5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

Because BCME is not currently used as an isolated material in this country, and because it is rapidly degraded in the environment, the probability of human exposure to BCME is low. The most likely means of exposure is inhalation of BCME vapors in the workplace during the production and use of chemicals such as CME, in which BCME may occur as a contaminant or be formed inadvertently. Inhalation of BCME in ambient air might also occur near such a facility, but there is no evidence that this occurs. Exposure through other media (water, food, soil) is unlikely to be significant.

5.2 RELEASES TO THE ENVIRONMENT

No information was located on the amount of BCME released to air, water or soil. Because BCME is readily volatile at room temperature, emissions into the atmosphere could occur, but OSHA regulations require that processes involving BCME be contained (OSHA 1974). Releases into water could occur but would be of little significance, due to the rapid hydrolysis of BCME in water.

5.3 ENVIRONMENTAL FATE

5.3.1 Transport and Partitioning

No information was located on the transport and partitioning of BCME in the environment. Due to the relatively short half-life in both air and water, it is unlikely that significant transport or partitioning between media occurs.

5.3.2 Transformation and Degradation

5.3.2.1 Air

The primary process for BCME degradation in air is believed to be reaction with photochemically-generated hydroxyl radicals,. Reaction products are believed to include chloromethyl formate, ClHCO, formaldehyde and HCl (Cupitt 1980; EPA 1987a). The atmospheric halflife due to reaction with hydroxyl radicals is estimated to be

1.36 hours. Hydrolysis in the vapor phase is slower, with an estimated half-life of 25 hours in moist air (80% relative humidity at 25°C) (Tou and Kallos 1974). Reaction of BCME with molecular oxygen may also occur, but the rate of this reaction is not known. Other calculations suggest an atmospheric residence time of 0.2 to 2.9 days (Cupitt 1980).

Although hydrolysis of BCME to formaldehyde and HCl is highly favored thermodynamically, low levels of BCME may form by the reverse reaction when high concentrations of formaldehyde and HCl are mixed. Frankel et al. (1974) studied this reaction, and found that although BCME levels increased exponentially in proportion to reactant concentrations, yields were only 0.002 to 0.01 mol% at reactant concentrations ranging from 20 to 1,000 ppm. For example, the BCME concentration was 3 ppb in a mixture of 100 ppm formaldehyde and 100 ppm HCl. Based on the data of Frankel et al. (1974), Travenius (1982) proposed the empirical equation:

$$\log(\text{BCME})_{\text{ppb}} = -2.25 + 0.67 \bullet \log(\text{HCHO})_{\text{ppm}} + 0.77 \bullet \log(\text{HCl})_{\text{ppm}}$$

Employing this equation, the concentration of BCME likely to form from any mixture of formaldehyde and HCl may be calculated. In the workplace, assuming that exposure occurred at the Threshold Limit Values for each (1 ppm for formaldehyde and 5 ppm for HCl), the resulting BCME concentration would be 0.02 ppb. Concentrations in the home and the ambient environment are likely to be significantly lower for one or both reactants, and concentrations of BCME would be expected to be essentially negligible.

5.3.2.2 Water

BCME is rapidly hydrolyzed in water to yield formaldehyde and HCl, with a hydrolysis rate constant of 0.018 sec^{-1} at 20°C (Tou et al. 1974). This corresponds to a half-life of approximately 38 seconds. Under laboratory conditions (a sealed vessel from which formaldehyde and HCl cannot escape), an equilibrium is established in which about 80% of the BCME is rapidly hydrolyzed, with about 20% of the BCME remaining (Van Duuren et al. 1972). In the environment, formaldehyde and HCl formed by hydrolysis of BCME would be expected to dissipate by diffusion or volatilization, and BCME hydrolysis would rapidly proceed to completion.

5.3.2.3 Soil

No information was located on the fate of BCME in soil. However, it is probable that BCME would rapidly hydrolyze upon contact with moisture in soil or would react with soil constituents. Consequently, it is not expected that BCME would persist for significant periods in soil.

5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

5.4.1 Air

BCME has not been detected in ambient air. Some early reported industrial air concentrations ranged from 0.7 to 5.2 ppm, but increased care in the handling of this compound has reduced workplace levels to the sub-ppb range (NIOSH 1972a). No other quantitative data on BCME levels in air were located.

5.4.2 Water

BCME has not been detected in ambient waters, but has been reported to be present in groundwater at one chemical waste site being investigated under Superfund (CLPSD 1988). Because BCME hydrolyzes so quickly in water, this observation must be considered with skepticism.

5.4.3 Soil

BCME was reported to be present at 0.5% of the waste sites being investigated under Superfund (CLPSD 1988), but quantitative data were not available. As with the data regarding occurrence in water, these data must be considered with caution, since BCME is unlikely to endure at measurable levels in soil.

5.4.4 Other Media

No studies were located regarding the occurrence of BCME in other media.

5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

The most likely route of human exposure to BCME is by inhalation, but available data are not adequate to estimate typical dose levels. Doses are'likely to be close to zero for the general population, but could be of concern inside or close by industrial sites where chloromethylation processes occur (Roe 1985).

5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

As discussed above, the individuals most likely to have potential exposure to BCME are industrial workers who manufacture or use chemicals such as CME that might contain BCME as a contaminant. The possibility exists that residents near a facility or a waste site that permits escape of BCME could also be exposed, but there are no data to establish whether or not this occurs or is of concern.

5.7 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of BCME is available. Where adequate information is not available, ATSDR, in cooperation with the National Toxicology Program (NTP), is required to assure the initiation of a program of research designed to determine these health effects (and techniques for developing methods to determine such health effects). The following discussion highlights the availability, or absence, of exposure and toxicity information applicable to human health assessment. A statement of the relevance of identified data needs is also included. In a separate effort, ATSDR, in collaboration with NTP and EPA, will prioritize data needs across chemicals that have been profiled.

5.7.1 Data Needs

Physical and Chemical Properties. The physical and chemical properties most important in evaluating the environmental fate of BCME have been determined (see Table 3-2). Although some of these values (eg, solubility in water) are calculated, this is not a significant limitation, and additional studies on the physical or chemical properties of BCME do not appear essential.

Environmental Fate. Available data make it clear that BCME is not likely to endure in the environment. No further studies appear to be required on fate in water or other moist media (food, soil), since the principal fate is rapid hydrolysis. Additional studies on the kinetics of BCME destruction in air by oxidation and hydrolysis would be valuable in refining mathematical models used to calculate levels of BCME in air around a point source.

Exposure Levels in Environmental Media. Information on the occurrence of BCME in environmental media is very limited. No information was located on levels in ambient air, water or soil. BCME has been reported to occur in water or soil near a few waste sites, but these findings may not be reliable. Because of the instability of BCME in water and soil, further efforts to measure BCME in these media are unlikely to produce useful information. However, the volatility and atmospheric lifetime of BCME are such that monitoring air for BCME in the vicinity of waste sites, industrial facilities or other possible sources could provide valuable information on the occurrence of this chemical in the environment.

Exposure Levels in Humans. No data exists on present-day exposure levels of humans to BCME. Exposure is likely to be close to zero for the general public. However, because BCME is such at potent carcinogen, even low levels of exposure are of potential concern, and additional data on exposure levels in the workplace and in the environment near waste sites would be valuable.

Exposure Registries. No exposure registries exist for humans exposed to BCME. Although the exposed population is likely to be quite small, creation of such a registry would provide the opportunity to obtain valuable additional data on the health effects of BCME.

5.7.2 Ongoing Studies

No information was located regarding any ongoing studies on the occurrence of BCME in the environment or the potential for human exposure to BCME.