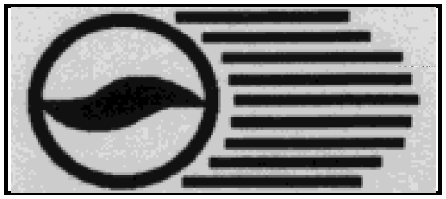

California Air Resources Board

STAFF REPORT/EXECUTIVE SUMMARY

Proposed Identification of

CHLOROFORM

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As a Toxic Air Contaminant

State of California
Air Resources Board
Stationary Source Division

SEPTEMBER 1990

Proposed Identification of Chloroform as a Toxic Air Contaminant

Staff Report

Executive Summary

Prepared by the Staffs of the Air Resources Board
and the Department of Health Services

SEPTEMBER 1990

constitute endorsement or recommendation for use.)

What is a toxic air contaminant?

According to Section 39655 of the California Health and Safety Code, a toxic air contaminant is "an air pollutant which may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health."

What is chloroform?

Chloroform is a chlorinated alkane (chlorinated aliphatic hydrocarbon compound containing single bonds), and is known by a variety of synonyms which include trichloromethane, methane trichloride, methyl trichloride, methenyl trichloride, trichloroform, and formyl trichloride. The molecular formula of chloroform is CHC13. Chloroform can be manufactured, or can occur naturally when a chlorine molecule (C12) reacts with an organic substance such as humic or fulvic acids.

Does the Air Resources Board (ARB) staff recommend identification of chloroform as a toxic air contaninant?

Yes, we recommend that chloroform be identified as a toxic air contaminant because:

- Chloroform is emitted from a variety of sources in California and can be detected in the ambient air in California. Chloroform does not break down in the atmosphere at a rate that would significantly reduce public exposure.

- Based on the evidence of chloroform induced carcinogenicity and the results of the risk assessment, the staff of the Department of Health Services (DHS) finds that Chloroform is an air pollutant which may cause or contribute to an increase in mortality or an increase in serious illness, or which- may pose a present or potential hazard to human health."

What are the sources of chloroform emissions?

Chloroform can be emitted to the air from direct and indirect sources. Direct sources include those where chloroform is used; indirect sources are those where chloroform is formed as a by-product.

Chloroform is commercially produced in the United States by several facilities, none of which are located in California. However, it is used and directly emitted by a number of facilities in the manufacture of fluorocarbon 22 refrigerants and fluorocarbon 22 fluoropolymers. Other direct sources of chloroform use include: pharmaceutical manufacturing, the production of oxybisphenoxarsine (OBPA) and 1,3-diisocyanate, and laboratory use.

The major indirect source of chloroform emissions is the chlorination of water. Sources include: publicly owned treatment works (POTWs), cooling towers, the bleaching of pulp at pulp and paper mills with chlorine, bleach used for domestic cleaning and laundry, combustion of leaded gasoline, air stripping towers, Perchloroethylene (PERC) production, and contamination of chlorinated products.

Now much chloroform is released into California air?

Total chloroform emissions in California are estimated to be approximately 750 - 1100 tons per year. The sources of emissions in California in descending order of estimated emissions are: the chlorination of water, bleaching of pulp in pulp and paper mills, pharmaceutical manufacturing, wastewater treatment in publicly owned treatment works (POTWs), laundry and household cleaning with liquid bleach, fluorocarbon 22 production, laboratory usage, cooling towers and air stripping towers.

What are the ambient concentrations of chloroform?

Chloroform is routinely monitored at the 19 sites of the ARB taxies monitoring network. Minimum concentrations range from below the limit of detection (LOD) of 0.02 ppb to 0.02 ppb at Santa Barbara. Maximum concentrations range in value from 0.03 ppb at Modesto to 0.20 ppb at Richmond. The estimated mean statewide annual population-weighted exposure to chloroform is 0.03 ppb. The annual population-weighted exposure is based on 20 million people represented by the toxics monitoring network (out of the 28 million total California population).

Are there "Hot Spot" emissions of chloroform in California?

Modeling of "hot spot" areas was not done for this report; however, we will prioritize and estimate "hot spot" exposures outdoors in the control phase if chloroform is identified as a toxic air contaminant. Based on emission estimates, potential hot spots include pulp and paper mills and pharmaceutical manufacturing.

Is there evidence of indoor air exposure to chloroform?

Yes. Chloroform is released into indoor air by vaporization from a number of sources including: chlorinated tap water, pools, and spas; household bleach products; and office and household products manufactured using chloroform as a solvent. Median indoor air concentrations of chloroform were estimated to be approximately equal to or 10 times greater than that of the median outdoor concentrations measured. Therefore, indoor inhalation is a significant portion of total exposure to chloroform, since Californians spend most of their time (about 87% on average) indoors.

Are there other routes of exposure to chloroform?

Yes. Other routes of exposure to chloroform are by water and food ingestion. In a 1984 study, chloroform was measured in tap water at median concentrations ranging from 14.5 to 48.9 ug/liter in Los Angeles and Contra Costa counties.

Chloroform also exists as a contaminant in food products. Data exist for a variety of beverages, fishes, butters and margarinos. However, the Food and Drug Administration (FDA) has not monitored chloroform in a sufficient variety of food and food products to estimate a per capita daily chloroform intake.

What are the emission trends of future chloroform usage and exposure?

Population in California is expected to increase by 19% and 31% by the years 2000 and 2010, respectively. Therefore, with the population increase, chloroform emissions probably will also increase. We do not anticipate that the current rate of use and sources of emissions of chloroform will change.

What is the persistence of chloroform in the atmosphere?

The tropospheric lifetime of chloroform ranges from 150 to 230 days. The only significant loss process for chloroform in the troposphere is the reaction with hydroxyl radicals. Chloroform is substantially persistent and dispersed throughout an air basin before it is degraded.

What are the health effects of chloroform exposure?

The health effects of chloroform exposure have been reviewed and evaluated to determine whether chloroform meets the definition of a toxic air contaminant. The following

text summarizes DHS's findings regarding the health effects of chloroform exposure.

What evidence exists that exposure to chloroform poses a public health hazard?

The International Agency for Research on Cancer (IARC) and the U.S. Environmental Protection Agency (EPA) both classify chloroform as a possible human carcinogen based on adequate evidence for carcinogenicity in animals. Chloroform is carcinogenic in rodents, producing liver tumors (hepatocellular carcinomas and neoplastic nodules) in both sexes of mice, kidney tubular epithelial tumors in male rats and cholangiocarcinomas in rats. Epidemiological evidence for human cancer from exposure to chloroform is inadequate.

Acute exposure to chloroform causes depression of central and peripheral nervous systems, cardiac sensitization to catecholamines, and liver and kidney-damage. Chronic exposure may also cause liver and kidney damage. In addition, chloroform interferes in rodents with the maintenance of pregnancy and is fetotoxic following exposure to 30 to 100 ppm chloroform in air. Concentrations of chloroform in air necessary to produce adverse effects in experimental animals are about five orders of magnitude greater than the measured ambient air concentrations of chloroform (0.03 ppb) in California. The DHS staff do not anticipate that non-cancer health effects will result from acute or chronic exposure to ambient levels of chloroform in California air.

What is the risk assessment for exposure to chloroform?

Since there is inadequate information regarding the carcinogenicity of chloroform to humans from epidemiological studies, data from animal bioassays must be extrapolated to estimate cancer risk for humans. The dose-response curve was extrapolated over five orders of magnitude from doses in animal experiments to levels of environmental exposure to humans.

The DHS' best estimate of potency as a unit risk for chloroform is $2.6 \times 10^{-5}(\text{ppb})^{-1}$.

Using California's population-weighted annual chloroform exposure of .03 ppb (.15 Fg/m^3), the DHS

staff estimates the excess carcinogenic risk from a 70-year lifetime exposure to ambient outdoor chloroform to be approximately 1 case per million persons exposed.

Chloroform in drinking water contributes more to the overall risk from chloroform exposure than chloroform In ambient air. The lifetime potential risk from ingestion of chlorinated drinking water is estimated to be 35 excess cancer cases per million people based on average drinking water consumption.

Is there a threshold level for chloroform?

The DHS does not believe that there is a carcinogenic threshold level for chloroform.

What are the alternatives to identifying chloroform as a TAC?

Government Code Section 11346.14 regulates agencies to describe alternatives to the regulation considered by the agency and the agencys' reasons for rejecting those alternatives. The only alternative to identifying chloroform is not to identify it. He are not recommending this alternative because we believe that chloroform meets the statutory definition of a toxic air contaminant. No alternative considered by the staff would be more effective in carrying out the purpose of the regulation or would be as effective or less burdensome to affected private persons.

What would be the environmental impact of the identification of chloroform as a toxic air contaminant?

The identification of chloroform as a toxic air contaminant is not foreseen to result in

any impact on the environment. The Boards' identification of chloroform as a toxic air contaminant may result in the adoption of control measures pursuant to Health and Safety Code Sections 39665 and 39666. In considering the adoption of control measures, the ARB will consider all potential impacts of these measures on human health and the environment, as well as

the potential benefits to public health by reducing chloroform emissions. Therefore, the identification of chloroform as a toxic air contaminant may ultimately result in control measures that will result in environmental benefits. Environmental impacts identified with respect to specific control measures will be included in the consideration of such control measures pursuant to Health and Safety Code Sections 39665 and 39666.

What are the findings of the Scientific Review Panel?

In accordance with the provisions of Health and Safety Code Section 39661, the Scientific Review Panel (SRP) has reviewed the reports of the staffs of the ARB and DHS on the public exposure and biologic and health effects of chloroform, and the public comments on these reports. Based on this review, the SRP finds that the reports are without serious deficiencies and agrees with the staffs of the ARB and DHS that:

1. Chloroform has been identified as an animal carcinogen and should be regarded as a possible human carcinogen.

2. Chloroform is emitted into the air by a variety of stationary sources in California. It is emitted indoors and can give rise to concentrations that are greater than outdoor concentrations.

3. Based on its gas-phase reactivity with hydroxyl radicals, chloroform has an atmospheric lifetime estimated to range from 150 to 230 days.

4. Approximately 20 million people in California represented by the ARB tonics monitoring network (out of the 28 million total California population) are estimated to be exposed outdoors to a population-weighted mean chloroform concentration of 0.03 parts per billion (ppb).

5. Adverse health effects other than cancer are not known or expected to occur et predicted concentrations of chloroform in ambient outdoor air.

6. Based on available scientific information, a chloroform exposure level below which carcinogenic effects are not expected to occur cannot be identified with certainty.

7. Based on an interpretation of available scientific evidence, DHS staff estimated the range of unit risk "exposure to 1 ug/m (.21 ppb)] based on the upper 95% confidence limit is from 2.9×10^{-6}/ppb to 9.8×10^{-5}/ppb. Based on available data, 2.6×10^{-5}/ppb is the best estimate of potency as a unit risk. These upper bound excess lifetime risks are health protective estimates; the actual risk may well be below these values.

8. Inhalation exposure to a statewide mean ambient outdoor concentration (weighted by population) of 0.03 ppb for a population of 20 million people, could result in up to 16 excess lifetime cancers, based on the DHS' best estimate for unit risk. Assuming that this applies to the California state population of 28 million, this could result in up to 22 excess lifetime cancers, based on the DHS' best estimate for unit risk.

9. Indoor inhalation exposures are greater than outdoor exposures and significantly contribute to risk beyond the estimated outdoor risk.

10. Chloroform in drinking water may contribute more to the overall risk from chloroform exposure than chloroform in ambient air. The risk of ingestion equals 3.5×10^{-5}. This corresponds to 38 excess cancer cases per 1 million people per lifetime based on average

drinking water consumption.

11. The numbers cited hare are subject to a significant degree of uncertainty, because chloroform's mechanism of carcinogenicity has not been identified.