AMBIENT WATER QUALITY ADVISORY

PENTACHLOROETHANE

OFFICEC OF WATER REGULATIONS AND STANDARDS
CRITERIA AND STANDARDS DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOTICES

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FOREWORD

The Criteria and Standards Division of the Office of Water Regulations and Standards has instituted water quality advisories as a vehicle for transmitting the best available scientific information concerning the aquatic life and human health effects of selected chemicals in surface waters. Advisories are prepared for chemicals for which information is needed quickly, but for which sufficient data, resources, or time are not available to allow derivation of national ambient water quality criteria.

Data supporting advisories are usually not as extensive as required for derivation of national ambient water quality criteria, and the strength of an advisory will depend upon the source, type, and reliability of the data available. We feel, however, that it is in the best interest of all concerned to make the enclosed information available to those who need it.

Users of advisories should take into account the basis for their derivation and their intended uses. Anyone who has additional information that will supplement or substantially change an advisory is requested to make the information known to us. An advisory for an individual chemical will be revised if any significant and valid new data make it necessary.

We invite comments to help improve this product.

Edmund M. Notzon, Director
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ACKNOWLEDGEMENTS

AQUATIC LIFE

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SECTION I. ADVISORIES

AQUATIC LIFE

If the measured or estimated ambient concentration of pentachloroethane exceeds 19 ug/L in fresh or salt water, one or more of the following options must be completed within a reasonable period of time:

1. Obtain more measurements of the concentration.

2. Improve the estimate of the concentration.

3. Reduce the concentration.

4. Obtain additional laboratory and/or field data on the effect of pentachloroethane on aquatic life so that a new aquatic life advisory or a water quality criterion can be derived.

After a reasonable period of time, unless a consideration of all the available data concerning the ambient concentration and the effects of pentachloroethane on aquatic life demonstrates that the ambient concentration is low enough, it must be reduced.

SECTION III. GENERAL INFORMATION

A. Biological, Chemical, and Physical Properties

The following information on the properties of pentachloroethane and its persistence in the aquatic environment was obtained from the QSAR System~ha~s on April 28, 1987, or from the CRC Handbook of Chemistry and Physics~hb~s. Some of the values were calculated using structure-activity relationships.

Property	Value	Source
Molecular Weight	202.3 g/mole	Calculated
Relative Density(20~ho~sc)	1.6796	Measured
Log P	3.63	Calculated
Melting Point	-29.00~ho~sC	Measured
Boiling Point	162.00~ho~sC	Measured
Vapor Pressure	3.25 mm Hg	Calculated
Heat of Vaporization	8,920.00 cal/mole	Calculated
pKa	(not applicable)	-
Solubility in Water	62.63 mg/L	Calculated
BCF	292.0	Calculated
Absorption Coef.[Log (Koc)]	3.31	Calculated

Hydrolysis Half-life = > 1000 days

Hydrolysis is not likely to be an important transformation mechanism for this chemical.

Biodegradation Half-life Analysis

This chemical has two or more halogen substitutions. Half-life for all chemicals with a similar structure is >15 days. Although microbial decomposition has been reported for some halogenated acids, the relative rate of decomposition appears to be retarded by the presence of the halogens.

Log 10 (Henry's Constant) = -1.87 $atmm^3/mole$

It could be concluded that a chemical with these properties will vaporize rapidly from and will not persist in open water.

Neely 100-day Partitioning Pattern

Air	=	54.75%
Water	=	23.23%
Ground	=	11.39%
Hydrosoil	=	10.63%

a For information on the QSAR system, see: Hunter, R., L. Faulkner, F. Culver and J. Hill. Draft user manual for the QSAR system. Center for Data Systems and Analysis, Montana State University. November, 1985.

b Handbook of Chemistry and Physics, 67th Ed., CRC Press, Boca Raton, FL.1986-1987.

SECTION III. AQUATIC TOXICITY

Introduction

Aquatic life advisory concentrations are conceptually different from national aquatic life water quality criteria. Because aquatic life advisories are intended to be used to identify situations where there is cause for concern and where appropriate action should be taken, the advisory concentration for a chemical is derived to be equal to or lower than what the Criterion Continuous Concentration (Stephan et al. 1985) would be if a national water quality criterion for aquatic life could be derived for the chemical. If the concentration of a chemical in a variety of surface waters is found to exceed the aquatic life advisory concentration, this may indicate that the U.S. EPA should consider deriving aquatic life water quality criteria for that chemical.

The literature searching and data evaluation procedures used in the derivation of aquatic life advisories are identical to those used in the derivation of water quality criteria for aquatic life (Stephan et al. 1985). However, advisories do not contain a section on "Unused Data" as in a criteria document. This aquatic life advisory concentration for pentachloroethane was derived using the procedures described in the "Guidelines for Deriving Ambient Aquatic Life Advisory Concentrations" (Stephan et al. 1986). A knowledge of these guidelines is necessary in order to understand the following text, tables, and calculations. The latest comprehensive search for information for this aquatic life advisory was conducted in February, 1987.

Based upon the relatively high volatility of pentachloroethane (see Section III-A), it is predicted that concentrations in static exposure systems may decrease by more than 50% within 96 hours. This was verified experimentally by Brooke (1987) who reported a half-life for pentachloroethane in static exposures to be 15.6 hours. Therefore, an adjustment factor was necessary for the interpretation of data from static tests. Brooke (1987) conducted a comparable flow-through, measured exposure and a static, measured (based upon 0-hr measurement) exposure with the fathead minnow (Pimephales promelas) (Table 1). The ratio of the flow-through - static 96-hr LC50s was 0.5417. Therefore, all results reported in Table 1 from static exposures in which the concentrations of chloroform were not measured were multiplied by 0.5417 to obtain an adjusted LC50. Only the adjusted values are used in the calculation of the Advisory Concentration and only results in Table 1 were adjusted.

Effects on Freshwater Organisms

Data on the acute toxicity of pentachloroethane to freshwater organisms are limited to an invertebrate and two species of fish (Table 1). In two separate tests, 48-hr EC50s for Daphnia magna were 4,690 ug/L and 7,320 ug/L (Ahmad et al. 1984; Call et al. 1983; Richter et al. 1983). Results by LeBlanc (1980) for this same species greatly exceeded these values, and were not considered useful in calculating a Species Mean Acute Value. The mean reported 96-hr LC50 for the fathead minnow (Pimephales promelas) was 7,480 ug/L (Ahmad et al. 1984; Brooke 1987; Geiger et al. 1985; Walbridge et al. 1983; Veith et al. 1983). Buccafusco et al. (1981) exposed the bluegill (Lepomis macrochirus) to pentachloroethane and calculated a 96-hr LC50 of 7,200 ug/L.

The chronic toxicity data for pentachloroethane are summarized in Table 2. Ahmad et al. (1984) conducted an early life-stage test with fathead minnow (Pimephales promelas). Survival was reduced to 45% at a concentration of 4,100 ug/L. Growth was reduced by 33% at a concentration of 1,400. No adverse effects were observed at a pentachloroethane concentration of 900 ug/L in the 32 day test. The chronic value was 1,120 ug/L and the acute-chronic ratio was 6.518. 6.68

Other data on the effects of pentachloroethane on freshwater organisms are found in Table 4. The three species of algae tested appear to be less sensitive than higher organisms. Call et al. (1983) found little difference in 48-hr EC50 when Daphnia magna were fed or unfed. Uptake of pentachloroethane was studied for two species of fish. Bioaccumumlation factors (BCF) of 62 and 67 were measured in the fathead minnow and the bluegill, respectively (Ahmad et al. 1984; Barrows et al. 1980; Veith et al. 1980).

Effects of Saltwater Organisms

Acceptable data on the acute toxicity of pentachloroethane are available for an invertebrate and a fish (Table 1). U.S. EPA (1978) reported a 96-hr LC50 for the mysid shrimp (Mysidopsis bahia) of 5,060 ug/L. The 96-hr LC50 for the sheepshead minnow (Cyprinodon variegatus) was 116,000 ug/L (Heitmuller et al. 1981).

No data are available on the chronic toxicity of pentachloroethane to any saltwater organisms.

U.S. EPA (1978) exposed a marine alga, Skeletonema costatum, for 4 days and calculated an EC50 (growth reduction) of 58,200 ug/L. Thursby and Steele (1986) and coworkers (1985) studied the effects of pentachloroethane on growth and reproduction of a red alga, Champia parvula. In a 14-day exposure, a concentration of 4,700 ug/L was found to affect growth, and a concentration of 1,680 ug/L was found to affect reproduction of the alga.

Calculation of the Advisory Concentration

A total of five Species Mean Acute Values (SMAV) and Genus Mean Acute Values (GMAV) were available for freshwater and saltwater organisms (Table 3). Values ranged from 2,740 ug/L for Mysidopsis to 62,800 ug/L for Cyprinodon. Based upon a total of five GMAVs, the lowest GMAV(2,740 ug/L) was divided by a factor of 9.0, in accordance with the guidelines, resulting in an Advisory Acute Value (AAV) of 304.4 ug/L. One experimentally determined acute-chronic ratio was available, (Table 2), which resulted in an Advisory Acute-Chronic Ratio (AACR) of 15.97. Dividing the AAV (304.4 ug/L) by the AACR (15.97) resulted in an Advisory Concentration of 19.06 ug/L.

Table 1. Acute Toxicity of Pentachloroethane to Aquatic Animals

Species	Method[a]	Chemical	Hardness (mg/L as $CaCO_3$)	LC50 or EC50 (µg/L)	Adjusted LC50 or EC50 (µg/L)[b]	Species Mean Acute Value (µg/L)	Reference
				FRESHWATER SPECIES			
Cladoceran (<24 hr), *Daphnia magna*	S, U	-	72	63,000	34,100[c]	-	LeBlanc 1980
Cladoceran, (<24 hr), *Daphnia magna*	S, M	-	46 7	4,690	4,690	-	Call et al. 1983; Richter et al. 1983
Cladoceran (<24 hr), *Daphnia magna*	S, M	-	46.5	7,320	7,320	5,860	Ahmad et al.1984
Fathead minnow (30 day), *Pimephales promelas*	S, M	-	47 8	5,750	5,750	-	Brooke 1987
Fathead minnow (30 day), *Pimephales promelas*	S, M[d]	-	47.8	13,900	7,530	-	Brooke 1987
Fathead minnow (30 day), *Pimephales promelas*	F, M	96%	46.5	7,530	7,530	-	Brooke 1987; Geiger et al. 1985
Fathead minnow (30 day), *Pimephales promelas*	F, M	-	45 1	7,340	7,340	7,430	Walbridge et al. 1983; Veith et al. 1983; Ahmad et al 1984

Table 1 (continued)

Species	Method[a]	Chemical	Hardness (mg/L as $CaCO_3$)	LC50 or EC50 (µg/L)	Adjusted LC50 or EC50 (µg/L)[b]	Species Mean Acute Value (µg/L)	Reference
				FRESHWATER SPECIES			
Bluegill (juvenile), *Lepomis macrochirus*	S, U	-	32-48	7,200	3,900	3,900	Buccafusco et al. 1981

Species	Method[a]	Chemical	Salinity (g/Kg)	LC50 or EC50 (µg/L)	Adjusted LC50 or EC50 (µg/L)[b]	Species Mean Acute Value (µg/L)	Reference
				SALTWATER SPECIES			
Mysid, *Mysidopsis bahia*	S, U	-	-	5,060	2,740	2,740	U.S. EPA 1978
Sheepshead minnow (juvenile), *Cyprinodon variegatus*	S, U	-	10-31	116,000	62,800	62,800	Heitmuller et al. 1981

[a] S = Static, R = Renewel, F = Flow-through; M = Measured, U = Unmeasured.
[b] Resuts of static tests in which the concentration of pentachloroethane was not measured were mulitiplied by a factor of 0.5417 (see text).
[c] Value not used in the calculation of Species Mean Acute Value (see text).
[d] 0-hr. measured only.

Table 2. Chronic Toxicity of Pentacloroethane to Aquatic Animals

Species	Test[a]	Chemical	Hardness (mg/L as $CaCO_3$)	Chronic Limits (µg/L)[b]	Chronic Value (µg/L)	Reference
			FRESHWATER SPECIES			
Fathead minnow, *Pimephales promelas*	ELS	-	-	900-1,400	1,120	Ahmad et al. 1984

[a] ELS = early life-stage test

[b] Results are based on measurel concentrations of Pentachloroethane.

Acute-Chronic Ratio

Species	Hardness (mg/L as $CaCO_3$)	Acute Value (µg/L)	Chronic Value (µg/L)	Ratio
Fathead minnow, *Pimephales promelas*	-	7,300	1,120	6.518

Table 3 Ranked Genus Mean Acute Values with Species Mean Acute-Chronic Ratios

Rank[a]	Genus Mean Acute Value (µg/L)	Species	Species Mean Acute Value (µg/L)[b]	Species Mean Acute-Chronic Ratio[c]
5	62,800	Sheepshead minnow, *Cyprinodon variegatus*	62,800	-
4	7,430	Fathead minnow, *Pimephales promelas*	7,430	6.518
3	5,860	Cladoceran, *Daphnia magna*	5,860	-
2	3,900	Bluegill, *Lepomis macrochirus*	3,900	-
1	2,740	Mysid, *Mysidopsis bahia*	2,740	-

[a] Ranked from most resistant to most sensitive based on Genus Mean Acute Value.

[b] From Table 1

[c] From Table 2

Advisory Acute Value = (12,740 µg/L)/ 9.0 = 304 4 µg/L.

Advisory Acute-Chronic Ratio = 15.97

Advisory Concentration = (304.4 µg/L)/ 15.97 = 19.05 µg/L

Table 4 Other Data on Effects of Pentachloroethane on Aquatic Organisms

Species	Chemical	Hardness (mg/L as $CaCO_3$)	Duration	Effect	Concentration (µg/L)	Reference
			FRESHWATER SPECIES			
Green alga, Chlamydomonas angulosa	-	-	3 hr	EC50 (photosynthesis)	24,280	Hutchinson et al. 1979,1980
Green alga, Chlamydomonas vulgaris	-	-	3 hr	EC50 (photosynthesis)	30,350	Hutchinson et al. 1979,1980
Green alga, Selenastrum capricornutum	-	-	4 day	EC50	121,000	U.S. EPA 1978
Cladoceran (<24 hr), Daphnia magna	-	46 5	48 hr (fed)	EC50	6,880	Call et al. 1983; Richter et al. 1983
Fathead minnow, Pimephales promelas	-	-	32 day	BCF = 62	-	Ahmad et al. 1984
Guppy, Poecilia reticulata	-	-	7 day	LC50	15,000	Konemann 1981
Bluegill (juvenile), Lepomis macrochirus	-	-	14 day	BCF = 67	7.93	Barrows et al. 1980; Veith et al. 1980

Table 4. (continued)

Species	Chemical	Salinity (g/kg)	Duration	Effect	Concentration (µg/L)	Reference
			SALTWATER SPECIES			
Alga, *Skeletonema costatum*	-	-	4 day	EC50	58,200	U.S. EPA 1978
Red alga (sporophyte), *Champia parvula*	-	-	11-14 day	Reduced growth	4,700	Thursby et al. 1985
Red alga (sporophyte), *Champia parvula*	-	-	11-14 day	Reduced rerproduction	1,680	Thursby et al. 1985
Red alga (gametophyte), *Champia parvula*	-	-	14 day	No sexual reproduction	10,200	Thursby and Steele 1986
Red alga (gametophyte), *Champia parvula*	-	-	2 day	No sexual reproduction	> 21,800	Thursby and Steele 1986
Red alga (gametophyte), *Champia parvula*	-	-	14 day	EC50 (reproduction)	2,200	Thursby and Steele 1986

SECTION IV. REFERENCES

Ahmad, N., D. Benoit, L. Brooke, D. Call, A. Carlson, D. DeFoe, J. Huot, A. Moriarity, J. Richter, P. Shubat, G. Veith and C. Walbridge. 1984. Aquatic toxicity tests to characterize the hazard of volatile organic chemicals in water: A toxicity data summary. Parts I and II. EPA 600/3-84-009 or PB84-141506. National Technical Information Service, Springfield, VA.

Barrows, M.E., S.R. Petrocelli, K.J. Macek and J.J. Carroll. 1980. Bioconcentration and elimination of selected water pollutants by bluegill sunfish (Lepomis macrochirus). In: Dynamics, exposure and hazard assessment of toxic chemicals. Hague, R. (Ed.). Ann Arbor Science Publ., Ann Arbor, MI. pp. 379-392.

Brooke L.T. 1987. Center for Lake Superior Environmental Studies, University of Wisconsin-Superior, Superior, WI. (Memorandum to L.J. Larson, Center for Lake Superior Environmental Studies, University of Wisconsin-Superior, Superior, WI. August 31).

Buccafusco, R.J., S.J. Ells and G.A. LeBlanc. 1981. Acute toxicity of priority pollutants to bluegill (Lepomis macrochirus). Bull. Environ. Contam. Toxicol. 26:446-452.

Call, D.J., L.T. Brooke, N. Ahmad and J.E. Richter. 1983. Toxicity and metabolism studies with EPA priority pollutants and related chemicals in freshwater organisms. EPA-600/3-83-095 or PB83-263665. National Technical Information Service, Springfield, VA.

Geiger, D.L., C.E. Northcott, D.J. Call and L.T. Brooke (Eds.). 1985. Acute toxicities of organic chemicals to fathead minnows (Pimephales promelas). Vol. II. Center for Lake Superior Environmental Studies, University of Wisconsin-Superior, Superior, WI.

Heitmuller, P.T., T.A. Hollister and P.R. Parrish. 1981. Acute toxicity of 54 industrial chemicals to sheepshead minnows (Cyprinodon variegatus). Bull. Environ. Contam. Toxicol. 27:596-604.

Hutchinson, T.C., J.A. Hellebust, D. MacKay, D. Tam and P. Kauss. 1979. Relationship of hydrocarbon solubility to toxicity in algae and cellular membrane efffects. American Petroleum Institute Publication No. 4308. pp. 541-547.

Hutchinson, T.C., J.A. Hellebust, D. Tam, D. MacKay, R.A. Mascarenhas and W.Y Shiu. 1980. The correlation of toxicity to algae of hydrocarbons and halogenated hydrocarbons with their physical-chemical properties. Environ. Sci. Res. 16:577-586.

Konemann, H. 1981. Quantitative structure-activity relationships in fish toxicity studies. Part 1: Relationship for 50 industrial pollutants. Toxicology 19:209-221.

LeBlanc, G.A. 1980. Acute toxicity of priority pollutants to water flea (Daphnia magna). Bull. Environ. Contam. Toxicol. 24:684-691.

Richter, J.E., S.F. Peterson and C.F. Kleiner. 1983. Acute and chronic toxicity of some chlorinated benzenes, chlorinated ethanes, and tetrachloroethylene to Daphnia magna. Arch. Environ. Contam. Toxicol. 12:679-684.

Stephan, C.E., D.I. Mount, D.J. Hansen, J.H. Gentiles, G.A. Chapman and W.A. Brungs. 1985. Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses. PB85-227049. National Technical Information Service, Springfield, VA.

Stephan, C.E., G.A. Chapman, D.J. Hansen and T.W. Purcell. 1986. Guidelines for deriving ambient aquatic life advisory concentrations. December 11 draft. U.S. EPA Environmental Research Laboratory, Duluth, MN.

Thursby, G.B. and R.L. Steele. 1986. Comparison of short- and long-term sexual reproduction tests with the marine red alga Champia parvula. Environ. Toxicol. Chem. 5:1013-1018.

Thursby, G.B., R.L. Steele and M.E. Kane. 1985. Effect of organic chemicals on growth and reproduction in the marine red alga Champia parvula. Environ. Toxicol. Chem. 4:797-805.

U.S. EPA. 1978. In-depth studies on health and environmental impacts of selected water pollutants. (Table of data available from Charles E. Stephan, U.S. EPA, Duluth, MN.)

Veith, G.D., K.J. Macek, S.R. Petrocelli and J. Carroll. 1980. An evaluation of using partition coefficients and water solubility to estimate bioconcentration factors for organic chemicals in fish. In: Aquatic toxicology. Eaton, J.G., P.R. Parrish and A.C. Hendricks (Eds.). ASTM STP 707. American Society for Testing and Materials. Philadelphia, PA. pp. 116-129.

Veith, G.D., D.J. Call and L.T. Brooke. 1983. Estimating the acute toxicity of narcotic industrial chemicals to fathead minnows. In: Aquatic toxicology and hazard assessment. ASTM STP 802. Bishop, W.E., R.D. Cardwell and B.B. Heidolph (Eds.). American Society for Testing and Materials. Philadelphia, PA. pp. 90-97.

Walbridge, C.T., J.T. Fiandt, G.L. Phipps and G.W. Holcombe. 1983. Acute toxicity of ten chlorinated aliphatic hydrocarbons to the fathead minnow (Pimephales promelas). Arch. Environ. Contam. Toxicol. 12:661-666.

SECTION V. EPA CONTACTS

AQUATIC LIFE ADVISORIES

For further information regarding the aquatic life and fish and water exposure advisories contact:

_____	FTS 382-7144	(202)382-7144
_____	FTS 475-7315	(202)475-7315