

## More Details on Dioxin 90 ppt value

# Excerpt from **PART 201 GENERIC SOIL DIRECT CONTACT CRITERIA**

## **TECHNICAL SUPPORT DOCUMENT**

**Michigan Department of Environmental Quality  
Environmental Response Division**

**August 31, 1998**

### **GENERAL INFORMATION ABOUT THE DIRECT CONTACT ALGORITHMS**

The equations yield values which represent concentrations of contaminants in soil in units of micrograms per kilogram (ug/kg) or parts per billion (ppb). To convert to units of parts per million or milligrams per kilogram (mg/kg) in soil, divide by 1,000.

The acceptable level of risk for carcinogens is one in one hundred thousand ( $10^{-5}$ ). Exposure to noncarcinogens is evaluated through the use of a hazard quotient (HQ). The HQ is the ratio of a single substance's exposure level over a specified time period to a reference dose for that substance derived from a similar exposure period. An acceptable HQ is equal to or less than one. An HQ > 1 indicates an unacceptable exposure (i.e., the exposure level is greater than the reference dose).

The EPA provides general guidance on how to characterize exposures and risks when conducting risk assessments. For exposure assessments, intake and exposure values should be selected so that the combination of all variables results in an estimate of the reasonable maximum exposure (RME) for that pathway. The RME is the maximum exposure that is reasonably expected to occur at a site. Under this approach, some intake variables may not be at their individual maximum values, but when in combination with other variables, will result in estimates of the RME (EPA, 1989). EPA guidance (EPA, 1992a), recommends estimating the high-end exposure by "...identifying the most sensitive parameters and using maximum or near-maximum values for one or a few of these variables, leaving others at their mean values." This guidance applies when only limited information on the distribution of the exposure or dose factors is available. This recommendation is based on the fact that maximizing all variables will result in an estimate that is above the range of actual values seen in the population. The algorithms presented in this document follow EPA guidance by combining exposure assumptions which represent a mix of high-end and mid-range values. For example, when evaluating the direct contact equation, a 70 year life span, body weight and surface area all represent a 50th percentile, while the exposure duration of 21 years and the soil ingestion rate represent 90th percentile values.

The selection of an appropriate averaging time (AT) is dependent upon the type of toxic effect being evaluated. AT represents the number of days over which the exposure is averaged. When evaluating long-term exposure to noncarcinogenic compounds, exposures are calculated by averaging over the period of exposure (i.e., subchronic or chronic exposures). The approach for developmental toxicants is different. Since one dose of a development toxicant can cause adverse effects (particularly during organogenesis), the acceptable daily dose should not be averaged. That is, AT and the exposure parameters (EF and ED) for developmental toxicants

should equal 1. For carcinogenic compounds, exposures are calculated by prorating the total cumulative dose over a lifetime (also called lifetime average daily dose). The approach for carcinogens is based on the assumption that a high dose of a carcinogen received over a short period of time is equivalent to a corresponding low dose spread over a lifetime.

The absorption efficiencies of contaminants for the gastrointestinal tract and skin are based on the volatility of the chemical, specifically the vapor pressure. Chemicals with a vapor pressure greater than 0.1 millimeters Hg are considered volatile. When chemical-specific data are not available, the default absorption efficiency applicable to ingestion ( $AE_i$ ) shall be either 100 percent for volatile organic chemicals or 50 percent for other organic chemicals, polychlorinated biphenyls, pesticides, or inorganic parameters. When chemical-specific data are not available, the default absorption efficiency applicable to dermal contact ( $AE_d$ ) shall be either 10 percent for volatile organic chemicals or 1 percent for nonvolatile organic chemicals or inorganic compounds.

The adherence factor of  $1.0 \text{ mg/cm}^2$  is the value recommended by EPA (EPA, 1991b). After evaluating the available soil adherence studies, EPA concludes that all of the studies considered have uncertainties thereby making a recommendation difficult. The studies provide a possible range from 0.2 to  $1.5 \text{ mg/cm}^2$ . A conservative central value of  $1.0 \text{ mg/cm}^2$  is recommended until better data are available.

### GENERIC SOIL DIRECT CONTACT ALGORITHMS

#### Generic Residential Soil DCC:

#### CARCINOGENS:

$$DCC = \frac{10^{-5} \times AT \times CF}{SF \times [(EF_i \times IF \times AE_i) + (EF_d \times DF \times AE_d)]}$$

where,

DCC (direct contact criterion)	= ug/kg (ppb)
$10^{-5}$ cancer risk	= target risk
AT (averaging time)	= 25,550 days (70 x 365)
CF (conversion factor)	= $1E+9$ ug/kg
SF (cancer slope factor)	= <b>75,000</b> (mg/kg-d) <sup>-1</sup> 2,3,7,8-TCDD specific
$EF_i$ (ingestion exposure frequency)	= 350 days/yr
IF (age-adjusted soil ingestion factor)	= 114 mg-yr/kg-day*
$AE_i$ (ingestion absorption efficiency)	= (see text)
$EF_d$ (dermal exposure frequency)	= 245 days/yr
DF (age-adjusted soil dermal factor)	= 2442 mg-yr/kg-day**
$AE_d$ (dermal absorption efficiency)	= (see text)

**NONCARCINOGENS: not used for 90 ppt calculation**

$$DCC = \frac{HQ \times RfD \times AT \times CF}{(EF_i \times IF \times AE_i) + (EF_d \times DF \times AE_d)}$$

where,

DCC (direct contact criterion)	= ug/kg (ppb)
HQ (hazard quotient)	= 1
RfD (oral reference dose)	= chemical-specific, mg/kg/day
AT (averaging time)	= 10,950 days (30 x 365)
CF (conversion factor)	= 1E+9 ug/kg
EF <sub>i</sub> (ingestion exposure frequency)	= 350 days/yr
IF (age-adjusted soil ingestion factor)	= 114 mg-yr/kg-day*
AE <sub>i</sub> (ingestion absorption efficiency)	= (see text)
EF <sub>d</sub> (dermal exposure frequency)	= 245 days/yr
DF (age-adjusted soil dermal factor)	= 2442 mg-yr/kg-day**
AE <sub>d</sub> (dermal absorption efficiency)	= (see text)

where,

$$IF_{\text{soil/age-adj}} = \frac{IR_{\text{soil/age 1-6}} \times ED_{\text{age 1-6}}}{BW_{\text{age 1-6}}} + \frac{IR_{\text{soil/age 7-31}} \times ED_{\text{age 7-31}}}{BW_{\text{age 7-31}}}$$

IR <sub>soil/age 1-6</sub> (soil ingestion rate)	= 200 mg/day
ED <sub>age 1-6</sub> (exposure duration)	= 6 years
BW <sub>age 1-6</sub> (body weight)	= 15 kg
IR <sub>soil/age 7-31</sub> (soil ingestion rate)	= 100 mg/d
ED <sub>age 7-31</sub> (exposure duration)	= 24 years
BW <sub>age 7-31</sub> (body weight)	= 70 kg

$$DF_{\text{soil/age-adj}} = \frac{SA_{\text{age 1-6}} \times AF \times ED_{\text{age 1-6}}}{BW_{\text{age 1-6}}} + \frac{SA_{\text{age 7-31}} \times AF \times ED_{\text{age 7-31}}}{BW_{\text{age 7-31}}}$$

where,

SA <sub>age 1-6</sub> (skin surface area)	= 1820 cm <sup>2</sup> /day
AF (soil adherence factor)	= 1.0 mg/cm <sup>2</sup>
ED <sub>age 1-6</sub> (exposure duration)	= 6 years
BW <sub>age 1-6</sub> (body weight)	= 15 kg
SA <sub>age 7-31</sub> (skin surface area)	= 5000 cm <sup>2</sup> /day
AF (soil adherence factor)	= 1.0 mg/cm <sup>2</sup>
ED <sub>age 7-31</sub> (exposure duration)	= 24 years
BW <sub>age 7-31</sub> (body weight)	= 70 kg

Ingestion and dermal contact rates within the residential direct contact soil criterion equation are adjusted to account for differences between children and adults. It is assumed that during the 30 year exposure period, 6 years is spent as a child who ingests more soil/day and the remaining 24 years is spent as a child/adult ingesting less soil/day. This approach is recommended by EPA (EPA, 1991b).

The skin surface area for child and adult receptors in the age-adjusted dermal factor is equal to 25 percent of the 50th percentile of total skin surface area for the respective age group (EPA, 1992c). Dermal exposure to soil is expected to occur on the hands, arms, legs, neck, and head, accounting for approximately 25 percent of the total skin surface area.

For ingestion of soil, EPA guidance (EPA, 1991b) recommends a daily intake rate of 200 mg/day for children aged 1-6 years and 100 mg/day for all others. These intake values are believed to represent upper-bound estimates of average soil ingestion rates.

EPA recommended soil ingestion rates account for ingestion of both outdoor soils and indoor dust. The values are derived primarily from fecal tracer studies which estimate the amount of soil ingested throughout a day's activities. As such, the intake rates are not event-specific (i.e., the rates do not represent the amount of soil ingested only during outdoor activities). Data suggest that up to 80 percent of indoor dust consists of outdoor soils which have been brought into a residence by air deposition and foot traffic. Therefore, it cannot be assumed that ingestion of contaminated soil is entirely precluded by climatic conditions such as snow cover.

There is no currently available method for determining the relative contribution of soil vs. dust to the daily total, or the effect of climatic conditions on the rate of soil ingestion. Therefore, a constant year round exposure is assumed and the appropriate exposure frequency (EF) value for ingestion of soil/dust for the residential soil DCC is 350 days per year.

The exposure duration of 30 years represents the national upper-bound time (90th percentile) at one residence (EPA, 1989). The EF of 350 represents the number of days per year that a resident is exposed to soil at their home; it assumes that people spend approximately 15 days per year away from their homes for vacations or other reasons. Two separate EF values are used for exposure to soil, each specific to the ingestion and dermal routes of exposure. The EPA recommends that local weather conditions such as snow cover be considered in determining the appropriate EF for dermal contact with soil. It is assumed that Michigan winters last for 4 months (120 days) making soil unavailable for contact. Therefore, the EF for dermal contact with soil for the residential soil DCC is 245 days per year (365-120).

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