Fact Sheet Date: March 12, 1998

NEW YORK STATE
- HUMAN HEALTH FACT SHEET -

Ambient Water Quality Value for
Protection of Sources of Potable Water

SUBSTANCE: p,p'-DDT **CAS REGISTRY NUMBER:** 50-29-3

AMBIENT WATER QUALITY VALUE: 0.2 ug/L

BASIS: Oncogenic

I INTRODUCTION

This value applies to the water column and is designed to protect humans from the effects of contaminants in sources of drinking water; it is referred to as a Health (Water Source) or H(WS) value.

Regulations (6 NYCRR 702.2) require that the water quality value be based on the procedures in sections 702.3 through 702.7. A previous fact sheet supported a value of 0.01 ug/L for the sum of p,p'-DDT, p,p'-DDD and p,p'-DDE (NYS, 1984). Available information on p,p'-DDT was examined as described in "Scope of Review," below. Potential water quality values are derived below, and the value of 0.2 ug/L selected as described under "Selection of Value."

II PRINCIPAL ORGANIC CONTAMINANT CLASSES AND SPECIFIC MCL (702.3)

A. Discussion

p,p'-DDT does not have a Specific MCL as defined in 700.1. However, it is in principal organic contaminant class iii as defined in 700.1.

The U.S. Environmental Protection Agency has not established a maximum contaminant level goal (MCLG) or MCL for drinking water for p,p'-DDT.

Under the State Sanitary Code (10 NYCRR Part 5, Public Water Supplies), the New York State Department of Health has established a general maximum contaminant level of 5 ug/L for principal organic contaminants such as p,p'-DDT in drinking water.

B. Derivation of Water Quality Value

Because p,p'-DDT is in a principal organic contaminant class and has no Specific MCL, regulations require that the water quality value not exceed 5 ug/L.

III ONCOGENIC EFFECTS (702.4)

A. Data

U.S. EPA (1994) classifies p,p'-DDT as B2; a probable human carcinogen, based on the observation of tumors (generally of the liver) in seven studies in mice and three in rats. p,p'-DDT is an animal oncogen as defined in 6 NYCRR 700.1.

U.S. EPA (1995) in a comprehensive review documenting its Tier I Human Cancer Criterion for p,p'-DDT under the Great Lakes Water Quality Initiative, presents a slope factor of 0.34 $(mg/kg/day)^{-1}$ for this substance. (See Exhibit 1). This slope factor, which is the geometric mean of ten slope factors from six studies, is believed an appropriate basis for the ambient water quality value derived in this fact sheet.

B. Derivation of Water Quality Value

The above slope factor was calculated by U.S. EPA using an interspecies scaling of doses based on the 2/3 power of relative body weights. Proposed New York State regulations call for such scaling to be done on the basis of the 3/4 power of relative body weights. An adjustment to U.S. EPA's slope is needed to account for the different scaling methods.

The adjustment factor for mouse (body weight of 0.030 kg) and rat (body weight of 0.35 kg) data is a multiplication factor of 0.556 based on a weighted average of the number of slopes from each species, which results in a slope of 0.189 $(mg/kg/day)^{-1}$.

At the one-in-one million risk level, the slope factor of 0.189 $(mg/kg/day)^{-1}$ corresponds to a human dose of 5.29×10^{-3} ug/kg/day as shown below:

$$\text{Human dose} = \frac{\text{risk level}}{\text{slope factor}}$$

$$= \frac{1 \times 10^{-6} \times 1000 \text{ ug/mg}}{0.189 \text{ (mg/kg/day)}^{-1}} = 5.29 \times 10^{-3} \text{ ug/kg/day}$$

Multiplying by an animal body weight of 70 kg and dividing by a drinking water consumption rate of 2 L/day, a potential water quality value is calculated as follows:

$$\frac{5.29 \times 10^{-3} \text{ ug/kg/day} \times 70 \text{ kg}}{2 \text{ L/day}} = 0.185 \text{ ug/L, rounded to } 0.2 \text{ ug/L}$$

IV NON-ONCOGENIC EFFECTS (702.5)

A. Data

U.S. EPA (1994) derived an oral reference dose (RfD) of 5×10^{-4} mg/kg/day for p,p'-DDT based on a NOEL of 1 ppm (0.05 mg/kg/day) from a 27-week rat feeding study by Laug et al. (1950). U.S. EPA (1995) used the same study and uncertainty factor as the basis of their Human Noncancer Criterion under the Great Lakes Water Quality Initiative (see Exhibit 2). This study is believed appropriate to derive a potential water quality value based on non-oncogenic effects.

B. Derivation of Water Quality Value

1. Selection of Data

   The study by Laug et al. (1950) was judged the most appropriate for deriving a water quality value based on non-oncogenic effects.

2. Calculation of Acceptable Daily Intake (ADI)

   An ADI is calculated from this study by dividing the NOEL of 0.05 mg/kg/day by a total uncertainty factor of 100 as follows:

$$\text{ADI} = \frac{0.05 \text{ mg/kg/day}}{100} = 5 \times 10^{-4} \text{ mg/kg/day}$$

   This uncertainty factor was selected to account for intraspecies (10) and interspecies (10) differences.

3. Calculation of Water Quality Value

   A potential water quality value is calculated from the ADI, above, based on a 70 kg adult consuming 2 liters of water per day and allocating 20% of the ADI to come from drinking water, as follows:

$$\text{Water Quality Value} = \frac{(5 \times 10^{-4} \text{ mg/kg/day})(1000 \text{ ug/mg})(70 \text{ kg})(0.2)}{2 \text{ L/day}}$$

= 3.5 ug/L, rounded to 4 ug/L

V CHEMICAL CORRELATION (702.7)

A potential water quality value for p,p'-DDT using chemical correlation was not derived because sufficient data exist to derive values based on 702.4 and 702.5.

VI SELECTION OF VALUE

The H(WS) value is designed to protect humans from oncogenic and non-oncogenic effects from contaminants in sources of drinking water. To protect for these effects, regulations (6 NYCRR 702.2(b)) require that the value be the most stringent of the values derived using the procedures found in sections 702.3 through 702.7. The oncogenic value of 0.2 ug/L (6 NYCRR 702.4) is the most stringent value derived by these procedures and is the ambient water quality value for p,p'-DDT.

VIII REFERENCES

Bayard, S. 1991. Toxicologist/Statistician with the U.S. EPA Office of Research and Development, Human Health Assessment Group. Personal communication with R. Sills, Michigan Department of Natural Resources. [As cited by U.S. EPA, 1995]

Cabral, J.R.P., R.K. Hall, L. Rossi, S.A. Bronczyk and P. Shubik. 1982. Effects of long-term intake of DDT on rats. Tumori. 68:11-17. [As cited by U.S. EPA, 1995]

Holder, J. 1991. Toxicologist with the U.S. EPA Office of Research and Development, Human Health Assessment Group. Personal communication with R. Sills, Michigan Department of Natural Resources. [As cited by U.S. EPA, 1995]

Laug, E.P., A.A. Nelson, O.G. Fitzhugh and F.M. Kunze. 1950. Liver cell alteration and DDT storage in the fat of the rat induced by dietary levels of 1-50 ppm DDT. J. Pharmacol. Exp. Therap. 98: 268-273. [As cited by U.S. EPA, 1995]

6 NYCRR (New York State Codes, Rules and Regulations). Water Quality Regulations, Surface Water and Groundwater Classifications and Standards: Title 6 NYCRR, Chapter X, Parts 700-705. Albany, NY: New York State Department of Environmental Conservation.

10 NYCRR (New York State Codes, Rules and Regulations). Public Water Systems: Title 10 NYCRR, Chapter 1, State Sanitary Code, Subpart 5-1. Albany, NY: New York State Department of Health, Bureau of Water Supply Protection.

NYS (New York State). 1984. Ambient Surface Water Quality Standards Documentation. DDT; DDD; DDE. Albany, NY: Department of Health.

Rossi, L., M. Ravera, G. Repetti and L. Santi. 1977. Long-term administration of DDT or phenobarbital-Na in Wistar rats. Int. J. Cancer. 19:179-185. [As cited by U.S. EPA, 1995]

Schoeny, R. 1991. U.S. EPA Environmental Criteria Assessment Office, Chair of the Cancer Risk Assessment Verification Endeavor (CRAVE) workgroup. Personal communication with R. Sills, Michigan Department of Natural Resources. [As cited by U.S. EPA, 1995]

Tarjan, R. and T. Kemeny. 1969. Multigeneration studies on DDT in mice. Food Cosmet. Toxicol. 7:215-222. [As cited by U.S. EPA, 1995]

Terracini, B., M.C. Testa, J.R. Cabral and N. Day. 1973. The effects of long-term feeding of DDT to BALB/c mice. Int. J. Cancer. 11:747-764. [As cited by U.S. EPA, 1995]

Thorpe, E. and A.I.T. Walker. 1973. The toxicology of dieldrin (HEOD). II. Comparative long-term oral toxicity studies in mice with dieldrin, DDT, phenobarbitone, β-BHC and gamma-BHC. Fd. Cosmet. Toxicol. 11: 433-442. [As cited by U.S. EPA, 1995]

Tomatis, L. and V. Turusov. 1975. Studies on the carcinogenicity of DDT. Gann Monograph Cancer Res. 17:219-241. [As cited by U.S. EPA, 1995]

Turusov, V.S., N.E. Day, L. Tomatis, E. Gati and R.T. Charles. 1973. Tumors in CF-1 mice exposed for six consecutive generations to DDT. J. Natl. Cancer Inst. 51:983-998. [As cited by U.S. EPA, 1995]

U.S. EPA (Environmental Protection Agency). 1980. 45 Federal Register No. 231, pp.79347-79356. Appendix C - Guidelines and Methodology Used in the Preparation of the Consent Decree Water Criteria Documents. [As cited by U.S. EPA, 1995]

U.S. EPA (Environmental Protection Agency). 1986a. The Assessment of the Carcinogenicity of Dicofol (Kelthane), DDT, DDE, and DDD (TDE). OHEA/ORD. EPA/600/6-86/001. PB 87-110904. [As cited by U.S. EPA, 1995]

U.S. EPA (Environmental Protection Agency). 1986b. 51 Federal Register No. 185, pp. 33992-34003. Guidelines for Carcinogen Risk Assessment. [As cited by U.S. EPA, 1995]

U.S. EPA (Environmental Protection Agency). 1987. Integrated Risk Information System (IRIS database). Chemical file for DDT (59-29-3). Verification Date 6/24/87. Last Revised 5/1/91. [As cited by U.S. EPA, 1995]

U.S. EPA (Environmental Protection Agency). 1989. Risk Assessment Guidance for Superfund. Volume 1. Human Health Evaluation Manual (Part A). Interim Final. OERR. EPA/540/1-89/002. [As cited by U.S. EPA, 1995]

U.S. EPA (Environmental Protection Agency). 1992. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States Compliance. Fed. Register 57(246):60848-60923. December 22, 1992.

U.S. EPA (Environmental Protection Agency). 1994. p,p'-Dichlorodiphenyl-trichloroethane (DDT). On-line. Integrated Risk Information System (IRIS). Cincinnati, OH: Office of Research and Development, Environmental Criteria and Assessment Office.

U.S. EPA (Environmental Protection Agency). 1995. Great Lakes Water Quality Initiative Criteria Documents for the Protection of Human Health. Office of Water. EPA-820-B-95-006.

VIII SCOPE OF REVIEW

Several of the widely-recognized sources listed below can provide a comprehensive review and often a quantitative assessment of the toxicity of a substance. These sources were searched for information on DDT; where none was found it is so noted.

- IRIS (U.S. EPA's Integrated Risk Information System) (on-line).
- RTECS (Registry of Toxic Effects of Chemical Substances) (on-line).

- CCRIS (Chemical Carcinogenesis Research Information System). On-line database.

- ATSDR (Agency for Toxic Substances and Disease Registry) toxicological profile.

- U.S. EPA health advisory (document not found).

- U.S. EPA drinking water criteria document (document not found).

- IARC (International Agency for Research on Cancer) Monographs Supplement 7.

Sources reviewed by NYSDOH (1984) include:

- IARC (International Agency for Research on Cancer). 1974. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. 5: 83-124.

- National Academy of Sciences. 1977. Drinking Water and Health, Vol. 1. National Academy of Sciences. Washington, D.C.

- U.S. Environmental Protection Agency. 1980. Ambient water quality criteria for DDT. NTIS No. PB81-117491.

The sources above were deemed adequate to assess the literature through 1990. Coverage of recent literature was provided by a New York State Library on-line search of the databases listed below.

- NTIS (National Technical Information Service)

- TOXLINE

- BIOSIS

New York State Department of Environmental Conservation
Division of Water
SJS
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ATTACHMENT

EXHIBIT I
(FROM U.S. EPA, 1995)

GREAT LAKES WATER QUALITY INITIATIVE
TIER I HUMAN HEALTH CRITERIA FOR
P,P'-DICHLORODIPHENYLTRICHLOROETHANE (DDT)
CAS NO. 50-29-3

Tier 1 Human Cancer Criterion

A review of the available literature for DDT carcinogenicity reveals a lack of adequate epidemiological data and an extensive database of chronic oral rodent bioassays. These studies indicate that the induction of liver tumors is the most consistent and significant tumorigenic response to DDT in rodents. EPA (1987) has classified the weight of evidence of DDT carcinogenicity as B2 based on multiple positive studies in two species (mice and rats), with ancillary evidence including promoting activity, genotoxicity, and structural relation to other rodent liver carcinogens. Therefore, the data are sufficient for Tier 1 HCC derivation.

The animal bioassay providing the highest slope factor estimation is the multigeneration mouse feeding study of Tarjan and Kemeny (1969). The predominant tumor types were leukemias and lung tumors; a significant liver response was not seen. EPA (1980) derived ambient water quality criteria from the slope factor of 8.422 $(mg/kg/day)^{-1}$ from this study.

EPA (1986a) evaluated the carcinogenicity of DDT and other related compounds and determined that the Tarjan and Kemeny (1969) study was not the most appropriate basis for quantitative risk assessment. The study's findings were not consistent with the numerous other positive bioassays in terms of the organ site (lung/leukemia versus liver) and the slope factor (about an order of magnitude greater). This slope factor was judged to be a statistical outlier in relation to the liver tumor induction data from six key studies, and the quality and validity of the study was also questionable. EPA (1986a) derived a slope factor from the consistent finding of liver tumor induction in rats and mice, for which the six key studies provided slope factors within a 13-fold range. The recommended slope factor of 3.4 E-1 $(mg/kg/day)^{-1}$ was derived as the geometric mean of ten slope factors from those six studies (Turusov et al., 1973; Terracini et al., 1973; Thorpe and Walker, 1973; Tomatis and Turusov, 1975; Cabral et al., 1982; Rossi et al., 1977). The averaging procedure was followed because no further database refinement or rejection could be logically made, and the geometric average of the values was viewed as the best rational estimate of the slope factor (EPA, 1986a). The EPA's CRAVE workgroup has reviewed and accepted this approach to slope factor estimation as a method to include all relevant data (EPA, 1987).

This averaging approach to slope factor estimation utilizing multiple studies, species, strains and sexes has not generally been recommended in earlier EPA guidelines (EPA, 1980; 1986b). However, more recently, EPA (1989) has stated: "Occasionally, in situations where no single study is judged most appropriate, yet several studies collectively support the estimate, the geometric mean of estimates from all studies may be adopted as the slope. This practice insures the inclusion of all relevant data" (EPA, 1989). In the specific case of DDT, the averaging process as applied to the best available studies may be the most reasonable means of quantitatively characterizing the carcinogenicity of DDT (Schoeny, 1991; Holder, 1991; Bayard, 1991).

The Tier 1 Human Cancer Criteria for DDT are derived from the slope factor of 3.4×10^{-1} $(mg/kg/d)^{-1}$ based on rodent liver tumor induction in the six key studies.

References:

Bayard, S. 1991. Toxicologist/Statistician with the U.S. EPA Office of Research and Development, Human Health Assessment Group. Personal communication with R. Sills, Michigan Department of Natural Resources.

Cabral, J. et al. 1982. Effects of long-term intake of DDT on rats. Tumori 68:11-17.

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Rossi, L. et al. 1977. Long-term administration of DDT or phenobarbital-Na in Wistar rats. Int. J. Cancer. 19:179-185.

Schoeny, R. 1991. U.S. EPA Environmental Criteria Assessment Office, Chair of the Cancer Risk Assessment Verification Endeavor (CRAVE) workgroup. Personal communication with R. Sills, Michigan Department of Natural Resources.

Tarjan, R. and T. Kemeny. 1969. Multigeneration studies on DDT in mice. Food Cosmet. Toxicol. 7:215-222.

Terracini, B. et al. 1973. The effects of long-term feeding of DDT to BALB/c mice. Int. J. Cancer. 11:747-764.

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Tomatis, L. and V. Turusov. 1975. Studies on the carcinogenicity of DDT. Gann Monograph on Cancer Research. 17:219-241.

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U.S. Environmental Protection Agency (EPA). 1987. Intergrated Risk Information System (IRIS database). Chemical file for DDT (59-29-3). Verification Date 6/24/87. Last Revised 5/1/91.

U.S. Environmental Protection Agency (EPA). 1989. Risk Assessment Guidance for Superfund. Volume 1. Human Health Evaluation Manual (Part A). Interim Final. OERR. EPA/540/1-89/002.

EXHIBIT II
(FROM U.S. EPA, 1995)

GREAT LAKES WATER QUALITY INITIATIVE TIER I HUMAN HEALTH CRITERIA FOR P,P'-DICHLORODIPHENYLTRICHLOROETHANE (DDT) CAS NO. 50-29-3

Tier 1 Human Noncancer Criterion

A review of the available literature indicates that the most appropriate basis for HNC derivation for DDT is the NOAEL from the subchronic rat feeding study of Laug et al. (1950). Weanling rats (15/sex/group) were fed commercial-grade DDT (81% p,p'-DDT, 19% o,p'-DDT) at levels of 0, 1, 5, 10 or 50 ppm for 15-27 weeks. The critical toxic effect was liver toxicity, demonstrated as relatively mild dose-dependent histopathologic changes in hepatocytes at doses of 5 ppm and higher. These included hepatocellular hypertrophy, increased cytoplasmic oxyphilia, and peripheral basophilic cytoplasmic granules. The NOEL was 1 ppm, or 0.05 mg/kg bw/day assuming a food consumption rate of 5% body weight per day. The LOAEL was 5 ppm (0.25 mg/kg bw/day).

The database is judged to be sufficient for Tier 1 HNC derivation. The key study (Laug et al., 1950) provides a subchronic (greater than 90 day) NOEL which is supported and supplemented by other data. In a 2-year rat dietary exposure study (Fitzhugh, 1948) rats were exposed to 10-800 ppm DDT in feed, resulting in liver lesions at all dose levels with a LOAEL of 10 ppm (0.5 mg/kg bw/day). The available mammalian reproduction and developmental studies of DDT indicate that an HNC derived from the critical effect of liver toxicity will be protective of potential human reproductive/ developmental effects (EPA, 1985). The HNC is based on the subchronic rat NOEL of 0.05 mg/kg bw/day, with a total uncertainty factor of 100. An uncertainty factor for subchronic exposure duration is not included because of the corroborating chronic study in the database. This approach is consistent with the oral RfD development by EPA (1985).

$$\text{ADE} = \frac{\text{NOAEL}}{\text{UF}} = \frac{0.05\ \text{mg/kg/d}}{100} = 5.0 \times 10^{-4}\ \text{mg/kg/d}$$

Where: Uncertainty Factor = 100, composed of:

10x for interspecies variability
10x for intraspecies differences

References:

Fitzhugh, O. 1948. Use of DDT insecticides on food products. Industrial and Engineering Chemistry. 40(4):704-705.

Laug, E., A. Nelson, O. Fitzhugh and F. Kunze. 1950. Liver cell alteration and DDT storage in the fat of the rat induced by dietary levels of 1-50 ppm DDT. J. Pharmacol. Exp. Therap. 98:268-273.

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