MEMORANDUM

DATE: October 27, 1994

SUBJECT: Dermal Absorption Information for Trichloroethylene and Perchloroethylene for the Fields Brook Site/Ashtabula, OH

FROM: Joan S. Dollarhide
Director
Superfund Health Risk Technical Support Center

TO: Ed Hanlon
U.S. EPA
Region V

This memorandum responds to the request of Paul Harrison of CH2M Hill for dermal absorption information regarding trichloroethylene and perchloroethylene for the Fields Brook Site/Ashtabula, OH.

Please find attached the following Risk Assessment Issue Papers:

Attachment I. Risk Assessment Issue Paper for: Evaluation of Oral and Dermal Absorption Information for Trichloroethylene (CASRN 79-01-6)


Please contact the Superfund Health Risk Technical Support Center at (513) 569-7300 with any additional questions.

cc: E. Moran (Region V)
P. Harrison (CH2M Hill)
As reviewed by the U.S. EPA (1985) and ATSDR (1991), data for humans and animals are available to indicate that trichloroethylene can be absorbed by the skin, but experimental estimates of fractional dermal absorption efficiencies are not available. Peak levels of trichloroethylene were measured in expired air and in blood within 30 minutes in humans whose hands or thumbs were immersed in the compound indicating that dermal absorption occurs rapidly (Sato and Nakajima, 1978; Stewart and Dodd, 1964). Absorption rates of 7.82 ug/min/cm² were measured in mice when undiluted trichloroethylene was applied to the skin for 15 minutes (Tsuruta, 1978). Jakobson et al. (1982) measured peak blood levels at 0.5 hours in guinea pigs during a 6-hour continuous exposure of skin. The vapor pressure of trichloroethylene (78 mm Hg at 25 C) indicates that volatilization is likely to limit its fractional absorption when applied to uncovered skin as undiluted compound or in soil. Although the lipid solubility and low molecular weight of trichloroethylene indicate that it may be readily absorbed across the skin, the dermal fractional absorption value of 0.05% is recommended for trichloroethylene based on analogy to benzene. As discussed elsewhere in this document, benzene (vapor pressure = 95.2 mm Hg at 25 C) was completely absorbed under occluded conditions in animals, but is barely absorbed when applied to uncovered skin (<0.2% in several species tested; 0.05% in humans).

Review documents for trichloroethylene (ATSDR, 1991; U.S. EPA, 1985) did not find quantitative data on fractional oral absorption efficiency in humans, but noted that there are extensive cases of poisonings following ingestion, thereby indicating that gastrointestinal absorption is extensive. In rats and mice, fractional recoveries of radioactivity in expired air and urine ranged from 80% to 98% following oral administration, indicating that nearly complete absorption of ingested trichloroethylene can occur (Prout et al., 1985; Dekant et al., 1984). Other experiments indicate that fasting and dosing vehicle can influence the kinetics of absorption of ingested trichloroethylene (D'Souza et al., 1985; Withey et al., 1983). Based on the available animal data, a value of 100% is recommended for the oral absorption efficiency of trichloroethylene.

REFERENCES FOR TRICHLOROETHYLENE


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ATSDR (1991) reviewed the available data regarding dermal absorption of tetrachloroethene. Human subjects exposed to tetrachloroethene vapors while wearing a full-facepiece respirator to prevent inhalation absorbed only 1% of the tetrachloroethene that would have been expected without the respirator, showing that dermal absorption of tetrachloroethene vapors is insignificant compared to inhalation absorption of vapors. Studies in animals showed that tetrachloroethene is absorbed across the skin and determined the rate at which this absorption takes place (0.24 mg/cm²/h, which was 2000 times slower than dichloromethane, the fastest compound), but did not calculate an absorption fraction. Comparison to benzene is one way to estimate dermal absorption factor. Studies of dermal absorption of benzene in humans and animals have shown that this compound is almost completely (99%) absorbed across the skin when covered with a watch glass to prevent volatilization, but that absorption falls to trivial levels (<0.2% in all species tested, 0.05% in humans) when application is to the skin uncovered, due to volatilization (Franz, 1984; Skowronski et al., 1988). Tetrachloroethene (vapor pressure = 24 mm Hg at 30°C) is considerably less volatile than benzene (vapor pressure = 95.2 mm Hg at 25°C), so the dermal absorption fraction for tetrachloroethene is expected to be somewhat higher than for benzene. Due to the lack of data to indicate otherwise, the "proposed" dermal absorption factor of 3% may be accepted as a reasonable estimate.

Data regarding absorption of tetrachloroethene following oral exposure were reviewed by U.S. EPA (1988) and ATSDR (1990). Quantitative data were not available for humans, but animal studies show that tetrachloroethene is rapidly and completely absorbed from the gastrointestinal tract. In rats, 98% of a single oral dose was recovered in the expired air and 2% was recovered in the urine, indicating 100% absorption. In mice, 85% of a single oral dose was recovered in the expired air and 12% was recovered in the urine, indicating at least 97% absorption. Based on these data, an oral absorption fraction of 100% is recommended to replace the "proposed" value of 80%, which apparently was based on an assumption rather than actual data (according to the footnote in Table 3-14).
REFERENCES FOR TETRACHLOROETHYLENE


