

Fact Sheet Date: March 12, 1998

**NEW YORK STATE
- HUMAN HEALTH FACT SHEET -**

**Ambient Water Quality Value
Based on Human Consumption of Fish**

SUBSTANCE: Heptachlor Epoxide

CAS REGISTRY NUMBER: 1024-57-3

AMBIENT WATER QUALITY VALUE: 3×10^{-4} ug/L

BASIS: Bioaccumulation

INTRODUCTION

This value applies to the water column and is designed to protect humans from the effects of waterborne contaminants that may bioaccumulate in fish; it is referred to as a Health (Fish Consumption) or H(FC) value. The H(FC) value is based on three components, the toxicity of the substance to humans, the extent to which it bioaccumulates in fish, and the rate of fish consumption.

SUMMARY OF INFORMATION

A. Toxicity

The toxicity of heptachlor epoxide relevant to human health is described in a separate fact sheet (NYS, 1997). That fact sheet, which supports an ambient water quality value for protection of sources of potable water, derives a human dose of 7.41×10^{-4} ug heptachlor epoxide/kg/day, corresponding to an excess lifetime cancer risk of one-in-one million.

B. Bioaccumulation

A measurement of bioaccumulation is necessary to derive a value to protect human consumers of fish. Bioaccumulation is the process by which a substance becomes concentrated in an organism through the organism's exposure to the contaminant in food and water. Bioaccumulation is represented numerically by a

bioaccumulation factor, or BAF, which is the ratio of the concentration of a substance in the organism to that in the water column.

The term bioconcentration also describes the concentration of a substance in an organism relative to the concentration in the water column. A bioconcentration factor (BCF), however, is measured with exposure to the contaminant by water only. A BCF may be equal to the BAF for many substances, but can substantially underestimate it for others.

U.S. EPA (1995a) has promulgated, as final Federal regulations, procedures for deriving bioaccumulation factors. The procedures are believed appropriate for deriving statewide values and are being used in this fact sheet.

A key aspect of this procedure is that bioaccumulation is believed to be related to the concentration of freely dissolved substance. Hydrophobic organic substances are considered to exist in water in three phases: freely dissolved, sorbed to dissolved organic matter and sorbed to suspended solids (U.S. EPA, 1995b). Because BAF determinations are often based on measurements of total or dissolved substance, a measured BAF must be adjusted based on the estimated fraction of freely dissolved material. In addition, because measured BAFs are determined based on the percent lipid in the species studied, they are adjusted, or normalized, to 100% lipid to allow comparison of BAFs derived from species with different tissue lipid fractions. A BAF adjusted for both fraction freely dissolved and normalized to 100% lipid is referred to as a "baseline BAF."

Although bioaccumulation is related to the freely dissolved substance, water quality criteria are based on total substance. A baseline BAF, therefore, is readjusted to a final BAF by the expected fraction freely dissolved and fish lipid content for the waters for which criteria are established. The relationship of field-measured or final BAF to the baseline BAF is shown in equation 1:

$$(Eq. 1) \quad \text{Baseline BAF} = \left[\frac{\text{Field or Final BAF}}{f_{fd}} \right] \left[\frac{1}{f_l} \right]$$

where f_l = fraction of tissue that is lipid and f_{fd} = fraction of substance that is freely dissolved.

U.S. EPA (1995b) presented the following equation for estimating f_{fd} :

$$(Eq. 2) \quad f_{fd} = \frac{1}{1 + \frac{(\text{DOC})(K_{ow})}{10} + (\text{POC})(K_{ow})}$$

where K_{ow} is the n-octanol-water partition coefficient of the substance in question, and DOC and POC are concentrations of dissolved and particulate organic carbon,

respectively, in kg/L. The basis for this equation is described by U.S. EPA (1995b).

When deriving a baseline BAF from a field-measured BAF, DOC and POC levels under which the field BAF was determined are used to calculate a f_{fd} . When the baseline BAF is readjusted to yield a final BAF, the DOC and POC levels appropriate for the applicability of the criterion are used.

Derivation of Baseline BAFs

The procedures (U.S. EPA, 1995 a,b) provide a hierarchy of methods to calculate a baseline BAF. A field-measured BAF for heptachlor epoxide, preferred under the procedures, was not found (U.S. EPA, 1993, 1995b). Therefore, a predicted baseline BAF from a laboratory-measured BCF, is calculated, using the following equation:

$$\text{Predicted Baseline BAF} = (\text{FCM}) \left[\frac{\text{Measured BCF}}{f_{fd}} \right] \left[\frac{1}{f_l} \right]$$

where FCM is a Food-Chain Multiplier, f_{fd} is the fraction of freely dissolved substance, and f_l is the fraction of lipid.

U.S. EPA (1993) presents a geometric mean normalized (to 1% lipid) BCF of 1,895 L/kg, based on Veith et al. (1979), and a "typical Log P" (log K_{ow}) of 4.09. From Table B1 U.S. EPA (1995a) this corresponds to FCMs of 1.309 for trophic level 3 and 1.094 for trophic level 4. As the value of f_{fd} will be close to 1 for log K_{ow} in this range, this fact sheet will use 1 for the f_{fd} . The value for f_l is 0.01 as the BCF was normalized to 1% lipid. Predicted baseline BAFs for trophic levels 3 and 4 are calculated below.

$$\text{Predicted Baseline BAF}_{\text{TL3}} = (1.309) \left[\frac{1,895 \text{ L/kg}}{1} \right] \left[\frac{1}{0.01} \right] = 247,900 \text{ L/kg}$$

$$\text{Predicted Baseline BAF}_{\text{TL4}} = (1.094) \left[\frac{1,895 \text{ L/kg}}{1} \right] \left[\frac{1}{0.01} \right] = 207,200 \text{ L/kg}$$

The readjustment of this baseline BAF to a final BAF is described below.

DERIVATION OF WATER QUALITY VALUE

As required by 6 NYCRR 702.8(a) the water quality value must equal the acceptable daily intake from fish consumption divided by a bioaccumulation factor and by a fish consumption rate of 0.033 kg/day.

A. Acceptable Daily Intake From Fish Consumption

As required by 6 NYCRR 702.8(b), the most stringent acceptable daily intake from fish consumption is the human dose for oncogenic effects, as determined from 6 NYCRR 702.4. This value is 7.41×10^{-4} ug heptachlor epoxide/kg/day from NYS (1997) as described above.

B. Final BAFs

As described above, a baseline BAF is adjusted by the fish lipid fraction and the fraction freely dissolved to yield a final BAF for the substance. Equation 1 (above) is rearranged to solve for final BAF:

$$\text{Final BAF} = [(\text{baseline BAF})(f_l) + 1](f_{fd})$$

where values for f_l and f_{fd} are appropriate to criteria for New York State. Because, as described below, humans are exposed to fish from two trophic levels, this calculation is performed to generate final BAFs for trophic levels 3 and 4.

A fish lipid content of 3% had previously been used when calculating BAFs for deriving criteria for New York State. U.S. EPA (1995a) apportions daily fish consumption between fish of trophic levels 3 and 4. Specifically, 24% is assigned to trophic level 3 fish, with a standardized lipid fraction of 0.0182 (1.82%), and 76% to trophic level 4 fish, with a standardized lipid fraction of 0.0310 (3.1%). The weighted average lipid fraction of trophic level 3 and 4 fish is thus 0.028 (2.8%), which is very close to the value of 3% that had been used in New York State. U.S. EPA's apportionment approach is believed to be protective of human consumers of fish statewide, and will be used in the derivation of the water quality value in this fact sheet to achieve consistency with requirements for the Great Lakes System.

As in the derivation of the baseline BAF, a value of 1 will be used for the f_{fd} in calculating the final BAFs.

As described above, the baseline BAFs for heptachlor epoxide for trophic levels 3 and 4 are 247,900 and 207,200 L/kg respectively.

The final BAF for trophic level 3 is calculated as:

$$\text{Final BAF}_{\text{TL3}} = [(\text{baseline BAF}_{\text{TL3}})(f_{\text{I TL3}}) + 1](f_{\text{fd}}) =$$

$$\text{Final BAF}_{\text{TL3}} = [(247,900)(0.0182)+1](1) = 4,510 \text{ L/kg}$$

The final BAF for trophic level 4 is calculated as:

$$\text{Final BAF}_{\text{TL4}} = [(\text{baseline BAF}_{\text{TL4}})(f_{\text{I TL4}}) + 1](f_{\text{fd}}) =$$

$$\text{Final BAF}_{\text{TL4}} = [(207,200)(0.0310)+1](1) = 6,420 \text{ L/kg}$$

C. Human Exposure (Fish Consumption)

6 NYCRR 702.8 requires that H(FC) values be based on a fish consumption rate of 0.033 kg/day.

D. Calculation of Water Quality Value

The water quality value (WQV) is derived using a human body weight of 70 kg and a daily fish consumption rate of 0.033 kg as shown below. The fish consumption is apportioned as 24% trophic level 3 and 76% trophic level 4.

$$\text{WQV} = \frac{\text{Acceptable Daily Intake from Fish Consumption} \times 70 \text{ kg}}{[(\text{BAF}_{\text{TL3}})(0.24) + (\text{BAF}_{\text{TL4}})(0.76)] \times 0.033 \text{ kg/day}}$$

$$\begin{aligned} \text{WQV} &= \frac{7.41 \times 10^{-4} \text{ ug heptachlor epoxide/kg/day} \times 70 \text{ kg}}{[(4,510 \text{ L/kg})(0.24) + (6,420 \text{ L/kg})(0.76)] \times 0.033 \text{ kg/day}} \\ &= 2.64 \times 10^{-4} \text{ ug/L, rounded to } 3 \times 10^{-4} \text{ ug/L} \end{aligned}$$

REFERENCES

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: Department of Environmental Conservation.

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U.S. EPA (Environmental Protection Agency). 1995b. Great Lakes Water Quality Initiative Technical Support Document for the Procedure to Determine Bioaccumulation Factors. Office of Water. EPA-820-B95-005.

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