

Appendix I

Alternative Method for Estimating Dermal Absorption

1 **ESTIMATING *k***

2 As discussed above, Eq I-2 is based on the assumption of slow soil-release kinetics.
3 Assuming that desorption from soil is slow relative to dermal permeation, the rate of dermal
4 permeation can be used to estimate the rate of desorption from soil. This approach is used here.

5 As discussed in Section 5, this report derives the dermal absorption properties of dioxin
6 from Roy et al. (1990), who measured dermal absorption of tetrachlorodibenzo-*p*-dioxin (TCDD)
7 in soil with an organic carbon content of 0.45% and applied at supermonolayer coverage
8 (monolayer estimated as 1.3 mg/cm² and amount applied was 6 mg/cm²). The saturation limit
9 for TCDD in this soil was estimated as follows:

$$C_{sat} = F_{oc} K_{oc} S_w \tag{I-3} \text{where:}$$

- 10 C_{sat} = saturation limit for TCDD in soil (mg/kg)
- 11 F_{oc} = fraction organic carbon in soil = 0.0045
- 12 K_{oc} = organic carbon-to-water partition coefficient = 10⁷ L/kg (U.S. EPA, 2003)
- 13 S_w = solubility of TCDD in water = 2 × 10⁻⁵ mg/L (U.S. EPA, 2003)

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15 On this basis, the soil used by Roy et al. would have a saturation limit for TCDD of 0.8 mg/kg.
16 Roy et al. used soils with TCDD concentration of 1 mg/kg (1 ppm). Thus, the testing was
17 conducted at levels slightly above the saturation limit, which should yield maximum flux rates
18 through the skin.

19 The 24-hour average flux rate from Roy et al. was calculated as follows:

$$J = AbsDose / (A_{exp} t_{exp}) \tag{I-4} \text{where:}$$

- 20 J = flux through the skin (ng cm⁻² hr⁻¹)
- 21 AbsDose = 0.048 ng (includes amount in skin)
- 22 A_{exp} = 1.77 cm²
- 23 t_{exp} = 24 hr

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25 This yields a flux estimate of 0.0011 ng cm⁻² hr⁻¹. Now, an absorption rate constant (k_a) can be
26 calculated as follows:

$$k_a = J_{SM} / C_{sat} \tag{I-5} \text{where:}$$

- 27 J_{SM} = maximum flux for supermonolayer coverage = 0.0011 ng cm⁻² hr⁻¹
- 28 C_{sat} = 0.8 mg/kg = 0.8 ng/mg

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30 On this basis, k_a is estimated to be 0.0014 mg cm⁻² hr⁻¹ and assumed equal to k .

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ESTIMATING THE ABSORBED DOSE

Finally, the absorbed dose can be calculated using Eq I-2. As an example, the parameter values for Subject 2 were used:

$$\begin{aligned} C_{\text{soil},0} &= 162 \text{ pg/g} = 0.162 \text{ pg/mg} \\ A_{\text{exp}} &= 970 \text{ cm}^2 \\ t_{\text{exp}} &= 4 \text{ hr} \\ f_{\text{area}} &= 1.0 \text{ (actual load exceeded monolayer)} \end{aligned}$$

This yields an absorbed dose of 0.88 pg. The absorbed dose calculation presented in Section 7 included an adjustment to reflect the observed difference between rat in vivo testing and rat in vitro testing. These tests indicated that the absorbed dose in vivo was about twice as high as the absorbed dose in vitro. Applying that factor to the dose estimate derived above yields an absorbed dose of 1.8 pg. This is very similar to the value reported in Table 9 (1.65 pg) based on the fraction absorbed approach. Note that the amount of dioxin in the monolayer can be estimated as 97 pg ($0.162 \text{ pg/mg} \times 0.62 \text{ mg/cm}^2 \times 970 \text{ cm}^2$). This means that the absorbed dose is less than 10% of the applied dose and Eq I-2 is valid to use.

1 **REFERENCES**

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Bunge, AL; Parks, JM. (1998) Soil contamination: theoretical descriptions. In: Roberts, MA; Walters, KA, eds. Dermal absorption and toxicity assessment. New York, NY: Marcel Dekker; pp. 669–696.

Roy, TA; Yang, JJ; Krueger, AJ; et al. (1990) Percutaneous absorption of neat 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and TCDD sorbed on soils. Toxicology 10(1):308.

U.S. EPA (Environmental Protection Agency). (1992) Dermal exposure assessment: principles and applications. Office of Science Policy, Office of Research and Development, Washington, DC; EPA/600/8-91/011B. Available online at <http://www.epa.gov/osa/spc>.

U.S. EPA (Environmental Protection Agency). (2004) Risk assessment guidance for Superfund. Vol. I: human health evaluation manual (part E, supplemental guidance for dermal risk assessment). Office of Superfund Remediation and Technology Innovation, Washington, DC; EPA/540/R/99/005. Available online at <http://www.epa.gov/superfund/programs/risk/ragse/index.htm>.