MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

INTEROFFICE COMMUNICATION

TO: Memo to File for Silicon Tetrafluoride [7783-61-1], aka Silicon Tetrafluoride

FROM: Margaret M Sadoff, Air Quality Division/Toxics Unit

DATE: December 6, 2007

SUBJECT: Derivation of Screening Level

A search of the literature and the following databases was performed for information regarding Silicon Tetrafluoride (SiTF). American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values, National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Hazardous Chemicals, EPA Integrated Risk Information System (IRIS), EPA High Production Volume Information System, Registry of Toxic Effects of Chemical Substances (RTECS), Environmental Protection Bureau Library, International Agency for Research on Cancer (IARC) Monographs, CAS Registry Online, Hazardous Substance Data Bank (HSDB), National Library of Medicine/Toxline, National Library of Medicine ToxSeek, Health Effects Assessment Summary Tables (HEAST), National Toxicology Program (NTP) Study Database, Entrez PubMed, Scirus, IPCS Intox Databank and CaIEPA's Toxicity Values Database.

The ITSL for silicon tetrafluoride is 0.2 µg/m^3 (annual).

General Properties

Sources:
1) INCHEM, IPCS, Environmental Health Criteria 36, Fluorine & Fluorides;
2) Toxline HSDB

SiTF is a colorless gas with a pungent odor. It is corrosive to the eyes, skin and respiratory tract. Inhalation of SiTF gas may cause lung edema and the effects may be delayed. SiTF is heavier than air so a harmful concentration can be achieved quickly. This substance will decompose upon heating to produce corrosive fumes such as hydrogen fluoride (HF). STF reacts with water to form HF and silicic acid. It attacks metals in the presence of water, releasing hydrogen.

A test reaction of SiTF in air at varying humidity levels, and room temperature did not produce significant amounts of HF. Twenty ppm SiTF was released at ambient room temperature and various humidity levels to determine how much hydrogen fluoride would be released, if any. The product broke down completely after 25 minutes at 82% humidity. The main reaction product was silicic acid; HF was not produced in significant amounts at any humidity level tested.
(Source: Ricks GM et aI. (1993). The possible formation of hydrogen fluoride from the reaction of silicon tetrafluoride with humid air. AIHA Journal 54(5): 272-276).

Based on this information, a hydrogen fluoride molar equivalent approach to determine appropriate health protective guideline is not recommended.

SiTF is formed during the combustion of coal and in the manufacture of superphosphate fertilizers, elemental phosphorus, wet-process phosphoric acid, aluminum, and brick and tile products. When bubbled into water, hydrolysis results in the formation of the hexafluorosilicate ion (SiF_6^{2-}), which is very toxic. Most of the fluorosilicates are soluble in water. In plants, where off-gases are scrubbed with water, most of the silicon tetrafluoride is removed as fluorosilicic acid. Fluorosilicic acid is a colorless liquid that is used to fluoridate drinking-water.

Acute exposure to SiTF may result in severe respiratory irritation and injury to the skin and respiratory tract. Largent (1952) listed the increasing intensity of acute effects with increasing concentrations of gaseous fluorides on the basis of controlled exposures of volunteers (1 ppm = 0.7 mg/m^3 for HF) as follows:

> 2.1 mg/m^3 (3 ppm): no local immediate systemic effects;
>
> 7 mg/m^3 (10 ppm): many subjects experienced discomfort;
>
> 21 mg/m^3 (30 ppm): all subjects complained and objected seriously to staying in the environment;
>
> 42 mg/m^3 (60 ppm): at brief exposures, definite irritation of conjunctiva, nasal passages, tickling and discomfort of pharynx and trachea;
>
> 84 mg/m^3 (120 ppm): the highest concentration tolerated (less than 1 minute by 2 male subjects), smarting of skin, as well as above effects were noted.

Screening Level Derivation

There is very little toxicology information available for SiTF. One rat LC50 (no duration given) was found in RTECs (2272 ppm = 9664 mg/m^3). One mouse 1-hour LC50 was provided by Dow Corning, which was listed on the MSDS, but does not seem to have been published elsewhere (450 ppm). A 1-hour rat LC5O was developed by Scheel et al. (1968) using a probit model to obtain a value of 922 ppm. LC50-based ITSLs range from I to 5 $\mu g/m^3$ (annual average).

ACGIH lists a TLV for Flourides as F, generally at 2.5 mg/m^3.

There is a proposed AEGL-1 of 0.05ppm (0.213 mg/m^3) for exposure durations of 10 minutes up to 8 hours. (http:llwww.era.gov/oppt/aegl/pubs/rest209.htm)

Key Study

There is no chronic data for this chemical. The longest duration study found is a 28-day inhalation study in rats that was submitted to the EPA through TsCA by Ethyl Corp. This study is the basis for a proposed AEGL-1 of 0.05 ppm (213 $\mu g/m^3$) (10 mins to 8 hour). Ten Sprague Dawley rats/sex/group were exposed to 0, 0.3, 3.0 and 15 ppm (0, 1.3, 13 and 64 mg/m^3) for 6 hrs/day, 5 days/wk for 28 days (Inhausen Research Institute, 1988). There was no exposure related mortality reported. Complete gross necropsy and histopathology was performed on all animals.

Significant Effects as Reported:

0.3 ppm	Irritation; squamous metaplasia of respiratory epithelium
3.0 ppm	Irritation; lesions in the rostral portion of nasal turbinates including squamous metaplasia of respiratory epithelium and degeneration of olfactory epithelium and ulceration; nasal, tooth and bone pathology (fluorosis).
15 ppm	Same as mid-dose group with increased severity.

Pursuant to Rule 229(2)(b), an alternate method of screening level development that can be supported by the scientific data may be used if the methodology in Rule 232 does not apply. The best methodology was determined to be a modified version of Rule 232(1)(d) as noted below:

$$ITSL = \frac{LOAEL}{10^{*}x\ 100\ x\ UF}\ x\ \frac{\frac{hours\ exposed}{day}}{\frac{24\ hours}{day}}$$

$$= \frac{1.3\ mg/m^3}{10^{*}x\ 100\ x\ 2^{**}}\ x\ \frac{6}{24}$$

$$= 0.1625\ or \sim \mathbf{0.2}\ \mu\boldsymbol{g/m^3}(\boldsymbol{annual})$$

* The factor of 35 was reduced to 10 to reflect the decrease in uncertainty when using a 28-day vs 7-day study.
** A UF of 2 was applied for mild effects in the respiratory system and a limited database.

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MS:lh