Common Implementation Strategy for the Water Framework Directive

Environmental Quality Standards (EQS)

Substance Data Sheet

Priority Substance No. 7

C_{10-13}-Chloralkanes

CAS-No. 85535-84-8

Final version
Brussels, 31 July 2005

Disclaimer

This data sheet provides background information on the setting of the Environmental Quality Standard in accordance with Article 16 of the Water Framework Directive (2000/60/EC). The information was compiled, evaluated and used as outlined in the Manual [4] and has been discussed in a consultative process with the Expert Advisory Forum on Priority Substances and the Expert Group on Quality Standards. Furthermore, it has been peer-reviewed by the SCTEE [6]. The substance data sheet may, however, not necessarily represent the views of the European Commission.

New upcoming information was considered and included up to the date of finalisation of this data sheet. Information becoming available after finalisation of this document will be evaluated in the review process of priority substances according to Art. 16(4) of the Water Framework Directive. If necessary, the Environmental Quality Standard substance data sheets will then be revised in the light of technical and scientific progress.

1 Identity of substance

Priority Substance No: 7	C_{10-13}-Chloralkanes
CAS-Number:	85535-84-8
Classification WFD Priority List *:	PHS

* PS: priority substance; PHS: priority hazardous substance; PSR: priority substance under review according to Decision 2455/2001.

2 Proposed quality standards

2.1 Overall quality standards

Ecosystem	Quality Standard	Quality Standard "rounded values"	Comment
AA-QS all surface waters *	0.41 µg/l (in SPM: 6296 µg/kg dry wt)	**0.4 µg/l** (in SPM: **6300 µg/kg** dry wt)	prevention of secondary poisoning of top predators, see 8.3 & 8.6
MAC-QS (ECO)	1.4 µg/l	**1.4 µg/l**	see 8.1

* The quality standards for sediment are only a transformation of the freshwater or saltwater standards by the equilibrium partitioning method. As C_{10-13} chloroalkanes are known to accumulate in the sediment, the standards derived by the EP-method should be reviewed as soon as valid toxicity data for sediment dwelling organisms become available. Based on the data available it cannot be excluded that protection of the sediment compartment may require more stringent overall Quality Standards.

2.2 Specific quality standards

Protection Objective	Quality Standard	Comment
Pelagic community (freshwater)	0.5 µg/l (or 7678 µg/kg SPM dry wt)	see 8.1
Pelagic community (saltwater)	0.5 µg/l (or 9413 µg/kg SPM dry wt)	see 8.1
Benthic community (freshwater & saltwater sediment)	217 µg/kg wet wt (or 998 µg/kg dry wt)	tentative (EP method), see 8.2 and 8.6
Predators (secondary poisoning)	16.6 mg/kg (tissue of prey); corresponding conc. in water 0.41 µg/l; corresponding conc. in SPM 6296 µg/kg dry wt	(wet weight)
Food uptake by man	60.87 mg/kg (biota as food) corresponding conc. in water 17.7 µg/l	see 8.4
Abstraction of water intended for human consumption (AWIHC)	not required	no drinking water abstraction standard set in CD 75/440/EEC; see 8.5
Water intended for human consumption (WIHC)	not required	no drinking water standard set by CD 98/83/EC; see 8.5

3 Classification

R-Phrases and Labelling	Reference
Carc. Cat. 3; R40 - N; R50-53	[5]

4 Physical and chemical properties

Property	Value	Ref.	Comments
Mol. Weight:	377 g/mole (for $C_{12}H_{20}Cl_6$)	[1]	
Water Solubility	0.15-0.47 mg/l (59% chlorine content)	[1]	with partial hydrolysis
Vapour Pressure:	0.021 Pa (50 % chlorine content)	[1]	

5 Environmental fate and partitioning

Property	Value	Ref.	Comments
Abiotic degradation Hydrolysis Photolysis		[1]	
Biodegradation		[1]	
Partition coefficients			
Octanol – Water (log) Chlorine content: 49% 60% 60% 63% 70% 71% used in the PEC estimation	 4.39-6.93 4.48-7.38 5.85-7.14[a] 5.47-7.30 5.68-8.69 5.37-8.01 6.0	[1]	measured by a high performance thin layer chromatography method except [a] which was measured by a slow stirring method
Koc (organic carbon-water) $K_{SPM-water}$ (suspended matter-water)	199526 l/kg 4988 m^3/m^3	[1]	Annex 3 of [1]
Bioaccumulation Bioconcentration Factor (BCF) Fish Mussel Biomagnification Factor (BMF) Fish	 1173 – 7816 (whole fish) 1300 – 1600 (flesh) 24000 – 40900 (whole body) 0.6 – 0.93 (56 % Cl) 1.76 – 2.15 (69% Cl)	[1]	[1]: High bioconcentration factors have been reported with a variety of freshwater and marine organisms. Chlorinated paraffins were taken up rapidly; uptake may be slower at the higher end of the chlorination range

6 Effect data (aquatic environment)

A large number of aquatic toxicity studies have been carried out using short chain length chlorinaed paraffins. The toxicity information collated in the RAR is generally of good quality and sufficient for risk assessment [1]. Further details on the data are given in tables 3.25 – 3.28 of the risk assessment report (see tables of Annex 1 to this data sheet). Supplementary information on the test methods used and an assessment of the reliability of the data is given in Appendix A of the RAR [1].

6.1 Predicted no effect concentrations (aquatic environment)

PNECs

Compartment	Value	Reference
Surface water	0.5 µg/l	[1]
Sediment	0.88 mg/kg	[1]
$PNEC_{oral}$ (secondary poisoning)	16.6 mg/kg food	[1]

6.1.1 Calculation of PNEC surface water

A complete ‘base set’ of acute toxicity data for short chain length chlorinated paraffins is available, and NOECs for fish, daphnia and algae are reported as well (see Annex 1). The PNEC in the RAR [1] is derived on the basis of the most sensitive NOEC from the daphnia studies with an assessment factor of 10.

The most sensitive NOEC reported refers to a 21 day multi-generation study of *Daphnia magna* using the 58% chlorinated short chain paraffin (C_{10-12}). The NOEC observed was 0.005 mg/l and applying an assessment factor of 10 to this value gives a PNEC of 0.5 µg/l for freshwater.

In addition to the freshwater toxicity data, several marine/estuarine data are also available (see Annex 1). Marine NOECs are available for fish (*Cyprinodon variegatus*), invertebrates (*Mysidopsis bahia*) and algae (*Skeletonema costatum)*. The shrimp NOEC was the most sensitive at 0.007 mg/l. Thus the marine data are similar in comparison to the freshwater data in that invertebrates appear to be the most sensitive species.

6.1.2 Calculation of PNEC sediment [1, Appendix C]

There are no studies available on sediment-dwelling organisms exposed via sediment (information is available on midge the *Chironomus tentans*, but exposure was via water only).

In the absence of any experimentally derived ecotoxicological data for sediment-dwelling organisms, the PNEC may provisionally be calculated using the equilibrium partitioning method from the PNEC for aquatic organisms and the sediment/water partition coefficient (4988 m^3/m^3). As, derogating from the TGD, the bulk density of settled sediment instead of SPM was used (1300 kg/m^3 instead of 1150 kg/m^3), this resulted in a tentative PNEC of 1.92 mg/kg wet weight for the sediment compartment.

6.1.3 Calculation of the PNEC for non compartment specific effects relevant for the food chain (secondary poisoning) [1]

The most relevant study for short chain length chlorinated paraffins is the Mallard reproduction study, from which a NOAEL of 166 mg/kg in diet was obtained. The lowest level seen to cause slight effects in this study was 1000 mg/kg food.

Since the NOAEL is from a reproductive study, the Technical Guidance Document suggests that an indicative assessment factor of 10 can be used. Thus, the $PNEC_{oral}$ is 16.6 mg/kg food.

6.2 Summary on endocrine disrupting potential

Substance with insufficient data [2].

7 Effect data (human health)

Summary on human health as drawn in the RAR [1]

There are several gaps in the database, particularly with regard to differing chain length and degree of chlorination. However, taking into account the low toxicity observed in all available studies and the generally unreactive nature of short chain length chlorinated paraffins, it would appear unnecessary to attempt to fill these gaps with further testing.

With regard to carcinogenicity it is recognised that the current evidence on the mechanism underlying the development of kidney tumours is not definitive. Given that the short chain length chlorinated paraffins are not genotoxic, it is considered that there would be no risk of kidney tumour development associated with exposures lower than those required to produce chronic toxicity in this target organ. A NOAEL for kidney toxicity in male rats has been identified at 100 mg/kg/day. This value is used for risk assessment in the RAR.

Table 7.1: Most critical oral NOAEL identified in the RAR [1]

Endpoint	**Effect parameters**	**Value**	**Reference**
$NOAEL_{oral}$ (rat)	Repeated dose toxicity and carcinogenicity	100 mg/kg/day	[1]

8. Calculation of quality standards

8.1 Quality standards for water

Freshwater

The $PNEC_{water}$ as identified in [1] (see table 6.1 of this data sheet) is the quality standard for water.

$QS_{freshwater}$ = 0.5 µg C_{10-13} chloroalkanes L^{-1}

As the log $Kp_{susp-water}$ is >3, the $QS_{freshwater}$ is additionally given as concentration in SPM of the TGD standard water (15mg/l SPM (dry weight), see section 4.3.1 of the Manual [4]):

$$QS_{SPM.wat}\ [\mu g/kg] = \frac{QS_{freshwater}\ [0.5\ \mu g/l]}{C_{SPM}\ [15\ mg/l] * 10^{-6}\ [kg/mg] + Kp^{-1}\ [(19953\ l/kg)^{-1}]} = \mathbf{7678\ \mu g/kg}\ \text{SPM (dry wt)}$$

Transitional, coastal and territorial waters

In addition to the freshwater toxicity data, several marine/estuarine data are also available (see tables in annex 1 to this data sheet) [1]. The NOEC of the shrimp $_{Mysidopsis\ bahia}$ was the most sensitive at 0.007 mg/l. Thus the marine data is similar to the freshwater data in that invertebrates appear to be the most sensitive species. As apparently no significant differences in the sensitivity of freshwater and saltwater species of the most sensitive taxonomic group exist, it is suggested to calculate the $QS_{saltwater}$ from the same data set as used for the derivation of the $QS_{freshwater}$. To this end, the TGD assessment factor method as proposed for the marine effects assessment is used (section 4.3 in chapter 3b of volume II of the draft revised TGD [3]).

At least three long term tests with freshwater species from 3 different taxonomic groups and additional tests with two further marine taxonomic groups (molluscs [1] and echinoderms [7]), indicating that these marine species are not the most sensitive, are available. In this case the appropriate assessment factor is 10 and it is suggested to apply this AF to the NOEC of the most sensitive species in long term studies available (*Daphnia magna,* 21 day NOEC reproduction, 5 µg/l).

$QS_{saltwater}$ = 0.5 µg C_{10-13} chloroalkanes L^{-1}

As the log $Kp_{Water-SPM}$ is >3, the $QS_{saltwater}$ is additionally presented as concentration in SPM. For the TGD standard water, the concentration corresponding to the $QS_{saltwater}$ is 1/5 of that calculated for freshwater (**1536 µg/kg** SPM dry wt). However, the SPM concentration in marine waters is significantly lower than in freshwater (discussed in the context of the marine risk assessment: approx. 3 mg/l as standard concentration). Therefore, the quality standard is, as an example, also calculated for a SPM concentration of 3 mg/l:

1 In July 2005 The Netherlands provided newly generated data on a test of C_{10-13} chloroalkanes with a further marine taxonomic group, the echinoderm Psammechinus miliaris. The 48 hrs NOEC, EC10 and EC50 for larval development was ≥ 21 µg/l, the highest concentration tested [7]. This test result corroborates the conclusion that marine groups are not more sensitive to C_{10-13} chloroalkanes than freshwater species.

$$QS_{SPM.saltwat}\ [\mu g/kg] = \frac{QS_{wat}\ [0.5\ \mu g/l]}{C_{SPM}\ [3\ mg/l] * 10^{-6}\ [kg/mg] + Kp^{-1}\ [(19953\ l/kg)^{-1}]} = \mathbf{9413\ \mu g/kg}\ \text{SPM dry wt}$$

Quality standard accounting for transient concentration peaks (MAC-QS)

Acute toxicity data are available for freshwater and marine organisms of different taxonomic groups (beside fish, crustaceans and algae also for molluscs and echinoderms). The lowest acute toxicity values in the data set selected for risk assessment [1] are E(L)C50s of 14 µg/l each for the saltwater shrimp *Mysidiopsis bahia* and for *Daphnia magna*.

The MAC-QS is derived on the basis of the E(L)C50s of 14 µg/l and the guidance given in the TGD on the effects assessment for intermittent releases (section 4.3.6 of the Manual [4]). As the available toxicity data cover a wider range of different taxonomic groups, it is suggested to use only a reduced assessment factor of 10 (instead of 100). This suggestion is supported by the values of the available NOECs in the data set, which are in the worst case more than 3 times higher than the MAC-QS.

MAC-QS = 1.4 µg C_{10-13} chloroalkanes L^{-1}

The derivation of a separate MAC-QS applicable to transient concentration peaks in coastal and territorial waters is not required as it is not probable that significant peaks occur in these waters. For transitional waters the freshwater MAC-QS may be used.

8.2 Quality standard for sediment

According to the TGD [3], the $PNEC_{sediment}$ may be calculated using the equilibrium partitioning method in the absence of ecotoxicological data for sediment-dwelling organisms.

The approach only considers uptake via the water phase. However, uptake may also occur via other exposure pathways like ingestion of sediment and direct contact with sediment. There is evidence from studies in soil that the proportion of the total dose remains low for chemicals with a log Kow up to 5. For compounds with a log Kow greater than 5 the equilibrium method is used in a modified way. It is recommended in the TGD to increase the $PEC_{sed}/PNEC_{sed}$ ratio by a factor of 10 for the risk assessment. However division of the $PNEC_{water}$ by a factor of 10 will result in the same ratio. Thus, it can be inferred that division of the QS_{water} by a factor of 10 will result in a tentative $QS_{sediment}$ that accounts for possible uptake via the mentioned additional routes of exposure.

As the octanol water partitioning coefficient of C_{10-13} chloroalkanes is high (log Kow 6 used in the risk assessment [1]) the QS_{water} is divided by 10.

$$QS_{sed.wet\_weight}\ [mg.kg^{-1}] = \frac{Kp_{SPM-water}\ [4988\ m^3/m^3]}{\text{bulk density}_{SPM.wet}\ [1150\ kg/m^3]} * 1000 * QS_{water}\ [0.0005\ mg/l] * 10^{-1}$$

with:
$K_{SPM-water}$ = 4988 m^3/m^3 (see section 5)
bulk $density_{SPM.wet}$ 1150 $kg.m^{-3}$
1000 = conversion factor m^3/kg to l/kg
10^{-1} = factor to account for possible additional uptake routes for substances with log Kow >5

The TGD defines wet SPM as 90% vol/vol water (density 1 kg/l) and 10% vol/vol solids (density 2.5 kg/l), thus giving a wet density of $(0.9 \times 1) + (0.1 \times 2.5) = 1.15$ kg/l. The dry weight of solids is therefore 0.25 kg (per litre wet SPM) and thus the wet:dry ratio is 1.15/0.25 = 4.6.

This results in the following quality standards for freshwater and marine sediments (wet and dry weight):

$QS_{sediment}$ 0.217 mg/kg (wet wt) 0.998 mg/kg (dry wt)

Standards derived by the EP-method should be considered as tentative for the reasons given above. In order to refine the quality standards calculated for the sediment compartment, results of tests conducted with benthic organisms using spiked sediment are required.

8.3 Secondary poisoning of top predators

The relevant $PNEC_{oral}$ identified in the risk assessment [1] is 16.6 mg/kg food of the predator (section 6.1.3 of this data sheet). The $PNEC_{oral}$ is the quality standard for biota tissue with respect to secondary poisoning of top predators as objective of protection.

C_{10-13} chloroalkanes have been shown to bioconcentrate to a large extent in fish and molluscs. BCFs in fish of up to 7816 (whole body) and in mussel of up to 40900 (soft body) have been found. As it has been demonstrated for fish that biomagnification by food uptake may be significant (BMF 2.15), it appears justified to use the highest BCF_{mussel} for the calculation of the concentration in water that corresponds to the QS_{biota}.

$QS_{secpois.biota}$ = 16.6 mg C_{10-13} chloroalkanes kg^{-1} food (wet weight)

$QS_{secpois.water}$ = 16.6 [mg/kg] * 40900^{-1} [kg/l] = 0.41 µg C_{10-13} chloroalkanes L^{-1}

Thus, protection of top predators from secondary poisoning in freshwater environments might require a lower quality standard than the protection of the pelagic community.

As the log $Kp_{Water-SPM}$ is >3, the $QS_{\mathbf{secpois.water}}$ is additionally given as concentration in SPM of the TGD standard water (15mg/l SPM, see section 4.3.1 of the Manual [4]):

$$QS_{SPM.wat}\ [\mu g/kg] = \frac{QS_{wat}\ [0.41\ \mu g/l]}{C_{SPM}\ [15\ mg/l] * 10^{-6}\ [kg/mg] + Kp^{-1}\ [(19953\ l/kg)^{-1}]} = \mathbf{6296\ \mu g/kg}\ \text{SPM (dry wt)}$$

8.4 Quality Standard referring to food uptake by humans

The lowest relevant $NOAEL_{oral}$ identified in the risk assessment [1] is 100 mg/kg bw d^{-1} for kidney toxicity in rats. If the usual assessment factor of 100 is applied to extrapolate from animal to man the $NOAEL_{oral.human}$ is 1 mg/kg bw d^{-1} (≈ 70 mg d^{-1} for a person with 70 kg body weight as relevant threshold level).

In the Manual (section 4.3.2.6) [4] it is suggested that the relevant threshold level may not be exhausted for more than 10% by consumption of food originating from aquatic sources (i.e. 7 mg d^{-1}).

The average fish consumption of an EU citizen is 115 g d^{-1} (TGD [3]). Thus, 115 g fish (or seafood) must not contain more than 7 mg C_{10-13} chloroalkanes (≈ 60.87 mg/kg).

Given the BCF_{fish} (flesh) of 1600 l/kg mentioned in the risk assessment [1] and the BMF observed in biomagnification studies with fish, a tissue concentration of 60.87 mg C_{10-13} chloroalkanes per kg fish results in a water concentration of:

$$\frac{60.87\ [mg/kg]}{BCF\ (1600\ [l/kg]) * BMF\ (2.15)} * 1000 = 17.7\ \mu g\ C_{10-13}\ \text{chloroalkanes /l}$$

The BCF_{mussel} is considerably higher than the BCF_{fish}. A maximum of 40900 was identified in the risk assessment [1]. With a tissue concentration of 60.87 mg/kg the BCF_{mussel} results in a water concentration of 1.49 µg/l C_{10-13} chloroalkanes.

The quality standards required to protect the freshwater and saltwater communities as well as top predators from secondary poisoning are lower than the concentration in water not to be exceeded in order to protect human health from adverse effects due to ingestion of food from aquatic sources. It is, therefore, not required to establish a quality standard referring to uptake of food originating from aquatic environments by humans.

8.5 Quality Standard for drinking water abstraction

No "guide values" or quality standards have been set in the context of Council Directives 75/440/EEC or 98/83/EC. Therefore, a provisional drinking water quality standard is calculated based on the recommendations given in the TGD [3].

The lowest relevant $NOAEL_{oral}$ identified in the risk assessment [1] is 100 mg/kg bw d^{-1}. If the usual assessment factor of 100 is applied to extrapolate from animal to man the $NOAEL_{oral.human}$ is 1 mg/kg bw d^{-1} (≈ threshold level for human health).

The provisional quality standard for drinking water is calculated with the provision that uptake by drinking water should in any case not exceed 10% of the threshold level for human health [3].

$$QS_{DW.provisional} = \frac{0.1 * TL_{HH} * BW}{Uptake_{DW}} = 3.5\ mg\ C_{10-13}\ \text{chloroalkanes /l}$$

with:

$QS_{DW.provisional}$	provisional quality standard for drinking water (mg/l)
TL_{HH}	threshold level for human health (1 mg C_{10-13} chloroalkanes /kg bw per day)
BW	body weight (70 kg)
$Uptake_{DW}$	uptake drinking water (2 l per day)

The provisional drinking water quality standard is by far higher than the standard required to protect the aquatic community. It is therefore not necessary to derive a quality standard referring to drinking water abstraction as objective of protection.

8.6 Overall quality standard

Due to lack of data for sediment dwelling organisms the quality standards for sediment are only a transformation of the freshwater or saltwater standards. As C_{10-13} chloroalkanes are known to accumulate in the sediment, the standards derived by the equilibrium partitioning method should be reviewed as soon as valid effects data for sediment dwelling organisms become available.

Protection of top predators from secondary poisoning is the objective that requires the lowest levels of C_{10-13} chloroalkanes in all types of surface waters.

9 References

[1] European Union Risk Assessment Report: ALKANES, C_{10-13}, CHLORO-, CAS Number: 85535-84-8. Final report, October 1999 (published in 2000). The final report is available at the internet site of the European Chemicals Bureau: http://ecb.jrc.it/existing-chemicals/ ⇒ tick ESIS button, then enter CAS or EINECS number of substance.

[2] COM(2001)262 final: Communication from the Commission to the Council and the European Parliament on the implementation of the Community Strategy for Endocrine Disrupters – a range of substances suspected of interfering with the hormone system of humans and wildlife

[3] Technical Guidance Document on Risk Assessment in Support of Commission Directive 93/67/EEC on Risk Assessment for New Notified Substances and Commission Regulation (EC) No 1488/94 on Risk Assessment for Existing Substances and Directive 98/8/EC of the European Parliament and the Council Concerning the placing of biocidal products on the market. Part II. European Commission Joint Research Centre, EUR 20418 EN/2, © European Communities 2003. Available at the internet-site of the European Chemicals Bureau: http://ecb.jrc.it/existing-chemicals/

[4] Manual of the Methodological Framework Used to Derive Environmental Quality Standards for Priority Substances of the Water Framework Directive. Peter Lepper, Fraunhofer-Institute Molecular Biology and Applied Ecology, 15 November 2004. Available at the internet-site of the European Commission: http://europa.eu.int/comm/environment/water/water-dangersub/pri_substances.htm

[5] ESIS: European Chemicals Bureau – ESIS (European Substances Information System), July 2005. http://ecb.jrc.it/existing-chemicals/ ⇒ tick ESIS button, then enter CAS or EINECS number of substance.

[6] Opinion of the Scientific Committee on Toxicity, Ecotoxicity and the Environment (SCTEE) on “The Setting of Environmental Quality Standards for the Priority Substances included in Annex X of Directive 2000/60/EC in Accordance with Article 16 thereof”, adopted by the CSTEE during the 43rd plenary meeting of 28 May 2004, European Commission Health & Consumer Protection Directorate General, Brussels. http://europa.eu.int/comm/health/ph_risk/committees/sct/documents/out230_en.pdf

[7] AquaSense (2005). Toxicity tests with priority substances in the Water Framework Directive. Sponsor: Institute for Inland Water Management and Waste Water Treatment (RIZA). Report number: 2034

Annex 1: Further short term and long term toxicity data evaluated in the European Union Risk Assessment Report [1]

Table 3.25 of [1]: Toxicity of short chain length chlorinated paraffins to fish

Species	Chlorinated paraffin	Test type	Comments	Temp. (°C)	Duration	Toxicity endpoint (mg/l)	Reference
Bleak *Alburnus alburnus* (estuarine)	C_{10-13}, 49% wt Cl	Static	Acetone as cosolvent	10	96 hour	LC_{50} >5,000	Linden et al (1979)
	C_{10-13}, 56% wt Cl	Static	Acetone as cosolvent	10	96 hour	LC_{50} >10,000	Linden et al (1979)
	C_{10-13}, 63% wt Cl	Static	Acetone as cosolvent	10	96 hour	LC_{50} >5,000	Linden et al (1979)
	$C_{11.5}$, 70% wt Cl	Static	Acetone as cosolvent	10	96 hour	LC_{50} >10,000	Linden et al (1979)
	C_{10-13}, 71% wt Cl	Static	Acetone as cosolvent	10	96 hour	LC_{50} >5,000	Linden et al (1979)
Channel catfish *Ictalurus punctatus*	C_{10-12}, 58% wt Cl	Static		20	96 hour	LC_{50} >300	Howard et al (1975)*
Bluegill *Lepomis macrochirus*	C_{10-12}, 58% wt Cl	Static		20	96 hour	LC_{50} >300	Howard et al (1975)*
Golden orfe *Leuciscus idus*	C_{10-13}, 52% wt Cl	Static			48 hour	LC_{50} >500	Hoechst (1977)
	C_{10-13}, 56% wt Cl	Static			48 hour	LC_{50} >500	Hoechst (1977)
	C_{10-13}, 58% wt Cl	Static			48 hour	LC_{50} >500	Hoechst (1977)
	C_{10-13}, 62% wt Cl	Static			48 hour	LC_{50} >500	Hoechst (1977)
	C_{10-13}, 70% wt Cl	Static			48 hour	LC_{50} >500	Hoechst (1976)
Fathead minnow *Pimephales promelas*	C_{10-12}, 58% wt Cl	Static		20	96 hour	LC_{50} >100	Howard et al (1975)*
Rainbow trout *Oncorhynchus mykiss*	C_{10-12}, 58% wt Cl	Static		10	96 hour	LC_{50} >300	Howard et al (1975)*
	C_{10-12}, 58% wt Cl	Flow		10	15-20 day	NOEC <0.040#	Howard et al (1975)*
	C_{10-12}, 58% wt Cl	Flow	Acetone as cosolvent		60 day	LC_{50} = 0.34	Madeley and Maddock (1983a)
Sheepshead minnow *Cyprinodon variegatus*	C_{10-12}, 58% wt Cl	Flow	Acetone as cosolvent; salinity = 25‰	25	32 day	NOEC = 0.28	Hill and Maddock (1983b)

Notes: #Sublethal effects observed at 0.040 mg/l (progressive loss of motor function leading to immobilisation. *Information also available in Johnson an Finley (1980).

Table 3.26 of [1]: Toxicity of short chain length chlorinated paraffins to *Daphnia magna*

Chlorinated paraffin	Test conditions	Temp. (°C)	Duration	Toxicity endpoint (mg/l)	Reference
C_{10-13}, 20% wt Cl	With emulsifier (stabilised)		21 day	NOEC = 0.05 EC_{50} = 0.228	Huels AG (1986)
C_{10-13}, 56% wt Cl	Acetone as cosolvent (stabilised)	21	24 hour	NOEC = 0.1 EC_{50} = 0.44	Huels AG (1984)
	With emulsifier (stabilised)	21	24 hour	NOEC = 0.13 EC_{50} = 0.45	Huels AG (1984)
	With emulsifier (unstabilised)	21	24 hour	NOEC <0.1 EC_{50} = 0.55	Huels AG (1984)
	Acetone as cosolvent(unstabilised)	21	24 hour	NOEC = 0.1 EC_{50} = 0.7	Huels AG (1984)
	With emulsifier(unstabilised)	21	24 hour	NOEC = 0.13 EC_{50} = 0.82	Huels AG (1984)
	Acetone as cosolvent(stabilised)	21	24 hour	NOEC = 2 EC_{50} = 11	Huels AG (1984)
	Acetone as cosolvent(unstabilised)	21	24 hour	NOEC <0.3 EC_{50} = 11.1	Huels AG (1984)
	With emulsifier(unstablised)		21 day	NOEC = 0.05 EC_{50} = 0.137	Huels AG (1984)
C_{10-12}, 58% wt Cl	With emulsifier	21	24 hour	NOEC = 0.5 EC_{50} = 1.9	Huels AG (1984)
	Acetone as cosolvent	21	24 hour	NOEC = 0.5 EC_{50} = 1.9	Huels AG (1984)
		20	48 hour	EC_{50} = 0.53	Thompson and Madeley (1983a)
	Flow-through test	20	72 hour	EC_{50} = 0.024	Thompson and Madeley (1983a)
	Flow-through test	20	96 hour	EC_{50} = 0.018	Thompson and Madeley (1983a)
	Flow-through test	20	5 day	EC_{50} = 0.014	Thompson and Madeley (1983a)
	With emulsifier		21 day	EC_{0} = 0.03 EC_{50} = 0.124	Huels AG (1986)
	Flow-through test	20	21 day	NOEC = 0.005 EC_{0} = 0.0089	Thompson and Madeley (1983a)

Table 3.26 continued overleaf.

Table 3.26: (continued) Toxicity of short chain length chlorinated paraffins to *Daphnia magna*

Chlorinated paraffin	Test conditions	Temp. (°C)	Duration	Toxicity endpoint (mg/l)	Reference
C_{10-13}, 60% wt Cl	With emulsifier (stabilised)	21	24 hour	NOEC = 0.06 EC_{50} = 0.51	Huels AG (1984)
	Acetone as cosolvent (stabilised)	21	24 hour	NOEC = 0.1 EC_{50} = 0.7	Huels AG (1984)
	With emulsifier (unstabilised)	21	24 hour	NOEC = 1.0 EC_{50} = 4.0	Huels AG (1984)
	Acetone as cosolvent (unstabilised)	21	24 hour	NOEC = 0.5 EC_{50} = 0.95	Huels AG (1984)
	With emulsifier (unstabilised)		21 day	NOEC <0.05 EC_{50} = 0.101	Huels AG (1986)
C_{10-13}, 61% wt Cl	With emulsifier (stabilised)	21	24 hour	NOEC <0.1 EC_{50} = 0.51	Huels AG (1984)
	Acetone as cosolvent (stabilised)	21	24 hour	NOEC = 0.1 EC_{50} = 3	Huels AG (1984)
	With emulsifier (unstabilised)	21	24 hour	NOEC = 0.1 EC_{50} = 1.02	Huels AG (1984)
	Acetone as cosolvent (unstabilised)	21	24 hour	NOEC <0.3 EC_{50} = 0.3	Huels AG (1984)
	With emulsifier (unstabilised)		21 day	NOEC = 0.02 EC_{50} = 0.104	Huels AG (1986)

Notes: EC_{50}s are based on immobilization; static tests unless stated otherwise

Table 3.27 of [1]: Toxicity of short chain length chlorinated paraffins to other aquatic invertebrates

Species	Chlorinated paraffin	Comments	Temp. (°C)	Duration	Toxicity endpoint (mg/l)	Reference
midge *Chironomus tentans*	C_{10-12}, 58% wt Cl	acetone (unstabilised)	21-23	48 hour	NOEC > 0.162	E & G Bionomics (1983)
	C_{10-12}, 58% wt Cl	acetone (unstabilised)	21-23	49 day	NOEC = 0.061	E & G Bionomics (1983)
mysid shrimp *Mysidopsis bahia*	C_{10-12}, 58% wt Cl	acetone (unstabilised); salinity = 20‰	25	96 hour	LC_{50} = 0.014	Thompson and Madeley (1983d)
	C_{10-12}, 58% wt Cl	acetone (unstabilised); salinity = 20‰	25	28 day	NOEC = 0.007	Thompson and Madeley (1983d)
mussel *Mytilus edulis*	C_{10-12}, 58% wt Cl	acetone (unstabilised); salinity ~35‰	15	60 day	LC_{50} = 0.074	Madeley and Thompson (1983)
	C_{10-12}, 58% wt Cl	acetone (unstabilised); salinity ~34 ‰	15	12 weeks	Effects on growth seen at 0.0093	Thompson and Shillabeer (1983)

Notes: the mysid shrimp test was a flow-through test (salinity = $20^{o}/_{oo}$); MATC = Maximum Acceptable Toxicant Concentration

Table 3.28 of [1]: Toxicity of short chain length chlorinated paraffins to algae

Species	Chlorinated paraffin	Comments	Temp. (°C)	Duration	Toxicity endpoint (mg/l)	Reference
Selenastrum capricornutum	C_{10-12}, 58% wt Cl	Cell density by particle count	24	96 hour	EC_{50} = 3.7*	Thompson and Madeley (1983b)
	C_{10-12}, 58% wt Cl	Cell density by particle count	24	7 day	EC_{50} = 1.6*	Thompson and Madeley (1983b)
	C_{10-12}, 58% wt Cl	Cell density by particle count	24	10 day	NOEC = 0.39	Thompson and Madeley (1983b)
	C_{10-12}, 58% wt Cl	Cell density by particle count	24	10 day	EC_{50} = 1.3*	Thompson and Madeley (1983b)
Skeletonema costatum	C_{10-12}, 58% wt Cl	Cell density by absorbance; salinity = 30.5‰	20	96 hour	EC_{50} = 0.056	Thompson and Madeley (1983c)
	C_{10-12}, 58% wt Cl	Cell density by particle count; salinity = 30.5‰	20	96 hour	EC_{50} = 0.043	Thompson and Madeley (1983c)
	C_{10-12}, 58% wt Cl	salinity = 30.5‰	20	96 hour	NOEC = 0.012	Thompson and Madeley (1983c)
	C_{10-12}, 58% wt Cl	Growth rate; salinity = 30.5‰	20	48 hour	EC_{50} = 0.032	Thompson and Madeley (1983c)

Note: *These EC_{50} values exceeded the highest mean measured concentrations of the test substance employed in the study (1.2 mg/l). This was considered the maximum that could be tested due to the low solubility of the test substance.