered in the drinking water did not increase the proportion of F344 rats and B6C3F1 mice with tumours. Under the conditions of the 2 year NTP drinking water study there was no evidence of carcinogenic activity of chlorinated water in male rats or in male and female mice. However, the study concluded that there was equivocal evidence of carcinogenic activity of chlorinated water in female rats based on a marginal statistical increase in the incidence of mononuclear cell leukemia. Similarly non-dose dependant increases in lymphoma/leukemia

were found in female Sprague-Dawley rats in another long term rodent bio-assay with chlorinated drinking water. This study was deemed suggestive but inconclusive by its authors. Drinking water containing 100 mg/L chlorine was tested for carcinogenicity in a multigeneration study in male and female BDII rats. No increase in the incidence of tumours was seen in the treated animals relative to controls through five generations. Taking into account all the available information, it can be concluded that carcinogenicity is not a relevant endpoint for the oral route.

No human data are available on carcinogenicity and the only data are related to chlorinated drinking water for which the epidemiological data are not sufficient to suggest a causal relationship between the use of chorinated drinking water and increased cancer risk.

The International Agency for Research on Cancer (IARC, 1991) has concluded that there is inadequate evidence for the carcinogenicity of sodium hypochlorite in animals and that sodium hypochlorite is not classifiable as to its carcinogenicity in humans (Group 3). This conclusion is still valid, taken into account the more recent available data.

Reproductive and developmental toxicity

There are no relevant studies of sodium hypochlorite per se looking at its reproductive toxicity potential in animals. However, relevant studies have been conducted using chlorine as the test substance, administered in solution by gavage or in drinking water. In a teratogenicity study, in which exposure was confined to the gestation period, no significant differences in the incidence of skeletal or soft tissue abnormalities were observed in treated groups when compared to controls. A small, but statistically significant increase in sperm head abnormalities was seen in mice, although the effect was not dose-dependant. However, no effects were seen in a well conducted one-generation reproductive toxicity study in rats up to a concentration of 5 mg/kg bw of available chlorine (maximum dose tested). Long-term toxicity studies provide also additional assurance that the substance is not a reproductive toxicant as they did not identify the testes or ovaries as target organs.
The Carlton study appears relatively more updated and reliable with a number of animals more suitable for statistical analysis. There are no studies performed at dose levels able to induce systemic toxicity. A pragmatic approach is to accept the NOAEL derived from the Carlton study because it is the best study available even if no severe effects are shown in all dosed groups.

Although limited data are available in animals, the available studies are sufficient in their design and quality to draw the conclusion that there is no evidence to suggest that sodium hypochlorite would present adverse effects on development or fertility. Similarly, no such evidence is forthcoming from epidemiological studies on populations consuming chlorinated drinking water.

(Delayed) neurotoxicity

No specific studies are available. In the summaries of all other studies described in the RAR no neurotoxic effects were reported.

Further toxicological studies

The available data show no carcinogenic effect due to topical application of sodium hypochlorite solution at different concentrations. There is an indication, supported by a poorly described study, of co-carcinogenicity using NaClO as a promoting agent. In the same study, 4-nitroquinolene 1-oxide alone did not show carcinogenicity, suggestive of methodological problems or unusual responses of the mouse strain used.

Two other studies using different initiators did not show promoting effects of NaClO, although the doses employed were lower. In one of these studies, a dermal two-stage carcinogenicity study, a clear no effect level was observed in female mice treated twice weekly for 51 weeks with 1% sodium hypochlorite solution. No animals died and no epidermal hyperplasia was observed in the treated group.

Some incidental effects related to the immune system were reported in rats and mice administered with low doses of NaClO in chlorinated water for 12 or 17 weeks. These effects were observed in rats receiving chlorinated water containing 15-30 mg/L available chlorine (about 0.75-1.5 mg/kg bw/day). However, in long term studies, no differences were reported between treated and controls for haematological analysis or thymus weight in rats given higher doses of NaClO in water (275 mg/L available chlorine or 15 mg/kg bw/d). It is not possible to derive a no effect level for this specific end-point.

Dermal absorption

Dermal exposure to solutions of sodium hypochlorite might also lead to dermal absorption. There are no data to indicate the degree of absorption of hypochlorite ions. However, the potential of hypochlorite solutions to penetrate the skin is low given its reactivity to proteinaceus material. The absorption has therefore been assessed by assuming a default fraction of 10% that is penetrating the skin. This is considered to be a conservative assumption based on the indicated low potential for dermal penetration given the reactivity and polarity of the substance.

The studies which are relevant for the derivation of the ADI, ARfD and AOEL are summarised in the tables 2.3.1-1, 2.3.1-2, 2.3.1-3 and 2.3.1-4. The NOAELs are expressed in mg/kg bw/day as available chlorine. The LOAELs are in most cases estimated based on the NOAELs, since the exact values are not reported in the limited study summaries in the RAR.

Table 2.3.1-1 Semichronic toxicity studies

Duration	Species	Route	NOAEL (as av. Cl_2 in mg/kg/day)	LOAEL (as av. Cl_2 in mg/kg/day)	Note / Critical effects	Reference	Val*
13 weeks	Rat	Oral, drinking water	47.5 (m) 54 (f)	≈ 95 (m) ≈ 108 (f)	Decreased body weight and specific organ weight, associated with some biochemical changes.	Hasegawa, 1986	2
92 days	Rat	Oral, drinking water	44.4 (m) 97.1 (f)	≈ 88 (m) ≈ 194 (f)	Decreased body weight gain.	Furukawa, 1980	2

* Validity of the study

Table 2.3.1-2 Long-term toxicity studies

Duration	Species	NOAEL (as av. Cl_2 in mg/kg bw/day)	LOAEL (as av. Cl_2 in mg/kg bw/day)	Notes / Results	Reference	Val*
Oral, drinking water						
104 weeks	Rat	≥ 58.7 (m) 67.0 (f)	- (NOAEL highest dose) ≈ 134 (f)	Well conducted study / negative	Hasegawa and Kurokawa, 1986	1
2 years	Rat	≥ 15 (m) ≥ 16 (f)	- (NOAEL is the highest tested dose)	Well conducted study / equivocal evidence in females	NTP, 1992	1
104 weeks	Rat	**		Well conducted study / Not dose-related increase in leukemia-lymphomas in female group	Soffritti, 1997	1
2 years (5 generations)	Rat	**		Sample analysis, necropsy / negative	Druckrey, 1968	3
103 weeks	Mouse	78.3 (m) 95.4 (f)	≈ 156 (m) ≈ 190 (f)	Well conducted study / negative	Kurokawa, 1986	1
2 years	Mouse	15.3 (m) 17 (f)	26.5 (m) 29 (f)	Well conducted study / negative	NTP, 1992	1
Inhalation, chlorine gas						
2 years	Rat	***	***	Supplemental information / negative	Wolf, 1995	3
2 years	Mouse	***	***	Supplemental information / negative	Wolf, 1995	3

* Validity of the study

** In the RAR, no NOEL was derived for this study (carcinogenicity study).

*** The LOAEL for respiratory irritation was 0.4 ppm chlorine gas

Table 2.3.1-3 Reproduction and teratogenicity studies

Type of study	Result	Notes	Reference	VAL*
Reproduction toxicity				
Gavage, rat, 1 generation	No effects observed NOAEL ≥ 5 mg/kg bw/d as av. chlorine	a.s.: Aq. chlorine Well conducted study NOAEL determined	Carlton, 1986	2
Drinking water, rat, 2 years, 5 generations	No effects observed	German paper, only limited data available	Druckrey, 1968	3
Sperm head assay, mutagenicity mice	Doubtful positive	Data well presented	Meier, 1985	2
^{3}H-thymidine incorporation tests	Equivocal result	Limited protocol and data	Abdel-Rahman, 1984	4
Embryo/fetal toxicity and teratogenicity				
Drinking water, developmental effects, rat foetus	Minor effects at 100 mg/L	Study well conducted	Abdel-Rahman, 1982	2
Tap water, foetal devel. mice	No evidence	Limited available data	Chernoff, 1979	3
Tap water, foetal devel. mice	No evidence	Limited available data	Staples, 1979	3

* Val: validity of the study

Table 2.3.1-4 Further toxicological studies

Duration	Species	Dose	Results	Notes	Reference	Val*
Dermal application						
450 days	female ddN mouse	NaClO 100 g/L ; NQ-oxide 0.25% - combined	Skin cancers in combined groups	Skin two-stage model promoting test; the strain mouse is unusual	Hayatsu, 1971	3
51 weeks	Female Sencar mouse	NaClO 10000 mg/L ; DMBA (initiator) 20 nM - combined	Negative NOAEL 1% NaClO solution	Skin two-stage model promoting test	Kurokawa, 1984	2
104 weeks	NMRI mouse	NaClO 10000 mg/L ; BP (initiator) 750, 1500 µg - combined	Cancer decrease in combined group	Promoting test, lack of data	Pfeiffer, 1978	3

* Val: validity of the study

2.3.2 ADI

The calculation of the ADI is based on the highest dose at which no adverse effect is observed in the most appropriate study in the most sensitive species. Sodium hypochlorite was tested in several subacute, semi-chronic, and chronic toxicity studies in rats and mice, providing the basis for the establishment of the ADI. The results show that only relatively slight systemic effects were observed (decreased body weight (gain) and specific organ weights) and that the semi-chronic and chronic NOAELs are in the same order of magnitude.

The NTP (1992) study is used as the key study for deriving a NOAEL for risk characterisation.

From this study a NOAEL of 15 mg/kg bw/d (or 275 mg/L available chlorine) administered in drinking water can be identified for repeated oral exposure in the rat following exposure to sodium hypochlorite. Taking the NOAELs from the semi-chronic and chronic studies into account, it is considered too conservative to use the NOAEL of 5 mg/kg bw/day from the 1-generation reproduction study, since no effects at all were observed in this study and the 'true' NOAEL is likely to be higher.

The NOAEL of 15 mg/kg bw/day is used as a starting point for the establishment of the ADI. Application of a safety factor for inter- and intraspecies differences of 100 results in an ADI of 0.15 mg/kg bw/day (as available chlorine).

2.3.3 ARfD (acute reference dose)

For sodium hypochlorite no ARfD is derived. No classification is required based on the acute oral toxicity studies and there are no indications for acute effects from the repeated dose toxicity studies.

2.3.4 AOEL

For establishing an AOEL for sodium hypochlorite, chronic studies are considered to be the most relevant, since sodium hypochlorite can be used frequently during the whole year in mushrooms (see B.6.14).
The NTP (1992) study is used as the key study for deriving a NOAEL for risk characterisation.
From this study a NOAEL of 15 mg/kg bw/d (or 275 mg/L available chlorine) administered in drinking water can be identified for repeated oral exposure in the rat following exposure to sodium hypochlorite, i.e. the same dose level used as starting point for the establishment of the ADI. Using the same safety factor, but correcting for oral absorption (approximately 40%), results in an AOEL for sodium hypochlorite of 0.06 mg/kg bw/day (as available chlorine).

2.3.5 Drinking water limit

According to Council Directive 97/57/EC, exposure to sodium hypochlorite through drinking water should account for not more than 10% of the ADI. If it is assumed that the average daily consumption of water amounts to 2 litre per person of 60 kilogram, a drinking water limit of ((60 x 0.14)/10)/2 mg/L, i.e. 0.42 mg/L can be established. According to Document 8064/VI/79 of the European Commission, the EU drinking water limit for pesticides of 0.1 μg/l would be applicable for sodium hypochlorite.
However, sodium hypochlorite is also used for water disinfection and the legally permissible quantity of available chlorine in the water is set at values between 0.1-0.5 mg/l in many European countries. These values are well below the concentration of 5 mg/l of available chlorine indicated by the WHO as a guideline value. Actual figures are not available for Europe but are estimated to be below 0.1 mg/l (for comparison, the maximum content of active chlorine in swimming pools is e.g. in Italy 1.2 ppm and in the Netherlands 1.5 ppm).

2.3.6 Impact on human or animal health arising from exposure to the active substance or to impurities contained in it

Internal exposure and risk assessment

Internal exposures and risk assessments are specified in Table 2.3.6-1.

Table 2.3.6-1 Operator internal exposure and risk assessment

Model	Route	Estimated internal exposure (mg a.s./day)		AOEL Systemic * (mg a.s/day)	% AOEL	
		without PPE	with PPE		without PPE	with PPE
*Manual spraying on mushrooms, indoors ***						
Dutch-90th	Respiratory	0.60	0.06	4.2	14	1
	Dermal	12.0	1.20	4.2	286	29
	Total	**12.6**	**1.26**	**4.2**	**300**	**30**

* Assuming a body weight of 70 kg
** No suitable module available in UK-POEM and / or German model

Bystander internal exposure and risk assessment
Indoors, no bystander exposure during application is considered, as Good Agricultural Practice requires that the presence of bystanders should be prohibited.

Worker internal exposure and risk assessment
Sodium hypochlorite can be applied until the mushrooms are pea size. From this growth stage until harvest takes about a week. Since sodium hypochlorite degrades rapidly and re-entry activities will be performed at least a week after the last application, worker exposure will be negligible. It should furthermore be taken into account that the growing rooms are continuously ventilated, so inhalation exposure, if this is relevant at all (see B.6.14), during re-entry activities is also negligible.

Conclusions on risk assessments for operators, bystanders and workers

Operator
Using the Dutch-90th greenhouse model, a safe use was identified for operators, with PPE (gloves and coverall), for manual spraying on mushrooms, indoors. It should be taken into account that this is a worst-case scenario, since application of sodium hypochlorite will in many cases be performed mechanically without an operator present in the growing room.

Bystander

Indoors, no bystander exposure during application is considered, as Good Agricultural Practice requires that the presence of bystanders should be prohibited.

Worker

No adverse health effects are expected for workers without PPE after application of sodium hypochlorite in mushrooms.

2.4 Residues

2.4.1 Definition of the residues relevant to MRLs

Plant products

No residue definition for post-registration monitoring and for risk assessment is proposed for sodium hypochlorite since no relevant residues are expected in mushroom fruit bodies.

Animal products

No residue definition for post-registration monitoring and for risk assessment is proposed since mushrooms are not fed to livestock in a significant amount.

2.4.2 Residues relevant to consumer safety

No relevant residues are expected in mushroom fruit bodies.

Residue intakes by livestock animals and humans

No intake of hypochlorite residues is expected since no relevant residues are expected in mushroom fruit bodies.

Intakes by livestock animals

Mushrooms are normally not fed to livestock.

Intake by humans

No intake of hypochlorite residues is expected since no relevant residues are expected in mushroom fruit bodies.

2.4.3 Residues relevant to worker safety

See toxicology section.

2.4.4 Proposed EU MRLs and compliance with existing MRLs

Since no residue definition nor MRLs are proposed, sodium hypochlorite is proposed as a candidate for Annex IV of the MRL regulation 396/2005/EC.

2.4.5 Proposed EU import tolerances and compliance with existing MRLs

Not applicable, since no non-EU applications are proposed for sodium hypochlorite.

2.4.6 Basis for differences, if any, in conclusions reached having regard to established or proposed CAC MRLs

Not applicable, since no Codex MRLs have been established or proposed for sodium hypochlorite.

2.5 Fate and behaviour in the environment

2.5.1 Definition of the residues relevant to the environment

The major components of the environmental residue are as follows:

Soil

None

Water and sediment

Sodium hypochlorite/chlorine

Air

None

2.5.2 Fate and behaviour in soil

Based on the proposed use of the product and the way contaminated used soils are dealt with, the notifier expects that soil will not be exposed to sodium hypochlorite, and therefore no studies were carried out.

In the Netherlands however compost will be spread onto agricultural soil. The hypochlorites break down rapidly (DT50 few minutes) in compost and/or soil. Therefore exposure of soil organisms is not expected. Information on reaction products is not available.

2.5.2.1 Route and rate of degradation

Based on the proposed use of the product and the way contaminated used soils are dealt with, the notifier expects that soil will not be exposed to sodium hypochlorite, and therefore no studies were carried out.

In the Netherlands however compost will be spread onto agricultural soil. The hypochlorites break down rapidly (DT50 few minutes) in compost and/or soil. Therefore exposure of soil organisms is not expected. Information on reaction products is not available.

2.5.2.2 Adsorption, desorption and mobility in soil

Based on the proposed use of the product and the way contaminated used soils are dealt with, the notifier expects that soil will not be exposed to sodium hypochlorite, and therefore no studies were carried out.

In the Netherlands however compost will be spread onto agricultural soil. The hypochlorites break down rapidly (DT50 few minutes) in compost and/or soil. Therefore exposure of groundwater is not expected. Information on reaction products is not available.

2.5.2.3 Predicted environmental concentrations in soil (PEC_S)

Based on the proposed use of the product and the way contaminated used soils are dealt with, the notifier expects that soil will not be exposed to sodium hypochlorite, and therefore no PECs calculations were carried out.

In the Netherlands however compost will be spread onto agricultural soil. The hypochlorites break down rapidly (DT50 few minutes) in compost and/or soil. Therefore exposure of soil organisms is not expected. Information on reaction products is not available.

2.5.3 Fate and behaviour in water

(from EPA red facts):

The environmental fate data requirements for the hypochlorite salts are primarily satisfied by the document, Ambient Water Quality Criteria for Chlorine, by J. Tobler, et. al., U.S. EPA, June 1981. In fresh water, the hypochlorites break down rapidly into non-toxic compounds when exposed to sunlight. In seawater, chlorine levels decline rapidly; however, hypobromite (which is acutely toxic to aquatic organisms) is formed. EPA believes that the risk of acute exposure to aquatic organisms is sufficiently mitigated by precautionary labeling and National Pollutant Discharge Elimination System (NPDES) permit requirements.

2.5.3.1 Rate of degradation

Hydrolysis

Bleach decomposition is 2nd order with respect to NaOCl concentration. The second order rate law predicts that diluting the NaOCl by a factor of 2 should decrease the rate of NaOCl decomposition by a factor of 4. However, actual decomposition data for sodium hypochlorite solutions shows that a factor of 2 decrease in NaOCl concentration results in an approximate factor of 5 decrease in the rate of decomposition. This is because of the effect on the decomposition rate by the decrease in the total ionic concentration of the solution. Since the dilution of a bleach solution not only decreases the NaOCl concentration but also decreases the concentration of all the ions in the solution (chloride ions, the chlorate ions, hydroxide ions, etc.), the total ionic strength is also decreased and further reduces the decomposition rate (T.C.I., 2006, pamphlet 96).

Photolysis

A sodium hypochlorite solution is very sensitive to light. Direct sunlight may cause rearrangement and decomposition resulting in the formation of chlorateand oxygen. The presence of isocyanuric acid in solution reduces this sensitivity to a great extent (RAR, 2007).

Half life of a 10 to 15% available chlorine solution will be reduced 3 to 4 times by sunlight. (IUCLID, 2000).

Biodegradability

Ready biodegradability

No studies are available. Not ready biodegradable.

Aerobic water/sediment studies

No studies are available. The hypochlorites break down rapidly. Therefore a DT50 in STP of 1 h is assumed.

2.5.3.2 Impact of water treatment procedures

(from AISE)

Due to its use in irrigation water in mushroom crop, some residual hypochlorite may be present in the discharged waste water. In drains and sewers, residual hypochlorite will further react with inorganic and organic sewage components, which are in excess over hypochlorite. The hydraulic residence time in these systems is typically 1-24 hours.

The pH of well-buffered municipal sewage (7-8.5) is not affected by the discharge of hypochlorite at the above mentioned concentrations. A pH of 7.5 implies a 50:50 ratio of HOCl and OCl-, and the presence of the more reactive hypochlorous acid (HOCl) than in the toilet bowl, with its elevated pH conditions. A typical COD value of domestic waste water would be around 400 mg/l, versus 0.25-4 mg NaOCl/l. The average ratio of hypochlorite to other sewage constituents is therefore very low (<<1). During peak emissions only, it can reach up to 1:1 locally.

The following organic sewage constituents were found in mechanically treated sewage, in decreasing order of concentration (Painter, 1971):

- Fats and greases, free and esterified, saturated and unsaturated fatty acids (174 mg/l),
- Carbohydrates, ranging from simple sugars to complex polysaccharides, starch, etc. (104 mg/l),
- Proteins and their breakdown products like amino acids (60 mg/l), volatile acids (25 mg/l),
- Surfactants (23 mg/l),
- Soluble acids (12.5 mg/l),

- Urea and its breakdown products (2-16 mg/l),
- Creatine (6 mg/l),
- Phenols (0.2 mg/l),
- Aliphatic amine (0.1 mg/l).

Reduced inorganic constituents are present at a rather low concentration in municipal sewage (mostly <0.1 mg/l), except for ammonia (Painter, 1971). In municipal sewage up to 70 mg/l total-N can be recorded, mainly in the form of urea and proteins (Rueffer, 1964) which are degraded to ammonia. An analysis of sewage in the UK showed 46 mg/l NH_3-N and 22 mg/l organic N (Painter, 1971). Hence, ammonia will on average be present at a 10-fold stoichiometric concentration versus hypochlorite, and N-chlorination will be a major process. Monochloramine will be the predominant species.

Formation of THMs and other volatile organohalogens, which require high concentrations of FAC and the completion of a long reaction sequence, is virtually impossible in sewers (Overleggroep Deskundigen Wasmiddelen-Milieu, 1989). At high NaOCl doses (> 10 mg/l) $CHCl_3$ represents 5-15% of the AOX (Raff et al, 1987). A chlorination study of primary and secondary sewage by Jolley (1975) showed that 99% of the added FAC is consumed in oxidation reactions and only <1% (on Cl weight basis) is incorporated into organic compounds (Jolley, 1975). Forty-six additional OBPs were identified after chlorination. It should be added that the studies were conducted in such a way that a residual FAC content of 2 mg/l was maintained with 60 minutes reaction time to simulate a worstcase situation. A figure around or below 1% AOX formation yield is also cited independently by Mills (1978) and Hull and Reckow (1993). Studies with secondary effluent, using a $NaO^{36}Cl$ tracer, gave comparable results of <1% and 1.4% incorporation of the chlorine into organic sewage constituents (Faith et al, 1980; Koczwara et al, 1983). Mori et al (1978) found that 0.01% of the FAC applied to primary effluents ends up as volatile halogenated compounds.

Raff et al (1987) reported a 0.6% NaOCl-to-AOX conversion upon continuous dosage of 7-10 mg NaOCl/l in an activated sludge unit. The authors noted that the AOX formed was of a polar and macromolecular nature. Figure 4.4 shows another experiment on AOX formation in sewage (Schowanek et al, 1996). Under these experimental conditions there seems to be a threshold effect before chlorination starts. This can probably be attributed to a buffer effect from the presence of reduced compounds, which up to a certain dose are immediately oxidised by the hypochlorite added. The slope of the curve suggests a degree of NaOCl-to-AOX conversion of 0.75-2.25%, depending on the reaction conditions.

In summary, the degree of conversion of NaOCl (FAC) to AOX in sewage is around 1%. This is the same order of magnitude as in laundry wash water. Virtually all identified non-volatile chloroorganic compounds identified in sewage under realistic formation conditions were

monochlorinated ones. 5-chlorouracil, 5- chlorouridine, 8-chlorocaffeine, 2-chlorophenol and 8-chloroxanthine were the five compounds present at the highest concentration in the Jolley study (Jolley, 1975). Peeters (1991) suggests that halogenated carboxylic acids, dichloroacetonitrile, chlorocyanide and chloropicrin can also be formed in sewage.

Based on background document edible mushrooms an emission of 0.09% of active substance was discharged to a WWTP.

FIELD STUDY RESULTS - IN SITU MONITORING OF AOX FORMATION FROM HYPOCHLORITE

A field monitoring program was carried out on the sewage of five large apartment blocks in the city of Parma, Italy, to quantify in situ the organohalogen compounds emitted as a result of the domestic use of bleach containing sodium hypochlorite (Schowanek et al, 1996). The halogenated by-products present in the sewage were determined as AOX. The average AOX level was determined for three distinct experimental phases, each lasting 21 days: an "undisturbed period", a "no bleach period", and a "period with monitored bleach consumption". The study involved the participation of the site inhabitants in the second and the third phase. This design allowed in a highly realistic way to 1) compare a bleach-use situation with a no-bleach use situation, and 2) to quantify the fraction of NaOCl involved in halogenation reactions.

While all average AOX concentrations observed in this study fell within the typical range for domestic sewage across Europe (around ca. 50-250 µg AOX/l), an effect from the use of hypochlorite bleach on the AOX concentration in domestic sewage was detected. In absolute terms, the difference in average sewage concentration between a "no bleach" (106 µg AOX/l) and an "undisturbed" bleach use situation (143 µg AOX/l) was 37 µg AOX/l ($P<0.05$). In relative terms, hypochlorite bleach contributed around 26% of the total AOX level in sewage at this particular site. Other sources of AOX in sewage were not quantified in this study. The POX fraction of the AOX was not measured separately.

The degree of NaOCl-to-AOX conversion was of the order of 1.5% (w/w). For perspective, this corresponds to a conversion of 0.075% (w/w) for bleach containing 5% NaOCl. These values are in good agreement with literature data. The average bleach-related AOX emission at the study site was around 7 mg per inhabitant per day. The EOX/AOX ratio, and the identity of the organohalogens was not further investigated in this study (EOX/AOX ratios have been published by Bakker et al, 1995).

2.5.3.3 Predicted environmental concentrations in surface water, groundwater and in sediment (PEC_{SW}, PEC_{GW}, PEC_{SED})

The model for the sewage treatment plant as described in USES (1994) for pesticides in the paper industry is used. The dilution factor to surface water is 10. Sodium hypochlorite is not readily biodegradable.

Surface water (PECSW)

Estimations are based on the following assumptions:

water solubility 10000 mg/L (i.e. not rate limiting);

octanol-water partition coefficient = -1;
Dose: 3.15 kg/ha
Number of applications: 40
Interval: 1 d
Kd estimated by model from octanol-water partition coefficient.
DT50 1 h
The removal rate in the WWTP is estimated by EUSES 2.0 based on the Kd value 85.1%.
An emission of 0.09% of active substance discharged to a WWTP.

When 40 times 0.09% * 3.15 kg/ha (0.002835 kg/ha) of sodium hypochlorite is discharged into to a WWTP, EUSES 2.0 estimates the concentration in the influent and effluent of the WWTP to be 3.3E-02 µg/L, and the concentration in surface water 3.3E-03 µg/L (during emission period) and 9.1E-03 µg/L (annual average concentration).

The corresponding available fraction expressed as clorine (CL_2) estimated by EUSES 2.0 are for the concentration in the influent and effluent of the WWTP to be 3.1E-02 µg/L, and the concentration in surface water 3.1E-3 µg/L (during emission period) and 8.6E-03 µg/L (annual average concentration).

Groundwater (PECGW)

Based on the proposed use of the product and the way contaminated used soils are dealt with, the notifier expects that soil will not be exposed to sodium hypochlorite, and therefore no studies were carried out.
In the Netherlands however compost will be spread onto agricultural soil. The hypochlorites break down rapidly (DT50 few minutes) in compost and/or soil. Therefore exposure of groundwater is not expected. Information on reaction products is not available.

Sediment (PECSED)

All ecotox data are expressed in mg/L. Therfore no PEC sed calculations are carried out.

2.5.4 Fate and behaviour in air

Because hypochlorite solutions are non volatile, no significant potential for dispersion in the air exists. However, hypochlorite may release chlorine when accidentally mixed with acids.
Based on a vapour pressure of 1.74 – 2.0 kPa at 20°C which is in fact the vapour pressure of water suggest that the concentrations of sodium hypochlorite in air are likely to be negligible and no PEC_{air} was calculated.

2.6 Effects on non-target species

2.6.1 Effects on terrestrial vertebrates

2.6.1.1 Birds

No data for birds is available. Only exposure via drinking water is expected. Considering the low concentration in surface water, a low risk is expected for birds.

2.6.1.2 Mammals

Based on the input from section B.6, an LD 50 of >5800 mg/kg bw (12.5% solution) and a long-term NOEC of ≥ 5 mg a.s./kg bw/d is available for mammals

Exposure to mammals is negligible, only exposure via drinking water is expected.

The acute risk assessment is based on a small mammal weighing 10 g, with a daily water intake (DWI) of 1.6 mL/day. The acute oral LD50 is >5800 mg /kg bw (Based on a 12.5% solution. This is considered equivalent with > 725 mg a.s./kg bw). With a maximum concentration in surface water of 0.0086 µg a.s./L, the ETE is 0.0000014 and the corresponding TER is 5.2×10^8. Therefore a low risk to mammals is expected.

2.6.2 Effects on aquatic species

Summary of toxicity data

Results of studies on the acute and chronic toxicity of sodium hypochlorite are summarised in the Table below.

Table 2.6.2-01 The toxicity of sodium hypochlorite to aquatic life. Bold data are the effect concentrations that are chosen for risk assessment.

Species	Parameter	Criterion	Value (µg/L)	Rating	reference
Algae					
Pytoplankton	biomass	21d EC50	1-10 (TRC)	s	Sanders et al (1981_
Algae (multispecies)	Algae biomass	7d EC50	**> 6 (TRC)** > 4.38 (FAC)	2	Cairns et al (1990)
Invertebrates					
Ceriodapnia dubia	mortality	24h LC50	**5 (FAC)**	2	Tylor (1993)
Pandalus goniurus	mortality	96h LC50	90 (TRC)	s	Thatcher (1978)
Crassostrea virginica (larvae)	mortality	48h LC50	80-120 (TRC)	s	Capuzzo et al (1976, 1979 a,b,)
Brachionus plicatilis	mortality	48h LC50	10-820 (TRC)	s	Capuzzo et al (1976, 1979 a,b,)
Acartia tonsa	mortality	48h LC50	180 (TRC)	s	Capuzzo et al (1976, 1979 a,b,)
Crassostrea	Shell deposition	96 h EC50	23 (TRC)	s	Roberts et al

virginica (juveniles)					(1975)
Crassostrea virginica (larvae)		48h EC50	26 (TRC)	2	Roberts and Gleeson (1978)
Acartia tonsa	mortality	48h LC50	29 (TRC)	2	Roberts and Gleeson (1978)
Crassostrea virginica	Shell deposition	15d LOEC	14 (TRO)	s	Liden et al (1980)
Rangia cuneata	mortality	15d NOEC	62 (TRO)	s	Liden et al (1980)
Fish					
Salmo gairdneri	mortality	96h LC50	60 (TRC) 30 (FAC)	s	Brass et al (1977) Heath (1978)*
Ictalurus punctatus	mortality	96h LC50	64 (TRC) 32 (FAC)	s	Brass et al (1977) Heath (1978)*
Salmo gairdneri (juveniles)	mortality	24h LC50	430	s	Brooks and Seegert (1977)**
Oncorhynchus kisutch *Alosa pseudoharengus* *Notropis hudsonius* *Osmerus mordax*	mortality	48h LC50	1260-2410	s	Seegert and Brooks (1978)
Pimephales promelas (juveniles)	mortality	96h LC50	80 (TRC) >40 (FAC)	s	Wilde et al (1981, a,b)***
Cyprinus caprio (prolarvae)	mortality	48h LC50	260	s	Tsai et al (1990)****
Gambusia affinis (prolarvae)	mortality	48h LC50	610	s	Tsai et al (1990)****
Gambusia affinis	mortality	48h LC50	840	s	Mattice et al (1981)
Leiostomus xanthurus	mortality	96h LC50	**90 (TRC and FAC)**	1	Bellanca and Bailey (1977)
Oncorhynchus kisutch	mortality	48h LC50	32 (TRO)	s	Thatcher (1978)
Gasterosteous aculeatus	mortality	48h LC50	167 (TRO)	s	Thatcher (1978)
Menidia menidia	mortality	96h LC50	37 (TRC)	s	Roberts et al (1975)
Morone saxatilis	hatchability	48h EC50	8 (TRC)	s	Middaugh et al (1977)
Ictalurus punctatus	growth	134d NOEC 134d LOEC	5 (TRC) 52 (TRC)	s	Hermanutz et al (1990)
Menida peninsula	ELS, fry survival	28d NOEC	**40 (TRC)**	1	Goodman et al (1983)
Outdoor mesocosm					

In a 28 d laboratory microcosm toxicity of hypochlorite to a microbial community was tested. The measured taxonomic parameter was the number of protozoan species and the non-taxonomic responses included chlorophyll *a* (expression of algal biomass*)*, ATP, total protein, extracellular alkaline phosphatase activity, and potassium. The lowest NOEC was calculated for the number of protozoan species and for depression of alkaline phosphatase activity (28d NOEC = 2.1 µg TRC/l). As far as chlorophyll *a* is concerned, a reliable NOEC cannot be derived because a clear concentration-effect relationship is lacking. However, this appeared to be the most sensitive endpoint, as a significant reduction of chlorophyll *a* (about 50%) was recorded at 2.1 µg/l of TRC (the lowest tested concentration).
Additionally an 24d outdoor mesocosm study with freshwater biota was conducted. In the enclosures chlorine was introduced as a daily pulse. At 79 µg TRC/l, neither chlorophyll *a* nor the number of algal genera was reduced (NOEC). Protozoan species number was not significantly reduced at the lower test concentration, i.e. NOEC = 24 µgTRC/l. The most sensitive endpoint was the zooplankton density (24d NOEC = 1.5 µgTRC/l). Only the number of zooplankton/ml of water without providing any other information about the effects on taxonomic composition of zooplankton community, so that it is not possible to draw any conclusion about the eventual elimination of taxa from the system.
This study can only be used for supportive information.

**Onchorhynchus kisutch*, *Notemigonus crysoleucas, Lepomis macrochirus* and *Cyprinus caprio* were also tested, but less sensitive (no toxicity data reported).

***Perca flavescens* was also tested, but less sensitive (no toxicity data reported)

**** *Lepomis macrochirus* was also tested, but less sensitive (no toxicity data reported).

****eggs and 1-year old young were less sensitive, sensitivity of *Dorosoma patenense* was slightly lower than *C. caprio.*

Risk assessment

For the proposed treatments contamination of surface water is possible following discharge of use solutions into the sewage system.

Acute risk

The table below shows the results.

Table 2.6.2-02 Acute TERs of hypochlorite for fish, invertebrates, and algae following discharge of use solutions into the sewage system

application	L(E)C50 (µg a.s./L)			PECsw	TERa		
	Fish	*Daphnia*	Algae	(µg a.s./L)	Fish	*Daphnia*	Algae
Mushrooms	90	5.0	6.0	0.0086	10465	581	>698

The acute TER for algae is above the Annex VI trigger of 10 and the acute TER for fish and invertebrates is above the ANNEX VI trigger of 100

Long-term risk

Sodium hypochlorite is a highly reactive substance with a low DT50 of < 1 hour in water. It is expected to cause mainly acute effects. No acceptable chronic endpoint is available for invertebrates, however a long-term risk assessment is performed for fish.

The long-term TER based on the above PECsw and the NOEC value of the active substance (40 µg a.s./L for fish) is shown in the Table below.

Table 2.6.2-05 Long-term TERs for fish following discharge of use solutions into the sewage system.

application	NOEC (µg as/L)	PECsw	TER
	fish	(µg a.s./L)	Fish
Mushrooms	40	0.0086	4651

The long-term TER for fish is above the Annex VI trigger of 10 and the long-term risk is considered to be acceptable.

Bioaccumulation

No data on hypochlorite effects on secondary poisoning are available but as mentioned previously (B.9.2.4) no hypochlorite residue is thought to be present or to accumulate in the food chain.

2.6.3 Effects on bees and other arthropod species

No data were submitted. This is acceptable, since for the proposed treatments (use in mushroom crops in containers) exposure of bees to sodium hypochlorite will not occur.

2.6.4 Effects on earthworms and other soil macro-organisms

No data were submitted. This is acceptable, since for the proposed treatments (use in mushroom crops in containers) exposure of earthworms to sodium hypochlorite will not occur.

2.6.5 Effects on soil micro-organisms

No data were submitted. This is acceptable, since for the proposed treatments (use in mushroom crops in containers) exposure of micro-organisms to sodium hypochlorite will not occur.

2.6.6 Effects on other non-target organisms (flora and fauna)

No data were submitted. This is acceptable, since for the proposed treatments (use in mushroom crops in containers) exposure of earthworms to sodium hypochlorite will not occur.

2.6.7 Effects on biological methods of sewage treatment

For the proposed treatment exposure of activated sludge is possible following discharge of use solutions into the sewage system.

Risk assessment is based on the EC50 of sodium hypochlorite for inhibition of the bacterial respiratory rate of >375 µg/L. The table below shows the results.

Table 2.6.7-01 TERs of sodium hypochlorite for micro-organisms in activated sludge following discharge of use solutions into the sewage system.

application	EC50 (µg a.s./L)	PEC_{STP} (µg a.s./L)	TER
mushrooms	>375	0.033	>11364

Annex VI of Directive 91/414/EC does not specify a trigger for exposure of micro-organisms in the STP. Micro-organisms in activated sludge have a very short reproductive cycle similar to green algae, and it is reasonable therefore to apply the trigger of 10 for exposure of algae also to exposure of micro-organisms in activated sludge. The TER for micro-organisms in activated sludge is above the trigger of 10 and the risk is considered to be acceptable.

APPENDIX 1

SODIUM HYPOCHLORITE

PART 1: Standard terms and abbreviations

PART 2: Organisations and publications

PART 3: Preparation (formulation) types and codes

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Part 1 Standard terms and abbreviations

A	ampere
ACh	acetylcholine
AChE	acetylcholinesterase
ADI	acceptable daily intake
ADP	adenosine diphosphate
AE	acid equivalent
AFID	alkali flame-ionisation detector or detection
A/G	albumin/globulin ratio
ai	active ingredient
ALD_{50}	approximate median lethal dose, 50%
ALT	alanine aminotransferase (SGPT)
AOEL	acceptable operator exposure level
AMD	automatic multiple development
ANOVA	analysis of variance
AP	alkaline phosphatase
approx	approximate
ARC	anticipated residue contribution
ARfD	acute reference dose
as	active substance
AST	aspartate aminotransferase (SGOT)
ASV	air saturation value
ATP	adenosine triphosphate
BCF	bioconcentration factor
bfa	body fluid assay
BOD	biological oxygen demand
bp	boiling point
BSAF	biota-sediment accumulation factor
BSE	bovine spongiform encephalopathie
BSP	bromosulfophthalein
Bt	bacillus thuringiensis
Bti	bacillus thuringiensis israelensis
Btk	bacillus thuringiensis kurstaki
Btt	bacillus thuringiensis tenebrionis
BUN	blood urea nitrogen
bw	body weight
c	centi- (x 10^{-2})
°C	degree Celsius (centigrade)
CA	controlled atmosphere
CAD	computer aided design
CADDY	computer aided dossier and data supply (an electronic dossier interchange and archiving format)
cd	candela
CDA	controlled drop(let) application
cDNA	complementary DNA
CEC	cation exchange capacity
cf	confer, compare to
CFU	colony forming units
ChE	cholinesterase
CI	confidence interval
CL	confidence limits
cm	centimetre
CNS	central nervous system
COD	chemical oxygen demand

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

CPK	creatinine phosphatase
cv	coefficient of variation
Cv	ceiling value
CXL	Codex Maximum Residue Limit (Codex MRL)
d	day
DES	diethylstilboestrol
DFR	dislodgeable foliar residue
DMSO	dimethylsulfoxide
DNA	deoxyribonucleic Acid
dna	designated national authority
DO	dissolved oxygen
DOC	dissolved organic carbon
dpi	days post inoculation
DRES	dietary risk evaluation system
DT_{50}	period required for 50 percent dissipation (define method of estimation)
DT_{90}	period required for 90 percent dissipation (define method of estimation)
dw	dry weight
DWQG	drinking water quality guidelines
ε	decadic molar extinction coefficient
EC_{50}	median effective concentration
ECD	electron capture detector
ECU	European currency unit
ED_{50}	median effective dose
EDI	estimated daily intake
ELISA	enzyme linked immunosorbent assay
e-mail	electronic mail
EMDI	estimated maximum daily intake
EPMA	electron probe micro analysis
ERC	environmentally relevant concentration
ERL	extraneous residue limit
F	field
F_0	parental generation
F_1	filial generation, first
F_2	filial generation, second
FIA	fluorescence immunoassay
FID	flame ionisation detector
FOB	functional observation battery
fp	freezing point
FPD	flame photometric detector
FPLC	fast protein liquid chromatography
g	gram
G	glasshouse
GAP	good agricultural practice
GC	gas chromatography
GC-EC	gas chromatography with electron capture detector
GC-FID	gas chromatography with flame ionisation detector
GC-MS	gas chromatography-mass spectrometry
GC-MSD	gas chromatography with mass-selective detection
GEP	good experimental practice
GFP	good field practice
GGT	gamma glutamyl transferase
GI	gastro-intestinal
GIT	gastro-intestinal tract
GL	guideline level
GLC	gas liquid chromatography

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

GLP	good laboratory practice
GM	geometric mean
GMO	genetically modified organism
GMM	genetically modified micro-organism
GPC	gel-permeation chromatography
GPPP	good plant protection practice
GPS	global positioning system
GSH	glutathion
GV	granulosevirus
h	hour(s)
H	Henry's Law constant (calculated as a unitless value) (see also K)
ha	hectare
Hb	haemoglobin
HCG	human chorionic gonadotropin
Hct	haematocrit
HDT	highest dose tested
hL	hectolitre
HEED	high-energy electron diffraction
HID	helium ionisation detector
HPAEC	high performance anion exchange chromatography
HPLC	high pressure liquid chromatography or high performance liquid chromatography
HPLC-MS	high pressure liquid chromatography - mass spectrometry
HPPLC	high pressure planar liquid chromatography
HPTLC	high performance thin layer chromatography
HRGC	high resolution gas chromatography
H_S	Shannon-Weaver index
Ht	haematocrit
I	indoor
I_{50}	inhibitory dose, 50%
IC_{50}	median immobilisation concentration or median inhibitory concentration
ICM	integrated crop management
ID	ionisation detector
IEDI	international estimated daily intake
IGR	insect growth regulator
im	intramuscular
inh	inhalation
ip	intraperitoneal
IPM	integrated pest management
IR	infrared
ISBN	international standard book number
ISSN	international standard serial number
iv	intravenous
IVF	in vitro fertilisation
k	kilo
K	Kelvin or Henry's Law constant (in atmospheres per cubic meter per mole, see also H)
K_{ads}	adsorption constant
K_{des}	apparent desorption coefficient
K_{oc}	organic carbon adsorption coefficient
K_{om}	organic matter adsorption coefficient
kg	kilogram
L	litre
LAN	local area network
LASER	light amplification by stimulated emission of radiation
LBC	loosely bound capacity
LC	liquid chromatography

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

LC-MS	liquid chromatography- mass spectrometry
LC_{50}	lethal concentration, median
LCA	life cycle analysis
LC_{Lo}	lethal concentration low
LC-MS-MS	liquid chromatography with tandem mass spectrometry
LD_{50}	lethal dose, median; dosis letalis media
LD_{Lo}	lethal dose low
LDH	lactate dehydrogenase
LOAEC	lowest observable adverse effect concentration
LOAEL	lowest observable adverse effect level
LOD	limit of detection
LOEC	lowest observable effect concentration
LOEL	lowest observable effect level
LOQ	limit of quantification (determination)
LPLC	low pressure liquid chromatography
LSC	liquid scintillation counting or counter
LSD	least squared denominator multiple range test
LSS	liquid scintillation spectrometry
LT	lethal threshold
m	metre
M	molar
µm	micrometer (micron)
MC	moisture content
MCH	mean corpuscular haemoglobin
MCHC	mean corpuscular haemoglobin concentration
MCV	mean corpuscular volume
MDL	method detection limit
MFO	mixed function oxidase
µg	microgram
mg	milligram
MHC	moisture holding capacity
min	minute(s)
mL	millilitre
MLT	median lethal time
MLD	minimum lethal dose
mm	millimetre
mo	month(s)
mol	Mole(s)
MOS	margin of safety
mp	melting point
MRE	maximum residue expected
MRL	maximum residue level or limit
mRNA	messenger ribonucleic acid
MS	mass spectrometry
MSDS	material safety data sheet
MTD	maximum tolerated dose
n	normal (defining isomeric configuration) or number of observations
NAEL	no adverse effect level
nd	not detected
NEDI	national estimated daily intake
NEL	no effect level
NERL	no effect residue level
ng	nanogram
nm	nanometer
NMR	nuclear magnetic resonance
no	number
NOAEC	no observed adverse effect concentration

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
NOED	no observed effect dose
NOEL	no observed effect level
NOIS	notice of intent to suspend
NPD	nitrogen-phosphorus detector or detection
NPV	nuclear polyhedrosis virus
NR	not reported
NTE	neurotoxic target esterase
OC	organic carbon content
OCR	optical character recognition
ODP	ozone-depleting potential
ODS	ozone-depleting substances
OM	organic matter content
op	organophosphorous pesticide
Pa	Pascal
PAD	pulsed amperometric detection
2-PAM	2-pralidoxime
pc	paper chromatography
PC	personal computer
PCV	haematocrit (packed corpuscular volume)
PEC	predicted environmental concentration
PEC_A	predicted environmental concentration in air
PEC_S	predicted environmental concentration in soil
PEC_{SW}	predicted environmental concentration in surface water
PEC_{GW}	predicted environmental concentration in ground water
PED	plasma-emissions-detector
pH	pH-value
PHED	pesticide handler's exposure data
PHI	pre-harvest interval
PIC	prior informed consent
pic	phage inhibitory capacity
PIXE	proton induced X-ray emission
pKa	negative logarithm (to the base 10) of the dissociation constant)
PNEC	predicted no effect concentration
po	by mouth
P_{OW}	partition coefficient between n-octanol and water
POP	persistent organic pollutants
ppb	parts per billion (10^{-9})
PPE	personal protective equipment
ppm	parts per million (10^{-6})
ppp	plant protection product
ppq	parts per quadrillion (10^{-24})
ppt	parts per trillion (10^{-12})
PSP	phenolsulfophthalein
PrT	prothrombin time
PRL	practical residue limit
PT	prothrombin time
PTDI	provisional tolerable daily intake
PTT	partial thromboplastin time
QSAR	quantitative structure-activity relationship
r	correlation coefficient
r^2	coefficient of determination
RBC	red blood cell
REI	restricted entry interval

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Rf	retardation factor
RfD	reference dose
RH	relative humidity
RL_{50}	median residual lifetime
RNA	ribonucleic acid
RP	reversed phase
rpm	rotations per minute
rRNA	ribosomal ribonucleic acid
RRT	relative retention time
RSD	relative standard deviation
s	second
SAC	strong adsorption capacity
SAP	serum alkaline phosphatase
SAR	structure/activity relationship
SBLC	shallow bed liquid chromatography
sc	subcutaneous
sce	sister chromatid exchange
SD	standard deviation
se	standard error
SEM	standard error of the mean
SEP	standard evaluation procedure
SF	safety factor
SFC	supercritical fluid chromatography
SFE	supercritical fluid extraction
SIMS	secondary ion mass spectroscopy
SOP	standard operating procedures
sp	species (only after a generic name)
SPE	solid phase extraction
SPF	specific pathogen free
spp	subspecies
sq	square
SSD	sulphur specific detector
SSMS	spark source mass spectrometry
STEL	short-term exposure limit
STMR	supervised trials median residue
t	tonne (metric ton)
$t_{½}$	half-life (define method of estimation)
T_3	tri-iodothyroxine
T_4	thyroxin
TADI	temporary acceptable daily intake
TBC	tightly bound capacity
TCD	thermal conductivity detector
TC_{Lo}	toxic concentration, low
TID	thermionic detector, alkali flame detector
TD_{Lo}	toxic dose low
TDR	time domain reflectrometry
TER	toxicity exposure ration
TER_I	toxicity exposure ration for initial exposure
TER_{ST}	toxicity exposure ration following repeated exposure
TER_{LT}	toxicity exposure ration following chronic exposure
tert	tertiary (in a chemical name)
TEP	typical end-use product
TGGE	temperature gradient gel electrophoresis
TIFF	tag image file format
TLC	thin layer chromatography
Tlm	median tolerance limit
TLV	threshold limit value

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

TMDI	theoretical maximum daily intake
TMRC	theoretical maximum residue contribution
TMRL	temporary maximum residue limit
TOC	total organic carbon
Tremcard	Transport emergency card
tRNA	transfer ribonucleic acid
TSH	thyroid stimulating hormone (thyrotropin)
TWA	time weighted average
UDS	unscheduled DNA synthesis
UF	uncertainty factor (safety factor)
ULV	ultra low volume
UV	ultraviolet
v/v	volume ratio (volume per volume)
WBC	white blood cell
wk	week
wt	weight
w/v	weight per volume
ww	wet weight
w/w	weight per weight
XRFA	X-ray fluorescence analysis
yr	year
<	less than
=	less than or equal to
>	greater than
=	greater than or equal to

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Part 2 Organisations and Publications

ACPA	American Crop Protection Association
ASTM	American Society for Testing and Materials
BA	Biological Abstracts (Philadelphia)
BART	Beneficial Arthropod Registration Testing Group
CA	Chemical Abstracts
CAB	Centre for Agriculture and Biosciences International
CAC	Codex Alimentarius Commission
CAS	Chemical Abstracts Service
CCFAC	Codex Committee on Food Additives and Contaminants
CCGP	Codex Committee on General Principles
CCPR	Codex Committee on Pesticide Residues
CCRVDF	Codex Committee on Residues of Veterinary Drugs in Food
CE	Council of Europe
CIPAC	Collaborative International Pesticides Analytical Council Ltd
COREPER	Comite des Representants Permanents
EC	European Commission
ECB	European Chemical Bureau
ECCA	European Crop Care Association
ECDIN	Environmental Chemicals Data and Information Network of the European Communities
ECDIS	European Environmental Chemicals Data and Information System
ECE	Economic Commission for Europe
ECETOC	European Chemical Industry Ecology and Toxicology Centre
ECLO	Emergency Centre for Locust Operations
ECMWF	European Centre for Medium Range Weather Forecasting
ECPA	European Crop Protection Association
EDEXIM	European Database on Export and Import of Dangerous Chemicals
EHC (number)	Environmental Health Criteria (number)
EINECS	European Inventory of Existing Commercial Chemical Substances
ELINCS	European List of New Chemical Substances
EMIC	Environmental Mutagens Information Centre
EPA	Environmental Protection Agency
EPO	European Patent Office
EPPO	European and Mediterranean Plant Protection Organization
ESCORT	European Standard Characteristics of Beneficials Regulatory Testing
EU	European Union
EUPHIDS	European Pesticide Hazard Information and Decision Support System
EUROPOEM	European Predictive Operator Exposure Model
FAO	Food and Agriculture Organization of the UN
FOCUS	Forum for the Co-ordination of Pesticide Fate Models and their Use
FRAC	Fungicide Resistance Action Committee
GATT	General Agreement on Tariffs and Trade
GAW	Global Atmosphere Watch
GIFAP	Groupement International des Associations Nationales de Fabricants de Produits Agro-chimiques (now known as GCPF)
GCOS	Global Climate Observing System
GCPF	Global Crop Protection Federation (formerly known as GIFAP)
GEDD	Global Environmental Data Directory
GEMS	Global Environmental Monitoring System
GIEWS	Global Information and Early Warning System for Food and Agriculture
GRIN	Germplasm Resources Information Network

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

HRAC	Herbicide Resistance Action Committee
IARC	International Agency for Research on Cancer
IATS	International Academy of Toxicological Science
IBT	Industrial Bio-Test Laboratories
ICBB	International Commission of Bee Botany
ICBP	International Council for Bird Preservation
ICES	International Council for the Exploration of the Seas
ICPBR	International Commission for Plant-Bee Relationships
ILO	International Labour Organization
IMO	International Maritime Organisation
IOBC	International Organisation for Biological Control of Noxious Animals and Plants
IPCS	International Programme on Chemical Safety
IRAC	Insecticide Resistance Action Committee
IRC	International Rice Commission
ISCO	International Soil Conservation Organization
ISO	International Organization for Standardization
IUPAC	International Union of Pure and Applied Chemistry
JECFA	FAO/WHO Joint Expert Committee on Food Additives
JFCMP	Joint FAO/WHO Food and Animal Feed Contamination Monitoring Programme
JMP	Joint Meeting on Pesticides (WHO/FAO)
JMPR	Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues (Joint Meeting on Pesticide Residues)
NATO	North Atlantic Treaty Organisation
NAFTA	North American Free Trade Agreement
NCI	National Cancer Institute (USA)
NCTR	National Centre for Toxicological Research (USA)
NGO	non-governmental organisation
NTP	National Toxicology Programme (USA)
OECD	Organisation for Economic Co-operation and Development
OLIS	On-line Information Service of OECD
PAN	Pesticide Action Network
RNN	Re-registration Notification Network
RTECS	Registry of Toxic Effects of Chemical Substances (USA)
SCPH	Standing Committee on Plant Health
SETAC	Society of Environmental Toxicology and Chemistry
SI	Systeme international d'Unites
SITC	Standard International Trade Classification
TOXLINE	Toxicology Information On-line
UN	United Nations
UNEP	United Nations Environment Programme
WCDP	World Climate Data Programme
WCP	World Climate Programme
WCRP	World Climate Research Programme
WFP	World Food Programme
WHO	World Health Organization

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

WTO	World Trade Organization
WWF	World Wildlife Fund

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Part 3 Preparation (formulation) types and codes

Code	*Description*	*Definition*
AB	Grain bait	Special forms of bait.
AE	Aerosol dispenser	A container-held preparation which is dispersed generally by a propellant as fine droplets/particles upon actuation of a valve.
AL	Other liquids to be applied undiluted	Self defining.
BB	Block blits	Special forms of bait.
BR	Briquette	Solid block designed for controlled release of active ingredient into water.
CB	Bait concentrate	A solid or liquid intended for dilution before use as a bait.
CG	Encapsulated granule	A granule with a protective or release controlling coating.
CS	Capsule suspension	A stable suspension of capsules in a fluid normally intended for dilution with water before use.
DC	Dispersible concentrate	A liquid homogeneous preparation to be applied as a solid dispersion after dilution in water.
DP	Dustable powder	A free-flowing powder suitable for dusting.
DS	Powder for dry seed treatment	A powder for application in the dry state directly to seed.
EC	Emulsifiable concentrate	A liquid, homogenous preparation to be applied as an emulsion after dilution in water.
ED	Electrochargeable liquid	Special liquid preparation for electrostatic (electrodynamic)spraying
EO	Emulsion. water in oil	A fluid. heterogeneous preparation consisting of a dispersion of fine globules of pesticide in water in a continuous organic liquid phase.
ES	Emulsion for seed treatment	A stable emulsion for application to the seed either directly or after dilution.
EW	Emulsion. Oil in water	A fluid, heterogeneous preparation consisting of a dispersion of fine globules of pesticide in an organic liquid in a continuous water phase.
FD	Smoke tin	Special form of smoke generator.
FG	Fine granule	A granule in the particle size range from 300 to 2500 :.
FK	Smoke candle	A smoke generator in the form of a candle.
FP	Smoke cartridge	Special form of smoke generator.
FR	Smoke rodlet	Special form of smoke generator.
FS	Flowable concentrate for seed treatment	A stable suspension for application to the seed either directly or seed treatment after dilution.

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Code	*Description*	*Definition*
FT	Smoke tablet	Special form of smoke generator.
FU	Smoke generator	A combustible preparation generally solid, which upon ignition releases the active substances in the form of a smoke.
FW	Smoke pellet	Special form of smoke generator.
GA	Gas	A gas packed in pressure bottle or pressure tank.
GB	Granular bait	Special forms of bait.
GE	Gas generating product	A preparation which generates a gas by chemical reaction.
GG	Macrogranule	A granule in the particle size range from 2000 to 6000 :.
GP	Flo-dust	Very fine dustable powder for pneumatic application in glasshouses.
GR	Hot fogging concentrate	A free-flowing solid preparation of a defined granule size range ready for use.
GS	Cold fogging concentrate	Very viscous preparation based on oil or fat.
HN	Hot fogging concentrate	A preparation suitable for application by fogging equipment either directly or after dilution.
KN	Cold fogging concentrate	A preparation suitable for application by cold fogging equipment, either directly or after dilution.
LA	Lacquer	A solvent based film-forming preparation.
LS	Solution for seed treatment	A solution for application to the seed either directly or after dilution.
MG	Microgranule	A granule in the particle ske range from 100 to 600
OF	Oil miscible flowable (=oil active substances in a miscible suspension)	A stable suspension of concentrate fluid intended for dilution in an organic liquid before use.
OL	Oil miscible liquid	A liquid, homogenous preparation to be applied as a homogenous liquid after dilution in an organic liquid.
OP	Oil dispersible powder	A powder preparation to be applied as a suspension after dispersion in an organic liquid.
PA	Paste	A water based film forming preparation.
PB	Plate bait	Special forms of bait.
PC	Gel or paste concentrate	A solid preparation to be applied as a gel or a paste after dilution with water.
PR	Plant rodlet	A small rodlet, usually a few centimetres in length and a few millimetres in diameter containing active substance.
PS	Seed coated with a pesticide	Self defining.

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Code	*Description*	*Definition*
RB	Bait (ready for use)	A preparation designed to attract and be eaten by the target species.
SB	Scrap bait	Special forms of bait.
SC	Suspension (= flowable concentrate)	A stable suspension of active substance(s) in a fluid intended for dilution with water before use
SE	Suspo-emulsion	A fluid. heterogeneous preparation consisting of a stable dispersion of active substance(s) in the form of solid particles.
SG	Water soluble granules	A preparation consisting of granules to be applied as a true solution of active substance after dissolution in water but many contain insoluble inert ingredients.
SL	Soluble concentrate	A liquid homogenous preparation to be applied as a true solution of active substance after dissolution in water but many contain insoluble inert ingredients.
SO	Spreading oil	A preparation designed to form a surface layer on application to water.
SP	Water soluble powder	A powder preparation to be applied as a true solution of the active substance after solution in water but which may contain insoluble inert ingredients.
SS	Water soluble powder for seed treatment	A powder to be dissolved in water before application to the seed.
SU	Ultra low volume (ULV) suspension	A suspension ready for use through ULV equipment.
TB	Tablet	Solid preparation in the form of small flat plates for dissolution in water.
TP	tracking powder	A rodenticidal contact preparation in powder form.
UL	Ultra low volume (ULV) liquid	A homogenous liquid ready for use through ULV equipment.
VP	Vapour releasing product	A preparation containing one or more volatile ingredients, the vapours of which are released into the air. Evaporation rate normally is controlled by using suitable preparations and/or dispensers.
WG	Water dispersible	A preparation granule consisting of granules to be applied after disintegration and dispersion in water.
WP	Wettable powder	A powder preparation to be applied as a suspension after dispersion in water.
WS	Water dispersible powder for slurry seed treatment	A powder to be dispersed at high concentration in water before application as a slurry to the seed.

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Code	*Description*	*Definition*
XX	Others	

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

APPENDIX 2

SODIUM HYPOCHLORITE

SPECIFIC TERMS AND ABBREVIATIONS

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Specific terms and abbreviations

a	absolute organ weight
AAP	Algal Assay Procedure medium
AASE	Acceptable Additional Systemic Exposure
aerob	aerobic test conditions
a-GT	alpha-glutamyl-transferase
ALAT	alanine aminotransferase
ALP	alkaline phosphatase
amu	atomic mass units
anaer	anaerobic test conditions
AR	applied radioactivity
ASAT	aspartate aminotransferase
ASTM	American Society for Testing and Materials
B	bacteria
biodeg	biodegradation
Chr. ab.	chromosome aberrations
CMC	carboxymethylcellulose
CoE	Council of Europe
crit.	criterion
d	decreased, but not statistically significantly
dc	statistically significantly decreased
DFI	Daily Food Intake
DMF	dimethylformamide
DO	Dissolved Oxygen
dr	dose-related
DWI	Daily Water Intake
E	total effect of mortality and fecundity/parasitic capacity, used in arthropod toxicity tests
E. coli	*Escherichia coli*
equal	used when the values given by the notifier are expressed in mg/kg bw/day.
equivalent	used when values given by the notifier are only expressed in mg/kg food, not in mg/kg bw/day, as species-dependent factor is used to translate these data to mg/kg bw/day.
ETE	Estimated Theoretical Exposure
GCP	good clinical practice
GIDH	glutamic-acid dehydrogenase
GOT	glutamic-oxalacetic transaminase
GPT	glutamic-pyruvic transaminase
HDL	high density lipoproteins
HPRT	hypoxanthine- guanine phosphoribosyl transferase
i	increased, but not statistically significantly
ic	statistically significantly increased

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

MC	moisture content in soil (v/v)
Mc	mammalian cells
MWHC	maximum water holding capacity (soils)
n/a	not applicable
n.d.	not detected
n.r.	not reported
ns	not significant
o.m.	organic matter
PEC	Predicted Environmental Concentration
PEG	polyethylene glycol
pF	moisture tension (soil) in [log $cm_{water\ column}$]
PIEC	Predicted Initial Environmental Concentration
pointmut.	pointmutations
r	relative organ weight
r.a.	radioactivity
res.	result
Ri	Reliability Index, referring to the intrinsic reliability of a test with respect to the quality of the study
S. typh.	*Salmonella typhimurium*
SPE	Solid Phase Extraction
Sub.	Substance
T	temperature
TWA	time weighted average
TWAEC	time weighted average environmental concentration
wat/sed	water/sediment systeem
w/w	weight per weight
-	negative
+	positive
-act.	without activation
+act.	with activation
%v/v	the percentage expressed by volume
%w/w	the percentage expressed by weight

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

APPENDIX 3

SODIUM HYPOCHLORITE

LIST OF END-POINTS

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Chapter 2.1 Identity, Physical and Chemical Properties, Details of Uses, Further Information

Active substance (ISO Common Name) ‡	sodium hypochlorite The following data is applicable to a 10-12% w/w available chlorine aqueous solution unless otherwise mentioned
Function (e.g. fungicide)	disinfectant

Rapporteur Member State	The Netherlands
Co-rapporteur Member State	-

Identity (Annex IIA, point 1)

Chemical name (IUPAC) ‡	sodium hypochlorite
Chemical name (CA) ‡	sodium hypochlorite
CIPAC No ‡	none
CAS No ‡	7681-52-9
EC No (EINECS or ELINCS) ‡	231-668-3
FAO Specification (including year of publication) ‡	None
Minimum purity of the active substance as manufactured ‡	10 – 12% (w/w) expressed as available chlorine (Cl_2)
Identity of relevant impurities (of toxicological, ecotoxicological and/or environmental concern) in the active substance as manufactured	no relevant impurities
Molecular formula ‡	NaClO
Molecular mass ‡	74.44
Structural formula ‡	$Na^+ – ClO^-$

Physical and chemical properties (Annex IIA, point 2)

Melting point (state purity) ‡	-20 to -30°C
Boiling point (state purity) ‡	96 – 120 °C
Temperature of decomposition (state purity)	decomposition rate doubles at every raise of temperature by 5.5°C. above 35°C decomposition Is very rapid
Appearance (state purity) ‡	Yellowish liquid with characteristic smell
Vapour pressure (state temperature, state purity) ‡	1.74 – 2.0 kPa at 20°C*
Henry's law constant ‡	not applicable
Solubility in water (state temperature, state purity and pH) ‡	miscible

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Solubility in organic solvents ‡ (state temperature, state purity)	not applicable (reacts with several organic solvents)
Surface tension ‡ (state concentration and temperature, state purity)	not applicable
Partition co-efficient ‡ (state temperature, pH and purity)	not applicable
Dissociation constant (state purity) ‡	In solution the sodium hypochlorite is in equilibrium with chlorine and hypochlorous acid. The equilibrium is temperature and pH dependant. hypochlorous acid has a pKa of 7.5 (25°C)
UV/VIS absorption (max.) incl. ε ‡ (state purity, pH)	no data
Flammability ‡ (state purity)	not applicable
Explosive properties ‡ (state purity)	not explosive as solution
Oxidising properties ‡ (state purity)	strong oxidising agent, however *not* oxidising in the sense of EEG method A17 (solids) or A21 (liquids)

*) This is in fact the vapour pressure of water

Classification and proposed labelling with regard to physical and chemical data (Annex IIA, point 10)

	RMS/peer review proposal
Active substance	none

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Summary of representative uses evaluated (sodium hypochlorite)*

Crop and/ or situation (a)	Member State or Country	Product name	F G or I (b)	Pests or Group of pests controlled (c)	Preparation		Application				Application rate per treatment (for explanation see the text in front of this section)			PHI (days) (m)	Remarks
					Type (d-f)	Conc. of as (i)	method kind (f-h)	growth stage & season (j)	number (max) (k)	interval between applications (min)	g as/hL min – max (l)	water L/ha min – max	g as/ha min – max (l)		
Mushrooms	EU	Sodium hypo-chlorite	I	Bacterial blotch caused by Pseudomonas tolaasii	SL	10 – 12% available chlorine	In irrigation water applied by watering tree	From appearance of mushrooms on beds until mushrooms are pea size	40[A]	1 day	31.5 NaClO ≈ 30 g available Cl_2	10,000	3150 NaClO ≈ 3000 g available Cl_2	1[B]	[A] 40 applications per year (assuming 10 cultivation cycles per year and 3-4 applications per cycle) [B] A PHI of 1 day was proposed by the notifier. However, in practice the PHI will be longer.

* For uses where the column "Remarks" is marked in grey further consideration is necessary. Uses should be crossed out when the notifier no longer supports this use(s).
(a) For crops, the EU and Codex classifications (both) should be taken into account; where relevant, the use situation should be described (e.g. fumigation of a structure)
(b) Outdoor or field use (F), greenhouse application (G) or indoor application (I)
(c) *e.g.* biting and suckling insects, soil born insects, foliar fungi, weeds
(d) *e.g.* wettable powder (WP), emulsifiable concentrate (EC), granule (GR)
(e) GCPF Codes - GIFAP Technical Monograph No 2, 1989
(f) All abbreviations used must be explained
(g) Method, e.g. high volume spraying, low volume spraying, spreading, dusting, drench
(h) Kind, *e.g.* overall, broadcast, aerial spraying, row, individual plant, between the plant- type of equipment used must be indicated
(i) g/kg or g/L. Normally the rate should be given for the active substance (according to ISO) and not for the variant in order to compare the rate for same active substances used in different variants (e.g. fluoroxypyr). **In certain cases, where only one variant is synthesised, it is more appropriate to give the rate for the variant (e.g. benthiavalicarb-isopropyl).**
(j) Growth stage at last treatment (BBCH Monograph, Growth Stages of Plants, 1997, Blackwell, ISBN 3-8263-3152-4), including where relevant, information on season at time of application
(k) Indicate the minimum and maximum number of application possible under practical conditions of use
(l) The values should be given in g or kg whatever gives the more manageable number (e.g. 200 kg/ha instead of 200 000 g/ha or 12.5 g/ha instead of 0.0125 kg/ha
(m) PHI - minimum pre-harvest interval

‡ End point identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Chapter 2.2 Methods of Analysis

Analytical methods for the active substance (Annex IIA, point 4.1)

Technical as (analytical technique)	titration with sodium thiosulphate for content available chlorine ICP-AES for sodium content
Impurities in technical as (analytical technique)	titration with hydrochloric acid
Plant protection product (analytical technique)	titration with sodium thiosulphate

Analytical methods for residues (Annex IIA, point 4.2)

Residue definitions for monitoring purposes

Food of plant origin	none
Food of animal origin	none
Soil	none
Water surface	sodium hypochlorite expressed as total available chlorine
drinking/ground	sodium hypochlorite expressed as total available chlorine
Air	none
Human tissues and body fluids	not required, not classified as (very) toxic

Monitoring/Enforcement methods

Food/feed of plant origin (analytical technique and LOQ for methods for monitoring purposes)	not required
Food/feed of animal origin (analytical technique and LOQ for methods for monitoring purposes)	not required
Soil (analytical technique and LOQ)	not required
Water (analytical technique and LOQ)	ISO method 7393:1985 (parts 1 to 3): 1: titration with N,N-diethyl-p-phenylene-diamine; LOQ 0.0004 mmol/L total Chlorine (~0.03 mg/L) 2: : coulometric detection with N,N-diethyl-p-phenylene-diamine; LOQ 0.0004 mmol/L total Chlorine 3: iodometric titration; LOQ 0.01 mmol/L chlorine
Air (analytical technique and LOQ)	Not required. NIOSH method, no 6011: sampling op a silver filter; analysis with ionchromatography and a conductivity detector. LOQ 0.06 mg/m3 chlorine (0.008 ppm).
Body fluids and tissues (analytical technique and LOQ)	not required, not classified as (very) toxic

Chapter 2.3 Impact on Human and Animal Health

Absorption, distribution, excretion and metabolism (toxicokinetics) (Annex IIA, point 5.1)

Rate and extent of oral absorption	Approximately 40% (based on urinary excretion)
Distribution	Widely distributed. Highest levels in plasma, whole blood, bone marrow, testis, skin, kidney and lung
Potential for accumulation	No evidence for accumulation
Rate and extent of excretion	Mainly via urine (36% over 96h), and 15% via faeces (poor total recovery)
Metabolism in animals	Not enzymatically metabolised. (Bio)transformation occurs readily through direct reaction with organic compounds or chemicals present in cellular environment
Toxicologically relevant compounds (animals and plants)	Parent compound
Toxicologically relevant compounds (environment)	Parent compound

Acute toxicity (Annex IIA, point 5.2)

Rat LD_{50} oral	> 5.8 mg/kg bw (for 12.5% NaClO solution)	
Rat LD_{50} dermal	> 2.0 mg/kg bw (for 5.25% NaClO solution)	
Rat LC_{50} inhalation	Low toxicity	
Skin irritation	NaClO solution ≥ 10%: corrosive	R34
Eye irritation	NaClO solution ≥ 10%: corrosive	R34
Skin sensitisation	Not sensitising (guinea pig sensitisation studies and human data)	

Short term toxicity (Annex IIA, point 5.3)

Target / critical effect	Decreased body weight (gain) and organ weight (lung, liver, spleen, salivary gland, heart, brain)	
Relevant oral NOAEL	13-week, rat 47.5 mg/kg bw/day	
Relevant dermal NOAEL	Very conservative NOAEL for repeated effects following dermal exposure to sodium hypochlorite solution is 0.1%	
Relevant inhalation NOAEL	No data – not required	

Genotoxicity (Annex IIA, point 5.4)

Sodium hypochlorite has no genotoxic potential *in vivo*	

Long term toxicity and carcinogenicity (Annex IIA, point 5.5)

Target/critical effect	Decreased body weight gain, decreased organ weights	
Relevant NOAEL	2-year, rat ≥ 15 mg/kg bw/day 2-year, mouse 15.3 mg/kg bw/day	
Carcinogenicity	Sodium hypochlorite has no carcinogenic potential	

Reproductive toxicity (Annex IIA, point 5.6)

Reproduction toxicity		
Reproduction target / critical effect	Parental: no adverse effects observed Reproductive: no adverse effects observed Offspring: no adverse effects observed	
Relevant parental NOAEL	≥ 5 mg/kg bw/day	
Relevant reproductive NOAEL	≥ 5 mg/kg bw/day	
Relevant offspring NOAEL	≥ 5 mg/kg bw/day	

Developmental toxicity

Developmental target / critical effect	No evidence from animal and human data to suggest that sodium hypochlorite would present adverse effects on development	
Relevant maternal NOAEL	No valued could be derived	
Relevant developmental NOAEL	No valued could be derived	

Neurotoxicity (Annex IIA, point 5.7)

Acute neurotoxicity	No data available – not required	
Repeated neurotoxicity	No data available – not required	
Delayed neurotoxicity	No data available – not required	

Other toxicological studies (Annex IIA, point 5.8)

Mechanism studies	Skin two-stage carcinogenesis model studies performed. Sodium hypochlorite did not have promoting effects. A NOAEL of 1% sodium hypochlorite solution could be derived. Some incidental effects related to the immune system were reported in rats and mice.
Studies performed on metabolites or impurities	Mixture of two impurities was less acute toxic than emamectin and was negative in an Ames test.

Medical data (Annex IIA, point 5.9)

No causal link between any long term health effect (including increased cancer risk) and consumption of chlorinated drinking water was established

Summary (Annex IIA, point 5.10)

	Value	Study	Safety factor
ADI	0.15 mg/kg bw/day	2-year rat	100
AOEL	0.06 mg/kg bw/day	2-year rat	100 *
ARfD	Not allocated, not necessary		

*correction for oral absorption of 40%

Dermal absorption (Annex IIIA, point 7.3)

^{14}C-emamectin and ^{3}H-emamectin B1a, formulated as Affirm (granulate)	No data available. Potential to penetrate the skin is low given its reactivity to proteinaceus material (concentrate and spray dilution contain predominantly hypochlorite ions). Default of 10%

Exposure scenarios (Annex IIIA, point 7.2)

Operator – use on mushrooms (% AOEL)		without PPE	with PPE
Manual downward spraying, greenhouse	Dutch-90th	300	30
Workers	worker exposure will be negligible		
Bystanders	presence of bystanders should be prohibited; indoor application		

Classification and proposed labelling with regard to toxicological data (Annex IIA, point 10)

	RMS/peer review proposal
Substance classified (sodium hypochlorite)	C “corrosive” R34 “causes burns”

Chapter 2.4 – Residues

Metabolism in plants (IIA, point 6.2 and 6.7, IIIA, point 8.2 and 8.7)

Plant groups covered	No data submitted and not required
Rotational crops	-
Metabolism in rotational crops similar to metabolism in primary crops?	-
Processed commodities	-
Residue pattern in processed commodities similar to residue pattern in raw commodities?	-
Plant residue definition for monitoring	-
Plant residue definition for risk assessment	-
Conversion factor (monitoring to risk assessment)	-

Metabolism in livestock (IIA, point 6.2 and 6.7, IIIA, point 8.2 and 8.7)

Animals covered	No data submitted and not required
Time needed to reach a plateau concentration in milk and eggs	-
Animal residue definition for monitoring	-
Animal residue definition for risk assessment	-
Conversion factor (monitoring to risk assessment)	-
Metabolism in rat and ruminant similar (yes/no)	-
Fat soluble residue: (yes/no)	

Residues in succeeding crops (IIA, point 6.6, IIIA, point 8.6)

Sodium hypochlorite will react to a number of reactive chlorine species, which are expected to end in Cl^- only. Higher levels of inorganic salts may be expected, which, however, do not result in relevant residues succeeding crops which pose a risk for consumers

Stability of residues (IIA, point 6.1, IIIA, point 8.1)

No data submitted and not required

Residues from livestock feeding studies (IIA, point 6.4, IIIA, point 8.4)

Ruminant:	Poultry:	Pig:
Conditions of requirement of feeding studies		

Expected intakes by livestock ≥ 0.1 mg/kg diet (dry weight basis) (yes/no - If yes, specify the level)	no	no	no
Potential for accumulation (yes/no):	-	-	-
Metabolism studies indicate potential level of residues ≥ 0.01 mg/kg in edible tissues (yes/no)	-	-	-
	Feeding studies Residue levels in matrices : Mean (max) mg/kg		
Muscle	-	-	-
Liver	-	-	-
Kidney	-	-	-
Fat	-	-	-
Milk	-		
Eggs		-	

Summary of residues data according to the representative uses on raw agricultural commodities and feedingstuffs (IIA, point 6.3, IIIA, point 8.3)

Crop	Northern or Mediterranean Region, field or glasshouse, and any other useful information	Trials results relevant to the representative uses	Recommendation/comments	MRL estimated from trials according to the representative use	HR	STMR
No data submitted and not required						

Consumer risk assessment (IIA, point 6.9, IIIA, point 8.10)

ADI	0.15 mg/kg bw/d
TMDI (% ADI) according to WHO European diet	Not necessary
TMDI (% ADI) according to national (to be specified) diets	Not necessary
IEDI (WHO European Diet) (% ADI)	Not necessary
NEDI (specify diet) (% ADI)	Not necessary
Factors included in IEDI and NEDI	Not necessary
ARfD	Not allocated
IESTI (% ARfD)	Not necessary
NESTI (% ARfD) according to national (to be specified) large portion consumption data	Not necessary
Factors included in IESTI and NESTI	Not necessary

Processing factors (IIA, point 6.5, IIIA, point 8.5)

Crop/ process/ processed product	Number of studies	Processing factors		Amount transferred (%) (Optional)
		Transfer factor	Yield factor	
No data submitted and not required				

Proposed MRLs (IIA, point 6.7, IIIA, point 8.7)

Proposed MRLs	Sodium hypochlorite is proposed as a candidate for Annex IV of Regulation 396/2005/EC.

Chapter 2.5 – Fate and Behaviour in the Environment

Route of degradation (aerobic) in soil (Annex IIA, point 7.1.1.1.1)

Mineralization after 100 days	not available: not required
Non-extractable residues after 100 days	not available: not required
Relevant metabolites - name and/or code, % of applied (range and maximum)	not available: not required

Route of degradation in soil - Supplemental studies (Annex IIA, point 7.1.1.1.2)

Anaerobic degradation	not available: not required
Soil photolysis	not available: not required

Rate of degradation in soil (Annex IIA, point 7.1.1.2, Annex IIIA, point 9.1.1)

Method of calculation	not available: not required
Laboratory studies (range or median, with n value, with r^2 value)	not available: not required
Field studies (state location, range or median with n value)	not available: not required
Soil accumulation and plateau concentration	not available: not required

Soil adsorption/desorption (Annex IIA, point 7.1.2)

Kf /Koc	not available: not required
Kd	
pH dependence (yes / no) (if yes type of dependence)	

Mobility in soil (Annex IIA, point 7.1.3, Annex IIIA, point 9.1.2)

Column leaching	not available: not required
Aged residues leaching	not available: not required
Lysimeter/ field leaching studies	not available: not required

PEC (soil) (Annex IIIA, point 9.1.3)

Parent

Method of calculation	not available: not required
Application rate	not available: not required

Route and rate of degradation in water (Annex IIA, point 7.2.1)

Hydrolysis of active substance and relevant metabolites (DT_{50}) (state pH and temperature)	Bleach decomposition is 2nd order with respect to NaOCl concentration. The second order rate law predicts that diluting the NaOCl by a factor of 2 should decrease the rate of NaOCl decomposition by a factor of 4. However, actual decomposition data for sodium hypochlorite solutions shows that a factor of 2 decrease in NaOCl concentration results in an approximate factor of 5 decrease in the rate of decomposition. This is because of the effect on the decomposition rate by the decrease in the total ionic concentration of the solution. Since the dilution of a bleach solution not only decreases the NaOCl concentration but also decreases the concentration of all the ions in the solution (chloride ions, the chlorate ions, hydroxide ions, etc.), the total ionic strength is also decreased and further reduces the decomposition rate (T.C.I., 2006, pamphlet 96).
Photolytic degradation of active substance and relevant metabolites	**Photolysis** A sodium hypochlorite solution is very sensitive to light. Direct sunlight may cause rearrangement and decomposition resulting in the formation of chlorateand oxygen. The presence of isocyanuric acid in solution reduces this sensitivity to a great extent (RAR, 2007). Half life of a 10 to 15% available chlorine solution will be reduced 3 to 4 times by sunlight. (IUCLID, 2000).
Readily biodegradable (yes/no)	Not ready biodegradable (because no data available)

Degradation in STP	- DT50 water	not applicable
	- DT90 water	
	- DT50 whole system	< 1 h (20°C)
	- DT90 whole system	< 1 h (20°C)
	- DT50 sediment	not applicable
	- DT90 sediment	
Mineralization		not available: not required

Non-extractable residues	not available: not required
Distribution in water / sediment systems (active substance)	
Distribution in water / sediment systems (metabolites)	

PEC (surface water) (Annex IIIA, point 9.2.3)

Parent

Method of calculation	DT_{50} STPt: < 1 h log Kow: -1 = Koc: 0.115 L/kg Water/solubility: 10000 mg/L USES (1994)
Application rate	Crop: Mushrooms Number of applications: 40 Dose rate: 3.15 kg/ha Interval: 1 d
Main routes of entry	Exposure via STP The removal rate in the WWTP is estimated by EUSES 2.0 based on the Kd value 85.1%. An emission of 0.09% of active substance discharged to a WWTP.

$PEC_{(sw)}$ (µg/L)					Multiple application Time weighted average		Multiple application Time weighted average	
Mushrooms					expressed as NaOCl		expressed as Chlorine (Cl_2)	
Initial						3.3E-03		3.1E-03
Short term 24h						3.3E-03		3.1E-03
	2d					3.3E-03		3.1E-03
	4d					3.3E-03		3.1E-03
Long term	7d					3.3E-03		3.1E-03
	14d					3.3E-03		3.1E-03
	21d					3.3E-03		3.1E-03
	28d					3.3E-03		3.1E-03
	42d					3.3E-03		3.1E-03

PEC (ground water) (Annex IIIA, point 9.2.1)

Method of calculation and type of study (e.g. modelling, monitoring, lysimeter)	not available: not required
Application rate	not available: not required
PEC(gw)	
Maximum concentration	
Average annual concentration	
(Results quoted for modelling with FOCUS gw scenarios, according to FOCUS guidance)	

Fate and behaviour in air (Annex IIA, point 7.2.2, Annex III, point 9.3)

Direct photolysis in air	not available: not required
Quantum yield of direct phototransformation	not available: not required
Photochemical oxidative degradation in air	not available: not required
Volatilization	from plant surfaces: no data submitted
	from soil: no data submitted

PEC (air)

Method of calculation	

$PEC_{(a)}$

Maximum concentration	negligible

Definition of the Residue (Annex IIA, point 7.3)

Relevant to the environment	**Soil** None **Water and sediment** Sodium hypochlorite/chlorine **Air** None

Monitoring data, if available (Annex IIA, point 7.4)

Soil (indicate location and type of study)	No data submitted
Surface water (indicate location and type of study)	No data submitted
Ground water (indicate location and type of study)	No data submitted
Air (indicate location and type of study)	No data submitted

Classification and proposed labelling (Annex IIA, point 10)

with regard to fate and behaviour data	No classification is proposed

Chapter 2.6 – Effects on Non-target Species

Effects on terrestrial vertebrates (Annex IIA, point 8.1, Annex IIIA, points 10.1 and 10.3)

Species	Test substance	Time scale	End point (mg/kg bw/day)	End point (mg/kg feed)
Birds				
no data				
Mammals				
Rat	12% formulation	Acute	LD50:	>5800
Rat	a.s.	Long-term	NOEL:	≥ 5
Additional higher tier studies ‡				
No data available – not required				

Toxicity/exposure ratios for terrestrial vertebrates (Annex IIIA, points 10.1 and 10.3)

Indicator species/Category	Time scale	ETE	TER	Annex VI Trigger
Tier 1 (Birds): Only exposure via drinking water is expected. Considering the low expected concentrations in surface water, the risk is considered to be low.				
Tier 1 (Mammals): Only exposure via drinking water is expected. Considering the low expected concentrations in surface water 0.0086 µg/L, and the low toxicity to mammals, the risk is considered to be low.				
Route: water	Acute	0.0000014	>5.2 x 10^8	10

Toxicity data for aquatic species (most sensitive species of each group) (Annex IIA, point 8.2, Annex IIIA, point 10.2) Endpoints used for risk assessment are given in bold.

Species	**Parameter**	**Criterion**	**Value (µg/L)**
Algae			
Pytoplankton	biomass	21d EC50	1-10 (TRC)
Algae (multispecies)	Algae biomass	7d EC50	**> 6 (TRC)** > 4.38 (FAC)
Invertebrates			
Ceriodapnia dubia	mortality	24h LC50	**5 (FAC)**
Pandalus goniurus	mortality	96h LC50	90 (TRC)

Crassostrea virginica (larvae)	mortality	48h LC50	80-120 (TRC)
Brachionus plicatilis	mortality	48h LC50	10-820 (TRC)
Acartia tonsa	mortality	48h LC50	180 (TRC)
Crassostrea virginica (juveniles)	Shell deposition	96 h EC50	23 (TRC)
Crassostrea virginica (larvae)		48h EC50	26 (TRC)
Acartia tonsa	mortality	48h LC50	29 (TRC)
Crassostrea virginica	Shell deposition	15d LOEC	14 (TRO)
Rangia cuneata	mortality	15d NOEC	62 (TRO)
Fish			
Salmo gairdneri	mortality	96h LC50	60 (TRC) 30 (FAC)
Ictalurus punctatus	mortality	96h LC50	64 (TRC) 32 (FAC)
Salmo gairdneri (juveniles)	mortality	24h LC50	430
Oncorhynchus kisutch *Alosa pseudoharengus* *Notropis hudsonius* *Osmerus mordax*	mortality	48h LC50	1260-2410
Pimephales promelas (juveniles)	mortality	96h LC50	80 (TRC) >40 (FAC)
Cyprinus caprio (prolarvae)	mortality	48h LC50	260
Gambusia affinis (prolarvae)	mortality	48h LC50	610
Gambusia affinis	mortality	48h LC50	840
Leiostomus xanthurus	mortality	96h LC50	**90 (TRC and FAC)**
Oncorhynchus kisutch	mortality	48h LC50	32 (TRO)
Gasterosteous aculeatus	mortality	48h LC50	167 (TRO)
Menidia menidia	mortality	96h LC50	37 (TRC)
Morone saxatilis	hatchability	48h EC50	8 (TRC)
Ictalurus punctatus	growth	134d NOEC 134d LOEC	5 (TRC) 52 (TRC)
Menida peninsula	ELS, fry survival	28d NOEC	**40 (TRC)**
Outdoor mesocosm			

In a 28 d laboratory microcosm toxicity of hypochlorite to a microbial community was tested. The measured taxonomic parameter was the number of protozoan species and the non-taxonomic responses included chlorophyll *a* (expression of algal biomass*)*, ATP, total protein, extracellular alkaline phosphatase activity, and potassium. The lowest NOEC was calculated for the number of protozoan species and for depression of alkaline phosphatase activity (28d NOEC = 2.1 µg TRC/l). As far as chlorophyll *a* is concerned, a reliable NOEC cannot be derived because a clear concentration-effect relationship is lacking. However, this appeared to be the most sensitive endpoint, as a significant reduction of chlorophyll *a* (about 50%) was recorded at 2.1 µg/l of TRC (the lowest tested concentration). Additionally an 24d outdoor mesocosm study with freshwater biota was conducted. In the enclosures chlorine was introduced as a daily pulse. At 79 µg TRC/l, neither chlorophyll *a* nor the number of algal genera was reduced (NOEC). Protozoan species number was not significantly reduced at the lower test concentration, i.e. NOEC = 24 µgTRC/l. The most sensitive endpoint was the zooplankton density (24d NOEC = 1.5 µgTRC/l). Only the number of zooplankton/ml of water without providing any other information about the effects on taxonomic composition of zooplankton community, so that it is not possible to draw any conclusion about the eventual elimination of taxa from the system.
This study can only be used for supportive information.

**Onchorhynchus kisutch*, *Notemigonus crysoleucas, Lepomis macrochirus* and *Cyprinus caprio* were also tested, but less sensitive (no toxicity data reported).

***Perca flavescens* was also tested, but less sensitive (no toxicity data reported)

**** *Lepomis macrochirus* was also tested, but less sensitive (no toxicity data reported).

****eggs and 1-year old young were less sensitive, sensitivity of *Dorosoma patenense* was slightly lower than *C. caprio.*

Toxicity/exposure ratios for the most sensitive aquatic organisms (Annex IIIA, point 10.2)

mushrooms, emission of 0.002835 kg sodium hypochlorite/day into sewage system

Test sub-stance	Organism	Toxicity endpoint (µg/L)	Time scale	PECsw (initial) (µg/L)	TER	Annex VI Trig-ger
a.s.	Fish	90	Acute	0.0086	10465	100
a.s.	Fish	40	Chronic*	0.0086	4651	10
a.s.	Aquatic invertebrates	5	Acute	0.0086	581	100
a.s.	Aquatic invertebrates	-	Chronic*	0.0086	-	10
a.s.	Algae	>6.0	Chronic	0.0086	>698	10

* Sodium hypochlorite is a highly reactive substance with a low DT50 of < 1 hour in water. It is expected to cause mainly acute effects. No acceptable chronic endpoint is available for invertebrates, however a long-term risk assessment is performed for fish.

Bioconcentration				
	Active sub-stance			
$logP_{OW}$	no data			
Bioconcentration factor (BCF)(A)	no data			
Annex VI Trigger for the bioconcentration factor	100			
Clearance time (days) (CT_{50})	no data			
(CT_{90})	no data			
Level and nature of residues (%) in organ-isms after the 14 day depuration phase	no data			

(A) Only required if log $P_{O/W}$ >3.

(B) Determined for radioactivity.

Effects on honeybees (Annex IIA, point 8.3.1, Annex IIIA, point 10.4)

Test substance	Acute oral toxicity (LD_{50} µg/bee)	Acute contact toxicity (LD_{50} µg/bee)
a.s.	no data	no data
Preparation	no data	no data
Tunnel tests		
no data		
Bee brood study		
no data		
Field or semi-field tests		
no data		

Hazard quotients for honey bees (Annex IIIA, point 10.4)

Not relevant (no exposure)

Effects on other arthropod species (Annex IIA, point 8.3.2, Annex IIIA, point 10.5)

Laboratory tests with standard sensitive species

Species	Test Substance	End point	Effect (LR_{50} g a.s./ha)
Typhlodromus pyri	no data		
Aphidius rhopalosiphi	no data		

Test substance	Species	Effect (LR_{50} g/ha)	HQ in-field	HQ off-field	Trigger
	Typhlodromus pyri		no expo-sure	no exposure	2
	Aphidius rhopalosiphi		no expo-sure	no exposure	2

Further laboratory and extended laboratory studies

Species	Life stage	Test type, substrate and duration	Dose (g a.s./ha)	Endpoint	% effect (positive effect is adverse) and LR50 and ER50 values	Trigger value
no data						

Field or semi-field tests
no data

Effects on earthworms, other soil macro-organisms and soil micro-organisms (Annex IIA points 8.4 and 8.5. Annex IIIA, points, 10.6 and 10.7)

Test organism	Test substance	Time scale	End point
Earthworms			
Eisenia fetida	a.s.	Acute 14 days	no data
	Preparation	Acute 14 days	no data
Field tests			
no data			
Other soil macro-organisms			
Soil mite			
Collembola	no data		
Soil micro-organisms			
Nitrogen mineralisa-tion	a.s.	Chronic 28 days	no data
	Preparation	Chronic 28 days	no data
Carbon mineralisa-tion	a.s.	Chronic 28 days	no data
	Preparation	Chronic 28 days	no data
Field studies			
no data			

Toxicity/exposure ratios for soil organisms

Not relevant (no exposure)

Effects on non target plants (Annex IIA, point 8.6, Annex IIIA, point 10.8)

Preliminary screening data

no data

Laboratory dose response tests

Most sensitive species	Test substance	ER_{50} (g/ha) vegetative vigour	ER_{50} (g/ha) emergence	Exposure (g/ha)	TER	Trigger
no data						

Additional studies (e.g. semi-field or field studies)

no data

Effects on biological methods for sewage treatment (Annex IIA 8.7)

Test type/organism	end point
Activated sludge	EC_{50} >375 µg a.s./L
Pseudomonas sp	no data

Ecotoxicologically relevant compounds (consider parent and all relevant metabolites requiring further assessment from the fate section)

Compartment	
soil	none
water	Sodium hypochlorite
sediment	none
groundwater	none

Classification and proposed labelling with regard to ecotoxicological data (Annex IIA, point 10 and Annex IIIA, point 12.3)

	RMS/peer review proposal
Active substance	Sodium hypochlorite: N, R50 & R53

LEVEL 3

SODIUM HYPOCHLORITE

PROPOSAL FOR THE DECISION

3 Proposed decision with respect to the application for inclusion of the active substance in Annex I

3.1 Background to the proposed decision

Sodium hypochlorite is produced as a liquid with 10-12% available chlorine (Cl_2). The content of the solution is expressed as available chlorine as in solution several compounds are formed and the equilibrium is dependent on pH and temperature.
Sodium hypochlorite reacts with a variety of compounds. It will not evaporate from water. The 10 – 12% solution is instable and will slowly decompose. Stability is dependent on concentration available chlorine, pH, temperature and other storage condition.
The plant protection product is the same as the active substance.

It is possible to determine the concentration on sodium hypochlorite in the technical material and formulation by measurement of the available chlorine content, in combination with the sodium content.
No methods are required for plant or animal products as there is no residue definition. Also a method for soil is not required. As the active substance is not classified as (very) toxic, no methods are required for body fluids or tissues. Methods are available to determine the content of (total available) chlorine in water and air.

For sodium hypochlorite, an Acceptable Daily Intake (ADI) of 0.15 mg/kg bw/day and an AOEL of 0.06 mg/kg bw/day can be established. An ARfD was not derived since this is not required for sodium hypochlorite.
Using the Dutch-90th greenhouse model, a safe use was identified for operators, with PPE (gloves and coverall), for manual spraying on mushrooms, indoors. It should be taken into account that this is a worst-case scenario, since application of sodium hypochlorite will in many cases be performed mechanically without an operator present in the growing room.
Indoors, no bystander exposure during application is considered, as Good Agricultural Practice requires that the presence of bystanders should be prohibited.
No adverse health effects are expected for workers without PPE after application of sodium hypochlorite in mushrooms.

The ADI is set at 0.15 mg/kg bw/d, which is in the same order as other moderately toxic active substances. As the notified use of sodium hypochlorite on mushrooms will not result in residues on treated crops or on food products of animal origin, it is not necessary to calculate estimates of dietary exposure. No risk is expected for consumers.
No residue definition nor MRLs need to be set for sodium hypochlorite, it is proposed to be taken up in Annex IV of Regulation 396/2005/EEC.

The use of sodium hypochlorite, consistent with good plant protection practice, will not have any unacceptable effects on the environment (fate and behaviour).

The use of sodium hypochlorite, consistent with good plant protection practice, will not have any unacceptable effects on the environment (ecotoxicology).

3.2 Proposed decision concerning inclusion in annex I

[redacted]

3.3 Rational for the postponement of the decision to include the active substance in Annex I, or for the conditions and restrictions to be associated with a proposed inclusion in Annex I, as appropriate

[redacted]

The information in sections 3.2 and 3.3 has been removed upon request by the EU Commission as it relates to risk management recommendations or proposals.

LEVEL 4

SODIUM HYPOCHLORITE

DEMAND FOR FURTHER INFORMATION

4 Further information to permit a decision to be made, or to support a review of the conditions and restrictions associated with the proposed inclusion in Annex I

4.1 Identity of the active substance and formulation

No data requirements.

4.2 Physical and chemical properties

1. The exact stability of the 10 – 12 % solution is unknown. The notifier is asked to provide data on stability of the 10 – 12 % solution.

4.3 Data on application and further information

1. The notifier is asked to provide proposed instructions for use as printed on the label.

4.4 Classification, packaging and labelling

No data requirements.

4.5 Methods of analysis

No data requirements.

4.6 Toxicology and metabolism

No data requirements.

4.7 Residue data

No data requirements.

4.8 Environmental fate and behaviour

No data requirements.

4.9 Ecotoxicology

No data requirements.