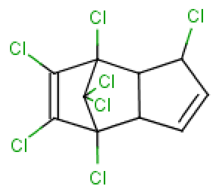
HEPTACHLOR INCLUDING HEPTACHLOR EPOXIDE

This EQS dossier was prepared by the Sub-Group on Review of the Priority Substances List (under Working Group E of the Common Implementation Strategy for the Water Framework Directive).

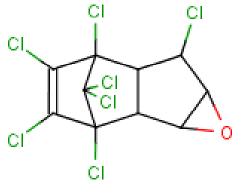
The dossier was reviewed by the Scientific Committee on Health and Environmental Risks (SCHER), which made several comments. This version distinguishes more clearly between the data for heptachlor and heptachlor epoxide, notes that the EQS relates to the sum of the two, takes account of additional toxicological data, and better explains the use of an additional assessment factor of 10 for the marine EQS, the representativeness of the BCF, and the absence of an additional assessment factor to cover endocrine disrupting properties.

In this document [1] refers to heptachlor and [2] refers to heptachlor epoxide.

1 CHEMICAL IDENTITY

Common name	Heptachlor
Chemical name (IUPAC)	1(3a),4,5,6,7,8,8-Heptachloro-3a[1],4,7,7a-tetrahydro-4,7-methanoindene
Synonym(s)	Velsicol 104
Chemical class (when available/relevant)	Organochlorinated insecticide
CAS number	76-44-8
EU number	200-962-3
Molecular formula	$C_{10}H_5Cl_7$
Molecular structure	
Molecular weight ($g.mol^{-1}$)	373.3

Common name	Heptachlor epoxide
Chemical name (IUPAC)	1,4,5,6,7,8,8-Heptachloro-2,3-epoxy-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene
Synonym(s)	Velsicol 53-CS-17
Chemical class (when available/relevant)	Organochlorinated insecticide
CAS number	1024-57-3
EU number	213-831-0
Molecular formula	$C_{10}H_5Cl_7O$

Molecular structure	
Molecular weight (g.mol^{-1})	389.4

2 EXISTING EVALUATIONS AND REGULATORY INFORMATION

Legislation			
Annex III EQS Directive (2008/105/EC)		Not included	
Existing Substances Regulation (793/93/EC)		Not applicable	
Pesticides(91/414/EEC)		Not included in Annex I	
Biocides (98/8/EC)		Not included in Annex I	
PBT substances		Not investigated	
Substances of Very High Concern (1907/2006/EC)		No	
POPs (Stockholm convention)		Yes	
Other relevant chemical regulation (veterinary products, medicament, ...)		Not applicable	
Endocrine disrupter		Heptachlor	Heptachlor epoxide
Petersen *et al.*, 2007	Human health	- Cat. 2: suspected to be endocrine disrupter	- Cat. 3a: no scientific basis for inclusion in the list (ED studies available but no indications of ED effects)
	Wildlife	- Cat. 3: insufficient scientific evidence	- Cat. 3b: no or insufficient data gathered
Groshart and Okkerman, 2000	Human health	- No data - Cat. 2: Evidence of potential to cause endocrine disruption (1)	- No data - Cat. 3: No evident scientific basis for inclusion in the list (2)
	Wildlife	- No data - Cat. 3: No evident scientific basis for inclusion in the list (3)	- No data - Cat. 3: No evident scientific basis for inclusion in the list

(1) No estrogenic activity in vitro (MCF-7cells, inactive, Sot92). Three papers (Akhtar *et al.*, 1996; Amita Rani and Krishnakumari, 1995; N.C.I., 1977 as cited *in* Groshart and Okkerman, 2000) possibly providing evidence for endocrine activity listed by BKH have not been available. Final categorisation has to be made after consultation of these papers.

(2) Three papers providing no evidence for endocrine activity are cited by BKH

(3) expression of CYP45 in American lobster after exposure to heptachlor (Snyder, 1998) ; may be considered as Cat. 2.

3 PROPOSED QUALITY STANDARDS (QS)

3.1 ENVIRONMENTAL QUALITY STANDARD (EQS)

QS for protection of human health via consumption of fishery products is the "critical QS" for derivation of an Environmental Quality Standard for heptachlor and heptachlor epoxide.

Heptachlor is not commercialised anymore and is a substance expected to be rapidly degraded into heptachlor epoxide in the environment. Hence, mainly heptachlor epoxide will be measured in the aquatic media. Although, the ecotoxicological data available are mainly on heptachlor and do not allow comparison with heptachlor epoxide toxicity, the reported toxicological data on mammals show that heptachlor epoxide is twice as toxic as heptachlor. Moreover, $QS_{biota,\ hh}$ (based on heptachlor epoxide data) converted into water is around 2 orders of magnitude more stringent than $QS_{water,\ eco}$ values. The $QS_{biota\ hh}$ is based on a virtually safe dose deemed sufficiently conservative and is therefore considered reliable. For the above cited reasons (heptachlor degraded into heptachlor epoxide and higher toxicity of the latter substance), the EQS proposed in this fact sheet is meant to be compared to the sum of concentrations of heptachlor and heptachlor epoxide.

	Value	Comments
Proposed AA-EQS for [biota] [µg.kg^{-1}$_{biota\ ww}$] Corresponding AA-EQS in [freshwater] [µg.l^{-1}] Corresponding AA-EQS in [marine water] [µg.l^{-1}]	**6.7 10^{-3}** 2.1 10^{-7} 1.0 10^{-8}	**Critical QS is $QS_{biota\ hh}$** **See section 7**
Proposed MAC-EQS for [freshwater] [µg.l^{-1}] **Proposed MAC-EQS for [marine water] [µg.l^{-1}]**	**3 10^{-4} µg.l^{-1}** **3 10^{-5} µg.l^{-1}**	**See section 7.1**

3.2 SPECIFIC QUALITY STANDARD (QS)

Protection objective[1]	**Unit**	**Value**	**Comments**
Pelagic community (freshwater)	[µg.l^{-1}]	3 10^{-5}	See section 7.1
Pelagic community (marine water)	[µg.l^{-1}]	3 10^{-6}	
Benthic community (freshwater)	[µg.kg^{-1}$_{dw}$]	1.5 10^{-2}	EqP, see section 7.1
Benthic community (marine)	[µg.kg^{-1}$_{dw}$]	1.5 10^{-3}	
Predators (secondary poisoning)	[µg.kg^{-1}$_{biota\ ww}$]	33	See section 7.2
	[µg.l^{-1}]	1 10^{-3} (freshwater) 5.2 10^{-5} (marine water)	
Human health via consumption of fishery products	[µg.kg^{-1}$_{biota\ ww}$]	6.7 10^{-3}	See section 7.3
	[µg.l^{-1}]	2.1 10^{-7} (freshwater) 1 10^{-8} (marine water)	
Human health via consumption of water	[µg.l^{-1}]	0.1	

[1] Please note that as recommended in the Technical Guidance for deriving EQS (E.C., 2011), "EQSs […] are not reported for 'transitional and marine waters', but either for freshwater or marine waters". If justified by substance properties or data available, QS for the different protection objectives are given independently for transitional waters or coastal and territorial waters.

ETOX database[2] refers to existing Quality Criteria (ETOX, 2007)
Germany: for protection of human health via consumption of drinking water = 0.1 µg/l
U.S.A.: for protection of aquatic life (freshwater; saltwater) = 0.0038; 0.0036 µg/L; health protection (fish consumption) = 0.00021 µg/L

[2] http://webetox.uba.de/webETOX/public/basics/ziel.do?id=3107

4 MAJOR USES AND ENVIRONMENTAL EMISSIONS

4.1 USES AND QUANTITIES

Heptachlor is banned as:

- not included in Annex I of Directive 91/414/EEC
- prohibited by Regulation 850/2004/EC

Therefore it is not used anymore in the EU.

4.2 ESTIMATED ENVIRONMENTAL EMISSIONS

As banned since entry into force of regulation 850/2004/EC (26th May 2004), heptachlor should not be emitted to the environment anymore.

5 ENVIRONMENTAL BEHAVIOUR

5.1 ENVIRONMENTAL DISTRIBUTION

		Master reference
Water solubility ($mg.l^{-1}$)	[1] 0.06 [2] 0.3 at 25°C	WHO, 1984 ATSDR, 2007
Volatilisation	Heptachlor and heptachlor epoxide are volatile substances (half-life of 0.73 days in distilled water without agitation).	HSDB, 2001
Vapour pressure (Pa)	$5.3.10^{-2}$ at 20°C [1] $3.5.\ 10^{-5}$ at 25°C [2]	Verschueren, 2001 Verschueren, 2001
Henry's Law constant ($Pa.m^3.mol^{-1}$)	[1] 29.8 at 20°C [2] 3.2	HSDB, 2001 HSDB, 2001
Adsorption	Heptachlor and heptachlor epoxide are likely to be strongly adsorbed to suspended and bottom sediment.	HSDB, 2001
Organic carbon – water partition coefficient (K_{OC})	K_{OC} = 10 000 – 661 000 Log K_{OC} = 4 – 5.82	HSDB, 2001
Sediment – water partition coefficient ($K_{sed\text{-}water}$)	250 – 16 525	*Calculated from K_{OC}*

		Master reference
Bioaccumulation		
Octanol-water partition coefficient (Kow)	[1] log K_{OW} = 5.44 – 6.10 [2] log Kow = 5.40	Verschueren, 2001 ; HSDB, 2001 Verschueren, 2001
BCF (measured)	Heptachlor and heptachlor epoxide are very lipophilic substances and as a fact have a high bioconcentration potential. Many BCF values are available for several fish, molluscs and other aquatic species, ranging from rather low to high values, but few of them were considered valid after assessment [(1)].**The BCF value of 14 400 for *Pimephales promelas* is used for derivation of quality standards.**	Veith *et al.*, 1979
BMF (measured)	According to the available literature, whole food web trophic magnification factors for heptachlor, including heptachlor epoxide range around a value of 6 or 7 (Hoekstra *et al.*, 2003a; Hoekstra *et al.*, 2003b, Fisk *et al.*, 2001). Single biomagnification factors values are also available in these articles but it is to be noted that as long as they are not normalised to trophic level, these are less reliable parameters to take into consideration. Moreover, there are some errors in the equations used by these authors to calculate single BMF values. In a study lead by Kelly *et al.*, 2007b for which supporting material is available (Kelly *et al.*, 2007a) heptachlor and heptachlor epoxide biomagnification was also studied. Trophic magnification factors were not calculated but data were reported that allow the calculation of worst case BMF values for heptachlor and heptachlor epoxide. Resulting values are low for the aquatic food chain (1.11 and 2.26 for heptachlor and heptachlor epoxide, respectively) while they are high when considering the upper levels of the food chain (11.5 and 19.8 for heptachlor and heptachlor epoxide, respectively), i.e. fish to mammals level. As a conclusion, as this latter study on biomagnification is the only reliable one reported up to date[(2)], it is proposed to rely on worst case BMF values found for heptachlor epoxide: BMF1= 2.26 and BMF2=19.8"	Fisk *et al.*, 2001 ; Hoekstra *et al.*, 2003a; Hoekstra *et al.*, 2003b ; Kelly *et al.*, 2007b; Kelly *et al.*, 2007a

[(1)] The value of BCF of 56 000 for crustaceans (Perez-Ruzafa *et al.*, 2000) comes from a study in which measurements were made in water and in various aquatic organisms representing different trophic levels. The samples were taken in a natural environment. The BCF of 56 000 is for crustaceans that have been contaminated not only by water but also by food. The value provided in the report cannot be interpreted as a BCF or a BAF, and these two factors cannot be recalculated from the information contained in the report. Another BCF value of 21 300 for *Cyprinodon variegatus* (Schimmel *et al.*, 1976) was not validated because fish were exposed to technical grade heptachlor, corresponding to a purity of 65% only. Hence, it is not possible to address with certainty how the remaining 35% affect bioaccumulation.. Moreover, the 37 000 value of BCF for fish could not be used either, because not enough information is available on the study reporting this value (Hansen and Parrish, 1977) at the time this assessment is made. Therefore, valid study reporting values of BCF ranging from 9 500 to 14 400 (Veith *et al.*, 1979) are used for the derivation of QS_{biota}.

[(2)] Data from Hoekstra et al., 2003a; Hoekstra et al., 2003b, Fisk et al., 2001 are not considered reliable. Some other studies on biomagnification of persistent organic pollutants in the aquatic food web are available in the literature but they are mostly reporting BMF values for the sum of chlordanes and/or not reporting BMF values as such (Ikemoto *et al.*, 2008; Jarman *et al.*, 1996; Kidd *et al.*, 1998; Ricca *et al.*, 2008; Roche *et al.*, 2009; Strandberg *et al.*, 1998). Therefore, these studies can not be use to evaluate heptachlor and heptachlor epoxide BMF values.

5.2 ABIOTIC AND BIOTIC DEGRADATIONS

		Master reference
Hydrolysis	[1] Heptachlor rapidly undergoes hydrolysis to 1-hydrochlordene ($DT_{50\text{-hydrolysis}}$ = 4.5 at pH7) which is then readily converted by microorganisms into heptachlor epoxide. [2] On the contrary, hydrolysis is not environmentally significant to heptachlor epoxide ($DT_{50\text{-hydrolysis}}$ = 4 years).	ATSDR, 2007; HSDB, 2001
Photolysis	[1] Direct and photosensitized photolysis of unabsorbed heptachlor may occur in the environment. [2] photolysis would only be significant in surface waters in the presence of photosensitizers for heptachlor epoxide.	HSDB, 2001
Biodegradation	[1] Heptachlor is not readily biodegradable: 0% of biodegradation after 28 days but it is metabolised in heptachlor epoxide by many living organisms and may be degraded partly by adapted bacterial strains. In this case, main degradation products are 1-hydroxy-2,3-epoxychlordene and heptachlor epoxide. [2] Heptachlor epoxide is a very persistent compound, notably in trophic chain.	MITI, 1992 US-EPA, 1980 HSDB, 2001 US-EPA, 1980 WHO, 1984

6 AQUATIC ENVIRONMENTAL CONCENTRATIONS

6.1 ESTIMATED CONCENTRATIONS

The substance is not on the market anymore and the quantities needed as input for modeling purpose are not available.

Compartment	Predicted environmental concentration (PEC)	Master reference
Freshwater	No data available	
Marine waters (coastal and/or transitional)		
Sediment		
Biota (freshwater)		
Biota (marine)		
Biota (marine predators)		

6.2 MEASURED CONCENTRATIONS

Compartment		Measured and quantified environmental concentrations	Master reference
Freshwater (µg.l^{-1})		PEC 1: 0.05 PEC 2: 0.01	James *et al.*, 2009[(1)]
Marine waters (coastal and/or transitional) (µg.l^{-1})		No data	
WWTP effluent (µg.l^{-1})		Median, Secondary sedimentation tanks: [1] 0.004 [2] 0.013	Katsoyiannis and Samara, 2004
Sediment (µg.kg^{-1} dw)	Sed <2 mm	PEC 1: 10.8 PEC 2: 13.8	James *et al.*, 2009[(1)]
	Sed <20 µm	PEC 1: - PEC 2: 25	
	Sed <63µm	PEC 1: 20.5 PEC 2: 3	
Biota (µg.kg^{-1})	Macroalgae	[1] geo. mean: 0.02 [2] geo. mean: 0.61 range: 0.2 – 1.9	Kelly *et al.*, 2007a
	Invertebrates (ww)	PEC 1: 10 PEC 2: 5.75	James *et al.*, 2009[(1)]
	Fish (ww)	PEC 1: 15 PEC 2: 10	
	Fish (ww)	[1] 0.01 – 0.48 [2] 0.15 – 0.88	Mayer, 1974
	Turtles (ww)	0.09 – 1.85	Swartz *et al.*, 2003
	Cetaceans (Brazil) (lipid w)	[2] Mean, blubber: 0.0015 – 0.013	Kajiwara *et al.*, 2004
	Pinnipeds (California) (lipid w)	[2] Mean, blubber: 0.03 – 0.2	Kannan *et al.*, 2004

[(1)] *data originated from EU monitoring data collection*

7 EFFECTS AND QUALITY STANDARDS

As a reminder, [1] refers to heptachlor and [2] refers to heptachlor epoxide in the tables below.

7.1 ACUTE AND CHRONIC AQUATIC ECOTOXICITY

Ecotoxicological databases publicly available such as the US-EPA AQUIRE database (US-EPA, 2007) were browsed in order to collate as far as possible an exhaustive dataset of acute and chronic toxicity data on aquatic organisms. Also, a number of other sources such as scientific reports (e.g. US-EPA Reregistration Eligibility Decision, US-EPA, 1992) were investigated. All studies considered were assessed for their relevancy and reliability. These studies are numerous, in particular acute ecotoxicity studies, but they most often refer to bioassays which were realised under static conditions and for which the concentrations are expressed as nominal concentrations. Given the high hydrophobicity and potential volatility of heptachlor and heptachlor epoxide, in the cases above described, there was a risk of underestimation of the toxicity and data were discarded because of a reliability index considered as low (≥3). Indeed, it was observed that many studies among those assessed which were realised under static conditions led to effects concentrations which were significantly higher than those reported from studies realised under continuous flow or renewal, and/or with analytical measurement of the substance. As a consequence, only continuous flow or renewal assays were validated and reported in the tables hereunder. The reliability was assessed according to Klimisch code (Klimisch *et al.*, 1997) which are specified as well in the tables below.

ACUTE EFFECTS			**Reliability**	**Master reference**
Algae & aquatic plants ($mg.l^{-1}$)	**Freshwater**	*Selenastrum capricornutum* / 96 h [1] EC_{50} = 0.028	2	Call *et al.*, 1983
	Marine	No available information		
Invertebrates ($mg.l^{-1}$)	**Freshwater**	No available information		
	Marine	*Penaeus duorarum* / 96 h [1] LC_{50} = 3 10^{-5} [2] LC_{50} = 4 10^{-5}	1	Schimmel *et al.*, 1976
	Sediment	No available information		
Fish ($mg.l^{-1}$)	**Freshwater**	No available information		
	Marine	*Leiostomus xanthurus* / 96 h [1] LC_{50} = 8.6 10^{-4}	1	Schimmel *et al.*, 1976

CHRONIC EFFECTS			**Reliability**	**Master reference**
Algae & aquatic plants ($mg.l^{-1}$)	**Freshwater**	No available information		
	Marine	No available information		
Invertebrates ($mg.l^{-1}$)	**Freshwater**	No available information		
	Marine	No available information		
	Sediment	No available information		
Fish ($mg.l^{-1}$)	**Freshwater**	No available information		
	Marine	*Cyprinodon variegatus* / 28 d [1] NOEC = 7.9 10^{-4}	2	Goodman *et al.*, 1978

As already noted above, numerous data are available for heptachlor [1] but a number of them were discarded because of their low reliability. According to the acute dataset available in the tables above, crustaceans appear to be more sensitive than fish and a lot more sensitive than algae. The lowest ecotoxicological data is a 96h-LC_{50} for *Penaeus duorarum*. It can be noted that for this individual test assessing the effects of both heptachlor and heptachlor epoxide, there is no apparent difference of toxicity between the two substances. Also, there are no valid ecotoxicological data available for algae and crustaceans in the chronic dataset. Therefore, the acute data is used for deriving both the MAC-QS_{water} and the AA-QS_{water} values.

Finally, although QS_{water} values below are derived from a marine data on *Penaeus duorarum*, it should be stressed that the additional marine assessment factor (AF) 10 is applicable for both the MAC-QS_{water} and the AA-QS_{water} values. In fact, this AF addresses the higher uncertainty in derivation of marine QS compared to freshwater QS because of the higher biodiversity of marine ecosystems and the fact that marine ecosystems include specific taxonomic groups not represented in the dataset (e.g. echinoderms).

Tentative QS_{water}	**Relevant study for derivation of QS**	**Assessment factor**	**Tentative QS**
$MAC_{freshwater, eco}$	*Penaeus duorarum* / 96 h LC_{50} : 3 10^{-5} mg.l^{-1}	100	3 10^{-4} µg.l^{-1}
$MAC_{marine water, eco}$		1 000	3 10^{-5} µg.l^{-1}
AA-$QS_{freshwater, eco}$		1 000	3 10^{-5} µg.l^{-1}
AA-$QS_{marine water, eco}$		10 000	3 10^{-6} µg.l^{-1}
AA-$QS_{freshwater, sed.}$	-	EqP(1)	5.8 10^{-3} µg.kg^{-1}_{ww} 1.5 10^{-2} µg.kg^{-1}_{dw}
AA-$QS_{marine water, sed.}$	-	EqP	5.8 10^{-4} µg.kg^{-1}_{ww} 1.5 10^{-3} µg.kg^{-1}_{dw}

(1) The worst case was applied to establish the $QS_{sediment}$, that is to use the lowest K_{OC} value (10 000) to calculate the QS. As this lowest K_{OC} corresponds to a log K_{OC} of 4, the additional security factor of 10 was not deemed necessary.

7.2 SECONDARY POISONING

Secondary poisoning of top predators		**Master reference**
Mammalian oral toxicity	[2] Dog / Oral / Chronic, 2 years / 0-1-3-5-7-10 ppm Hepatic effects (Increased relative liver weight, histologic changes) [2] Dog / Oral / F0, 4 females & 2 males F1 / Reproductive study / 0-1-3-5-7-10 ppm Developmental effect (increased mortality in pups) For both studies: NOAEL : 0.025 mg.kg^{-1}_{bw}.d^{-1} NOEC : 1 mg.$kg^{-1}_{feed\ ww}$ (CF=40)	Wazeter *et al.*, 1971a; Wazeter *et al.*, 1971b as cited *in* WHO, 2008
	[1] Mink / Oral / reproductive study / 181d Reduced pup growth LOAEL = 6.25 mg.kg^{-1}_{bw}.d^{-1} NOAEL = 2.08 mg.kg^{-1}_{bw}.d^{-1} ($CF_{LOAEL->NOAEL}$=3(1)) NOEC = 609 mg.kg^{-1}_{food} ($CF_{NOAEL->NOEC}$=8.77, study specific)	Crum *et al.*, 1994 as cited *in* Ritter *et al.*, undated

Avian oral toxicity	[1] *Coturnix japonica* / Oral / 5 days LC 50 : 93 $mg.kg^{-1}_{bw}.d^{-1}$; NOEC : 744 $mg.kg^{-1}_{feed\ ww}$	U.S. FWS, 1975 as cited *in* HSDB, 2011

(1) No recommendation is made about this conversion factor in the Technical Guidance for EQS derivation (E.C., 2011) but this value is recommended by REACH guidances (ECHA, 2008).

A lower value (LOAEL = 0.03 $mg.kg^{-1}_{bw}.d^{-1}$) was found on rats in the literature (WHO, 2006). Considering the uncertainty of the LOAEL, the study on dogs, selected by WHO (WHO, 2008) has been chosen for the determination of QS_{biota}.

The BCF value 14 400 on fish is used for back calculation of $QS_{biota,\ sec.pois.}$ in water as well as BMF_1 = 2.26 and BMF_2 = 19.8 (cf. section 5.1).

Tentative QS_{biota}	**Relevant study for derivation of QS**	**Assessment factor**	**Tentative QS**
Biota	NOEC : 1 $mg.kg^{-1}_{feed\ ww}$	30	33 $\mu g.kg^{-1}_{biota\ ww}$ corresponding to 1 10^{-3} $\mu g.l^{-1}$ (freshwater) 5.2 10^{-5} $\mu g.l^{-1}$ (marine water)

7.3 HUMAN HEALTH

Human health via consumption of fishery products		Master reference
Mammalian oral toxicity	[2] Mice /Oral / 2 years / Cancer Hepatocellular carcinomas / Linearized multistage procedure / non-threshold approach Slope factor : 9.1 $(mg.kg^{-1}.d^{-1})^{-1}$ Virtually safe dose for a 10^{-6} risk : 1.1 10^{-7} $mg.kg^{-1}.d^{-1}$	Davis, 1965; Velsicol, 1973 Virtually sure proposed on the basis ofUS-EPA, 1993a
	[1] Mice /Oral / 2 years / Cancer Hepatocellular carcinomas / Linearized multistage procedure / non-threshold approach Slope factor : 4.5 $(mg.kg^{-1}.d^{-1})^{-1}$ Virtually safe dose for a 10^{-6} risk : 2.2 10^{-7} $mg.kg^{-1}.d^{-1}$	Davis, 1965; NCI, 1977 Virtually safe dose proposed on the basis of US-EPA, 1993b
CMR	Regulation on classification, labelling and packaging of substances and mixtures: heptachlor and heptachlor epoxide classified as in Category 2 (suspected human carcinogen)	E.C., 2008
	US-EPA : heptachlor and heptachlor epoxide classified as in Group B2 (probable human carcinogen)	US-EPA, 1993a
	IARC: heptachlor and heptachlor epoxide classified as in Group 2b (possibly carcinogenic to humans).	IARC, 1991

The value used for the derivation of $QS_{biota\ hh}$ is a virtually safe dose for a 10^{-6} carcinogenic risk. This value is the outcome of a slope factor calculation relying on a non-threshold methodology which is deemed conservative enough (e.g. order of magnitude of the virtually safe dose is 10^{-7} $mg.kg^{-1}.d^{-1}$). Therefore, it is considered that the virtually safe dose selected above covers potential endocrine disrupting effects. Although heptachlor is considered a suspected endocrine disrupter for human health according to two documents elaborated by consultants for the European Commission in 2000 and 2007 (see section 2), no additional assessment factor is deemed required.

The BCF value 14 400 on fish is used for back calculation of $QS_{biota,\ hh}$ in water as well as BMF_1 = 2.26 and BMF_2 = 19.8 (cf. section 5.1).

Tentative $QS_{biota,\ hh}$	Relevant study for derivation of $QS_{biota,\ hh}$	Assessment Factor	Tentative $QS_{biota,\ hh}$
Human health	Virtually safe dose for a 10^{-6} risk : 1.1 10^{-7} $mg.kg^{-1}.d^{-1}$	1	6.7 10^{-3} $\mu g.kg^{-1}{}_{biota\ ww}$ corresponding to 2.1 10^{-7} $\mu g.l^{-1}$ (freshwater) 1 10^{-8} $\mu g.l^{-1}$ (marine waters)

Human health via consumption of drinking water		Master reference
Existing drinking water standard(s)	0.1 $\mu g.l^{-1}$ (preferred regulatory standard)	Directive 98/83/EC
	0.03 $\mu g.l^{-1}$	WHO, 2004

The existing regulatory standards (Directive 98/83/EC, WHO, 2004) are less stringent than the proposed QS_{water}. Therefore, a quality standard for drinking water abstraction is not needed.

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