Lindane – corrected lists of endpoints

Extracted from reports (1999) of the EU ECCO Peer Review Programme under Directive 91/414/EEC

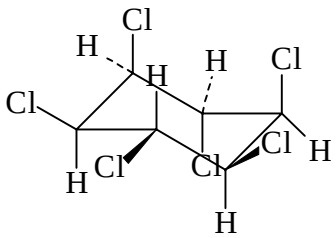
LIST OF END POINTS: **LINDANE**

1 Physical chemical properties section

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

Active substance (ISO Common Name)	Lindane
Function (*e.g.* fungicide)	Insecticide
Rapporteur Member State	Austria

Identity (Annex IIA, point 1)

Chemical name (IUPAC)	(1,2,4,5/3,6)- gamma stereo isomer of 1,2,3,4,5,6-hexachlorocyclohexane
Chemical name (CA)	1α,2α,3β,4α,5α,6β- hexachlorocyclohexane
CIPAC No	488
CAS No	58-89-9
EEC No (EINECS or ELINCS)	200-401-2
FAO Specification (including year of publication)	FAO 4?/TC/S (1990)
Minimum purity of the active substance as manufactured (g/kg)	995 g/kg
Molecular formula	$C_6H_6Cl_6$
Molecular mass	290.82
Structural formula	

2.2 Physical and chemical properties, including a listing of end points relating to physical and chemical properties

2.2.1 Physical - chemical properties (Annex IIA, point 2)

Melting point (state purity)	112.86°C (100%)
Boiling point (state purity)	not applicable, substance is a solid

Temperature of decomposition	Decomposition in the range of 200 to 400°C, variable between the assay and the operating conditions. (purity >99.5%)
Appearance (state purity)	Colourless, crystalline solid, faint to odourless (>99.5%)
Relative density (state purity)	1.88 g/ml (>99.78%)
Surface tension	The surface tension of a 90% saturated aqueous solution of Lindane is 72.1 mN/m at 20°C. (purity 99.78%)
Vapour pressure (in Pa, state temperature)	4.4×10^{-3} Pa at 24°C (>99.5%)
Henry's law constant	1.483×10^{-6} Atm m^3/mol at 25°C (>99.5%)
Solubility in water (g/l or mg/l, state temperature	8.52×10^{-3} g/l in deionized water (25°C) 8.35×10^{-3} g/l in buffered water at pH 5 (25°C) (purity 99.5%)
Solubility in organic solvents (in g/l of mg/l, state temperature)	purity 99.78% at 20°C: 10-14 g/l in n-heptane >250 g/l in xylene >250 g/l in dichloromethane 29-40 g/l in methanol >200 g/l in acetone >200 g/l in ethyl acetate
Partition co-efficient (log Pow) (state pH and temperature)	deionized water: log K_{OW} = 3.50 at 22°C (99.5%)
Hydrolytic stability (DT50) (state pH and temperature)	(purity 99.8%) at 25°C (buffer 0.01 M) pH half-life (days) 5 752 7 732 9 182 Pentachlorocyclohexene was the only relevant degradate.
	(purity >98%) at 25°C pH ionic strength half-life (days) 5 0.05 173.3 0.10 115.5 7 0.05 309.4 0.10 281.7 9 0.05 36.3 0.10 35.4 Major degradates identified as pentachlorocyclo-hexene, 1,2,4-trichlorobenzene and 1,2,3-tri-chlorobenzene.
Dissociation constant	No data submitted
UV/VIS absorption (max.) (if absorption >290 nm state ? at wavelength)	UV spectrum (in methanol) (purity 99.6%) No absorption maximum was observed No absorption occurred above 290 nm in neutral medium
Photostability (DT50) (aqueous, sunlight, state pH)	Lindane is not photodegraded with natural sunlight (day 28, carbon-14 in nonpolar extractables by LSC: 100%).(purity >97.8%)
Quantum yield of direct phototransformation in water at λ>290 nm	No data submitted No absorption occurred above 290 nm.

Flammability	The notifier stated that Lindane is not flammable. No data submitted
Explosive properties	A spark with an energy of 1440 mJ does not cause flammability of the dust of Lindane (dust concentrations of 500 g/m^3 and 300 g/m^3).

Summary of intended uses (Annex IIA 3.4, Annex IIIA 3.3 to 3.7, 3.9)

Table B.3.3-1 Summary of intended uses of Lindane Flowable

No. of application: 1

Pre-harvest interval: -

Timing: before sowing or at the date of sowing

Method of application: soil treatment by spraying with subsequent soil incorporation

Crop	**Pests/ Weeds controlled**	**Application rate per treatment**			**Region of the EU**
		spray conc. max. a.i.g/l	water l/ha min.	kg a.i./ha	
Sugar beet	Insecticide, e.g.: White grub, Click-beetle Wire worms	5.6	200	1.12	Northern Europe
Cereals	Insecticide, e.g.: Wire worms, Click-beetle	5.6	200	1.12	Northern Europe
Rape	Insecticide, e.g.: Flea beetle, Gall weevil	2.8	200	0.56	Northern Europe

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

Technical as (principle of method)	Technical material is dissolved in ethylacetate and ?-HCH is?analysed by GC-FID
Impurities in technical as (principle of method)	Technical material is dissolved in ethylacetate analysed by GC-FID
Plant protection product (principle of method)	The formulation is dissolved in ethylacetate or acetone and ?-HCH is?analysed by GC-FID

Analytical methods for residues (Annex IIA, point 4.2)

Food/feed of plant origin (principle of method and LOQ for methods for monitoring purposes)	Samples are extracted by organic solvents, followed by clean-up with a florisil column. The residues are quantified by GC-ECD. LOQ=0.01 mg/kg (for cucumber, maize, sunflowers), not specified for sugar beet and cereals
Food/feed of animal origin (principle of method and LOQ for methods for monitoring purposes)	Solvent extraction, residue purification and detection and quantification by GLC. LOQ=0.01 - 0.001 mg/kg
Soil (principle of method and LOQ)	Solvent extraction, residue purification and detection and quantification by GLC. LOQ=0.005 mg/kg
Water (principle of method and LOQ)	Extraction with methylene chloride, solvent exchange with methylterbutylether, GC-ECD. LOQ=0.01 µg/l
Air (principle of method and LOQ)	Elution with petrolether/diethylether of the XAD-2 resinous adsorbent, solvent reduction, GC-ECD. LOQ=0.1 ng/m³
Body fluids and tissues (principle of method and LOQ)	Human whole blood, porcine liver and porcine muscle samples are extracted with hexane. Clean-up by liquid/ liquid partition and silica cartridge. GC-ECD.

2 Fate and behaviour section

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

Mineralisation after 112 -126 days	1.9 - 40 % AR
Non-extractable residues after 112 - 126 days	4.8 - 26 % AR
Relevant metabolites- name and/or code- % of applied (range and maximum)	no metabolites >10 % AR

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

Anaerobic degradation	after 30 d aerobe + 67 d anaerobe incubation: mineralisation: 6.3 % AR non-extractable residues: 17 % AR
Soil photolysis	no significant photolysis

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

Method of calculation	1st order kinetics; n = 11; r^2 = 0.92
Laboratory studies (range or median, with n value, with r2 value	DT50lab (24.5°C, aerobic): 980 d DT50lab (20°C, aerobic): 133 d - >182 d
	DT90lab (20°C, aerobic): not provided
	DT50lab (10°C, aerobic): not submitted
	DT50lab (24.5°C, anaerobic): 37 d
Field studies (state location, range or median with n value) * DT50 excluding lag phase	DT50f * / lag phase / location 30 - 54 d / 0- 4 weeks / Germany 23 - 165 d / 4-16 weeks / Netherlands 70 - 88 d / 3 - 4 weeks / Poland (spring applic.) 26 - 37 d / 22 - 24 weeks / Poland (autumn applic.) 154 - 193 d / 4 weeks / California 107 d / no / US/Georgia
	DT50f including lag phase: 27 - 277 d (European studies) DT90f including lag phase: 89 - 921 d (European studies) DT90f excluding lag phase: 76 - 640 d (all studies) DT90f excluding lag phase: 76 - 548 d (European studies)
Soil accumulation and plateau concentration	not submitted

Soil adsorption/desorption (Annex IIA, point 7.1.2)

Kf/Koc	K_{OC}: 871 – 1671
pH dependence (yes/no)	no

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

Column leaching	0.02 - 0.14 % AR in leachate
Aged residues leaching	0.04 - 0.2 % AR in leachate
Lysimeter /field leaching studies	-

PEC (soil) (Annex IIIA, point 9.1.3)

Method of calculation	actual: $C_{(t)} = C_{(0)} \times e^{-\ln 2/DT50 \times t}$ time weighted: $C_{(t)} = C_{(0)} \times DT_{50}/(t \times \ln 2) \times (1 - e^{(-t \times \ln 2/DT50)})$
Application rate	1.5 kg a.i./ha incorporated into 20 cm soil layer;
Assumptions	soil density: 1.5 single application DT50 = 96 d; lag phase = 4 weeks (spring application)

PEC $_{(s)}$ mg/kg	DT50 = 96 d		DT50 = 96 d + lag phase = 4 weeks	
	actual	time weighted average	actual	time weighted average
initial	0.50000	0.50000	0.50000	0.50000
short term 24 h 2 d 4 d	0.49640 0.49283 0.48577	0.49819 0.49641 0.49285	persistent	persistent
long term 7 d 14 d 28 d 42 d 100 d	0.47536 0.45193 0.40848 0.36921 0.24288	0.48757 0.47556 0.45269 0.43130 0.35610	persistent 0.50000 0.50000 0.45193 0.29730	persistent 0.50000 0.50000 0.47556 0.38991

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

Hydrolysis (DT_{50}) 25° C	pH 5: 752 d
	pH 7: 732 d
	pH 9: 182 d
Photolytic degradation	photolytically stable
Readily biodegradable (yes/no)	no
Degradation in water/sediment -DT_{50} water -DT_{50} sediment	47 d (20°C) 135 d (20°C) no water/sediment study according to guideline was submitted
Distribution in water/sediment systems (as)	not submitted
Distribution in water/sediment systems (metabolites)	not submitted

Mesocosm studies	DT_{50} water: 15 - 47 d DT_{50} sediment: 48 d

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

Method of calculation	actual: $C_{(t)} = C_{(0)} \times e^{-\ln 2/DT50 \times t}$ time weighted: $C_{(t)} = C_{(0)} \times DT_{50}/(t \times \ln 2) \times (1 - e^{(-t \times \ln 2/DT50)})$
Application rate	1.5 kg a.i./ha; single application; water depths: 0.3 m; DT_{50}: 47 d
Main routes of entry	spray drift

PEC $_{(sw)}$ mg/kg		1m spray distance actual	1m spray distance time weighted average	20 m spray distance actual	20 m spray distance time weighted average
initial		0.02000	0.02000	0.00050	0.00050
short term	24 h	0.01971	0.01985	0.00049	0.00050
	2 d	0.01942	0.01971	0.00049	0.00049
	4 d	0.01885	0.01942	0.00047	0.00049
long term	7 d	0.01804	0.01900	0.00045	0.00048
	28 d	0.01323	0.01638	0.00033	0.00041
	42 d	0.01077	0.01491	0.00027	0.00037
	100 d	0.00458	0.01046	0.00011	0.00026

PEC (sediment)

Method of calculation	actual: $C_{(t)} = C_{(0)} \times e^{-\ln 2/DT50 \times t}$ time weighted: $C_{(t)} = C_{(0)} \times DT_{50}/(t \times \ln 2) \times (1 - e^{(-t \times \ln 2/DT50)})$
Application rate	1.5 kg a.i./ha; single application; maximum concentration in sediment: 100 % of water conc.; incorporation into 3 cm sediment layer; density: 1.5 DT_{50} = 135 d

PEC $_{(sed)}$ mg/kg		1 m spray distance actual	1 m spray distance time weighted average	20 m spray distance actual	20 m spray distance time weighted average
initial		0.13333	0.1333	0.00333	0.00333
short term	24 h	0.13265	0.13299	0.00332	0.00332
	2 d	0.13197	0.13265	0.00330	0.00332
	4 d	0.13062	0.13197	0.00327	0.00330

PEC (sed) mg/kg		1 m spray distance actual	1 m spray distance time weighted average	20 m spray distance actual	20 m spray distance time weighted average
long term	7 d	0.12863	0.13097	0.00322	0.00327
	28 d	0.11548	0.12419	0.00289	0.00310
	42 d	0.10747	0.11994	0.00269	0.00300
	100 d	0.07979	0.10428	0.00199	0.00261

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

	PEC (gw)
Maximum concentration Average annual concentration	From column leaching studies and monitoring studies it is concluded that under the proposed uses the risk for ground water contamination can be considered negligible.

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

Direct photolysis in air	not submitted
Photochemical oxidative degradation in air (DT_{50})	4.6 d (*Maestracci, 1993*) 40 d (*Behnke et al., 1989*) 11 835 d (*Hillmann, 1993*)
Volatilisation	from plant surfaces: DT_{50}: 0.3 - 0.68 d (10 - 20° C; (180 m/h laminar air flow) 62 - 95% AR volatilised after 24 h; field
	from soil surfaces: DT_{50}: 1 - 4 d (moist; 27° C; 299 m/h air flow) 88 % volatilised after 24 h (moist; soil T: 19° C; 5-6 km/h laminar air flow 13 – 28 % volatilised after 24 h (field) DT_{50}: 5.5 - 21 d (dry; 10-20° C; 180 m/h laminar air flow) DT_{50}: 1.2 - 22 d (moist; 10-20° C; 180 m/h laminar air flow) from soil after incorporation: dry: 0 % volatilised after 24 h (25° C) moist: 2 – 4 % volatilised after 24 h (25° C) 8 % volatilised after 14 d (moist; 25° C; 10 cm incorporated; wind speed: 1 km/h) 13 % volatilised after 24 h when treated soil was covered with 1.5 cm untreated soil layer (moist, soil T: 19° C; 5-6 km/h laminar air flow)

PEC (air)

PEC (a)	
Maximum concentration	field study with „Nexit stark“: 0.8 kg a.i./ha, incorporated into 5 cm soil layer; Application date: April mean temperature (April - Oct.): 13.8 °C concentration in the air (25 cm and 80 cm height) between April - September: 5 - 128 ng/m^3 (average: 30 ng/m^3)

Monitoring data (Annex IIA, point 7.4)

Soil	Austria: out of 36 grassland samples 11 have been positive for lindane (21 - 249 ng/kg (0 - 5 cm)). forest soil close to industry: 3.2 μg/kg in the humuslayer 1.13 μg/kg in 0 - 5 cm soil layer
Surface water	Austria: sediments of River Danube and Traun: 0.2 - 0.3 μg/kg dw ditch and pond (Lower Austria): 3 - 18 ng/l (water) and 0.2 - 0.3 μg/kg dw (sediments)
Ground water	Austria: out of 5 323 ground water probes 5 have been positive for lindane (0.1μg/l or lower), 1 sample >0.1μg/l
Air	Austria: rain samples, monthly measurements 1 site: concentrations during 1996: 11 - 29 ng/l 3 sites: concentrations during 1995: 4 - 44 ng/l 4 sites: concentrations during 1994: 4 - 52 (280) ng/l 7 sites: concentrations during 1993: 3 - 50 (890) ng/l Sweden: 0.01 - 0.52 ng/m^3 air (average: 0.1) (1991 - 1994) Germany: concentrations in the rain (1990-1992): 117-710 (3830) ng/l Norway: concentrations in precipitation (1993) 10 - 84 ng/l Denmark: concentrations in the rain (1990 - 1992): 3 - 100 ng/l France (Paris area): Atmospheric fallout: 1.3 - 1.7 ng/m^3 (3/89 - 1/90) 2.1 - 2.4 ng/m^3 (7/90)

3 Ecotoxicology section

Active substance (ISO Common Name)	Lindane
Function (*e.g.* fungicide)	Insecticide
Rapporteur Member State	Austria

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)

Acute toxicity to mammals	LD_{50} = 65 mg ai/kg bw (Mouse) LD_{50} = 163 mg ai/kg bw (Rat)
Short term toxicity to mammals	NOEC = 80 mg ai/kg feed (rat, 42 d)
Long term toxicity to mammals	NOAEL/ NOEL = 1 mg/kg bw (rat, multigeneration study)
Acute toxicity to birds	LD_{50} = 122 mg ai/kg bw (Bobwhite quail)
Dietary toxicity to birds	LC_{50} = 919 mg ai/kg feed (Bobwhite quail) LC_{50} = 695 mg ai/kg feed (Mallard duck)
Reproductive toxicity to birds	No data

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

Application rate		Crop	Category (*e.g.* insectivorous bird)	Time-scale	TER	Annex VI Trigger
kg as/ha	mg as/kg seed					
0.4	40000	rape	large seed-eating bird	Acute	**0.01**	10
0.06	1800	maize	large seed-eating bird	Acute	**0.23**	10
0.16	750	cereal	large seed-eating bird	Acute	**0.54**	10
0.02	2500	beet	large seed-eating bird	Acute	**0.16**	10
0.4	40000	rape	large seed-eating bird	Short term	**0.02**	10
0.06	1800	maize	large seed-eating bird	Short term	**0.4**	10
0.16	750	cereal	large seed-eating bird	Short term	**1.4**	10
0.02	2500	beet	large seed-eating bird	Short term	**0.3**	10
0.4	40000	rape	seed-eating mammal	Acute	**0.01**	10
0.06	1800	maize	seed-eating mammal	Acute	**0.1**	10
0.16	750	cereal	seed-eating mammal	Acute	**0.3**	10
0.02	2500	beet	seed-eating mammal	Acute	**0.1**	10
0.4	40000	rape	seed-eating mammal	Short term	**0.002**	10
0.06	1800	maize	seed-eating mammal	Short term	**0.04**	10
0.16	750	cereal	seed-eating mammal	Short term	**0.11**	10
0.02	2500	beet	seed-eating mammal	Short term	**0.03**	10
0.4	40000	rape	seed-eating mammal	long term	**0.00008**	5
0.06	1800	maize	seed-eating mammal	long term	**0.0018**	5
0.16	750	cereal	seed-eating mammal	long term	**0.004**	5
0.02	2500	beet	seed-eating mammal	long term	**0.0013**	5
1.5 kg as/ha		Sunflower, maize	small insectivorous bird	Acute	**9**	10
1.5		Sunflower, maize	large insectivorous bird	Acute	100	10
1.5		Sunflower, maize	eartworm eating bird*	Acute	81	10
1.5		Sunflower, maize	fish eating bird**	Acute	16	10
1.5		Sunflower, maize	small insectivorous bird	Short term	21	10
1.5		Sunflower, maize	large insectivorous bird	Short term	224	10

1.5	Sunflower, maize	eartworm eating bird*	Short term	184	10
1.5	Sunflower, maize	fish eating bird**	Short term	35	10
1.5	Sunflower, maize	insectivorous mammal	Acute	**5**	10
1.5	Sunflower, maize	insectivorous mammal	Acute	54	10
1.5	Sunflower, maize	earthworm eating mammal*	Acute	43	10
1.5	Sunflower, maize	small insectivorous mammal	Short term	**1.8**	10
1.5	Sunflower, maize	large insectivorous mammal	Short term	20	10
1.5	Sunflower, maize	earthworm eating mammal*	Short term	16	10
1.5	Sunflower, maize	fish eating mammal**	Short term	**3**	10
1.5	Sunflower, maize	Earthworm eating mammal*	Long term	**0.2**	5
1.5	Sunflower, maize	Fish eating mammal***	Long term	**0.85**	5

* Calculation earthworm: PEC soil assuming an accumulationfactor of 10
** Calculation fish acute, short term: PECi (1 m distance) x BCF = 0.02 mg ai/l x 1300 (BCF) = 26 ppm in fish
*** Calculation fish chronic risk: PEC_i (1 m distance) x BCF x remaining residues in % = 0.02 mg ai/l x 1300 (BCF) x 15 % = 3.9 ppm in fish

Toxicity data for aquatic species (most sensitive species of each group) (Annex IIA, point 8.2, Annex IIIA, point 10.2)

Group	Test substance	Time-scale	Endpoint	Toxicity (µg ai/l)
Laboratory tests				
Rainbow trout	25% wettable powder	96 h static	LC_{50}	22
Daphnia magna	25% wettable powder	48 h static	EC_{50}	1600
Selenastrum capricornutum	Lindane technical	96 h static	E_bC_{50}	770
Rainbow trout	Lindane technical	85 d flow-through	NOEC	2.9
Daphnia magna	Lindane technical	21 d flow-through	NOEC	54
Microcosm or mesocosm tests				
No useful data provided				

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

Application rate (kg as/ha)	Crop	Organism	Time-scale	Distance (m)	TER	Annex VI Trigger
1.5	Sunflower, maize	Fish	acute	1 m	1.1	100
1.5	Sunflower, maize	Fish	acute	20 m	**45**	100
1.5	Sunflower, maize	Invertebrates	acute	1 m	**80**	100
1.5	Sunflower, maize	Invertebrates	acute	20 m	3200	100
1.5	Sunflower, maize	Algae	acute	1 m	38	10
1.5	Sunflower, maize	Fish	chronic	1 m	**0.25**	10
1.5	Sunflower, maize	Fish	chronic	20 m	10.2	10
1.5	Sunflower, maize	Invertebrates	chronic	1 m	**3.1**	10
1.5	Sunflower, maize	Invertebrates	chronic	20 m	125	10

Bioconcentration

Bioconcentration factor	Whole fish: 1300
Annex VI Trigger:for the bioconcentration factor	100
Clearance time (CT50) (CT90)	Total radioactive residues in the whole fish after a 14–day depuration period: 15 % of the max. concentration

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

Acute oral toxicity	LD50 = 0.011 µg ai / bee
Acute contact toxicity	LD50 = 0.23 µg ai / bee

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

Application rate (kg as/ha)	Crop	Route	Hazard quotient	Annex VI Trigger
Laboratory tests				
1.5	Sunflower	Oral	136364	50
1.5	Sunflower	Contact	6522	50

Field or semi-field tests No data provided

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

No data provided

Effects on earthworms (Annex IIA, point 8.4, Annex IIIA, point 10.6)

Acute toxicity	LC_{50} = 57 mg/kg* (Lumbricus terrestris)
Reproductive toxicity	No data provided

*According to the EPPO risk assessment scheme the toxicity data from laboratory tests in artificial soil are divided by the factor of 2 when the log Pow > 2.

Toxicity/exposure ratios for earthworms (Annex IIIA, point 10.6)

Application rate (kg as/ha)	Crop	Time-scale	TER	Annex VI Trigger
1,5 (soil treatment)*	Sunflower, maize	Acute	114 (L. terrestris)	10
0,4 (seed treatment)**	Rape	Acute	108 (L. terrestris)	10

* incorporated into 20 cm soil layer (0.5 mg ai/kg)
** incorporated into 5 cm soil layer (0.53 mg ai/kg)

Effects on soil micro-organisms (Annex IIA, point 8.5, Annex IIIA, point 10.7)

Nitrogen mineralization	<25 %, no significant effects
Carbon mineralization	<25 %, no significant effects

Classification and proposed labelling (Annex IIA, point 10)

with regard to ecotoxicological data	R 50/53: Very toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment

4 Mammalian toxicology section

Impact on Human and Animal Health

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

Rate and extent of absorption:	rapid and complete absorption in mouse
Distribution:	mainly in fat tissue, brain, liver, kidneys
Potential for accumulation:	insufficient data but support assumption of potential for accumulation, particularly in body fat and brain
Rate and extent of excretion:	insufficient data but data indicate slow and incomplete excretion in bile and urine
Metabolism in animals	extensively metabolised via hydroxylation, dehydrogenation and dehydrochlorination (mainly to di-, tri- and tetrachlorophenoles);
Toxicologically significant compounds (animals, plants and environment)	parent compound and metabolites

Acute toxicity (Annex IIA, point 5.2)

Rat LD_{50} oral	163 mg/kg bw	**T, R 25**
Rat LD_{50} dermal	approx. 1000 mg/kg bw	**Xn, R 21**
Rat LC_{50} inhalation	1.56 mg/l (4h; aerosol)	**Xn, R 20**
Skin irritation (rabbit)	not irritant	
Eye irritation (rabbit)	not irritant	
Skin sensitization (test method used and result)	not sensitising (M & K, and medical use experience in humans)	

Short term toxicity (Annex IIA, point 5.3)

Target / critical effect	liver, kidneys; neurotoxic effects
Lowest relevant oral NOAEL / NOEL	0.3 mg/kg bw (13 weeks oral rat)
Lowest relevant dermal NOEL	10 mg/kg bw (13 weeks dermal rabbit)
Lowest relevant inhalative NOAEL / NOEL	0.3 mg/m^3 (14 weeks mouse study whole body exposure)

Genotoxicity (Annex IIA, point 5.4)	no genotoxic potential

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

Target/critical effect	liver, kidneys; neurotoxic effects
Lowest relevant oral NOAEL / NOEL	0.5 mg/kg bw/d (combined chronic toxicity/oncogenicity study, rat)

Carcinogenicity	phaeochromocytomas only in male rats at doses above MTD Evidence of liver and lung tumours in mice; **carc. cat 3; R 40**

Reproductive toxicity (Annex IIA, point 5.6)

Reproduction target / critical effect	reduced body weight gain and viability as well as delays in the development of offspring (F_1 and F_2) at parental toxic dose
Lowest relevant reproductive NOAEL / NOEL	1 mg/kg bw/d (rat, multigeneration study)
Developmental target / critical effect	fetotoxicity at maternal toxic dose
Lowest relevant developmental NOAEL/ NOEL	5 mg/kg bw/d (rabbit teratology study)

Neurotoxicity / Delayed neurotoxicity (Annex IIA, point 5.7)

neurotoxicity including seizures and convulsions; possible post-natal and developmental implications
Further data required

Other toxicological studies (Annex IIA, point 5.8)

from published data:
- Inducer of xenobiotic metabolising enzymes; myelination process in developing rats;
- effects on oestrous cycle, ovulation rate and hormone levels;
- indications of promotion of liver foci in rat;
- increase of cell transformation in-vitro

Medical data (Annex IIA, point 5.9)

following acute oral and dermal exposure: CNS effects (unconsciousness, convulsions, seizures; fatalities)

no clear evidence of a causal relationship between lindane and effects observed in epidemiological studies addressing haematotoxicity (blood dyscrasia), genotoxicity, carcinogenicity and reproductive effects:

Summary (Annex IIA, point 5.10)

	Value	Study	Safety factor
ADI (provisional)	0.001 mg/kg bw/d	chronic toxicity rat	500
AOEL (systemic; provisional))	0.001 mg/kg bw/d	chronic toxicity rat	500
Drinking water limit	0.1 µg/l		
ARfD (acute reference dose) (provisional)	0.01 mg/kg bw	developmental study rabbits	500

Dermal absorption (Annex IIIA, point 7.3)

	absorption rate: 60 %, based on the results of in-vivo studies with monkeys (57%, pure lindane), and rabbits (51.2%, dilution 1 : 100 of an aqueous formulation containing 20 % lindane), confirmed by the dermal penetration rate in human volunteers (60% lindane/white spirit formulation)

Acceptable exposure scenarios (including method of calculation)

Operator	No acceptable exposures identified. Provisional systemic AOEL is exceeded even with the proposed personal protective equipment for soil treatment according to POEM- and BBA-model as well as for seed treatment according to TROPEX-model
Workers	No risk identified for proposed use for soil treatment. For seed treatment: worker exposure must be avoided.
Bystanders	no exposure expected from identified uses

Classification and proposed labelling (Annex IIA, point 10)

with regard to toxicological data	T, Xn, R25, R20, R21, R40

5 Residues section

Residues

Metabolism in plants (Annex IIA, point 6.1 and 6.7, Annex IIIA, point 8.1 and 8.6)

Plant groups covered	apples, spinach (study regarded as invalid), cucumbers (only supplementary information) seed dressing: sugar beet, radish, spinach, mustard, maize, spring wheat, sweet corn; clarification of ”bound residues” required soil treatment: new/further information required
Rotational crops	barley, carrot, lettuce
Plant residue definition for monitoring	lindane (γ-HCH)
Plant residue definition for risk assessment	lindane (γ-HCH)
Conversion factor (monitoring to risk assessment)	-

Metabolism in livestock (Annex IIA, point 6.2 and 6.7, Annex IIIA, point 8.1 and 8.6)

Animals covered	lactating goat (clarification of kidney and liver metabolites required), laying hen (clarification of kidney metabolites required) clarification of toxicological significance of tri- and tetrachlorobenzenes required
Animal residue definition for monitoring	lindane (γ-HCH) - provisional
Animal residue definition for risk assessment	lindane (γ-HCH) - provisional
Conversion factor (monitoring to risk assessment)	-
Metabolism in rat and ruminant similar (yes/no)	to be further assessed (toxicological significance of metabolites found in lactating goats and laying hens)
Fat soluble residue: (yes/no)	yes

Residues in succeeding crops (Annex IIA, point 6.6, Annex IIIA, point 8.5)

.....	further studies (”field test”) required in order to estimate the actual residue situation under conditions closest to those found in agricultural practices; a new study has been carried out but not yet submitted

Stability of residues (Annex IIA, point 6 introduction, Annex IIIA, point 8 introduction)

.....	no studies submitted; data required

Residues from livestock feeding studies (Annex IIA, point 6.4, Annex IIIA, point 8.3)

Intakes by livestock ≥ 0.1 mg/kg diet/day:	Ruminant: yes/no	Poultry: yes/no	Pig: yes/no
Muscle	0.4	0.05	0.05
Liver	0.04	<0.01*	<0.01*
Kidney	0.04	<0.01*	<0.01*
Fat	0.4	0.05	0.05
Milk	0.004	-	-
Eggs	-	0.006	-

Consumer risk assessment (Annex IIA, point 6.9, Annex IIIA, point 8.8)

ADI	0.001 mg/kg bw/day
TMDI (European Diet) (% ADI)	Provisional TMDI-calculations; improved calculation should be performed as soon as the results of further trials (as required) have been made available, the still existing veterinary uses are identified and the new study on succeeding crops has been submitted: European diet: 29 % German diet: 69 % including EMRLs: European diet: 42 % German diet: 88 %
NEDI (% ADI)	not assessed
Factors included in NEDI	-
ARfD	0.01 mg/kg bw
Acute exposure (% ARfD)	an assessment of acute risk was not considered necessary, because a ”no-residue situation” was assumed

Processing factors (Annex IIA, point 6.5, Annex IIIA, point 8.4)

Crop/processed crop	Number of studies	Transfer factor	% Transference *
no study submitted; processing studies on oilseed required	-	-	-

* Calculated on the basis of distribution in the different portions, parts or products as determined through balance studies

Proposed MRLs (Annex IIA, point 6.7, Annex IIIA, point 8.6)

no MRL could be established for food of plant origin; further residue data are required	-
Because of the insufficient residue data base also for feed items, residue levels for lindane in food of animal origin can be established provisionally:	
milk	0.004 mg/kg[1)]
eggs	0.006 mg/kg[1)]
fat	0.4 mg/kg[1)] (cattle); 0.05 mg/kg[1)] (other than cattle)
meat	0.4 mg/kg[1)] (cattle); 0.05 mg/kg[1)] (other than cattle)
edible offal	0.04 mg/kg[1)] (cattle); 0.01* mg/kg[1)] (other than cattle)

(1) results expressed as mg lindane/kg