United States
Environmental Protection
Agency

Environmental Criteria and
Assessment Office
Research Triangle Park NC 27711

Research and Development

EPA/600/S8-82/003F Sept. 1985

EPA

Project Summary

Health Assessment Document for 1,1,1-Trichloroethane (Methyl Chloroform)

Methyl chloroform (MC) is a volatile chlorinated hydrocarbon used extensively as an industrial solvent and in consumer products. It has been detected in the ambient air of a variety of urban and non-urban areas of the United States. Normally, background levels are in the range of 0.1 to 0.2 ppb (0.54 x 10^{-3} to 1.08 x 10^{-3} mg/m^3). Levels in some urban areas have ranged up to 20 ppb (0.11 mg/m^3). MC has been less frequently detected in water, generally at levels of 1 ppb or less. In certain instances involving contamination of groundwater, much higher levels have been reported.

The weight of available evidence obtained from both human and animal data suggests that long-term exposure to environmental levels of MC poses no serious health concern to the general population. However, the available data are inadequate for classifying the mutagenic and carcinogenic potential for MC.

The no-observed-effect level (NOEL*) for short-term exposure of humans is in the range of 350 to 500 ppm (1,890 to 2,700 mg/m^3).

This Project Summary was developed by EPA's Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

*NOEL (no-observed-effect level) the lowest exposure level at which there are no statistically significant increases in frequency or severity of effects between the exposed population and its appropriate control

Introduction

1,1,1-Trichloroethane (methyl chloroform, MC) is a volatile chlorinated hydrocarbon. Since its commercial introduction, MC has been used increasingly as an industrial solvent and in consumer products such as spot removers. Production of MC in the United States is estimated to have increased from 121,000 metric tons in 1970 to 315,000 in 1980. About 88 percent of annual production in the United States is released largely to the atmosphere through dispersive use. There are no known natural sources of emissions of MC.

Methyl chloroform has been detected in the ambient (natural environment) air of a variety of urban and non-urban areas of the United States and other regions of the world. Levels range from trace amounts in rural areas to about 20 parts per billion (ppb) or 0.108 mg/m^3 in some large urban centers. Normally, background levels of MC are in the range of 0.1 to 0.2 ppb (0.54 x 10^{-3} to 1.08 x 10^{-3} mg/m^3). Less frequently has MC been detected in water. It is not soluble to any appreciable extent but in some surface and drinking waters has been monitored at levels of 1 ppb or less. In certain instances involving contamination of groundwater, much higher levels have been reported.

In the troposphere, a region of the atmosphere extending from ground level to as high as 15 kilometers, MC is removed to a substantial extent through reaction with hydroxyl radicals. Based on current knowledge of its reaction kinetics, the lifetime of MC in the troposphere is in the range of 5 to 10 years. This time period permits a portion of the MC to be

conveyed to the stratosphere where, along with other compounds, it may participate in ozone (O_3) destruction pathways. MC and other compounds that add to the chlorine burden in the stratosphere may contribute to the effects of global O_3 depletion. Occurrence of such depletion could result in an increased incidence of non-malignant forms of skin cancer due to increases in the amount of biologically damaging radiation reaching the earth's surface. The extent to which past, current, and future emissions of MC contribute to O_3 depletion can be realistically estimated only by assessing the interrelationships between all the principal reactions involved in both the formation and destruction of atmospheric O_3. The extent and direction to which actual global O_3 levels have changed over the years can not be estimated with available measurement methods.

Exposure and Effects

Because MC is primarily an air contaminant, inhalation is the principal and most rapid route of exposure. An 8-hour exposure to the TWA** of 350 parts per million (ppm) or 1,890 mg/m^3 is estimated to result in about two grams of MC absorbed into the body of an average-sized 70 kg man. The total amount absorbed increases in direct proportion to inspired air concentrations and to the length of exposure and physical activity. Once body equilibrium or steady-state has been attained, no further uptake is possible. There is strong evidence that MC will partition selectively into lipid-tissues upon chronic or long-term exposure to even low ambient air concentrations, until steady-state is attained. Because of its lipophilic nature, MC is expected to cross membrane barriers in the body and diffuse into the brain and the colostrum of nursing mothers, as well as into the fetus during pregnancy. Unlike other chlorinated solvents such as trichloro- and tetrachloroethylene, MC is only metabolized in humans to a limited extent, about six percent or less of the total retained dose. Although metabolism of MC is affected by other chemicals and drugs, there is no evidence that it enhances its own metabolism. The primary route of elimination from the body is via the lungs, through which MC is exhaled in unchanged form along with a metabolite, carbon dioxide. The only identified urinary metabolites are trichloroethanol and trichloroacetic acid.

Based on presently available data, the likelihood of adverse health effects resulting from chronic exposure to the ambient air levels commonly encountered appears to be extremely low. Although the available health data are inadequate to classify MC's mutagenic and carcinogenic potential, if any, the NOEL for short-term exposure of humans to MC is estimated to be in the range of approximately 350 to 500 ppm (1,890 to 2,700 mg/m^3). This NOEL is many orders of magnitude higher than the highest levels of MC (20 ppb; 0.108 mg/^{3}) measured in the ambient air of urban areas. Based upon available human data, the estimated relationship between acute effects and single short-time exposures is as follows:

Exposure	Acute Effect
100 ppm (540 mg/m^3)	Apparent odor threshold
350 - 500 ppm (1,890 - 2,700 mg/m^3)	Obvious odor, slight changes in perception
1,000 ppm (5,400 mg/m^3)	Disturbance of equilibrium
1,900 - 2,650 ppm (10,260 - 14,310 mg/m^3)	Lightheadedness, irritation of the throat
> 5,000 ppm (27,000 mg/m^3)	Onset of narcosis

In the range of the NOEL, no significant abnormal blood chemistry or organ function decrements have been noted. Symptoms of neurological dysfunction were observed at higher exposure levels. These symptoms were qualitatively diagnosed by the subjects' impaired performance of clinical-level cognitive and manual tasks. More extensive human and laboratory animal data are needed before firm conclusions about adverse health responses to low-level exposures to MC can be drawn.

Similarly, MC has not demonstrated any teratogenic potential in the studies conducted to date in rodent species. Commercially available samples of MC are genotoxic to mouse hepatocytes and are weakly mutagenic in *Salmonella* under treatment conditions where sufficient exposure is ensured. The available data are inadequate, however, for reaching firm conclusions regarding the ability of MC to cause gene mutations in other organisms; however, the possibility that this substance, its associated stabilizing materials, or its metabolites may have mutagenic effects in humans has not been eliminated.

On the basis of animal bioassays performed to date and in the absence of epidemiological information, it is not possible to classify MC as to its carcinogenic potential in humans.

Recommendations for Further Studies

Although the available human and toxicity data indicate that ambient exposure to MC is not currently a human health concern, it is apparent that further investigation is needed in several areas. Areas in which incomplete information is available, and that should be considered when formulating research needs, are presented below, not necessarily in order of priority.

1. *Neurobehavioral Toxicity.* Few animal studies have been made of the effects of MC on the nervous system and behavior. Most endpoints studied have been relatively insensitive. Further studies on more sensitive endpoints are needed.
2. *Teratogenicity and Reproductive Effects.* Published data on three-generation animal studies via inhalation do not adequately assess the teratogenic and reproductive effects potential of MC.
3. *Mutagenicity.* In order to determine conclusively the mutagenic potential of MC, pure MC should be tested in studies appropriately designed to ensure exposure of the indicator organism.
4. *Carcinogenicity.* In order to determine more effectively the human carcinogenic potential of MC, lifetime inhalation studies in appropriate rodent species should be undertaken.

**TWA (Time Weighted Average): the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be exposed repeatedly, day after day, without adverse effect

This Project Summary was prepared by staff of Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

***Mark Greenberg** is the EPA Project Officer (see below).*

The complete report, entitled "Health Assessment Document for 1,1,1-Trichloroethane (Methyl Chloroform)," (Order No. PB 84-183 565; Cost: $17.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

Environmental Criteria and Assessment Office
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268