Euro Chlor Risk Assessment for the Marine Environment

OSPARCOM Region - North Sea

1,2-Dichloroethane

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Euro Chlor
representing the chlor-alkali industry

EURO CHLOR RISK ASSESSMENT FOR THE MARINE ENVIRONMENT

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EXECUTIVE SUMMARY

Euro Chlor has voluntarily agreed to carry out risk assessment of 25 chemicals related to the chlorine industry, specifically for the marine environment and according to the methodology laid down in the EU risk assessment Regulation (1488/94) and the Guidance Documents of the EU Existing Substances Regulation (793/93).
The study consists of the collection and evaluation of data on effects and environmental concentrations. Basically, the effect data are derived from laboratory toxicity tests and exposure data from analytical monitoring programs. Finally the risk is indicated by comparing the "predicted environmental concentrations" (PEC) with the "predicted no effect concentrations" (PNEC), expressed as a hazard quotient for the marine aquatic environment.
To determine the PNEC value, three different trophic levels are considered: primary producers (aquatic plants), primary consumers (invertebrates) and secondary consumers (fishes).
In the case of 1,2-dichloroethane (EDC) 21 data for fish, 16 data for invertebrates and 7 data for algae have been evaluated according to the quality criteria recommended by the European authorities. Both acute and chronic toxicity studies have been taken into account and the appropriate assessment factors have been used to define a final PNEC value of 1100µg/l.

All the monitoring data available indicate a progressive decrease of the 1,2-dichloroethane concentration in surface waters since 1983 up to now. Most of the available monitoring data apply to river and estuary waters and were used to calculate PECs. The most recent data (1991-1995) support a typical PEC of
0.5 µg EDC/l water and a worst case PEC of 5 to 6.4 µg EDC/l water. The calculated PEC/PNEC ratios give a safety margin of 170 to 2200 between the probable no effect concentration and the exposure concentration. Dilution within the sea would of course increase those safety margins.

Moreover, as the available data on persistence of 1,2-dichloroethane indicate a half-life in water of a few hours or days and as the bioaccumulation in marine organisms can be considered as negligible, it can be concluded that the present use of 1,2-dichloroethane does not represent a risk to the aquatic environment.

1. INTRODUCTION : PRINCIPLES AND PURPOSES OF EURO CHLOR RISK ASSESSMENT

Within the EU a programme is being carried out to assess the environmental and human health risks for "existing chemicals", which also include chlorinated chemicals. In due course the most important chlorinated chemicals that are presently in the market will be dealt with in this formal programme. In this activity Euro Chlor members are cooperating with member state rapporteurs. These risk assessment activities include human health risks as well as a broad range of environmental scenarios.

Additionally Euro Chlor has voluntarily agreed to carry out limited risk assessments for 25 prioritised chemicals related to the chlorine industry. These compounds are on lists of concern of European Nations participating in the North Sea Conference. The purpose of this activity is to explore if chlorinated chemicals presently pose a risk to the marine environment especially for the North Sea situation. This will indicate the eventual necessity for further refinement of the risk assessments and eventually for additional risk reduction programmes.
These risk assessments are carried out specifically for the marine environment according to principles given in *Appendix 1* . The EU methodology is followed as laid down in the EU risk assessment Regulation (1488/94) and the Guidance Documents of the EU Existing Substances Regulation (793/93).
The exercise consists in the collection and evaluation of data on effects and environmental concentrations. Basically, the effect data are derived from laboratory toxicity tests and exposure data from analytical monitoring programs.
Where necessary the exposure data are backed up with calculated concentrations based on emission models.
Finally the risk is indicated by comparing the "predicted environmental concentrations" (PEC) with the "predicted no effect concentrations" (PNEC), expressed as a hazard quotient for the marine aquatic environment.

2. DATA SOURCES

The data used in this risk assessment activity are primarily derived from the data given in the HEDSET (updated version of 8/95) for this compound. Where necessary additional sources have been used. For interested parties the HEDSET is available at Euro Chlor. The references of the HEDSET and additional sources are given in chapter 10.

3. COMPOUND IDENTIFICATION

3.1 Description

CAS number	:	107-06-2
EINECS number	:	203-458-1
EEC number	:	602-012-00-7

IUPAC name : 1,2-dichloroethane

1,2-dichloroethane is commonly abbreviated to EDC or 1,2-DCEa.
Other synonyms which are used include:

- ethane dichloride
- ethylene dichloride
- ethane, 1,2-dichloro
- sym-dichloroethane

1,2-dichloroethane has the following formula:

$C_2H_4Cl_2$

```
     H    H
     \    /
Cl - C - C- Cl
     /    \
    H      H
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3.2 EU labelling

According to Annex I of Directive 93/72/EEC (1.9.93 - 19th TPA), 1,2-dichloroethane is classified as:

* carcinogenic, category 2: T, R45 (may cause cancer)
* harmful if swallowed: Xn, R22
* highly flammable: F, R11
* irritating to eyes, respiratory system and skin: Xi, R36/37/38

This classification is applicable for the pure compound. Specific limits are existing for the toxicological properties:

Range of concentration	**Classification**
conc. ≥ 25 %	T, R45-22-36/37/38
20 % ≤ conc. < 25 %	T, R45-36/37/38
0.1 % ≤ conc. < 20 %	T, R45

Environmental labelling was discussed at the EU Working Group; as a result 1,2 dichloroethane should not be classified as “dangerous for the environment” according to the EU criteria.

4. PHYSICO-CHEMICAL PROPERTIES

Table 1 gives the major chemical and physical properties of the compound which were adopted for the purpose of this risk assessment.

Table 1 : Physical and chemical properties of 1,2-dichloroethane

Property	**Value**
Molecular weight	**98.96**
Aspect	Colourless liquid
Melting point	-35 to -36 °C
Boiling point	83.5-84.1 °C at 1013 hPa
Decomposition temperature	>200°C
Density	1.23-1.25
Vapour pressure	8700 Pa (at 20°C)
log octanol-water partition coefficient, log Kow	1.45 (measured)
Koc	19-152
Water solubility	8.5-9.0 g/l
Henry's Law constant	1.1 10^2 Pa. m^3 / mol

5. COMPARTMENT OF CONCERN BY MACKAY LEVEL I MODEL

The risk assessment presented here focuses on the aquatic marine environment, with special attention to the North Sea conditions where appropriate. Although this risk assessment only focuses on one compartment, it should be borne in mind that all environmental compartments are inter-related.

An indication of the partitioning tendency of a compound can be defined using Mackay level I calculation obtained through the ENVCLASS software distributed by the "Nordic Council of Ministers". This model describes the ultimate distribution of the compound in the environment (Mackay et al., 1990 - Pederson et al., 1994).

It should be recognized, however, that this model takes no account of transfer rates between compartments, the compartment into which the chemical is discharged, or any removal processes within compartments. Hence it is not designed to predict environmental concentrations for the purpose of risk assessment.

The results of such a calculation for 1,2-dichloroethane are given in Table 2.

Table 2 : Results of a Mackay level I calculation for 1,2-dichloroethane

Compartment	**%**
Air	97.10 -97.26
Water	2.73 - 2.89
Soil	0.01
Sediment	0.01

(See *Appendix 2 (a and b)* for details of calculation)

6. USE, APPLICATIONS

6.1 Anthropogenic Sources - EDC Emissions

1, 2 Dichloroethane (EDC) is the chemical intermediate of the Vinyl Chloride Monomer (VCM) manufacture obtained either by direct chlorination of ethylene, or oxychlorination in the presence of oxygen and HCl.

In a further step, EDC is transformed by pyrolysis into VCM and HCl.

More than 95 % of the manufactured EDC is transformed into VCM.

Less than 5 % of the manufactured EDC is used as :
- Raw material for ethyleneamines, trichloroethylene, perchloroethylene
- Extraction and cleaning solvent
- Lead scavenger for gasoline

6.2 Applicable regulations

In the European Union, 1,2 Dichloroethane emissions in water are governed by the EC Directive 90/415 of July 27, 1990 which gives the following emission values:

For production of EDC and transformation on the same site into VCM:

Monthly emission limit on 1.1.1995 : 5g per tonne of processed EDC capacity
Monthly average Concentrations limit on 1.1.1995 : 2,5 mg/l.

6.3 Best Available Technique

On its proposal for a definition of Best Available Technique for the manufacture of EDC the European Council of Vinyl Manufacturers (ECVM, 1994) has proposed a concentration limit of 1 mg/l EDC in the process effluent which corresponds to a limit of 2 g/t of processed EDC capacity using the same effluent rate as those given by the EC Directive (year average).

The same document from ECVM proposes a limit of 5 mg/m^3 in the emission of the off gas treatments. This figure is that of the ECVM Charter, a voluntary agreement within ECVM members to achieve the BAT proposals by 1998.

7. EFFECT ASSESSMENT

As a first approach, this chapter only considers the following three trophic levels: primary producers (aquatic plants), primary consumers (invertebrates) and secondary consumers (fish). The effects on other organisms are only discussed when indicated.

The evaluation of the data was conducted according to the quality criteria recommended by the European authorities (Commission Regulation 1488/94/EEC).
The evaluation criteria are given in *Appendix 1*.

Documented data from all available sources, including company data and data from the open literature, were collected and incorporated into the HEDSET for 1,2-dichloroethane, including their references (updated version of 8/95).

A summary of all data is given in *Appendix 3*. In total 21 data for fish, 16 data for invertebrates and 7 data for algae are given. Respectively 3, 3 and 0 data were considered valid for risk assessment purposes. For the respective taxonomic groups 5, 5 and 1 should be considered with care, and 13, 8 and 6 data respectively were judged as not valid or not assignable for the risk assessment.

It is necessary to distinguish the acute studies (LC50/EC50) from chronic studies (NOEC/LOEC). In the tables presented in *Appendix 3*, the data are ranked based on class (fish, invertebrates, algae), criterion (LC50/EC50, NOEC/LOEC), environment (freshwater/saltwater) and validity (1, 2, 3, 4).

The different trophic levels are reviewed hereafter. The reference numbers are those listed in the Table of *Appendix 3* and given in *Appendix 6*.

7.1 Marine fish

Four acute toxicity studies are reported for three marine fish species.

Three of them (Heitmuller, P.T. et al. 1981 - Syracuse Res. Corp. 1978 - Dawson, G.W. et al. 1975/1977) were conducted under static conditions and are considered non-valid as no precaution was taken to avoid volatile losses and the test concentrations were not analysed.
Only the result of one study with *Limanda limanda* was expressed as measured concentrations giving a 96h LC50 of 115 mg/l which is the lowest toxicity value for marine fish (Pearson, C.R., McConnell, G. 1975).

No long-term studies are available.

All remaining data are for freshwater organisms.

7.2 Freshwater fish

Twelve acute toxicity studies are reported for six freshwater fish species; only two were conducted in a flow-through system, both on *Pimephales promelas* (Ahmad, N. et al. 1984 - Walbridge, C.T. et al; 1983 - Veith, G.D. et al. 1983); for both studies, the results were based on measured concentrations and are considered valid with 96h LC50 of 116 and 118 mg/l.

Other studies are static or semi-static studies and most of them are conducted without analysis of the test concentrations. Only two of them give results expressed as measured concentrations so that these 2 studies are considered valid but should be used with care: 96h LC50 for *Lepomis macrochirus* was 94 mg/l and for *Micropterus salmoides* 66 mg/l (Rinehart, W.E. 1971) which is the lowest acute toxicity value for freshwater fish.

The lowest 48h LC value of 1.8 mg/l (Knie, J. et al. 1983) is considered non-valid for complete lack of information on test procedure. Moreover, when comparing this result with those obtained by other authors on the same species, the EC50 of 1.8 mg/l is completely out of the range (>100 mg/l) for *Leuciscus idus melanotus*; this is also confirmed when taking into account all available results obtained with other species.

Three long-term studies are conducted with early lifestage of three different species. One study was performed with eggs and larvae of *Pimephales promelas* in a flow-through system giving a 32d NOEC for survival and hatching of 29 mg/l measured concentration) (Ahmad, N. 1984 - Benoit, D.A. et al. 1982). This is the lowest NOEC value for freshwater fish.

The early lifestage study with *Oncorrhynchus mykiss* giving a 27d NOEC of 0.2mg/l for survival and hatching is considered non-valid (Black, J.A. et al. 1982). The ratio between measured concentrations is very variable and the greater sensitivity could be due to the short period between fertilization and initiation of exposure (<30min. instead of 48h in other tests).

The evaluation of all available ecotoxicity data on 1,2-dichloroethane shows a great coherence of the results and makes it unlikely that large differences in sensitivity between species occur so that this study Black et al. (1982) is not representative of the ecosystem.

7.3 Marine invertebrates

Seven acute toxicity studies are reported for four marine invertebrates species.
All of them are conducted with static conditions without analysis of the test compound so that they are considered valid but should be used with care or even not valid. The lowest EC50 value is observed for *Artemia salina* with a 24h EC50 of 36 mg/l (Foster, G.D. & R.E. Tullis, 1983).

The 24h EC50 of 0.25 mg/l is considered non-valid for lacking of test procedure description and because of non-standard conditions for assessing acute toxicity (early lifestage and endpoint) (Kerster, H.W., Schaeffer, D.J. 1983).

No long-term toxicity study is reported for marine invertebrates.

7.4 Freshwater invertebrates

Seven acute EC50 values are reported for *Daphnia magna*, all above 100 mg/l. The lowest measured 48h EC50 was 155 mg/l; the test was performed in a system where a control of volatile losses was provided (Ahmad, N. 1984 - Call, D.J. et al. 1983 - Richter, J.E. et al. 1983). This study is considered valid and represents the lowest acute toxicity value for freshwater invertebrate.

One long-term study with *Daphnia magna* was reported, giving a 28d NOEC for reproduction of 11 mg/l (Richter, J.E. et al. 1983). This is the only result considered valid.

7.5 Marine algae

Two studies (Pearson, C.R., McConnell, G. 1975 - Syracuse Res; Corp. 1978) are reported for marine algae; 96h EC50 based on growth are far above 100 mg/l; these results are considered not valid as the available information on test procedure was insufficient.

7.6 Freshwater algae

Only one study of the five available on four species is considered valid but should be used with care; the 72h measured EC50 of 189 mg/l was obtained on *Scenedesmus subspicatus*, tested in a system controlling volatile losses (capped vessels) (Freitag, D. et al. 1994) and is considered to be the lowest EC50 value for growth inhibition of algae. A corresponding NOEC is not available but, based on this EC50, it is however unlikely that the NOEC would be lower than NOEC obtained on *Daphnia magna* (28d NOEC of 11 mg/l for reproduction : see table 3).

[(Bringmann, G. 1975 - Bringmann, G., Kuekn, G. (1976), (1977), (1978) [a], (1978) [b], (1979), (1980)] are considered non-valid as the test duration is too long for one species (*Scenedesmus subspicatus*; for *Microcystis aeruginosa*, the growth is slower), the control growth is unknown and definition of endpoint is vague.

The two remaining studies (Knie, J. et al. 1983 - von Tuempling, W. 1972 - Syracuse Res. Corp. 1978) are considered non-valid too for insufficient description of test procedure or incoherence between literature reference.

Table 3 : Summary of ecotoxicity data selected for the PNEC derivation, with the appropriate assessment factors for 1,2 dichloroethane

Available valid data	Assessment factor	Comments
At least 1 short-term LC50 from each trophic level (fish, daphnia, algae)	1000 PNEC = 36 µg/l	- *Micropterus salmoides*, LC50, 96h = 66 mg/l; Rinehart et al. 1971 - *Limanda limanda* LC50, 96h=115 mg/l; Pearson et al. 1975 - *Daphnia magna*, EC50, 48h = 155 mg/l; Ahmad, 1984; Call et al, 1983; Richter et al, 1983 - *Artemia salina*, EC50, 24h = 36 mg/l (nominal concentration); Foster et al, 1985 – *Scenedesmus subspicatus*, EC50, 72h = 189 mg/l; Freitag et al, 1984
Long-term NOEC from at least 3 species representing three trophic levels (fish, daphnia, algae)	10 PNEC = 1100 µg/l	- *Pimephales promelas*, NOEC, 32d = 29 mg/l; Ahmad, 1984; Benoit et al, 1982 - *Daphnia magna*, NOEC (reproduction), 28d = 11 mg/l; Ahmad, 1984; Call et al, 1983 - *Scenedesmus subspicatus*, EC50, 72h = 189 mg/l; Freitag et al, 1984
Field studies	case by case: X PNEC = -	No data

7.7. PNEC for marine environment

From an evaluation of the available toxicity data for aquatic organisms, it is reasonable to conclude that the sensitivity of both marine and freshwater organisms to 1,2-dichloroethane is quite similar.

A summary of the valid data selected for the derivation of PNEC values at different levels is given in Table 3. This table summarises the PNEC values derived from acute, chronic and ecosystem studies. When these studies are available, it is generally considered that the latter are closer to real world than the former. Therefore the more reliable value should be in the lower end of the table. As far as the North Sea is concerned, acute effect studies are not relevant because of the absence of local sources.

The final PNEC which is calculated for this risk assessment of 1,2-dichloroethane is
1100 mg/l.

7.8 Bioaccumulation

Bioaccumulation of EDC in aquatic species is unlikely in view of its physical and chemical properties. A bioconcentration factor of 2 was found for bluegill sunfish (Lepomis macrochirus) in flowing water. The half life for the elimination of EDC from aquatic species tissues has been found to be 1 to 2 days (Barrows et al. 1978), Gosset et al. published in 1983 a study of several aquatic species collected near a discharge zone of a waste water treatment plant with an average effluent concentration of 41 µg/litre. The concentration of the tissues was less than 0.5 µg/kg wet weight in all cases and the sediment concentration was less than 0.5 µg/kg dry weight. A measured log P_{OW} of 1.45 and observed Bioconcentration factor (BCF) below 10 for fishes allow the conclusion that bioaccumulation would be negligible in marine organisms.
Moreover, the EC expert report B 13/86 on EDC states:
"Concentrations in biosphere and hydrosphere do not provide any sign of bioaccumulation".

7.9 Persistence

7.9.1 Half-life in water

As indicated by the Henry's law constant, EDC entering aquatic systems would be transferred to the atmosphere through volatilization.
In laboratory experiments, a half-live in water of 0.5 to 4 hours has been reported (Dilling, W.L. et al. 1975).
In a controlled outdoor experiment the half-life for the disappearance from running river water was found to be 1.4 hour (Scherb, K. 1978).
Such values will involve a rapid disappearance in a few hours of EDC by volatilization to atmosphere from the water.

7.9.2. Degradation processes

7.9.2.1 In the Atmosphere

In the troposphere EDC is photochemically oxidized by hydroxyl radicals abstracting H atoms (Howard, Evenson 1976). The reported degradation products are formyl chloride, (89%) and monochloroacetyl chloride (11%) (Pearson et al. 1975), (Wallington et al. 1996).
Half-live has been reported to be about 62 days (Wallington et al. 1996) based on a liftetime of about 3 months. Based on the latest kinetic data and accepted conventions (IPCC, Intergovernmental Panel on Climate Change - WMO, World Meteorological Organisation) a predicted lifetime of 75 days can be calculated. The corresponding half-live, 52 days would preclude accumulation in the troposphere and transport to the stratosphere.
Formylchloride and chloroacetylchloride do have high solubility in water and subsequent rain-out preclude any significant impact on the ozone layer. Final decomposition products are carbon dioxide and hydrogen chloride.

7.9.2.2 In Biological Systems

In the aquatic environment, biodegradation will not be a significant sink due to the volatility of EDC.
EDC was biodegraded in aqueous media by acclimated aerobic cultures from soils and sewage samples (Tabak et al 1981). An aerobic bacteria, a pseudomonas strain, was able to use 1,2-dichloroethane as a sole source of carbon and energy for growth (Janssen et al. 1984).
However, in unacclimated conditions the half life of EDC in water for biodegradation process is estimated between 100 and 180 days.

7.10 Conclusion

It can be deduced from the above information that EDC is not a "toxic, persistent and liable to bioaccumulate" substance as mentioned by the Oslo and Paris Conventions for the Prevention of Marine Pollution (OSPARCOM) according to the criteria currently under discussion and especially those defined by UN-ECE, Euro Chlor and CEFIC.

8. EXPOSURE ASSESSMENT

The exposure assessment is essentially based on exposure data from analytical monitoring programs. 1,2-dichloroethane has been measured in a number of water systems. These levels in surface waters (river water and marine waters) are detailed in *Appendix 4*. References of the available monitoring data can be found in HEDSET Data Sheet for 1,2-dichloroethane (updated version of 8/95). Additional sources have been also used. All the references are given in *Appendix*

7.

As it is generally not specified if the location of sampling is close to a source of emission (production or processing), it is assumed that the lower levels correspond to the background "regional" concentrations and the higher to contaminated areas, or "local" concentrations, considered as worst cases.

8.1 Marine waters

In coastal waters and estuaries, observed concentrations are in a range from below 0.005 µg/l up to 6.4 µg/l. Typical recent monitoring data for EDC in coastal waters and estuaries which are part of the OSPARCOM region are given hereafter and illustrated on the North Sea map in *Appendix 5*.

Elbe estuary (D)	<1µg/l	1993
Weser estuary (D)	<1µg/l	1993
Rhine (D/NL border)	<0.5 µg/l	1993
Ijsselmeer (NL)	<2 µg/l	1990-1991
Schelde (B/NL border)	0.2µg/l	1993
Rhine estuary (NL)	<0.647 µg/l	1983-1984
Meuse (B/NL border)	<2 µg/l	1993
Tees estuary (UK)	0.1-6.4 µg/l	1995
	0.72-4.02 µg/l	1994
Solent estuary (UK)	0.04-0.53 µg/l	1991
Other UK estuaries	<0.03 µg/l	1993
Seine estuary (F)	<1 µg/l (*)	1995
Coastal water (NL)	<0.005-0.647 µg/l	1983-1984

The symbol < indicates that the value is under the detection limit of the analytical method.

(*) Computed by the model EXAMS (US EPA) from the measured concentration in the river Seine.

8.2 River waters

Background levels of 1,2-dichloroethane in typical river in non-industrialised area are in general lower than 0.5 µg/l.

In the Rhine river water and other adjacent industrialised rivers, up to 5 µg/l is measured (worst case) (See *Appendix 4*).

EDC is classified as potentially carcinogen to humans. Therefore, the quality standard for EDC in water should be based on its potential effect on human health. The guideline of WHO (1993) for EDC in potable water is 30 µg/l and the recommended value by US-EPA in drinking water is 10 µg/l.

In Europe (Directive 90/415/CEE), the quality objective for EDC in surface water applicable from 1993 is 10 µg EDC/l.

Globally the available data indicate that the present human exposure via the drinking water in the early eighties was below the detection limit at that time e.g. 0.5 µg/l.

8.3 Other monitoring data

Recent data on 1,2-dichloroethane levels measured in aquatic organisms are not available. As already stated (see 7.8) we can consider that bioaccumulation is negligible in marine organisms.

In the second part of the eighties, 1,2-dichloroethane was detected in sediments in the North Sea (Southampton estuary) and in Baltic Sea from 0.07 up to 10 µg/kg. (Bianchi et al, 1991 and TemaNord, 1994 in *Appendix 7*).

9. RISK ASSESSMENT CONCLUSION

In the risk characterisation of 1,2-dichloroethane for the aquatic organisms, the PNEC is compared to the PEC.

A PNEC of 1100 µg/l was obtained for the aquatic species exposed to 1,2-dichloroethane.

In coastal waters and estuaries, 1,2-dichloroethane is observed up to 6.4 µg/l (worst case) but the concentrations of the river waters support a typical water concentration of less than 0.5 µg/l.

In non-industrialised areas, a typical river water concentration below 0.5 µg/l was derived from the measured levels; a worst case was also identified in an industrialized zone with measured levels up to 5 µg/l.

These monitoring values allow to calculate the ratios PEC/PNEC which are summarized in Table 4.

Table 4 : Calculation of PEC/PNEC ratios for 1,2-dichloroethane

Type of water	PEC level	PEC/PNEC
Coastal waters/Estuaries		
• worst case	6.4 µg/l	0.0058
• typical water	0.5 µg/l	0.00045
River waters :		
• worst case	5 µg/l	0.0045
• typical water	0.5 µg/l	0.00045

These calculated ratios, **which do not take into account any dilution factor within the sea**, correspond to a safety margin of 170 to 2200 between the aquatic effect and the exposure concentration so that the present use of 1,2-dichloroethane should not represent a risk to the aquatic environment. In addition, as stated in section 7.8, "Concentrations in biosphere and hydrosphere do not provide any sign of bioaccumulation" (EC expert report B13/86).

10. REFERENCES

10.1 General References

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10.2 **References for ecotoxicity data**: see *Appendix 6*.

Those references are used in *Appendix 3*.

10.3 **References for monitoring data**: see *Appendix 7*.

Those references are used in *Appendix 4*.

Environmental quality criteria for assessment of ecotoxicity data

APPENDIX 2

Ultimate distribution in the environment according to Mackay level I model
(details of calculation)

Fugacity Level I calculation

Chemical: 1,2 dichloroethane

Temperature (C)	20
Molecular weight (g/mol)	98.96
Vapor pressure (Pa)	8700
Solubility (g/m3)	8500
Solubility (mol/m3)	85.89
Henry's law constant (PA.m3/mol)	101.29
Log octanol water part. coefficient	1.45
Octanol water part. coefficient	28.18
Organic C-water part. coefficient	11.56
Air-water partition coefficient	0.04
Soil-water partition coefficient	0.35
Sediment-water partition coefficient	0.69
Amount of chemical (moles)	1
Fugacity (Pa)	.39506966E-6
Total VZ products	2531199.16

Phase properties and compositions:

Phase	Air	Water	Soil	Sediment
Volume (m3)	.6000E+10	.70000E+7	.45000E+5	.21000E+5
Density(kgm3)	.12056317E+2	.10000E+4	.15000E+4	.15000E+4
Frn org carb.	.00000E+0	.00000E+0	.20000000E-1	.40000000E-
Z mol/m3.Pa	.41029864E-3	.98727919E-2	.34225129E-2	.68450258E-
VZ mol/Pa	.24617918E+7	.69109543E+5	.15401308E+3	.14374554E+
Fugacity	.39506966E-6	.39506966E-6	.39506966E-6	.39506966E-
Conc mol/m3	.16209654E-9	.39004405E-8	.13521310E-8	.27042620E-
Conc g/m3	.16041074E-7	.38598760E-6	.13380688E-6	.26761377E-
Conc ug/g	.13305118E-5	.38598760E-6	.89204591E-7	.17840918E-
Amount mol	.97257928E+0	.27303084E-1	.60845896E-4	.56789503E-
Amount %	97.26	2.73	0.01	0.(

SUMMARY TABLE OF ECOTOXICITY DATA ON 1,2-DICHLOROETHANE

1.a FISH

Species	Duration d (days) - h0 (hours)	Type of study	Criterium (LC50/EC50 NOEC/LOEC)	Concentration (mg/l)	Validity	Comments & remarks	Reference
EC50/LC50 STUDIES							
1. FRESHWATER							
Pimephales promelas	96 h	F-T; A	LC50	116	1		Ahmad et al,1984 Walbridge et al, 1983
Pimephales promelas	96 h	F-T; A	LC50	118	1		Veith et al,1983
Lepomis macrochirus	96 h	S; A	LC50	94	2		Rinehart,1971
Micropterus salmoides	96 h	S; A	LC50	66	2		Rinehart,1971
Poecilia reticulata	7 d	SS; N; C	LC50	106	2		Koenemann,1981
Lepomis macrochirus	96 h	S; N	LC50	550	3		Dawson et al,1975/1977
Lepomis macrochirus	96 h	S; N; C	LC50	430	3		Buccafusco et al,1981 Syracuse,1978a
Leuciscus idus melanotus	48 h	S	LC50	356	3		Juhnke & Luedemann,1978
Leuciscus idus melanotus	48 h	S	LC50	406	3		Juhnke & Luedemann,1978
Leuciscus idus melanotus	48 h	S	LC50	1.8	3		Knie et al,1983

SUMMARY TABLE OF ECOTOXICITY DATA ON 1,2-DICHLOROETHANE

1.b FISH

Species	Duration d (days) - h0 (hours)	Type of study	Criterium (LC50/EC50 NOEC/LOEC)	Concentration (mg/l)	Validity	Comments & remarks	Reference
EC50/LC50 STUDIES							
Oncorhynchus mykiss	96 h	S	LC50	225	3		Johnson & Finley,1980 Mayer & Ellersieck,1986
Oncorhynchus mykiss	96 h	S	LC50	336	3		Bartlett, 1979
Pimephales promelas	96 h	F-T; A	LC50	140	4		Brooke,1985
Pimephales promelas	96 h		LC50	136	4		Center Lake Sup,1986
2. SALTWATER							
Limanda limanda	96 h	A	LC50	115	2		Pearson & McConnell,1975
Cyprinodon variegatus	96 h	S	LC50	130-230	3		Heitmuller et al,1981
Cyprinodon variegatus	96 h	S	LC50	126-226	3		Syracuse,1978b
Menida beryllina	96 h	S	LC100	480	3		Dawson et al,1975/1977

SUMMARY TABLE OF ECOTOXICITY DATA ON 1,2-DICHLOROETHANE

1.c FISH

Species	Duration d (days) - h (hours)	Type of study	Criterium (LC50/EC50 NOEC/LOEC)	Concentration (mg/l)	Validity	Comments and remarks	Reference
NOEC/LOEC STUDIES							
1. FRESHWATER							
Pimephales promelas	32 d	F-T; A	NOEC LOEC	29 59	1	eggs, larvae; endpoint = survival + hatching	Ahmad,1984 Benoit et al,1982
Oncorhynchus kisutch	21 d	F-T; A	NOEC LOEC	56 150	2	eggs; endpoint = hatching	Reid et al,1982
Oncorhynchus mykiss	27 d	A	NOEC	0.2	3	eggs; endpoint = survival + hatching; LC50 = 34 mg/l	Black et al,1982
2. SALTWATER (NO DATA AVAILABLE)							

All endpoints of the tests are based on survival/mortality. Other effects are explicitly mentioned in the table.

SUMMARY TABLE OF ECOTOXICITY DATA ON 1,2-DICHLOROETHANE

2.a INVERTEBRATES

Species	Duration d (days) - h (hours)	Type of study	Criterium (LC50/EC50 NOEC/LOEC)	Concentration (mg/l)	Validity	Comments and remarks	Reference
LC50/EC50 STUDIES							
1. FRESHWATER							
Daphnia magna	48 h	A; C	EC50 LC50	155-183 268-315	1		Ahmad,1984 Call et al,1983 Richter et al,1983
Daphnia magna	24 h	A	EC50	150	2		Freitag et al,1994
Daphnia magna	48 h	N; C	EC50	324	2		Kuehn et al,1989
Daphnia magna	24 h	N	EC50	540	3		Bringmann & Kuehn,1982
Daphnia magna	24 h	N	EC50	600	3		Knie et al,1983
Daphnia magna	24 h	N	EC50	1 350	3		Bringmann & Kuehn,1977
Daphnia magna	48 h	N	EC50	220	3		Richter et al,1983
Gammarus fasciatus	96 h		EC50	> 100	3		Mayer & Ellersieck,1986

SUMMARY TABLE OF ECOTOXICITY DATA ON 1,2-DICHLOROETHANE

2.b INVERTEBRATES

Species	Duration d (days) - h (hours)	Type of study	Criterium (LC50/EC50 NOEC/LOEC)	Concentration (mg/l)	Validity	Comments and remarks	Reference
LC50/EC50 STUDIES							
2. SALTWATER							
Artemia salina	24 h	N; C	EC50	94	1		Foster & Tullis,1984
Artemia salina	24 h	S; N; C	EC50	36	2		Foster & Tullis,1985
Artemia salina	24 h	S; N; C	EC50	320	2		Price et al,1974
Eliminius modestus	48 h	N; C	EC50	186	2	larvae	Pearson & McConnell,1975
Crangon crangon	24 h	N	EC50	170	3		Rosenberg et al,1975
Mysidopsis bahia	96 h	N	EC50	113	3		Syracuse,1978b US EPA,1978
Artemia salina	24 h	N	EC	0.25	3	young nauplii; endpoint = length	Kertser & Schaeffer,1983

SUMMARY TABLE OF ECOTOXICITY DATA ON 1,2-DICHLOROETHANE

2.c INVERTEBRATES

Species	Duration d (days) - h (hours)	Type of study	Criterium (LC50/EC50 NOEC/LOEC)	Concentration (mg/l)	Validity	Comments and remarks	Reference
NOEC/LOEC STUDIES							
1. FRESHWATER							
Daphnia magna	28 d	SS; A; C	NOEC LOEC	11 21	1	endpoint = reproduction	Ahmad,1984 Call et al,1983
2. SALTWATER (NO DATA AVAILABLE)							

All endpoints of the tests are based on survival/mortality. Other effects are explicitly mentioned in the table.

SUMMARY TABLE OF ECOTOXICITY DATA ON 1,2-DICHLOROETHANE

3.a AQUATIC PLANTS

Species	Duration d (days) - h (hours)	Type of study	Criterium (LC50/EC50 NOEC/LOEC)	Concentration (mg/l)	Validity	Comments and remarks	Reference
1. FRESHWATER							
Scenedesmus subspicatus	72 h	A; C	EC50	189	2		Freitag et al,1994
Haematococcus pluvialis	4 h	N	EC50	130	3	inhibition of O_2 production	Knie et al,1983 von Tuempling,1972
Microcystis aeruginosa	8 d	N; C	LOEC	105	3		Bringmann,1975 Bringmann & Kuehn, 1976,1978 a&b

SUMMARY TABLE OF ECOTOXICITY DATA ON 1,2-DICHLOROETHANE

3.b AQUATIC PLANTS

Species	Duration d (days) - h (hours)	Type of study	Criterium (LC50/EC50 NOEC/LOEC)	Concentration (mg/l)	Validity	Comments and remarks	Reference
Scenedesmus subspicatus	8 d	N; C	LOEC	710	3		Bringmann & Kuehn,1977, 1978a&b, 1979, 1980
Selenastrum capricornutum	96 h		EC50	> 433	3		Syracuse,1978b
2. SALTWATER							
Phaeodactylum tricornutum			EC50	340	3	carbon uptake	Pearson McConnell,1975
Skeletonema costatum	96 h		EC50	> 433	3		Syracuse,1978b

All endpoints of the tests are based on growth.

LIST OF ABBREVIATIONS USED IN TABLES

A	**=**	**analysis**
C	**=**	**closed system or controlled evaporation**
h	**=**	**hour(s)**
d	**=**	**day(s)**
MATC	**=**	**maximum acceptable toxicant concentration**
N	**=**	**nominal concentration**
S	**=**	**static**
SS	**=**	**semistatic**
F-T	**=**	**flow-through**

Validity column : 1 = valid without restriction

2 = valid with restrictions : to be considered with care

3 = invalid

4 = not assignable

BACKGROUND LEVELS OF 1,2-DICHLOROETHANE IN NATURAL SURFACE WATERS

Area	Year of measurement	Average or medium concentration (µg/l)	Reference
1. Coastal waters and Estuaries			
Great-Britain : • National monitoring plan stations : - Tees estuary - Mersey estuary - Other estuaries (Tyne, Humber, ...)	1992	 0.72 - 4.02 < 0.05 < 0.025	Dawes et al, 1994
• 10 estuaries	1986-87 (winter)	< 0.1	DoE, 1992
• Solent estuary	< 1991	0.04-0.53	Bianchi et al, 1991
• Rivers estuaries (Tweed, Blyth, Tyne, Wear, Humber, Wash, Poole, Channel, Thames)	1993	typical value < 0.01 max. 0.03	MAFF Report 1995
• Mersey estuary	1993	< 0.01 upto 1.1 max.	MAFF Report 1995
• Tees estuary	1995	min. 0.1 average 1.3 max. 6.4	NRA Report 1996
Netherlands : • North sea, open sea	1983-84	< 0.005	van de Meent et al, 1986
• North sea coasts, 9 sites	1983-84	0.05	van de Meent et al, 1986
• Rhine estuary	1983-84	max. 0.647	van de Meent et al, 1986
Germany • Elbe estuary • Weser estuary	 1993 1993	 < 1 < 1	 Elbe Bericht 1994 Weser Bericht 1994
France • Seine estuary	1995	< 1	Agence de Bassin (modelisation)

Area	Year of measurement	Average or medium concentration (µg/l)	Reference
2. River waters			
Germany : • Elbe, Schnackenburg (mean flow : 730 m^3/s)	1981-82	< 0.15 (max. 2.1)	ARGE Elbe, 1982
• Ruhr, km 124-46	1983-86	0.03 (max. 0.1)	AWWR, 1983-86
• Emscher	1988-91	5.6 - < 5	LWA, 1989-92
• Rhine : Bad Honnef (km 650), Dusseldorf (km 740), Kleve-Bimmen (km 865) (D/NL borderline, mean flow : 2270 m^3/s)	1990	< 5	Umwelt Bundesamt, 1992-93
• Rhine D/NL border	1990 1993	< 0.1 max. 0.57 < 0.5	Rapport Etat du Rhin Rhein Bericht 1995
• Rhine affluents (mean flow : 730 m^3/s) : Sieg, Wupper, Erft, Ruhr, Lippe	1987	< 5	LWA, 1988
Netherlands : • Ijsselmeer/Maas • Ijsselmeer, Andijk	 1990-1991 1991	 max 2 < 2	 Janus (1994) RIWA, 1990-91
• Lekwater, Hagestein (flow : 183 m^3/s)	1991	< 0.1	RIWA, 1990-91
• Rhine	1983	0.2	van de Meent et al, 1986
• Rhine, Lobith	1991	0.3	RIVM, 1993
• Meuse, Eijsden (flow : 249 m^3/s)	1992 1993	< 2 1	De Rooij 1994 RIWA, 1995
• Meuse, Keizersveer (flow : 288 m^3/s)	1993	< 2	RIWA, 1995
Belgium : • Meuse, Tailfer (flow : 159 m^3/s)	 1993	 0.2	 RIWA, 1995
• Schelde, Doel	1992 1993	< 0.2 < 0.085 (max. 0.2)	De Rooij 1994 Min. Verkeer en Waterstaat, 1994
France : • Seine river	 1995	 < 2	 Agence de Bassin

NORTH SEA monitoring data on 1,2-dichloroethane

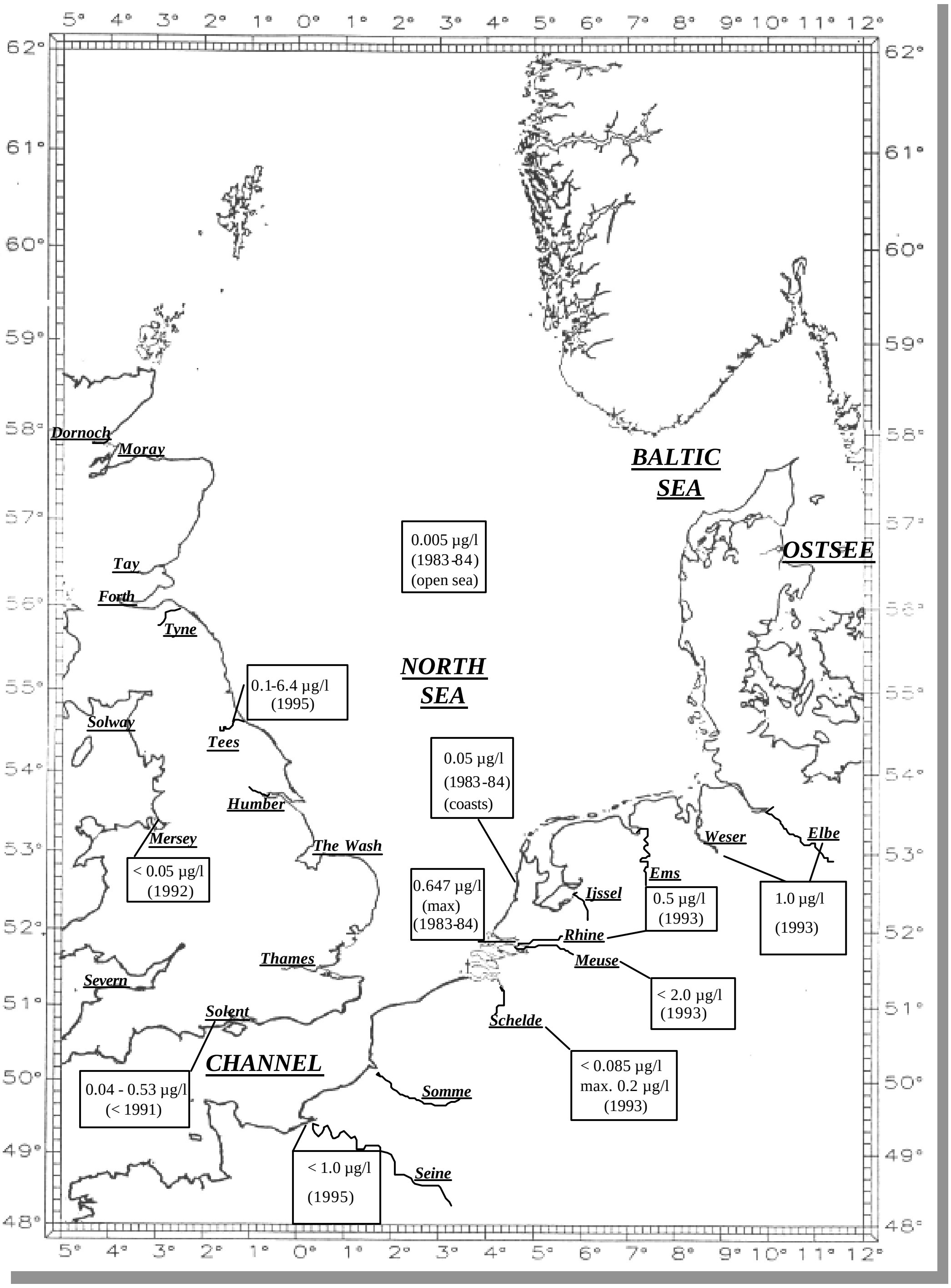

Figure 1: North Sea monitoring data on 1,2-dichloroethane

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