TOXICOLOGICAL PROFILE FOR
1,2,3-TRICHLOROPROPANE

Agency for Toxic Substances and Disease Registry
U.S. Public Health Service

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DISCLAIMER

The use of company or product name(s) is for identification only and does not imply endorsement by the Agency for Toxic Substances and Disease Registry.

FOREWORD

The Superfund Amendments and Reauthorization Act (SARA) of 1986 (Public Law 99-499) extended and amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund). This public law directed the Agency for Toxic Substances and Disease Registry (ATSDR) to prepare toxicological profiles for hazardous substances which are most commonly found at facilities on the CERCLA National Priorities List and which pose the most significant potential threat to human health, as determined by ATSDR and the Environmental Protection Agency (EPA). The lists of the 250 most significant hazardous substances were published in the Federal Register on April 17, 1987; on October 20, 1988; on October 26, 1989; and on October 17, 1990. A revised list of 275 substances was published on October 17, 1991.

Section 104(i)(3) of CERCLA, as amended, directs the Administrator of ATSDR to prepare a toxicological profile for each substance on the lists. Each profile must include the following content:

(A) An examination, summary, and interpretation of available toxicological information and epidemiological evaluations on the hazardous substance in order to ascertain the levels of significant human exposure for the substance and the associated acute, subacute, and chronic health effects.

(B) A determination of whether adequate information on the health effects of each substance is available or in the process of development to determine levels of exposure which present a significant risk to human health of acute, subacute, and chronic health effects.

(C) Where appropriate, an identification of toxicological testing needed to identify the types or levels of exposure that may present significant risk of adverse health effects in humans.

This toxicological profile is prepared in accordance with guidelines developed by ATSDR and EPA. The original guidelines were published in the Federal Register on April 17, 1987. Each profile will be revised and republished as necessary.

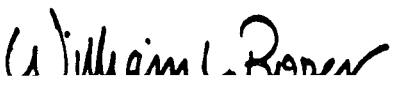
The ATSDR toxicological profile is intended to characterize succinctly the toxicological and adverse health effects information for the hazardous substance being described. Each profile identifies and reviews the key literature (that has been peer-reviewed) that describes a hazardous substance's toxicological properties. Other pertinent literature is also presented but described in less detail than the key studies. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced.

Foreword

Each toxicological profile begins with a public health statement, which describes in nontechnical language a substance's relevant toxicological properties. Following the public health statement is information concerning levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine a substance's health effects is described in a health effects summary. Data needs that are of significance to protection of public health will be identified by ATSDR, the National Toxicology Program (NTP) of the Public Health Service, and EPA. The focus of the profiles is on health and toxicological information; therefore, we have included this information in the beginning of the document.

The principal audiences for the toxicological profiles are health professionals at the federal, state, and local levels, interested private sector organizations and groups, and members of the public.

This profile reflects our assessment of all relevant toxicological testing and information that has been peer reviewed. It has been reviewed by scientists from ATSDR, the Centers for Disease Control, the NTP, and other federal agencies. It has also been reviewed by a panel of nongovernment peer reviewers. Final responsibility for the contents and views expressed in this toxicological profile resides with ATSDR.



manufacturing processes generally occur in closed and tightly sealed systems (NIOSH 1981). The National Occupational Exposure Survey (NOES) conducted by NIOSH from 1981 to 1983 statistically estimated that 492 workers are potentially exposed to 1,2,3-trichloropropane in the United States. The NOES database does not contain information on the frequency, concentration, or duration of exposure of workers to any of the chemicals listed therein. This summary provides only estimates of the number of workers potentially exposed to chemicals in the workplace. Occupational exposure probably results from inhalation and dermal contact.

5.2 RELEASES TO THE ENVIRONMENT

5.2.1 Air

Data on releases of 1,2,3-trichloropropane to the atmosphere are lacking. Based on the few data available, current releases to the air are expected to be relatively small. Minor releases may have occurred as exhaust, stack, and fugitive emissions from its manufacture, formulation, and use as a solvent (HSDB 1989). 1,2,3-Trichloropropane may have been released in the past into the air as a result of its use as a paint- and varnish-remover, a degreasing agent, and a cleaning and maintenance reagent (Hawley 1981; NIOSH 1981). No information was found that indicates that 1,2,3-trichloropropane is still used for these purposes today. Very small amounts may be released during its use as a chemical intermediate and as a result of its formation during the synthesis of other organic chemicals (see Section 4.1). Volatilization from contaminated surface waters, effluent waters, and near-surface soils may also be minor atmospheric sources of this compound. This includes volatilization from identified and unidentified hazardous waste dumps that contain 1,2,3-trichloropropane and from farmland treated with 1,2,3-trichloropropane-contaminated fumigants and nematocides (no information is available to determine whether or not the soil fumigants and nematocides currently manufactured contain 1,2,3-trichloropropane). Small amounts may be released *to* the air during treatment of water containing 1,2,3-trichloropropane, because some of the chemical may be removed via evaporative stripping from the water.

5.2.2 Water

Data on the release of 1,2,3-trichloropropane to environmental waters are lacking. Based on the few data available, current releases to environmental waters are expected to be relatively small. Releases to surface water may have occurred through runoff of waste water from hazardous waste sites containing 1,2,3-trichloropropane and runoff from farmland treated with certain soil fumigants and nematocides that contain 1,2,3-trichloropropane. Releases to surface and groundwater may have occurred as a result of the improper disposal of 1,2,3-trichloropropane-containing industrial wastes or wastes from its use in paint- and varnish-removers, cleaning and degreasing agents, and maintenance reagents. Releases to groundwater may have occurred

as a result of the chemical leaching through soil at waste sites and agricultural soil treated with fumigants that contain the chemical. Small amounts of the chemical may have entered surface waters as a result of washout from 1,2,3-trichloropropane-contaminated air; however, some of the 1,2,3-trichloropropane removed from the atmosphere by washout is likely to have re-entered the atmosphere by volatilization. The chemical was found in groundwater at 0.71% of the sites in the Contract Laboratory Program Statistical Database (CLPSD) at a geometric mean concentration of 57.3 µg/L (CLPSD 1989). Note that the CLPSD includes data from both NPL and non-NPL sites.

5.2.3 Soil

Data on releases of 1,2,3-trichloropropane to soils are sparse, which makes a quantitative estimation of the magnitude of such releases impossible. However, releases to soils are expected to be relatively small based upon the available data. Releases to farmland soil have occurred as a result of the use of certain soil fumigants and nematocides known to contain 1,2,3-trichloropropane as an impurity. No current information is available, however, that indicates that these soil fumigants and nematocides still contain 1,2,3-trichloropropane. Releases of the chemical to soil may have occurred as a result of disposal of 1,2,3-trichloropropane-containing sewage sludge from municipal sewage treatment plants (Jacobs and Zabik 1983). Very small amounts of the chemical may be brought to the surface of the earth as a result of washout from 1,2,3-trichloropropane-containing air; however, much of the 1,2,3-trichloropropane removed from the atmosphere by washout may re-enter the atmosphere by volatilization from near-surface soil. Land disposal of wastes from its use in paint- and varnish-removers, cleaning and degreasing agents, and cleaning and maintenance reagents may have released 1,2,3-trichloropropane to soil. The chemical was found in soil at 0.71% of the sites in the CLPSD at a geometric mean concentration of 204 µg/kg (CLPSD 1989). Note that the CLPSD includes data from both NPL and non-NPL sites.

5.3 ENVIRONMENTAL FATE

5.3.1 Transport and Partitioning

No experimental or predictive data were located in the literature regarding the transport of 1,2,3-trichloropropane in the atmosphere. 1,2,3-Trichloropropane is expected to exist in the atmosphere predominantly in the vapor phase, based on its vapor pressure (Table 3-2) (Eisenreich et al. 1981; MacKay et al. 1982). The speculation that substantial amounts of 1,2,3-trichloropropane are not likely to be present in the particulate phase indicates that dry deposition to the earth's surface will not be an important removal process. Based upon its low water solubility and moderate vapor pressure (Table 3-2), very small amounts of 1,2,3-trichloropropane present in

air may be removed by wet deposition; however, much of the 1,2,3-trichloropropane removed from the atmosphere by washout is likely to re-enter the atmosphere by volatilization.

Based upon an estimated soil organic carbon partition coefficient (K_{oc}) of 98 (calculated from water solubility) (Lyman et al. 1982; Riddick et al. 1986), 1,2,3-trichloropropane is expected to display high mobility in soil (Swann et al. 1983); therefore, it has the potential to leach into groundwater. This predicted mobility is confirmed by the detection of 1,2,3-trichloropropane in groundwater from various locations (see Section 5.4.2). The vapor pressure of 1,2,3-trichloropropane (3.1 mmHg at 25°C) (MacKay et al. 1982), and the calculated Henry's law constant (3.17×10^{-4} atm-m^3/mol at 25°C) (Lyman et al. 1982) suggest that volatilization from either dry or moist soil to the atmosphere will be a significant environmental process.

1,2,3-Trichloropropane in surface water is expected to volatilize rapidly to the atmosphere. An experimental half-life of 56.1 minutes has been measured for evaporation of 1,2,3-trichloropropane from a 1 ppm solution, with a depth of 6.5 cm, stirred with a shallow pitch propeller at 200 rpm at 25°C under still air (less than 0.2 mph air currents) (Dilling 1977). Using the Henry's law constant, a half-life of 6.9 hours was calculated for evaporation from a model river 1 m deep, flowing at 1 m/set, with a wind velocity of 3 m/set, and neglecting adsorption to sediment (Lyman et al. 1982). A volatilization half-life of 3.5 days from a model pond can be estimated (EPA 1985). 1,2,3-Trichloropropane is not expected to significantly adsorb to sediment and suspended organic matter based upon the estimated K_{oc} of 98 (calculated from water solubility) (Lyman et al. 1982; Riddick et al. 1986). It is also not expected to significantly bioconcentrate in fish and aquatic organisms based upon an estimated bioconcentration factor (BCF) of 9.2 (calculated from log octanol-water partition coefficient (K_{ow}) (EPA 1988b; Lyman et al. 1982). No data were located to indicate a potential for 1,2,3-trichloropropane to biomagnify from lower to higher trophic states of the food chain, but based upon the estimated BCF, this is not likely.

5.3.2 Transformation and Degradation

5.3.2.1 Air

The primary degradation process for 1,2,3-trichloropropane in the atmosphere is expected to occur via gas-phase reaction with photochemically produced hydroxyl radicals. The rate constant for this process is an estimated 1.0475×10^{-12} cm^3/molecule-sec (Atkinson 1987). This corresponds to a half-life of 15.3 days at an estimated atmospheric concentration of 5×10^5 hydroxyl radicals/cm^3. Direct photolysis of 1,2,3-trichloropropane is not

expected to occur in the atmosphere because the chemical lacks a chromophore that absorbs light at environmentally significant wavelengths (greater than 290 nm) (Silverstein et al. 1974).

5.3.2.2 Water

Degradation of 1,2,3-trichloropropane in natural waters is expected to be a slow process. The chemical should volatilize from surface waters before significant degradation can occur. Hydrolysis of 1,2,3-trichloropropane in natural waters is not expected to be a significant removal process. The measured neutral and base hydrolysis rate constants at 25°C are 1.8×10^{-6} $hour^{-1}$ and 9.9×10^{-4} M^{-1} $hour^{-1}$, respectively (EPA 1988c). These rate constants correspond to a hydrolysis half-life of 44 years over a pH range of 5-9. Direct photolysis of 1,2,3-trichloropropane is not expected to occur in environmental waters because the chemical lacks a chromophore that absorbs light at environmentally significant wavelengths (greater than 290 nm) (Silverstein et al. 1974).

No studies were located regarding the biodegradation of 1,2,3-trichloropropane in natural waters. An aqueous screening study with activated sewage sludge has indicated that 1,2,3-trichloropropane can be removed by biological treatment processes and that at least part of the removal was due to volatilization. However, this study cannot be used to predict the biodegradability of this compound under natural conditions. Other authors have observed that halogenated hydrocarbons, in general, and especially those with multiple chlorine substitution, such as 1,1,2-trichloroethane and 1,1,2,2-tetrachloroethane, are recalcitrant towards biodegradation (Kawasaki 1980; Tabak et al. 1981). No data concerning the potential for anaerobic aqueous biodegradation of 1,2,3-trichloropropane were found.

5.3.2.3 Soil

No data specifically regarding the degradation of 1,2,3-trichloropropane in soil were found. However, it has been observed that 1,2-dichloropropane will not significantly biodegrade in soil (Roberts and Stoydin 1976). Therefore, 1,2,3-trichloropropane is expected to be even less biodegradable because it contains an additional chlorine. The rate of 1,2,3-trichloropropane loss from soil due to biodegradation may not be significant when compared with its loss by volatilization and leaching from soil. 1,2,3-Trichloropropane will be lost from the soil by evaporation (from both moist and dry near-surface soil) and by leaching to groundwater before 1,2,3-trichloropropane will hydrolyze in soil. Direct photolysis on the surface of soil will not occur.

5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

5.4.1 Air

No data were located regarding the detection of 1,2,3-trichloropropane in ambient air in the United States. Therefore, no estimate of U.S. atmospheric levels of the chemical, including background levels, is possible.

5.4.2 Water

Limited data are available regarding the detection of 1,2,3-trichloropropane in environmental waters. It has been detected by one of the sampling techniques at less than 0.2 µg/L in drinking water from the Carrollton Water Plant in New Orleans, Louisiana, sampled during August, 1974; however, since two of the three sampling techniques failed to detect the compound, the significance of this detection is in question (Keith et al. 1976). 1,2,3-Trichloropropane has been qualitatively detected in the drinking water of Cincinnati, Ohio, sampled during 1978 (EPA 1984), and Ames, Iowa, on an unspecified date (EPA 1987). Data from the EPA STORET Data Base indicate that 1,2,3-trichloropropane was found in 39% of 941 samples of groundwater at a median concentration of 0.69 µg/L, at an average concentration of 1.0 µg/L, and a range of trace (below unspecified detection limit) to 2.5 µg/L (STORET 1989). It has been found at concentrations ranging from 0.1 to 5.0 µg/L in groundwater samples from California and Hawaii during small- and large-scale retrospective studies of farmlands possibly treated with fumigants and nematocides that contained 1,2,3-trichloropropane as an impurity (Cohen et al. 1986, 1987). The locations that had 1,2,3-trichloropropane-contaminated wells included the island of Oahu, Hawaii, and the Central Valley of California. Typical concentrations ranged from 0.2 to 2 µg/L. 1,2,3-Trichloropropane was found in water from nine of nine wells in Oahu, Hawaii, sampled in 1983 and 1984 at maximum concentrations ranging from 0.30 to 2.8 µg/L (Oki and Giambelluca 1987). The wells had been closed previously to drinking water use due to contamination with other halogenated hydrocarbons.1,2,3-Trichloropropane has been detected in groundwater from 2 of 10 sites in an agricultural community in Suffolk County, New York, at concentrations of 6 and 10 µg /L (Lykins and Baier 1985).

1,2,3-Trichloropropane was qualitatively found in 1 of 30 water samples from the Delaware, Schuylkill, and Lehigh Rivers, taken February 17-20, 1976 (DeWalle and Chian 1978). 1,2,3-Trichloropropane was qualitatively found in water from Narragansett Bay, Rhode Island, sampled during the summers of 1979 and 1980, and the winters of 1980 and 1981 (Wakeham et al. 1983). Some samples reportedly contained significant levels of the chemical. The chemical was qualitatively detected in effluent from an advanced waste treatment plant in Lake Tahoe, California, in 1974 (EPA 1984). The chemical was found in groundwater at 0.71% of the sites in the CLPSD, which includes data from both NPL and non-NPL sites, at a geometric mean concentration of 57.3 µg/L (CLPSD 1989). 1,2,3-Trichloropropane was found in 69 of 141 samples of sewage

sludges from municipal sewage treatment plants in Michigan in 1980 (Jacobs and Zabik 1983). The median and average concentrations of 1,2,3-trichloropropane in the sludges were 0.352 and 1.07 mg/kg, respectively, and the range was 0.00459-19.5 mg/kg on a dry-weight basis.

5.4.3 Soil

Limited data are available regarding the detection of 1,2,3-trichloropropane in soil samples. It has been found in soil samples from California and Hawaii during small- and large-scale retrospective studies at levels typically ranging from 0.2 to 2 ppb (Cohen et al. 1987). It was found at least 10 feet down in the soil profiles in Hawaii. 1,2,3-Trichloropropane may be present in these soils as a result of the use of dichloropropene (a soil fumigant and nematocide). 1,2,3-Trichloropropane is used in the preparation of this nematocide and is an impurity in the formulation of it (Baier et al. 1987). 1,2,3-Trichloropropane was not found in any of the soil samples from the sites in the CLPSD (1988). The detection of the chemical in the groundwater of hazardous waste sites, however, suggests that it is released to soil at these sites. The chemical was found in soil at 0.71% of the sites of the CLPSD at a geometric mean concentration of 204 pg/L (CLPSD 1989); the CLPSD includes data from both NPL and non-NPL sites.

5.4.4 Other Environmental Media

1,2,3-Trichloropropane has been qualitatively identified as a component of ethylene dichloride-tar, a tarlike, oily waste byproduct of vinyl chloride production that had been disposed of by dumping into the sea (Jensen et al. 1975). The chemical has been found in the volatile products from the thermal oxidative degradation of the flame-retardant plasticizer, tris(dichloropropy1) phosphate (Christos et al. 1977). No information was found that indicated that 1,2,3-trichloropropane has been found in food. Because of the lack of recent comprehensive monitoring data, the average daily intake of i,2,3-trichloropropane and the relative significance of each source of exposure cannot be determined.

5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

There are not enough measured data to assess the general population's exposure to this compound. The paucity of data may be the result of either a lack of 1,2,3-trichloropropane contamination in the environment or a lack of studies that attempt to identify and quantify the compound in the environment using sufficiently sensitive techniques. Based upon the few data available, the estimated transport and partitioning properties of the compound, and information on production and use, the following estimations concerning exposure can be made. A small part of the population may be exposed to very low levels of 1,2,3-trichloropropane through the ingestion of contaminated drinking water. Exposure to very low levels of 1,2,3-trichloropropane also may occur through the inhalation of contaminated air; however, no monitoring

data regarding the presence of 1,2,3-trichloropropane in the atmosphere in the United States were located. General exposure to air containing low levels may occur near chemical manufacturing facilities that produce 1,2,3-trichloropropane and certain other chemicals, near 1,2,3-trichloropropane-containing hazardous waste dumps, and farmlands treated with fumigants and nematocides that contain 1,2,3-trichloropropane. No current information is available, however, that indicates that 1,2,3-trichloropropane is still present in soil fumigant formulations, and commercial manufacturing processes generally occur in closed and tightly sealed systems (NIOSH 1981). Inhalation and dermal exposure may occur during the use of 1,2,3-trichloropropane as a solvent and extractive agent, in paint- and varnish-removers, in cleaning and degreasing agents, and in cleaning and maintenance reagents, although there is no current information that indicates that the compound is still used for these purposes (Hawley 1981; NIOSH 1981). No data regarding the detection of 1,2,3-trichloropropane in humans in the United States were located.

According to the NOES conducted by NIOSH from 1981 to 1983, 492 workers (of which 9 were women) were potentially exposed to 1,2,3-trichloropropane in the workplace in 1980 (NIOSH 1989); however, no report of actual measured exposure levels in any occupational situation in the United States was located. The NOES database does not contain information on the frequency, concentration, or duration of exposure of workers to any of the chemicals therein. This survey provides only an estimate of the number of workers potentially exposed to chemicals in the workplace. Occupational exposure to 1,2,3-trichloropropane is expected to be higher in facilities where the chemical or products containing the chemical are used than in facilities that produce 1,2,3-trichloropropane either directly or as a byproduct, since the commercial manufacturing processes generally occur in closed and tightly sealed systems (NIOSH 1981). Furthermore, exposure may result from procedures that require direct handling of the material; these include purification, formulation of products, sampling and quality control, packaging and storage, leakage of equipment, startup and shutdown procedures, maintenance, cleanup, spills, and other plant emergencies (NIOSH 1981).

5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Data regarding the presence of 1,2,3-trichloropropane in the environment are lacking, which prevents the thorough assessment of the potential for high exposure in various populations. Populations with potentially high exposure to 1,2,3-trichloropropane will generally include those that may be exposed to environmental contamination over long periods of time. These may include populations exposed to low levels of 1,2,3-trichloropropane via inhalation of contaminated air at or near both identified and unidentified 1,2,3-trichloropropane-containing waste disposal sites and landfills. Children playing in and around these sites may also be dermally exposed to soil containing 1,2,3-trichloropropane, although any 1,2,3-trichloropropane il surface soil would be expected to volatilize or leach through the soil.

Persons whose drinking water is derived from 1,2,3-trichloropropanecontaminated groundwater or surface water for a long period of time may be exposed to relatively high levels of 1,2,3-trichloropropane. Workers involved in the manufacture or use of 1,2,3-trichloropropane or 1,2,3-trichloropropanecontaining products may have the highest potential for exposure to 1,2,3-trichloropropane. Potentially high general population exposure may occur during the use of 1,2,3-trichloropropane-containing products, such as paint- and varnish-removers and cleaners, especially when they are used in poorly ventilated areas such as in the cleaning of reactors. Exposure through the manufacture or use of 1,2,3-trichloropropane-containing products may not be significant, however, since current manufacturing processes generally occur in closed and tightly sealed systems (NIOSH 1981) and no current information indicates that 1,2,3-trichloropropane is still used for those purposes listed.

5.7 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA as amended 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 1,2,3-trichloropropane is available. Where adequate information is not available, ATSDR, in conjunction with the NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of 1,2,3-trichloropropane. The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that, if met, would reduce or eliminate the uncertainties of human health assessment. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

5.7.1 Data Needs

Physical and Chemical Properties. Physical and chemical property data are essential for estimating the transport and partitioning of a chemical in the environment. Many of the physical and chemical properties of 1,2,3-trichloropropane are available (Table 3-2) (Hawley 1981; HSDB 1989; Mackay et al. 1982; McNeil1 1979; Riddick et al. 1986; Ruth 1986; Weast 1985; Williams 1949). However, only estimated values are listed for the log K_{ow}, K_{oc}, and BCF (Lyman et al. 1982). Since the log K_{ow} was used to estimate the K_{oc} and BCF, an experimentally determined log K_{ow} would lead to less uncertainty in those estimated properties. Experimentally determined values would remove any doubt regarding the reliability of these data, although the techniques used for the estimations appear to be accurate.

Production, Import/Export, Use, and Disposal. Data regarding the production methods for 1,2,3-trichloropropane are available (Bauer et al.

1987; Hawley 1981; NIOSH 1981; SRI 1989; Williams 1949); however, data regarding current production, import, and export volumes, and use patterns are lacking. We do know that the chemical is currently produced (SRI 1989), but not in what quantities or whether future production levels will increase, We do not know if the chemical is widely used in the home, the environment, or in the workplace, but it does not appear that such widespread use is likely. It has not been found in food although foods may not have been tested for its presence. Use, release, and disposal information is useful for determining where environmental exposure to 1,2,3-trichloropropane may be high, and may help in estimating whether exposure is likely, and therefore may help to determine whether further toxicological studies are warranted. General data are available regarding the methods of disposal of 1,2,3-trichloropropane (HSDB 1989; Matsui et al. 1975), but information concerning the efficiencies of these methods, as well as the amount disposed of by each method is lacking. Specific disposal information, obtainable by polling industries or industry organizations, may be useful for determining environmental burden and potential concentrations where environmental exposures may be high. Rules and regulations governing land disposal of 1,2,3-trichloropropane are known (EPA 1988a).

Environmental Fate. The environmental fate of 1,2,3-trichloropropane remains unclear due to a lack of experimental data. We do not know where the chemical partitions in the environment. However, based upon estimated physical properties (Lyman et al. 1982), the chemical is expected to partition into the atmosphere and groundwater (Swann et al. 1983). It has been shown that the chemical leaches through soil (Cohen et al. 1986, 1987; Lykins and Baier 1985; Oki and Giamelluca 1987; STORET 1989). It is estimated that it can volatilize ,through near-surface soil and water to the atmosphere (EPA 1985; Lyman et al. 1982). Nothing definitive is known about the biodegradability of the compound. The rate constant for reaction with hydroxyl radicals in the atmosphere is an estimated value (Atkinson 1987), as are significant partition coefficient values used in predicting the environmental fate of the compound (EPA 1988b). Experimental data in these areas would aid in assessing the ultimate environmental fate of 1,2,3-trichloropropane, which would, in turn aid in assessing its background levels in the environment and levels of human exposure.

Bioavailability from Environmental Media. Studies have shown that 1,2,3-trichloropropane is absorbed through the lungs, gastrointestinal tract, and skin of animals (see Section 2.3.1) (Alpert 1982; Clark 1977; Johannsen et al. 1988; Sipes et al. 1982; Union Carbide 1958; Volp et al. 1984). This indicates that it may be absorbed through the inhalation of contaminated air, ingestion of contaminated water, food, and soil, and through dermal contact. The amount of 1,2,3-trichloropropane that is bioavailable from each route is not well documented, and no data were found for humans. Data on the bioavailability of 1,2,3-trichloropropane would be helpful in assessing the importance of environmental exposure levels.

Food Chain Bioaccumulation. The estimated BCF for 1,2,3-trichloropropane (EPA 1988b; Lyman et al. 1982) indicates that this compound would not significantly bioconcentrate in plants, aquatic organisms, or animals. No experimental data were found to support this conclusion. Information was unavailable on the biomagnification of 1,2,3-trichloropropane in food chains. Additional information on bioconcentration by plants, aquatic organisms, and animals and biomagnification in terrestrial and aquatic food chains could be helpful because it might help to indicate whether the chemical biomagnifies in food chains and thereby poses a potential for significant exposure. Biomagnification is not likely, however, based upon the estimated BCF.

Exposure Levels in Environmental Media. Limited data were available regarding the levels of 1,2,3-trichloropropane in the environment (Baier et al. 1987; CLPSD 1989; Cohen et al. 1986, 1987; Dewalle and Chian 1978; EPA 1984, 1987; Jacobs and Zabik 1983; Keith et al. 1976; Lykins and Baier 1985; Oki and Giambelluca 1987; STORET 1989; Wakeham et al. 1983). Information on exposure to 1,2,3-trichloropropane from environmental media would be useful, especially from drinking water derived from groundwater downgradient from 1,2,3-trichloropropane-containing hazardous waste disposal sites and other contaminated surface waters, air near facilities that make or use products containing the compound, and soil at waste disposal sites. Data concerning the presence of 1,2,3-trichloropropane in foods would also be useful in assessing potential exposure.

Exposure Levels in Humans. No data have been found that indicate that 1,2,3-trichloropropane has been found in human samples of blood, urine, fat, or breast milk. Furthermore, no biomarkers of exposure or effect have been identified. Data on both workplace exposure and ambient environmental exposure are sparse and outdated (NIOSH 1981; 1989). A detailed, recent database of exposure would be helpful in determining the current exposure levels, thus allowing estimation of the average daily dose associated with various scenarios such as living near a hazardous waste disposal site, drinking contaminated drinking water, or working in a contaminated workplace. This database of exposure may be very useful if current use patterns, for which information is not available, warrant it.

Exposure Registries. No exposure registries for 1,2,3-trichloropropane were located. This compound is not currently one of the compounds for which a subregistry has been established in the National Exposure Registry. The compound will be considered in the future when chemical selection is made for subregistries to be established. The information that is amassed in the National Exposure Registry facilitates the epidemiological research needed to assess adverse health outcomes that may be related to the exposure to this compound.

5.7.2 On-going Studies

Remedial investigations and feasibility studies conducted at the eight NPL sites known to be contaminated with 1,2,3-trichloropropane will add to the available database on exposure levels in environmental media, exposure levels in humans, and exposure registries and will increase the current knowledge regarding transport and transformation of 1,2,3-trichloropropane in the environment.

As part of the Third National Health and Nutrition Evaluation Survey (NHANES III), the Environmental Health Laboratory Sciences Division of the Center for Environmental Health and Injury Control, Centers for Disease Control, will be analyzing human blood samples for 1,2,3-trichloropropane and other volatile organic compounds. These data will indicate the frequency of occurrence and background levels of these compounds in the general population.

No other on-going studies were located.

6. ANALYTICAL METHODS

The purpose of this chapter is to describe the analytical methods that are available for detecting and/or measuring and monitoring 1,2,3-trichloropropane in environmental media and in biological samples. The intent is not to provide an exhaustive list of analytical methods that could be used to detect and quantify 1,2,3-trichloropropane. Rather, the intention is to identify well-established methods that are used as the standard methods of analysis. Many of the analytical methods used to detect 1,2,3-trichloropropane in environmental samples are the methods approved by federal agencies such as EPA and the National Institute for Occupational Safety and Health (NIOSH). Other methods presented in this chapter are those that are approved by groups such as the Association of Official Analytical Chemists (AOAC) and the American Public Health Association (APHA). Additionally, analytical methods are included that refine previously used methods to obtain lower detection limits, and/or to improve accuracy and precision.

6.1 BIOLOGICAL MATERIALS

No completed studies were located in the literature that reported the analysis of 1,2,3-trichloropropane in human biological matrices. Methods were located, however, for the analysis of the compound in rat biological matrices. These methods are listed in Table 6-l. With suitable modifications, the methods used to detect this chemical in animal samples may apply generally to its determination in human biological samples. Section 6.2 includes a discussion of the methods that may be most sensitive for the determination of 1,2,3-trichloropropane concentrations in environmental samples, including advantages and disadvantages of the commonly used methods. Initial testing to determine minimum detection limits, recovery, accuracy, and precision of the particular, suitably modified methods is necessary to gauge the applicability of the methods used to detect 1,2,3-trichloropropane in animal biological samples for the chemical's determination in human biological samples.

6.2 ENVIRONMENTAL SAMPLES

Methods for analyzing 1,2,3-trichloropropane in environmental samples are presented in Table 6-2. All of the methods listed use either adsorption on a sorption column (air samples) or purge-and-trap methods (solid and liquid samples), followed by thermal desorption and some form of gas chromatography (GC) with an appropriate detector as the analytical quantification technique. Purge-and-trap methods involve the purging of the vapor from the sample or its suspension in water with an inert gas and the trapping of the desorbed vapors in a sorbent trap. Particular care must be taken in sampling and storage of samples in view of the compound's high volatility. Although 1,2,3-trichloropropane was listed as a chemical that could be determined using the listed techniques, significant factors such as the detection limit and percent recovery were not reported for this chemical. Both halogen-specific detection (e.g., Hall electrolytic conductivity detectors) and mass spectrometry (MS) provide excellent detection limits (EPA 1986a; Ho 1989;

TABLE 6-1. Analytical Methods for Determining 1,2,3-Trichloropropane in Biological Materials

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Exhaled air in rats	Dry air drawn through cage and trap filled with ethyl alcohol at -15°C	GC-ECD	No data	No data	Sipes et al. 1982
Urine, feces, bile, major tissues, blood	Sample homogenized and centrifuged, extracted with n-hexane; blood added to water and bile added to ethyl alcohol prior to extraction	GC-ECD	No data	No data	Sipes et al. 1982

ECD = electron capture detection
GC = gas chromatography

TABLE 6-2. Analytical Methods for Determining 1,2,3-Trichloropropane in Environmental Samples

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Occupational air	Sample sorbed on charcoal; desorbed by CS_2	GC-FID (NIOSH method 1003)	0.3 mg/sample	95%	NIOSH 1987
Finished drinking/ raw source water	Purge and trap in Tenax/ silica/charcoal; thermally desorb	GC-HECD (EPA method 502.1)	No data	100% at 0.4 µg/L	EPA 1986a
Finished drinking/ raw source water	Purge and trap in Tenax/ silica/charcoal; thermally desorb	Subambient programmable HRGC-MS (EPA method 524.1)	No data	No data	EPA 1986a
Finished drinking/ raw source water	Purge and trap in Tenax/ silica/charcoal; thermally desorb	Cryofocusing (wide or narrow bore) HRGC-MS (EPA method 524.2)	0.03 µg/L (wide bore) 0.14 µg/L (narrow bore)	108% at 0.5-10 µg/L (wide bore) 96% at 0.5 µg/L (narrow bore)	EPA 1986a
Drinking water	Purge and trap in Tenax/ silica/charcoal; thermally desorb	GC-HECD and PID in series	0.03 µg/L	97%	Ho 1989
Liquid and solid waste, groundwater, soil, and sludge	Soil and viscous samples dispersed in water or methanol/water; purge and trap in Tenax/silica/charcoal and thermally desorb	GC-HECD (EPA method 5030 and 8010)	No data	No data	EPA 1986b
Solid and liquid waste, soil	Sample dispersed in a glycol; purged and trapped in Tenax/ silica/charcoal; thermally desorbed	GC-ECD and PID in series	No data	No data	Lopez-Avila et al. 1987
Citrus fruit (lemon, orange, grapefruit)	Sample blended with water; distilled into cyclohexane in essential oil apparatus; cleanup on Flourisil column; injected into GC	GC-ECD	No data	98%-99% at 0.01 ppm	Tonogai et al. 1986

ECD = electron capture detector
FID = flame ionization detector
GC = gas chromotagraphy
HECD = Hall electron capture detector
HRGC = high-resolution gas chromatography
MS = mass spectrometry
NIOSH = National Institute for Occupational Safety and Health
PID = photoionization detector

Lopez-Avila et al. 1987; Ramus et al. 1984). An advantage of halogenspecific detectors is that they are very sensitive and specific to halogen compounds. MS, on the other hand, provides additional confirmation of the identity of a compound through its ion fragment patterns. High-resolution gas chromatography (HRGC) with capillary columns coupled with MS provides better resolution and increased sensitivity for volatile compounds than packed columns. In this method, desorbed compounds are cryogenically trapped onto the head of the capillary column. This HRGC-MS method overcomes some common problems involved in analyses of excessively complex samples, samples with large ranges of concentrations, and samples that also contain nonvolatile compounds (Dreisch and Munson 1983; EPA 1986a).

6.3 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA as amended 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 1,2,3-trichloropropane is available. Where adequate information is not available, ATSDR, in conjunction with the NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of 1,2,3-trichloropropane.

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that, if met, would reduce or eliminate the uncertainties of human health assessment. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

6.3.1 Data Needs

Methods for Determining Biomarkers of Exposure and Effect. No biomarker, other than possibly 1,2,3-trichloropropane itself, that can be associated quantitatively with exposure to 1,2,3-trichloropropane has been identified (see Section 2.5). Even the compound itself may not be a quantitative biomarker of exposure because the levels found have not been proven to qualitatively reflect exposure levels. Nevertheless, there are methods for analyzing 1,2,3-trichloropropane in most of the biological matrices for the rat, although important information such as detection limits and recoveries was not reported (Sipes et al. 1982). These methods may be sufficient for the analysis of human biological matrices.

No biomarkers have been identified that can be associated quantitatively with effects caused by exposure to 1,2,3-trichloropropane. Therefore, methods for biomarkers of effects are not currently available.

Methods for Determining Parent Compounds and Degradation Products in Environmental Media. Analytical methods for determining 1,2,3-trichloropropane in contaminated air, water, soil, liquid and solid waste, sewage sludge, and citrus fruits are available (EPA 1986a, 1986b; Ho 1989; Lopez-Avila et al. 1987; NIOSH 1987; Tonogai et al. 1986). No methods were found for the determination of 1,2,3-trichloropropane in sediments. Most of the methods used for environmental samples, however, did not report detection limits, recovery, accuracy, and precision for 1,2,3-trichloropropane. Knowledge of these factors, as well as the development of alternative methods of analysis, would help in estimating the potential for human exposure to 1,2,3-trichloropropane. No information was found regarding degradation products of 1,2,3-trichloropropane. Consequently, no comment regarding the availability of analytical methods for determining degradation products can be made.

6.3.2 On-going Studies

The Environmental Health Laboratory Sciences Division of the Center for Environmental Health and Injury Control, Centers for Disease Control, is developing methods for analyzing 1,2,3-trichloropropane and other volatile organic compounds in blood. These methods use high resolution gas chromatography and magnetic sector mass spectrometry, which gives detection limits in the low ppt (parts per trillion) range.

7. REGULATIONS AND ADVISORIES

National regulations and guidelines pertinent to human exposure to 1,2,3-trichloropropane are summarized in Table 7-l. Guidance from the World Health Organization and the International Agency for Research on Cancer is not available.

7. REGULATIONS AND ADVISORIES

TABLE 7-1. Regulations and Guidelines Applicable to 1,2,3-Trichloropropane

Agency	Description	Information	References
NATIONAL			
Regulations:			
a. Air:			
OSHA	PEL	50 ppm (300 mg/m^3)	OSHA 1989 (29 CFR 1910)
	TWA	10 ppm (60 mg/m^3)	OSHA 1989 (29 CFR 1910)
Guidelines:			
a. Air:			
ACGIH	TLV-TWA (skin)	10 ppm (60 mg/m^3)	ACGIH 1989
b. Water:			
EPA ODW	Health advisories		IRIS 1991
	Longer-term, child	0.6 mg/L	
	Longer-term, adult	2 mg/L	
	DWEL (lifetime)	0.2 mg/L	
c. Other:			
EPA	RfD (oral)	6x10^{-3} mg/kg/day	IRIS 1991
STATE			
Regulations and Guidelines:			
a. Air:	Acceptable ambient air concentrations		NATICH 1988
Connecticut		6 mg/m^3 (8-hr avg)	
North Dakota		3 mg/m^3 (8-hr avg) 4.5 mg/m^3 (1-hr avg)	
Nevada		7.143 mg/m^3 (8-hr avg)	
Virginia		5 mg/m^3 (24-hr avg)	

ACGIH = American Conference of Governmental Industrial Hygienists
avg = average
DWEL = Drinking Water Equivalent Level
EPA = Environmental Protection Agency
hr = hour
OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Limit
RfD = Reference dose
TLV = Threshold Limit Value
TWA = Time-Weighted Average

8. REFERENCES

*ACGIH. 1989. Threshold limit values and biological exposure indices for 19894990. American Conference of Governmental Industrial Hygenists, Cincinnati, OH, 41.

Albrecht WN. 1987. Central nervous system toxicity of some common environmental residues in the mouse. J Toxicol Environ Health 21(4):405-421.

*Alpert JR. 1982. Acute toxicity studies with 1,2,3-trichloropropane. Report to Shell Oil Co. OTS 0515726. [Unpublished study]

*Atkinson R. 1987. A structure-activity relationship for the estimation of rate constants for the gas-phase reactions of OH radicals with organic compounds. J Chem Kinet 19:799-828.

*Baier JH, Lykins BW Jr., Fronk CA, et al. 1987. Using reverse osmosis to remove agricultural chemicals from groundwater. Am Water Works Assoc J 79(8):55-60.

*Barnes D, Bellin J, DeRosa C, et al. 1988. Reference dose (RfD) description and use in health risk assessments. Volume I, Appendix A: Integrated risk information system supportive documentation. Washington, DC; US Environmental Protection Agency, Office of Health and Environmental Assessment. EPA/600/8-86/032a.

*Burka L. 1990a. Personal communication (telephone conversation) from Dr. L. Burka, Staff Scientist, National Toxicology Program, Division of Toxicology Research and Testing, to Stephen J. Bosch, Syracuse Research Corporation. March 12, 1990.

*Burka L. 1990b. Memo to Dr. Terri Damstra on ATSDR document on 1,2,3-trichloropropane. March 29, 1990.

*CAS. 1989. Chemical Abstracts Service, American Chemical Society, Chemical Abstracts Registry File. [Database] September 8, 1989.

*CHEMLINE. 1989. National Library of Medicine Chemline [Database].

*Christos T, Forshey DR, Hartstein AM. 1977. Coal mine combustion products: Ingredients of conveyor belts. U.S. Bur Mines Rep Invest, (RI):8235

*Clark DG. 1977. Acute toxicity, skin and eye irritancy and skin sensitizing potential of 1,2,3-trichloropropane. Report to Shell Oil Co. OTS 0515731. [Unpublished study]

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*Cited in text.

8. REFERENCES

CLPSD. 1989. Contract Laboratory Program Statistical Database. Viar and Company, Alexandria, VA, July 12, 1989.

*Cohen SZ, Eiden C, Lorber MN. 1986. Monitoring ground water for pesticides. In: Garner WY et al., ed. ACS Symp Ser, Washington, DC. 315:170-196.

*Cohen SZ, Eiden C, Lorber MN. 1987. Monitoring ground water for pesticides in the U.S.A. Schriftenr Ver Wasser-, Bodenlufthyg 68:265-294.

*DeWalle FB, Chian ESK. 1978. Presence of trace organics in the Delaware River and their discharge by municipal and industrial sources. Proc Ind Waste Conf 32:908-919.

*Dilling WL. 1977. Interphase transfer process. II. Evaporation rates of chloromethanes, ethanes, ethylenes, propanes, and propylenes from dilute aqueous solutions. Comparisons with theoretical predictions. Environ Sci Technol 11:405-409.

*Dix KM. 1979. Toxicity of fine chemicals: preliminary studies for the detection of testicular changes in rats. Report to Shell Oil Co. OTS 0510352. [Unpublished study]

*Dreisch FA, Munson TO. 1983. Purge-and-trap analysis using fused silica capillary column gas chromatography-mass spectrometry. J Chromatogr Sci 21(3):111-118.

Drew RT, Pate1 JM, Lin FN. 1978. Changes in serum enzymes in rats after inhalation of organic solvents singly and in combination. Toxicol Appl Pharmacol 45(3):809-819.

*Eisenreich SJ, Looney BB, Thornton JD. 1981. Airborne organic contaminants in the Great Lakes ecosystem. Environ Sci Technol 15(1):30-38.

*Ellerstein SM, Bertozzi ER. 1982. Polysulfides. In: Kirk-Othmer encyclopedia of chemical technology. 3rd ed. New York, NY: John Wiley and Sons, 11:814-815.

*EPA. 1984. GC/MS analysis of organics in drinking water concentrates and advanced waste treatment concentrates. Vol. 2. Computer-printed tabulations of compound identification results for large-volume concentrates. Columbus Labs, Health Effects Research Lab, Columbus, OH. EPA/600/i-84-020B. NTIS PB85-128239.

*EPA. 1985. Exposure analysis modeling system: reference manual for EXAMS II. U.S. Environmental Protection Agency, Environmental Research Lab, Athens, GA. EPA/600/3-85/038.

8. REFERENCES

*EPA. 1986a. Method for the determination of organic compounds in finished drinking water and raw source water. Method Nos. 502.1, 524.1 and 524.2. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, OH.

*EPA. 1986b. Test method for evaluating solid waste, physical/chemical methods, SW-846, Methods No. 5030 and 8010. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

*EPA. 1987. Health and environmental effects document for trichloropropanes. Prepared by the Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, U.S. Environmental Protection Agency, Cincinnati, OH for the Office of Solid Waste and Emergency Response.

*EPA. 1988a. List of halogenated organic compounds regulated under 268.32. 40 CFR 268, Appendix III. July 1, 1988.

*EPA. 1988b. PC Gems CLOGP3 (Octanol/Water Partition Coefficient). Graphical Exposure Modeling Systems. U.S. Environmental Protection Agency, Washington, DC.

*EPA. 1988c. Measurement of hydrolysis rate constants for evaluation of hazardous waste land disposal: Volume 3. Data on 70 chemicals. U.S. Environmental Protection Agency, Washington, DC. NTIS PB88-234 042/AS. EPA/600/S3-88/028.

*EPA. 1989a. Interim methods for development of inhalation reference doses. U.S. Environmental Protection Agency, Office of Health and Environmental Assessment. Washington, DC. EPA 600/8-88-066F.

*EPA. 1989b. CIS computer printout: 1977 Non-confidential production data from TSCA inventory. OPTS, CID, U.S. Environmental Protection Agency, Washington, DC. September 1, 1989.

*Gangal SV. 1980. Fluorinated ethylene-propylene copolymers. In: Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed. New York, NY: John Wiley and Sons, 11:24-25.

*Gushow TS, Quast JF. 1984. 1,2,3-Trichloropropane: Acute inhalation toxicity evaluation in male rats and mice. Report to Dow Chemical Co. OTS 0510175. [Unpublished study]

*Hardin BD, Bond GP, Sikov MR, et al. 1981. Testing of selected workplace chemicals for teratogenic potential. Stand J Work Environ Health 7(Suppl 4):66-75.

*Hawley GG. 1981. The condensed chemical dictionary. 10th ed. New York, NY: Van Nostrand Reinhold Co., 1043.

8. REFERENCES

*Haworth S, Lawlor T, Mortelmas K, et al. 1983. Salmonella mutagenicity test results for 250 chemicals. Environ Mutagen Supplement 5(1):3-142.

*Ho JSY. 1989. A sequential analysis for volatile organics in water by purge-and-trap capillary column gas chromatography with photoionization and electrolytic conductivity detectors in a series. J Chromatogr Sci 27:91-98.

*HSDB. 1989. Hazardous Substance Data Bank. National Library of Medicine, National Toxicology Information Program, Bethesda, MD. Profile No. 1340. September 8, 1989.

*IRIS. 1991. Integrated Risk Information System (IRIS). Online. Cincinnati, OH: Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency.

*Ivanetich KM, Lucas S, Marsh JA, et al. 1978. Organic compounds: Their interaction with and degradation of hepatic microsomal drug -- Metabolizing enzymes in vitro. Drug Metab Dispos 6(3):218-225.

*Jacobs LW, Zabik MJ. 1983. Importance of sludge-borne organic chemicals for land application programs. Sixth annual Madison waste conference municipal and industrial waste, September 14-15, 1983. 418-426.

*Jensen S, Lange R, Berge G, et al. 1975. Chemistry of EDC-tar and its biological significance in the sea. Proc. R. Sot. London, Ser B, 189(1096):33-46.

*Johannsen FR, Levinskas GJ, Rusch GM, et al. 1988. Evaluation of the subchronic and reproductive effects of a series of chlorinated propanes in the rat. I. Toxicity of the 1,2,3-trichloropropane. J Toxicol Environ Health 25(3):299-315.

*Kawasaki M. 1980. Experience with the test scheme under the chemical control law of Japan: An approach to structure-activity correlations. Ecotox Environ Safety 4:444-454.

*Keith LH, Garrison AW, Allen FR, et al. 1976. Identification of organic compounds in drinking water from thirteen U.S. cities. In: Keith LH, ed. Ident Anal Organic Pollut Water. Ann Arbor, MI: Ann Arbor press, 329-373.

*Lopez-Avila V, Heath N, Hu A. 1987. Determination of purgeable halocarbons and aromatics by photoionization and Hall electrolytic conductivity detectors connected in series. J Chromatogr Sci 25(8):356-363.

*Lykins BW Jr., Baier JH. 1985. Removal of agricultural contaminants from ground water. U.S. Environmental Protection Agency, Washington, DC. EPA/600/D-85/136.

8. REFERENCES

*Lyman WJ, Reehl WF, Rosenblatt DH. 1982. Handbook of chemical property estimation methods. Environmental behavior of organic compounds. New York, NY: McGraw-Hill Book Co., 4-9, 5-5, 15-9 to 15-31.

*MacKay D, Bobra A, Chan DW, et al. 1982. Vapor pressure correlations for low-volatility environmental chemicals. Environ Sci Technol 16:645-649.

*Mahmood NA, Burka LT, Cunningham ML. 1988. Metabolism and mutagenicity of 1,2,3-trichloropropane. Pharmacologist. 30:A8.

*Matsui S, Murakami T, Sasaki T, et al. 1975. Activated sludge degradability of organic substances in the waste water of the Kashima petroleum and petrochemical industrial complex in Japan. Prog Water Technol 7:645-659.

*McNeil1 WC Jr. 1979. Trichloroethylene. In: Kirk-Othmer encyclopedia of chemical technology, 3rd ed. New York, NY: John Wiley and Sons, 5:745.

*McOmie WA, Barnes TR. 1949. Acute and subacute toxicity of 1,2,3-trichloropropane in mice and rabbits. Fed Proc 8:319.

*Miller RR, Quast JF, Gushow TS. 1986a. 1,2,3-Trichloropropane: 2-Week vapor inhalation study in rats and mice. Report to Dow Chemical Co. OTS 0517050. [Unpublished study]

Miller RR, Quast JF, Momany-Pfruender JJ. 1986b. 1,2,3-Trichloropropane: 2-Week vapor inhalation study to determine the no-adverse-effect level in rats and mice. Report to Dow Chemical Co. OTS 0517055. [Unpublished study]

Moody DE, James JL, Clawson GA, et al. 1981. Correlation among the changes in hepatic microsomal components after intoxication with alkyl halides and other hepatotoxins. Mol Pharmacol 20(3):685-693.

*NAS/NRC. 1989. Biologic markers in reproductive toxicology. National Academy of Sciences/National Research Council. Washington, DC: National Academy Press, 15-35.

*NATICH. 1988. National Air Toxics Information Clearinghouse. July 1988.

*NIOSH. 1975. NIOSH Analytical Method 1,2,3-Trichloropropane S126. National Institute for Occupational Safety and Health, Rockville, MD.

*NIOSH. 1981. Trichloropropanes. Report 4. Report to National Institute for Occupational Safety and Health, Cincinnati, OH by Franklin Research Center, Silver Springs, MD.

8. REFERENCES

*NIOSH. 1987. Manual of analytical methods. Vol. 1, 3rd ed. U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, Cincinnati, OH.

*NIOSH. 1989. National Occupational Exposure Survey (NOES) as of March 29, 1989. National Institute for Occupational Safety and Health. Cincinnati, OH.

*NTP. 1983a. Final report. 120-Day toxicity gavage study of 1,2,3-trichloropropane in Fischer 344 rats. Report to the National Toxicology Program by Hazelton Laboratories, [Unpublished study]

*NTP. 1983b. Final report. 120-Day gavage toxicity study in B6C3Fl mice. 1,2,3-Trichloropropane. Report to the National Toxicology Program by Hazelton Laboratories. [Unpublished study]

*NTP. 1991. National Toxicology Program -- technical report series no. 384. Toxicology and carcinogenesis studies of 1,2,3-trichloropropane (CAS no. 96-18-4) in F344/N rats and B6C3Fl mice (gavage studies). Research triangle Park, NC: Department of Health and Human Services, National Institute of Health. NTH publ. no. 91-2839.

*Oki DS, Giambelluca TW. 1987. DBCP, EDB, and TCP contamination of ground water in Hawaii. Ground Water 25:693-702.

Olson KS. 1975. Results of range finding toxicological tests on 1,2,3-trichloropropane. Report to Dow Chemical Company. OTS 0510177. [Unpublished study]

*OSHA. 1989. U.S. Department of Labor. Occupational Safety and Health Administration. Air contaminants; final rule. 29 CFR 1910. Federal Register 54:2955 (January 19, 1989).

Pinkerton MN, Schwebel RL. 1975. Acute toxicological properties and industrial handling hazards of crude 1,2,3-trichloropropane. Report to Dow Chemical Company. OTS 0510173. [Unpublished study]

Pullin TG, Schwebel RL. 1958. Acute toxicological properties and industrial handling hazards of 1,2,3-trichloropropane, crude. Report to Dow Chemical Company. OTS 0510174. [Unpublished study]

*Ramus TL, Hein SJ, Thomas LC. 1984. Determinations of chlorinated hydrocarbons by gas chromatography using response factor calibration. 3 Chromatogr 314:243-251.

*Ratpan F, Plaurnann H. 1988. Mutagenicity of halogenated propanes and their methylated derivatives. Environ Mol Mutagen 12(2):253-260.

8. REFERENCES

*Riddick JA, Bunger WB, Sakano TK. 1986. Organic solvents: Physical properties and methods of purification. Techniques of chemistry. 4th ed. New York, NY: Wiley-Interscience, 524.

*Roberts TR, Stoydin G. 1976. The degradation of (Z)- and (E)-,1,3-dichloropropenes and 1,2-dichloropropane in soil. Pestic Sci 7:325-335.

*Robinson M, McKean DL, Condie LW et al. 1989. 1,2,3-Trichloropropane (TCP) induced heart and liver toxicity. Toxicologist 9:278.

*RTECS. 1989. Registry of Toxic Effects of Chemical Substances on-line database. U.S. Department of Health and Human Service, Public Health Service, Center for Disease Control, National Institute of Occupational Safety and Health, Research Triangle Park, NC. September 8, 1989.

*Ruth JH. 1986. Odor thresholds and irritation levels of several chemical substances. A review. Am Ind Hyg Assoc J 47:A142-A151.

*Saito-Suzuki R, Teramoto S, Shirasu Y. 1982. Dominant-lethal studies in rats with 1,2-dibromo-3-chloropropane and its structurally related compounds. Mutat Res 101(4):321-328.

*Salmon AG, Jones RB, Mackrodt WC. 1981. Microsomal dechlorination of chloroethanes: Structure-reactivity relationships. Xenobiotica. 11(11):723-734.

*Silverman L, Schulte HF, First MW. 1946. Further studies on sensory response to certain industrial solvent vapors. J Ind Hyg Toxicol 28: 262-266.

*Silverstein RM, Bassler GC, Merrill TC. 1974. Spectrometric identification of organic compounds. 3rd ed. New York, NY: John Wiley and Sons, 239.

*Sipes IG, Carter DE, Volp RF. 1982. Pharmacokinetics of xenobiotics: 1,2,3-Trichloropropane. Study performed for N.I.E.H.S. under Contract No. NOl-ES-8-2130. [Unpublished study]

*Smyth HF, Carpenter CP, Weil CS, et al. 1962. Range-finding toxicity data: List VI. Ind Hyg J 23:95-107.

*SRI. 1989. 1989 Directory of chemical producers. United States of America. Standard Research International, Menlo Park, CA. 1042,

*Stolzenberg SJ, Hine CH. 1980. Mutagenicity of 2- and 3- carbon halogenated compounds in the Salmonella/mammalian-microsome test. Environ Mutagen 2(1):59-66.

8. REFERENCES

*STORET. 1989. STORET database. U.S. Environmental Protection Agency, Washington, D.C. September 13, 1989.

*Stutz DR, Janusz SJ. 1988. Hazardous materials injuries. A handbook for pre-hospital care. 2nd ed. Beltsville, MD: Bradford Communications Corporation. p. 300-301.

*Swarm RL, Laskowski DA, McCall PJ, et al. 1983. A rapid method for the estimation of the environmental parameters octanol/water partition coefficient, soil sorption constant, water to air ratio and water solubility. Res Rev 85:17-28.

*Tabak HK, Quave SA, Mashin CI, et al. 1981. Biodegradability studies with organic priority pollutant compounds. J Water Pollut Contr Fed 53:1503-1517.

*Tonogai Y, Ito Y, Ogawa S, et al. 1986. Determination of dibromochloropropane and related fumigants in citrus fruit. J Food Prot 49(11):909-913.

Tsulaya VR, Bonashevskaya TI, Zykova VV. 1977. [Toxicological characteristics of some chlorinated hydrocarbons.] Gig Sanit 8:50-53. (Russian)

*Union Carbide Company. 1958. Range finding tests on 1,2,3-trichloropropane. OTS 0515585. [Unpublished study]

*Van Dyke RA, Wineman CG. 1971. Enzymic dechlorination. Dechlorination of chloroethanes and propanes in vitro. Biochem Pharmacol 20(2):463-470.

*View Database. 1989. Agency for Toxic Substances and Disease Registry (ATSDR), Office of External Affairs, Exposure and Disease Registry Branch, Atlanta, GA, September 25, 1989.

*Villeneuve DC, Chu I, Secours VE, et al. 1985. Results of a go-day toxicity study on 1,2,3- and 1,1,2-trichloropropane administered via the drinking water. Sci Total Environ 47:421-426.

*Volp RF, Sipes IG, Falcoz DE, et al. 1984. Disposition of 1,2,3-trichloropropane in the Fischer-344 rat: Conventional and physiological pharmacokinetics. Toxicol Appl Pharmacol 75(1):8-17.

*Von Der Hude W, Scheutwinkel M, Gramlich U, et al. 1987. Genotoxicity of three-carbon compounds evaluated in the SCE test In vitro. Environ Mutagen 9(4):401-410.

*Wakeham SG, Goodwin JT, Davis AC. 1983. Distributions and fate of volatile organic compounds in Narragansett Bay, Rhode Island. Can J Fish Aquat Sci 40:304-321.

8. REFERENCES

*Weast RC. 1985. CRC handbook of chemistry and physics. 66th ed. Boca Raton, FL: CRC Press, Inc., C-444.

*Weber GL, Sipes IG. 1988. Investigations into the role of biotransformation in the covalent binding of 1,2,3-trichloropropane (TCP) to hepatic protein and DNA. Toxicologist. 8:51.

*Williams PH. 1949. Chlorine compounds, organic. In: Kirk-Othmer encyclopedia of chemical technology. 1st ed. Kirk RE, Othmer DF, ed. New York, NY: Interscience Encyclopedia, Inc., 3:775-776, 838.

Wright WH, Schaffer JM. 1932. Critical anthelmintic tests of chlorinated alkyl hydrocarbons and a correlation between the anthelmintic efficacy, chemical structure and physical properties. Am J Hyg 16:325-428.

8. REFERENCES

*Weast RC. 1985. CRC handbook of chemistry and physics. 66th ed. Boca Raton, FL: CRC Press, Inc., C-444.

*Weber GL, Sipes IG. 1988. Investigations into the role of biotransformation in the covalent binding of 1,2,3-trichloropropane (TCP) to hepatic protein and DNA. Toxicologist. 8:51.

*Williams PH. 1949. Chlorine compounds, organic. In: Kirk-Othmer encyclopedia of chemical technology. 1st ed. Kirk RE, Othmer DF, ed. New York, NY: Interscience Encyclopedia, Inc., 3:775-776, 838.

Wright WH, Schaffer JM. 1932. Critical anthelmintic tests of chlorinated alkyl hydrocarbons and a correlation between the anthelmintic efficacy, chemical structure and physical properties. Am J Hyg 16:325-428.

9. GLOSSARY

Acute Exposure -- Exposure to a chemical for a duration of 14 days or less, as specified in the Toxicological Profiles.

Adsorption Coefficient (K_{oc}) -- The ratio of the amount of a chemical adsorbed per unit weight of organic carbon in the soil or sediment to the concentration of the chemical in solution at equilibrium.

Adsorption Ratio (Kd) -- The amount of a chemical adsorbed by a sediment or soil (i.e., the solid phase) divided by the amount of chemical in the solution phase, which is in equilibrium with the solid phase, at a fixed solid/solution ratio. It is generally expressed in micrograms of chemical sorbed per gram of soil or sediment.

Bioconcentration Factor (BCF) -- The quotient of the concentration of a chemical in aquatic organisms at a specific time or during a discrete time period of exposure divided by the concentration in the surrounding water at the same time or during the same period.

Cancer Effect Level (CEL) -- The lowest dose of chemical in a study, or group of studies, that produces significant increases in the incidence of cancer (or tumors) between the exposed population and its appropriate control.

Carcinogen -- A chemical capable of inducing cancer.

Ceiling Value -- A concentration of a substance that should not be exceeded, even instantaneously.

Chronic Exposure -- Exposure to a chemical for 365 days or more, as specified in the Toxicological Profiles.

Developmental Toxicity -- The occurrence of adverse effects on the developing organism that may result from exposure to a chemical prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the life span of the organism.

Embryotoxicity and Fetotoxicity -- Any toxic effect on the conceptus as a result of prenatal exposure to a chemical; the distinguishing feature between the two terms is the stage of development during which the insult occurred. The terms, as used here, include malformations and variations, altered growth, and in utero death.

EPA Health Advisory -- An estimate of acceptable drinking water levels for a chemical substance based on health effects information. A health advisory is not a legally enforceable federal standard, but serves as technical guidance to assist federal, state, and local officials.

9. GLOSSARY

Immediately Dangerous to Life or Health (IDLH) -- The maximum environmental concentration of a contaminant from which one could escape within 30 min without any escape-impairing symptoms or irreversible health effects.

Intermediate Exposure -- Exposure to a chemical for a duration of 15-364 days as specified in the Toxicological Profiles.

Immunologic Toxicity -- The occurrence of adverse effects on the immune system that may result from exposure to environmental agents such as chemicals.

In vitro -- Isolated from the living organism and artificially maintained, as in a test tube.

In vivo -- Occurring within the living organism.

Lethal Concentration$_{(Lo)}$ (LC_{Lo}) -- The lowest concentration of a chemical in air which has been reported to have caused death in humans or animals.

Lethal Concentration$_{(50)}$ (LC_{50}) -- A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

Lethal Dose$_{(Lo)}$ (LD_{Lo}) -- The lowest dose of a chemical introduced by a route other than inhalation that is expected to have caused death in humans or animals.

Lethal Dose$_{(50)}$(LD_{50}) -- The dose of a chemical which has been calculated to cause death in 50% of a defined experimental animal population.

Lethal Time$_{(50)}$ (LT_{50}) -- A calculated period of time within which a specific concentration of a chemical is expected to cause death in 50% of a defined experimental animal population.

Lowest-Observed-Adverse-Effect Level (LOAEL) -- The lowest dose of chemical in a study, or group of studies, that produces statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control.

Malformations -- Permanent structural changes that may adversely affect survival, development, or function.

Minimal Risk Level -- An estimate of daily human exposure to a chemical that is likely to be without an appreciable risk of deleterious effects (noncancerous) over a specified duration of exposure.

Mutagen -- A substance that causes mutations. A mutation is a change in the genetic material in a body cell. Mutations can lead to birth defects, miscarriages, or cancer.

9. GLOSSARY

Short-Term Exposure Limit (STEL) -- The maximum concentration to which workers can be exposed for up to 15 min continually. No more than four excursions are allowed per day, and there must be at least 60 min between exposure periods. The daily TLV-TWA may not be exceeded.

Target Organ Toxicity -- This term covers a broad range of adverse effects on target organs or physiological systems (e.g., renal, cardiovascular) extending from those arising through a single limited exposure to those assumed over a lifetime of exposure to a chemical.

Teratogen -- A chemical that causes structural defects that affect the development of an organism.

Threshold Limit Value (TLV) -- A concentration of a substance to which most workers can be exposed without adverse effect. The TLV may be expressed as a TWA, as a STEL, or as a CL.

Time-Weighted Average (TWA) -- An allowable exposure concentration averaged over a normal 8-hour workday or 40-hour workweek.

Toxic Dose (TD_{50}) -- A calculated dose of a chemical, introduced by a route other than inhalation, which is expected to cause a specific toxic effect in 50% of a defined experimental animal population.

Uncertainty Factor (UF) -- A factor used in operationally deriving the RfD from experimental data. UFs are intended to account for (1) the variation in sensitivity among the members of the human population, (2) the uncertainty in extrapolating animal data to the case of human, (3) the uncertainty in extrapolating from data obtained in a study that is of less than lifetime exposure, and (4) the uncertainty in using LOAEL data rather than NOAEL data. Usually each of these factors is set equal to 10.

APPENDIX A

USER'S GUIDE

Chapter 1

Public Health Statement

This chapter of the profile is a health effects summary written in nontechnical language. Its intended audience is the general public especially people *living* in the vicinity of a hazardous waste site or substance release. If the Public Health Statement were removed from the rest of the document, it would still communicate to the lay public essential information about the substance.

The major headings in the Public Health Statement are useful to find specific topics of concern. The topics are written in a question and answer format. The answer to each question includes a sentence that will direct the reader to chapters in the profile that will provide more information on the given topic.

Chapter 2

Tables and Figures for Levels of Significant Exposure (LSE)

Tables (2-1, 2-2, and 2-3) and figures (2-l and 2-2) are used to summarize health effects by duration of exposure and endpoint and to illustrate graphically levels of exposure associated with those effects. All entries in these tables and figures represent studies that provide reliable, quantitative estimates of No-Observed-Adverse-Effect Levels (NOAELs), Lowest-Observed- Adverse-Effect Levels (LOAELs) for Less Serious and Serious health effects, or Cancer Effect Levels (CELs). In addition, these tables and figures illustrate differences in response by species, Minimal Risk Levels (MRLs) to humans for noncancer end points, and EPA's estimated range associated with an upper-bound individual lifetime cancer risk of 1 in 10,000 to 1 in 10,000,000. The LSE tables and figures can be used for a quick review of the health effects and to locate data for a specific exposure scenario. The LSE tables and figures should always be used in conjunction with the text.

The legends presented below demonstrate the application of these tables and figures. A representative example of LSE Table 2-1 and Figure 2-1 *are* shown. The numbers in the left column of the legends correspond to the numbers in the example table and figure.

LEGEND

See LSE Table 2-l

(1). Route of Exposure One of the first considerations when reviewing the toxicity of a substance using these tables and figures should be the relevant and appropriate route of exposure. When sufficient data exist,

three LSE tables and two LSE figures are presented in the document. The three LSE tables present data on the three principal routes of exposure, i.e., inhalation, oral, and dermal (LSE Table 2-1, 2-2, and 2-3, respectively). LSE figures are limited to the inhalation (LSE Figure 2-l) and oral (LSE Figure 2-2) routes.

(2). Exposure Duration Three exposure periods: acute (14 days or less); intermediate (15 to 364 days); and chronic (365 days or more) are presented within each route of exposure. In this example, an inhalation study of intermediate duration exposure is reported.

(3). Health Effect The major categories of health effects included in LSE tables and figures are death, systemic, immunological, neurological, developmental, reproductive, and cancer. NOAELs and LOAELs can be reported in the tables and figures for all effects but cancer. Systemic effects are further defined in the "System" column of the LSE table.

(4). Key to Figure Each key number in the LSE table links study information to one or more data points using the same key number in the corresponding LSE figure. In this example, the study represented by key number 18 has been used to define a NOAEL and a Less Serious LOAEL (also see the two '18r" data points in Figure 2-l).

(5). Species The test species, whether animal or human, are identified in this column.

(6). Exposure Frequency/Duration The duration of the study and the weekly and daily exposure regimen are provided in this column. This permits comparison of NOAELs and LOAELs from different studies. In this case (key number 18), rats were exposed to [substance x] via inhalation for 13 weeks, 5 days per week, for 6 hours per day.

(7). System This column further defines the systemic effects. These systems include: respiratory, cardiovascular, gastrointestinal, hematological, musculoskeletal, hepatic, renal, and dermal/ocular. "Other" refers to any systemic effect (e.g., a decrease in body weight) not covered in these systems. In the example of key number 18, one systemic effect (respiratory) was investigated in this study.

(8). NOAEL A No-Observed-Adverse-Effect Level (NOAEL) is the highest exposure level at which no harmful effects were seen in the organ system studied. Key number 18 reports a NOAEL of 3 ppm for the respiratory system which was used to derive an intermediate exposure, inhalation MRL of 0.005 ppm (see footnote "c").

(9). LOAEL A Lowest-Observed-Adverse-Effect Level (LOAEL) is the lowest exposure Level used in the study that caused a harmful health effect. LOAELs have been classified into "Less Serious" and "Serious" effects. These distinctions help readers identify the levels of exposure at which

adverse health effects first appear and the gradation of effects with increasing dose. A brief description of the specific end point used to quantify the adverse effect accompanies the LOAEL. The "Less Serious" respiratory effect reported in key number 18 (hyperplasia) occurred at a LOAEL of 10 ppm.

(10). Reference The complete reference citation is given in Chapter 8 of the profile.

(11). CEL A Cancer Effect Level (CEL) is the lowest exposure level associated with the onset of carcinogenesis in experimental or epidemiological studies. CELs are always considered serious effects. The LSE tables and figures do not contain NOAELs for cancer, but the text may report doses which did not cause a measurable increase in cancer.

(12). Footnotes Explanations of abbreviations or reference notes for data in the LSE tables are found in the footnotes. Footnote "c" indicates the NOAEL of 3 ppm in key number 18 was used to derive an MRL of 0.005 ppm.

LEGEND

See LSE Figure 2-1

LSE figures graphically illustrate the data presented in the corresponding LSE tables. Figures help the reader quickly compare health effects according to exposure levels for particular exposure duration.

(13). Exposure Duration The same exposure periods appear as in the LSE table. In this example, health effects observed within the intermediate and chronic exposure periods are illustrated.

(14). Health Effect These are the categories of health effects for which reliable quantitative data exist. The same health effects appear in the LSE table.

(15). Levels Of Exposure Exposure levels for each health effect in the LSE tables are graphically displayed in the LSE figures. Exposure levels are reported on the log scale "y" axis. Inhalation exposure is reported in mg/m3 or ppm and oral exposure is reported in mg/kg/day.

(16). NOAEL In this example, 18r NOAEL is the critical end point for which an intermediate inhalation exposure MRL is based. As you can see from the LSE figure key, the open-circle symbol indicates a NOAEL for the test species (rat). The key number 18 corresponds to the entry in the LSE table. The dashed descending arrow indicates the extrapolation from the exposure level of 3 ppm (see entry 18 in the Table) to the MRL of 0.005 ppm (see footnote "b" in the LSE table).

(17). CEL Key number 38r is one of three studies for which Cancer Effect Levels (CELs) were derived. The diamond symbol refers to a CEL for the test species (rat). The number 38 corresponds to the entry in the LSE table.

(18). Estimated Upper-Bound Human Cancer Risk Levels This is the range associated with the upper-bound for lifetime cancer risk of 1 in 10,000 to 1 in10,000,000. These risk levels are derived from EPA's Human Health Assessment Group's upper-bound estimates of the slope of the cancer dose response curve at low dose levels (q1*).

(19). Key to LSE Figure The Key explains the abbreviations and symbols used in the figure.

SAMPLE

1 → **TABLE 2-1. Levels of Significant Exposure to [Chemical x] - Inhalation**

Key to figure[a]	Species	Exposure frequency/ duration	System	NOAEL (ppm)	LOAEL (effect) Less serious (ppm)	LOAEL (effect) Serious (ppm)	Reference
2 → INTERMEDIATE EXPOSURE							
3 → Systemic	5	6	7	8	9		10
4 → 18	Rat	13 wk 5d/wk 6hr/d	Resp	3[b]	10 (hyperplasia)		Nitschke et al. 1981
CHRONIC EXPOSURE							
Cancer					11		
38	Rat	18 mo 5d/wk 7hr/d				20 (CEL, multiple organs)	Wong et al. 1982
39	Rat	89-104 wk 5d/wk 6hr/d				10 (CEL, lung tumors, nasal tumors)	NTP 1982
40	Mouse	79-103 wk 5d/wk 6hr/d				10 (CEL, lung tumors, hemangiosarcomas)	NTP 1982

[a] The number corresponds to entries in Figure 2-1.

12 → [b] Used to derive an intermediate inhalation Minimal Risk Level (MRL) of 5 x 10^{-3} ppm; dose adjusted for intermittent exposure and divided by an uncertainty factor of 100 (10 for extrapolation from animal to humans, 10 for human variability).

CEL = cancer effect level; d = day(s); hr = hour(s); LOAEL = lowest-observed-adverse-effect level; mo = month(s); NOAEL = no-observed-adverse-effect level; Resp = respiratory; wk = week(s)

SAMPLE

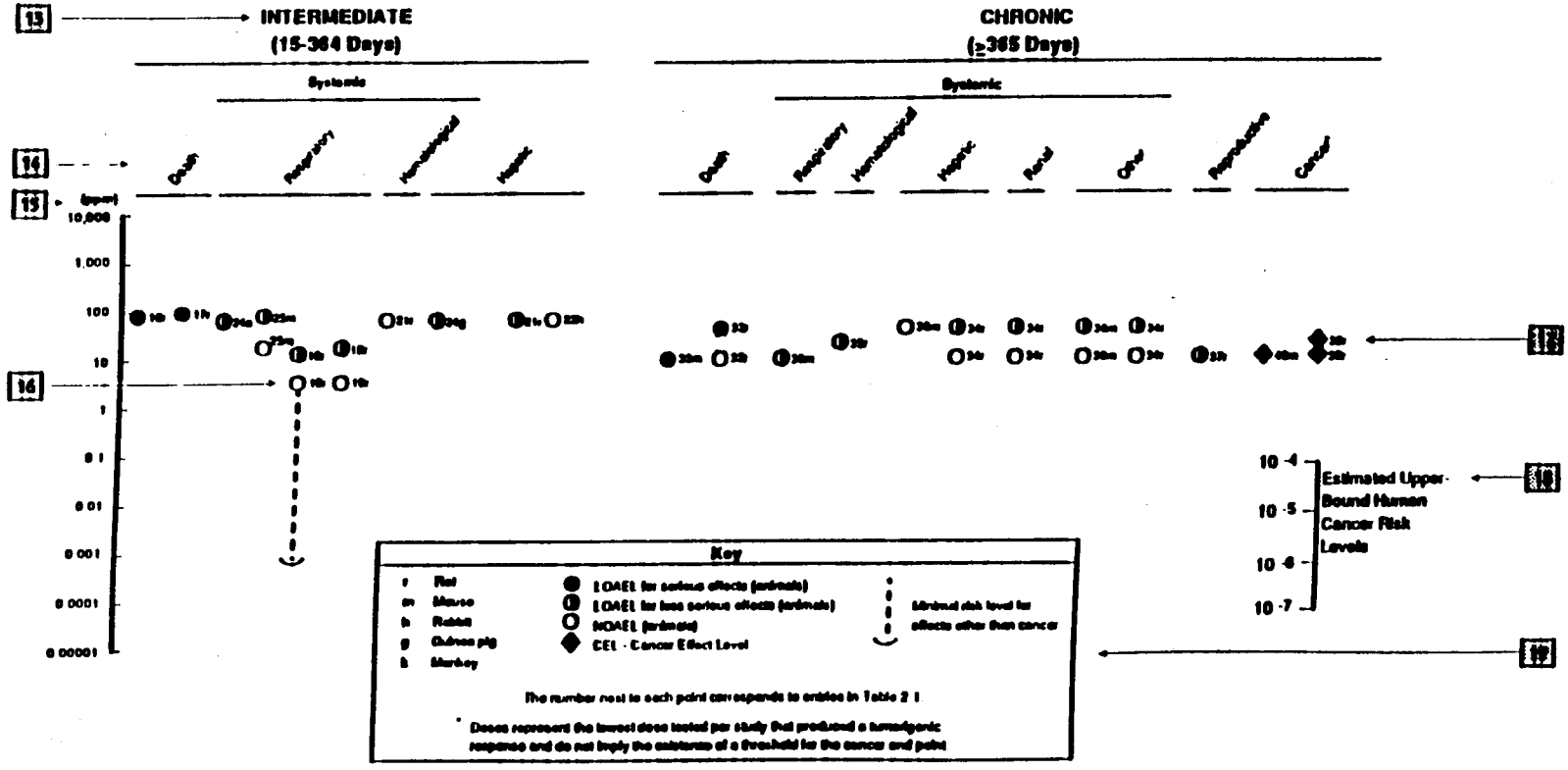

FIGURE 2-1. Levels of Significant Exposure to [Chemical X]-Inhalation

APPENDIX A

Chapter 2 (Section 2.4)

Relevance to Public Health

The Relevance to Public Health section provides a health effects summary based on evaluations of existing toxicological, epidemiological, and toxicokinetic information. This summary is designed to present interpretive, weight-of-evidence discussions for human health end points by addressing the following questions.

1. What effects are known to occur in humans?

2 . What effects observed in animals are likely to be of concern to humans?

3 . What exposure conditions are likely to be of concern to humans, especially around hazardous waste sites?

The section discusses health effects by end point. Human data are presented first, then animal data. Both are organized by route of exposure (inhalation, oral, and dermal) and by duration (acute, intermediate, and chronic). In vitro data and data from parenteral routes (intramuscular, intravenous, subcutaneous, etc.) are also considered in this section. If data are located in the scientific literature, a table of genotoxicity information is included.

The carcinogenic potential of the profiled substance is qualitatively evaluated, when appropriate, using existing toxicokinetic, genotoxic, and carcinogenic data. ATSDR does not currently assess cancer potency or perform cancer risk assessments. MRLs for noncancer end points if derived, and the end points from which they were derived are indicated and discussed in the appropriate section(s).

Limitations to existing scientific literature that prevent a satisfactory evaluation of the relevance to public health are identified in the Identification of Data Needs section.

Interpretation of Minimal Risk Levels

Where sufficient toxicologic information was available, MRLs were derived. MRLs are specific for route (inhalation or oral) and duration (acute, intermediate, or chronic) of exposure. Ideally, MRLs can be derived from all six exposure scenarios (e.g., Inhalation - acute, -intermediate, -chronic; Oral - acute, -intermediate, - chronic). These MRLs are not meant to support regulatory action, but to aquaint health professionals with exposure levels at which adverse health effects are not expected to occur in humans. They should help physicians and public health officials determine the safety of a community living near a substance emission, given the concentration of a contaminant in air or the estimated daily dose received via food or water. MRLs are based largely on toxicological studies in animals and on reports of human occupational exposure.

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MRL users should be familiar with the toxicological information on which the number is based. Section 2.4, "Relevance to Public Health," contains basic information known about the substance. Other sections such as 2.6, "Interactions with Other Chemicals" and 2.7, "Populations that are Unusually Susceptible" provide important supplemental information.

MRL users should also understand the MRL derivation methodology. MRLs are derived using a modified version of the risk assessment methodology used by the Environmental Protection Agency (EPA) (Barnes and Dourson, 1988; EPA 1989a) to derive reference doses (RfDs) for lifetime exposure.

To derive an MRL, ATSDR generally selects the end point which, in its best judgement, represents the most sensitive human health effect for a given exposure route and duration. ATSDR cannot make this judgement or derive an MRL unless information (quantitative or qualitative) is available for all potential effects (e.g., systemic, neurological, and developmental). In order to compare NOAELs and LOAELs for specific end points, all inhalation exposure levels are adjusted for 24hr exposures and all intermittent exposures for inhalation and oral routes of intermediate and chronic duration are adjusted for continous exposure (i.e., 7 days/week). If the information and reliable quantitative data on the chosen end point are available, ATSDR derives an MRL using the most sensitive species (when information from multiple species is available) with the highest NOAEL that does not exceed any adverse effect levels. The NOAEL is the most suitable end point for deriving an MRL. When a NOAEL is not available, a Less Serious LOAEL can be used to derive an MRL, and an uncertainty factor (UF) of 10 is employed. MRLs are not derived from Serious LOAELs. Additional uncertainty factors of 10 each are used for human variability to protect sensitive subpopulations (people who are most susceptible to the health effects caused by the substance) and for interspecies variability (extrapolation from animals to humans). In deriving an MRL, these individual uncertainty factors are multiplied together. The product is then divided into the adjusted inhalation concentration or oral dosage selected from the study. Uncertainty factors used in developing a substance-specific MRL are provided in the footnotes of the LSE Tables.

APPENDIX B

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ACGIH	American Conference of Governmental Industrial Hygienists
ADME	Absorption, Distribution, Metabolism, and Excretion
ATSDR	Agency for Toxic Substances and Disease Registry
BCF	bioconcentration factor
BSC	Board of Scientific Counselors
CDC	Centers for Disease Control
CEL	Cancer Effect Level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm	centimeter
CNS	central nervous system
DHEW	Department of Health, Education, and Welfare
DHHS	Department of Health and Human Services
DOL	Department of Labor
ECG	electrocardiogram
EEG	electroencephalogram
EPA	Environmental Protection Agency
EKG	see ECG
FAO	Food and Agricultural Organization of the United Nations
FEMA	Federal Emergency Management Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
f_1	first generation
fpm	feet per minute
ft	foot
FR	Federal Register
g	gram
GC	gas chromatography
HPLC	high performance liquid chromatography
hr	hour
IDLH	Immediately Dangerous to Life and Health
IARC	International Agency for Research on Cancer
ILO	International Labor Organization
in	inch
Kd	adsorption ratio
kg	kilogram
Koc	octanol-soil partition coefficient
Kow	octanol-water partition coefficient
L	liter
LC	liquid chromatography
LC_{Lo}	lethal concentration low
LC_{50}	lethal concentration 50 percent kill
LD_{Lo}	lethal dose low
LD_{50}	lethal dose 50 percent kill
LOAEL	lowest-observed-adverse-effect level

APPENDIX B

LSE	Levels of Significant Exposure
m	meter
mg	milligram
min	minute
mL	milliliter
mm	millimeters
mmol	millimole
mppcf	millions of particles per cubic foot
MRL	Minimal Risk Level
MS	mass spectroscopy
NIEHS	National Institute of Environmental Health Sciences
NIOSH	National Institute for Occupational Safety and Health
NIOSHTIC	NIOSH's Computerized Information Retrieval System
nm	nanometer
ng	nanogram
NHANES	National Health and Nutrition Examination Survey
nmol	nanomole
NOAEL	no-observed-adverse-effect level
NOES	National Occupational Exposure Survey
NOHS	National Occupational Hazard Survey
NPL	National Priorities List
NRC	National Research Council
NTIS	National Technical Information Service
NTP	National Toxicology Program
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
pg	picogram
pmol	picomole
PHS	Public Health Service
PMR	proportional mortality ratio
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
REL	recommended exposure limit
RfD	Reference Dose
RTECS	Registry of Toxic Effects of Chemical Substances
sec	second
SCE	sister chromatid exchange
SIC	Standard Industrial Classification
SMR	standard mortality ratio
STEL	short-term exposure limit
STORET	STORAGE and RETRIEVAL
TLV	threshold limit value
TSCA	Toxic Substances Control Act
TRI	Toxic Release Inventory
TWA	time-weighted average
U.S.	United States
UF	uncertainty factor

APPENDIX B

WHO	World Health Organization
>	greater than
≥	greater than or equal to
=	equal to
<	less than
≤	less than or equal to
%	percent
α	alpha
β	beta
δ	delta
γ	gamma
μm	micron
μg	microgram

APPENDIX C

PEER REVIEW

A peer review panel was assembled for 1,2,3-trichloropropane. The panel consisted of the following members: Dr. Hugh Farber, Private Consultant, Midland, MI; Dr. I.G. Sipes, Professor and Head, Department of Toxicology, University of Arizona, Tucson, AZ; and Dr. Shane Que Hee, Associate Professor, School of Public Health, University of California, Los Angeles, CA. These experts collectively have knowledge of 1,2,3-trichloropropane's physical and chemical properties, toxicokinetics, key health end points, mechanisms of action, human and animal exposure, and quantification of risk to humans. All reviewers were selected in conformity with the conditions for peer review specified in the Comprehensive Environmental Response, Compensation, and Liability Act of 1986, Section 104.

Scientists from the Agency for Toxic Substances and Disease Registry (ATSDR) have reviewed the peer reviewers' comments and determined which comments will be included in the profile. A listing of the peer reviewers' comments not incorporated in the profile, with a brief explanation of the rationale for their exclusion, exists as part of the administrative record for this compound. A list of databases reviewed and a list of unpublished documents cited are also included in the administrative record.

The citation of the peer review panel should not be understood to imply its approval of the profile's final content. The responsibility for the content of this profile lies with the ATSDR.

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