United States
Environmental Protection Agency

Office of Water
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October 1995

EPA NATIONAL PRIMARY DRINKING WATER REGULATIONS

Contaminant Specific Fact Sheets
Volatile Organic Chemicals - Technical Version

Acrylamide
Benzene
Carbon tetrachloride
Chlorobenzene
o-Dichlorobenzene
p-Dichlorobenzene
1,2-Dichloroethane
1,1-Dichloroethylene
cis-and trans-1,2-Dichloroethylene
Dichloromethane
1,2-Dichloropropane
Epichlorohydrin
Ethylbenzene
Styrene
Tetrachloroethylene
Toluene
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Vinyl Chloride
Xylenes (Total)

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Acrylamide

Chemical/ Physical Properties

CAS Number: 79-06-1

Color/ Form/Odor: White odorless flake-like crystals derived from benzene. Available in powder form or as an aqueous solution of 50% acrylamide monomer.

M.P.: 84.5° C **B.P.:** 125° C

Vapor Pressure: 0.007 mm Hg at 20° C

Octanol/Water Partition (Kow): Log Kow = -0.67

Density/Spec. Grav.: 1.122 at 30° C

Solubility: 2.2 kg/L of water at 25° C; Extremely soluble in water

Soil sorption coefficient: N/A; High mobility in soil

Odor/Taste Thresholds: N/A

Bioconcentration Factor: BCFs of 0.86 to 1.12 in fish; not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 3.2×10^{-10} atm-cu m/mole;

Trade Names/Synonyms: 2-Propenamide, Acrylic amide, Ethylenecarboxamide, Amresco Acryl-40, Acrylagel, Optimum

Drinking Water Standards

MCLG: zero mg/L

MCL: Treatment Technique

HAL(child): 1 day: 1.5 mg/L
10-day: 0.3 mg/L

Health Effects Summary

Acute: EPA has found acrylamide to potentially cause the following health effects from acute exposures at levels above the MCL: damage to central and peripheral nervous systems, weakness and ataxia in hind limbs.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: a one-day exposure of 1.5 mg/L; a ten-day exposure to 0.3 mg/L; upto a 7-year exposure to 0.002 mg/L.

Chronic: Acrylamide has the potential to cause the following health effects from long-term exposures at levels above the MCL: damage to central and peripheral nervous systems, paralysis.

Cancer: There is some evidence that acrylamide may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Demand for acrylamide was projected to increase slightly: from 110 million lbs. in 1987 to 120 million lbs in 1992 (projected). In 1987 it was estimated that industries consumed it as follows: Water treatment, 45%; oil drilling, 20%; pulp and paper, 20%; mineral processing, 10%; other, 5%.

The greatest use of acrylamide is as a flocculant in the treatment of sewage, waste and drinking water.

Other uses of include: as an intermediate in the production of organic chemicals; synthesis of dyes, in the sizing of paper and textiles; in ore processing; in the construction of dam foundations and tunnels.

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	36,287	5,818
Top Releases by State*		
MI	12,200	0
WA	8,000	0
CT	5,690	0
LA	4,367	500
PA	2,505	20
Major Industries*		
Plastics and resins	19,002	2,177
Pulp mills	8,000	0
Indust. organics	3,107	2,200

* Water/Land totals only include facilities with releases greater 100 lbs.

Release Patterns

Acrylamide may be released into wastewater during its production and use in the synthesis of dyes, manufacture of polymers, adhesives, paper, paperboard and textile additive, soil-conditioning agents, ore processing, oil recovery, and permanent press fabrics, and in the manufacture of polyacrylamides for use as a flocculating agent for water treatment. The latter is the largest end use, being employed in processing mineral ores as well as treating waste water and drinking water. Improvements in the polymerization process has reduced the monomer content of these polymers from 5% to 0.3%. Other sources of release to water is from acrylamide-based sewer grouting and recycling of waste paper.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, acrylamide releases to land and water totalled over 40,000 lbs., of which about 85 percent was to water. These releases were primarily from plastics industries which use acrylamide as a monomer. The largest releases occurred in Michigan.

Environmental Fate

Acrylamide degrades rapidly with acclimation in biodegradability screening tests. Acrylamide degraded in filtered river water in 4 to 12 days. Adsorption to sediment should not be significant.

If released on land, acrylamide would be expected to leach readily into the ground and biodegrade within a few weeks based on experimental data. In 5 surface soils that were moistened to field capacity, 74-94% degradation occurred in 14 days in 3 soils and 79 to 80% degradation occurred in 6 days in the other two soils.

In order to access the efficiency of sewage works in removing acrylamide, two sewage works were dosed for four times longer than the residence time. Little loss of acrylamide occured during initial or final settling. However 50 to 70% was lost in the activated sludge plants. Further studies showed that high loss rates required high microbial activity or, in particular, contact with surfaces of high microbial activity. Studies of the river into which the sewage works discharged its effluents suggest that microbial degradation is unlikely to affect the level of acrylamide in river water for several hours, and possibly days, even in a river into which acrylamide is continually discharged. Degradation was however, more marked in the summer.

In the atmosphere, the vapor phase chemical should react with photochemically produced hydroxyl radicals (half-life 6.6 hr) and be washed out by rain.

Bioconcentration in fish is not significant. Uptake of acrylamide was studied in fingerling trout for 72 hr found the BCF in the carcass and viscera was 0.86 and 1.12, respectively, indicating that no appreciable bioaccumulation had occurred. The uptake was rapid in the first 24 hr and then leveling off to a plateau after 72 hr. When the fish were transferred to fresh water, levels of acrylamide declined to 75% of the initial concn after 96 hr.

In another report, the rate of accumulation of acrylamide monomer in fish was about 0.8 times the concentration in the rearing water (10 ppm) at day 40. The accumulation of acrylamide monomer in fish from polymer was nondetectable. Therefore, it is concluded that the use of acrylamide polymer as a coagulant may not cause serious problems for human health.

Human exposure will be primarily occupational via dermal contact and inhalation, although exposure to the general public has resulted from the leaching of the acrylamide monomer from polyacyrlamide flocculants used in water treatment.

Other Regulatory Information

Monitoring and Analysis:

No analytical methods are available so monitoring is not required. This contaminant is being regulated by requiring use of a treatment technique to limit its use by drinking water systems.

Treatment

Treatment technique: When acrylamide is used in drinking water systems, the combination of dose and monomer level may not exceed the following level:

0.05 % dosed at 1 mg/L

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

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Benzene

Chemical/ Physical Properties

CAS Number: 71-43-2

Color/ Form/Odor: Clear, colorless aromatic liquid; highly flammable

M.P.: 5.5° C **B.P.:** 80.1° C

Vapor Pressure: 100 mm Hg at 26.1° C

Octanol/Water Partition (Kow): Log Kow = 2.13

Density/Spec. Grav.: 0.8787 at 15° C

Solubilities: 1.8 g/L of water at 25° C; Slightly soluble in water;

Soil sorption coefficient: Koc estimated at 98; high to very high mobility in soil

Odor/Taste Thresholds: Taste threshold in water is 0.5 to 4.5 mg/L

Bioconcentration Factor: 3.5 to 4.4 in fish; not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 0.0053 atm-cu m/mole;

Trade Names/Synonyms: Benzol 90, Pyrobenzol, Polystream, Coal naphtha, Phene

Drinking Water Standards

MCLG:	Zero	
MCL:	0.005 mg/L	
HAL:	1 to 10 day:	0.2 mg/L
	Longer-term:	0.2 mg/L

Health Effects Summary

Acute: Acute exposure to high levels of benzene produces central nervous system (CNS) effects and death. At lower levels, above the MCL, mild CNS effects appear to be concentration dependent and rapidly reversible. Other effects include immune system depression and bone marrow toxicity leading to aplastic anemia.

Drinking water levels which are considered "safe" for short-term exposures: For a 10 kg (22 lb.) child consuming 1 liter of water per day: upto a ten-day exposure to 0.2 mg/L.

Chronic: Benzene has the potential to cause chromosomal aberrations in people who are chronically exposed at levels above the MCL.

Cancer: Benzene has the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production of benzene in the USA in 1993 was over 12 billion lbs.

Used for printing & lithography, paint, rubber, dry cleaning, adhesives & coatings, detergents, extraction and rectification, preparation and use of inks in the graphic arts industries, as a thinner for paints and as a degreasing agent. In the tire industry and in shoe factories, benzene is used extensively.

Used primarily as a raw material in the synthesis of styrene (polystyrene plastics and synthetic rubber), phenol (phenolic resins), cyclohexane (nylon), aniline, maleic anhydride (polyester resins), alkylbenzenes (detergents), chlorobenzenes, and other products used in the production of drugs, dyes, insecticides, and plastics.

In future, coal will increasingly replace petroleum &

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	583,210	1,566,900
Top Releases by State*		
TX	1,446	1,136,681
AL	199,892	0
LA	138,268	4,413
CO	0	40,793
NM	0	38,699
IL	3	34,110
Major Industries		
Petroleum refining	141,876	1,240,777
Industrial chemicals	103,239	287,305
Steelworks, blast furn.	146,594	21,022
Alkalies, chlorine	150,934	988

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

natural gas as a source of hydrocarbons both for fuel & petrochemicals. Processes such as USA Steel Corporation's Clean Coke process, which yields 38% coke & 20% chemical by-products compared to 73% coke & 2% chemical by-products in conventional coking technology, should soon be used commercially. New coking, liquefaction, & gasification processes for coal are all potential sources of benzene.

Release Patterns

Benzene will enter the atmosphere primarily from fugitive emissions and exhaust connected with its use in gasoline. Another important source is emissions associated with its production and use as an industrial intermediate. In addition, there are discharges into water from industrial effluents and losses during spills. Benzene is also released from its indirect production in coke ovens; from nonferrous metal manufacture, ore mining, wood processing, coal mining and textile manufacture. Although most public drinking water supplies are free of benzene or contain <0.3 ppb, exposure can be very high from consumption of contaminated sources drawn from wells contaminated by leaky gasoline storage tanks, landfills, etc.

From 1987 to 1993, according to the Toxics Release Inventory, releases of benzene to water totalled 583,210 lbs. Releases to land totalled 1,566,900 lbs. As indicated in the Table below, these releases were primarily from petroleum refining industries, with the greatest releases occuring in Texas and Alabama.

Environmental Fate

If benzene is released to soil, it will be subject to rapid volatilization near the surface and that which does not evaporate will be highly to very highly mobile in the soil and may leach to groundwater. It may be subject to biodegradation based on reported biodegradation of 24% and 47% of the initial 20 ppm benzene in a base-rich para-brownish soil in 1 and 10 weeks, respectively. It may be subject to biodegradation in shallow, aerobic groundwaters, but probably not under anaerobic conditions.

If benzene is released to water, it will be subject to rapid volatilization; the half-life for evaporation in a wind-wave tank with a moderate wind speed of 7.09 m/sec was 5.23 hrs; the estimated half-life for volatilization of benzene from a model river one meter deep flowing 1 m/sec with a wind velocity of 3 m/sec is estimated to be 2.7 hrs at 20 deg C.

It will not be expected to significantly adsorb to sediment, bioconcentrate in aquatic organisms or hydrolyze.

It may be subject to biodegradation based on a reported biodegradation half-life of 16 days in an aerobic river die-away test. In a marine ecosystem biodegradation occurred in 2 days after an acclimation period of 2 days and 2 weeks in the summer and spring, respectively, whereas no degradation occurred in winter. According to one experiment, benzene has a half-life of 17 days due to photodegradation which could contribute to benzene's removal in situations of cold water, poor nutrients, or other conditions less conductive to microbial degradation.

If benzene is released to the atmosphere, it will exist predominantly in the vapor phase. Gas-phase benzene will not be subject to direct photolysis but it will react with photochemically produced hydroxyl radicals with a half-life of 13.4 days calculated using an experimental rate constant for the reaction. The reaction time in polluted atmospheres which contain nitrogen oxides or sulfur dioxide is accelerated with the half-life being reported as 4-6 hours. Products of photooxidation include phenol, nitrophenols, nitrobenzene, formic acid, and peroxyacetyl nitrate.

Benzene is fairly soluble in water and is removed from the atmosphere in rain. The primary routes of exposure are inhalation of contaminated air, especially in areas with high traffic, and in the vicinity of gasoline service stations and consumption of contaminated drinking water.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

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Carbon tetrachloride

Chemical/ Physical Properties

CAS Number: 56-23-5

Color/ Form/Odor: Colorless, clear, heavy liquid; sweet aromatic odor similar to chloroform

M.P.: -23° C **B.P.:** 76.54° C

Vapor Pressure: 91.3 mm Hg at 20° C

Density/Spec. Grav.: 1.59 at 20° C

Octanol/Water Partition (Kow): Log Kow = 2.62 to 2.83

Solubilities: 1.2 g/L of water at 25° C

Soil sorption coefficient: Koc = 71; moves readily through soil

Odor/Taste Thresholds: Odor threshold in water is 0.52 mg/L

Henry's Law Coefficient: 0.0304 atm-cu m/mole at 24.8° C

Bioconcentration Factor (BCF): Log BCF = 1.24 to 1.48 in fish; not significant

Trade Names/Synonyms: Perchloromethane; Methane tetrachloride; Benzinoform; Univerm; Necatorina; Facsiolin; Flukoids; R10 (refrigerant); Tetraform; Tetrasol; Freon 10; Halon 104

Drinking Water Standards

MCLG:	zero
MCL:	0.005 mg/L
HAL:	1 day: 4 mg/L
	10-day: 0.2 mg/L

Health Effects Summary

Acute: EPA has found carbon tetrachloride to potentially cause liver kidney and lung damage when people are exposed to it in drinking water at levels above the MCL for relatively short periods of time.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: a one-day exposure of 4 mg/L; a ten-day exposure to 0.2 mg/L; upto a 7-year exposure to 0.07 mg/L.

Chronic: Carbon tetrachloride has the potential to cause liver damage from a lifetime exposure at levels above the MCL.

Cancer: There is some evidence that carbon tetrachloride has the potential to cause liver cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production of carbon tetrachloride in 1988 was 761 million lbs; most of it is used for chemical synthesis of fluorocarbons and this has been declining at a rate of 7.9%/yr.

Formerly used as dry cleaning agent and fire extinguisher, its production peaked in the USA in 1974. EPA regulation of fluorocarbon propellants will continue the trend in production cutback unless new applications are found for the chemical.

Its solvent uses include: solvent for rubber cement; cleaning agent for machinery and electrical equipment; for reducing fire hazard of grain fumigants; in soap perfumery and insecticides; in pharmaceuticals; for cable and semiconductor manufacture; as plasma etching gases for etching aluminum in integrated circuits; for oils, fats,

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	52,719	23,078
Top Releases by State*		
TX	22,922	75
WV	4	14,443
LA	7,720	2,213
AL	8,205	0
CA	20	2,400
Major Industries*		
Alkalies, chlorine	31,147	17,545
Inorganic chemicals	8,796	460
Petroleum refining	4,450	1,530
Misc. Indust. Organics	3,266	377
Agricultural chems.	817	2,400

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

lacquers, varnishes, rubber waxes, resins.

In chemical manufacture its uses include: in polymer technology as reaction medium, catalyst; in synthesis of nylon-7 and other organic chlorination processes; in the formulation of petrol additives; in organic synthesis for chlorination of organic compounds; catalyst regeneration; a chemical intermediate for fluorocarbons

Release Patterns

In Soil: Carbon tetrachloride occurs due to spills, runoff from agricultural sites, dumping, and through landfill leaching.

In Surface Waters: Carbon tetrachloride occurs as a result of industrial and agricultural activities, some may reach surface water through rainfall. Waste water from iron and steel manufacturing, foundries, metal finishing, paint and ink formulations, petroleum refining and nonferrous metal manufacturing industries contain carbon tetrachloride.

In Air: The major source of carbon tetrachloride is industrial emission. The total nationwide emissions of carbon tetrachloride in 1978 from all sources was estimated at 65 million lb (4.5 million lb from production facilities). The primary source of these emissions is solvent uses.

From 1987 to 1993, according to the Toxic Release Inventory, carbon tetrachloride releases to water totalled nearly 53,000 lbs. Releases to land totalled over 23,000 lbs. These releases were primarily from chemical manufacturing industries which use it in chlorination processes. The largest releases occurred in Texas.

Environmental Fate

In the troposphere, carbon tetrachloride is extremely stable (residence time of 30-50 years). The primary loss process is by escape to the stratosphere where it photolyzes. As a result of its emission into the atmosphere and slow degradation, the amount of carbon tetrachloride in the atmosphere has been increasing. Some carbon tetrachloride released to the atmosphere is expected to partition into the ocean.

In water systems, evaporation appears to be the most important removal process, although biodegradation may occur under aerobic and anaerobic conditions (limited data). Hydrolysis half-life in water is 7000 years at 25 deg C

Releases or spills on soil should result in rapid evaporation due to high vapor pressure and leaching in soil resulting in groundwater contamination due to its low adsorption to soil. A measured KOC of 71 was reported. Estimated retardation factor in breakthrough sampling in groundwater is 1.44 - 1.8. Carbon tetrachloride is expected to be highly mobile in soil and only slightly adsorbed to sediment.

Carbon tetrachloride has a low potential to bioconcentrate. Log of the bioconcentration factor in trout is 1.24, in bluegill sunfish - 1.48.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2; 551

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

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Chlorobenzene

Chemical/ Physical Properties

CAS Number: 108-90-7

Color/ Form/Odor: Colorless liquid with a faint, almond-like, aromatic odor

M.P.: -45.6° C **B.P.:** 132° C

Vapor Pressure: 11.8 mm Hg at 25° C

Octanol/Water Partition (Kow): Log Kow = 2.18 to 2.84

Density/Spec. Grav.: 1.11 at 20° C

Solubilities: 0.45 g/L in water

Soil sorption coefficient: N/A

Odor/Taste Thresholds: N/A

Bioconcentration Factor (BCF): Log BCF = 1 to 2 in fish; not significant

Henry's Law Coefficient: 0.00356 atm-cu m/mole (calculated)

Trade Names/Synonyms: Benzene chloride, Chlorbenzol, Monochlorobenzene, Phenyl chloride, IP Carrier T 40, Tetrosin SP

Drinking Water Standards

MCLG: 0.1 mg/L

MCL: 0.1 mg/L

HAL: 1 to 10 day: 2 mg/L
Longer-term: 2 mg/L

Health Effects Summary

Acute: EPA has found chlorobenzene to potentially cause anesthetic effects and impaired liver and kidney function from short-term exposures at levels above the MCL.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: upto a 7-year exposure to 2 mg/L.

Chronic: Chlorobenzene has the potential to cause liver, kidney and central nervous system damage from long-term exposure at levels above the MCL.

Cancer: There is inadequate evidence to state whether or not chlorobenzene has the potential to cause cancer from a lifetime exposure in drinking water.

Usage Patterns

Production of chlorobenzene in 1988 was 270 million pounds, and was expected to decrease.

Uses of chlorobenzene include: an intermediate in the manufacture of other organic chemicals, dyestuffs and insecticides (60%); as a solvent for adhesives, drugs, rubber, paints and dry-cleaning (30%); miscellaneous uses include fiber-swelling agent in textile processing.

Release Patterns

Major environmental releases of chlorobenzene are due to its use as a solvent in pesticides.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, chlorobenzene releases to water totalled over 326,000 lbs. Releases to land totalled nearly 37,000 lbs. These releases were primarily from alkali and chlorine industries which use chlorobenzene in chlorination processes. Most of these releases occurred in West Virginia.

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	326,017	36,910
Top Five States*		
WV	262,653	263
OH	20,598	12,500
NJ	13,710	13,261
LA	16,460	265
SC	1,401	5,939
Major Industries		
Alkalis, chlorine	261,058	67
Plastics, resins	23,756	13,312
Cyclic crudes, dyes	21,657	6,637
Indus. organics	13,460	9,375
Gum, wood chems	0	4,909

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

Environmental Fate

Chlorobenzene will enter the atmosphere from fugitive emissions connected with its use as a solvent in pesticide formulations and as an industrial solvent. Once released it will decrease in concentration due to dilution and photooxidation.

Releases into water and onto land will dissipate due to vaporization into the atmosphere and slow biodegradation in the soil or water.

It is relatively mobile in sandy soil and aquifer material and biodegrades very slowly or not at all in these soils. Therefore, it can be expected to leach into the groundwater. It has a moderate adsorption onto organic soil. If retained long enough, a large number of soil bacteria and fungi are capable of degrading chlorobenzene and mineralizing it. 2- and 4-chlorophenol are products of this biodegradation. Degradation will generally be slow, but fairly rapid mineralization (20%/week) has been reported in one study. Acclimation of soil microorganisms to hydrocarbon metabolism is an important factor.

In water,.the primary loss will be due to evaporation, with a half-life estimated at up to 10 to 11 hours, depending on the wind speed and water movement. The half-life for evaporation is approximately 4.5 hours with moderate wind speed.

Biodegradation will occur during the warmer seasons and will proceed more rapidly in fresh water than in estuarine and marine systems. Again, acclimation of soil microorganisms is important. A moderate amount of adsorption will occur onto organic sediments.

Little bioconcentration is expected into fish and food products. Log BCF is 1to 2 for several species of fish.

Primary human exposure is from ambient air, especially near point sources.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791

- Other sources of toxicological and environmental fate data include:
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  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
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o-Dichlorobenzene

Chemical/ Physical Properties

CAS Number: 95-50-1

Color/ Form/Odor: Colorless liquid with pleasant, aromatic odor

M.P.: -17° C **B.P.:** 180.5° C

Vapor Pressure: 1.47 mm Hg at 25° C

Octanol/Water Partition (Kow): Log Kow = 3.38

Density/Spec. grav: 1.31 g/L at 20° C

Solubility: 0.14 g/L of water at 25° C; Slightly soluble in water

Soil sorption coefficient: Koc measured at 280 to 320 for loam soils; low to moderate mobility in soil

Odor/Taste Thresholds: N/A

Bioconcentration Factor: BCF measured at 270 to 560 in fish; expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 0.0012 atm-cu m/mole at 20° C

Trade Names/Synonyms: ortho Dichlorobenzol, Dilantin, Dowtherm E, Chloroben, Dilatin DB

Drinking Water Standards

MCLG:	0.6 mg/L	
MCL:	0.6 mg/L	
HAL:	1 to 10 day:	9 mg/L
	Longer-term:	9 mg/L

Health Effects Summary

Acute: EPA has no data on the acute toxicity of o-dichlorobenzene which is relevant to the drinking water context.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: upto a 7-year exposure to 9 mg/L.

Chronic: EPA has found o-dichlorobenzene to potentially cause damage to the nervous system, liver, kidneys and blood cells from long-term exposure at levels above the MCL.

Cancer: There is inadequate evidence to state whether or not o-dichlorobenzene has the potential to cause cancer from lifetime exposures in drinking water.

Usage Patterns

Production of o-dichlorobenzene has decreased since the 1970's: from 54.6 million lbs. in 1975 to an estimated 43 million lbs. in 1991. In 1987 it was estimated that industries consumed o-dichlorobenzene as follows: Organic synthesis (mainly for herbicides), 90%; toluene diisocyanate processing solvent, 5%; solvent and miscellaneous uses, 5%.

The greatest use of o-dichlorobenzene is as a chemical intermediate for making agricultural chemicals, primarily herbicides.

Other present and past uses include: solvent for waxes, gums, resins, wood preservatives, paints; insecticide for termites and borers; in making dyes; as a coolant, deodorizer, degreaser.

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	75,967	171,663
Top Five States*		
NJ	19,602	165,661
WV	39,653	0
OR	7,260	0
SC	1,502	4,628
TX	1,418	1,000
Major Industries		
Industrial Organics	15,416	98,092
Cyclic crudes, dyes	7,639	67,418
Alkalis, chlorine	38,029	0
Paper mills	7,260	0
Gum, wood chems.	250	4,378

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

Release Patterns

1,2-Dichlorobenzene's use in manufacturing and solvents may be significant sources of discharges into water. Dichlorobenzenes also enter the water systems (raw and contaminated water) from the use of 1,2-DCB as a deodorant in industrial wastewater treatment. Chemical waste dump leachates and direct manufacturing effluents are reported to be the major source of pollution of the chlorobenzenes (including the dichlorobenzenes) to Lake Ontario. The major source of 1,2-dichlorobenzene emission to the atmosphere has been reported to be solvent applications which may emit 25% of annual production to the atmosphere.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, o-dichlorobenzene releases to land and water totalled over 240,000 lbs., of which nearly 172,000 lbs. was to land. These releases were primarily from organic chemicals manufacturing industries which use it as an intermediate in herbicide production. The largest releases occurred in New Jersey.

Environmental Fate

If released to soil, 1,2-dichlorobenzene can be moderately to tightly adsorbed. Experimental Koc values of 280 to 320 were determined in silt loam soils containing less than 2 percent organic matter. In equilibrium batch studies, a relatively strong adsorption of 1,2-dichlorobenzene to collected aquifer material was observed. However, the detection of 1,2-dichlorobenzene in various groundwaters indicates that leaching can occur. Volatilization from soil surfaces may be an important transport mechanism. It is possible that 1,2-dichlorobenzene will be slowly biodegraded in soil under aerobic conditions. Chemical transformation by hydrolysis, oxidation or direct photolysis are not expected to occur in soil.

If released to water, adsorption to sediment will be a major environmental fate process based upon extensive monitoring data in the Great Lakes area and Koc values. Analysis of Lake Ontario sediment cores has indicated the presence and persistence of 1,2-dichlorobenzene since before 1940. 1,2-Dichlorobenzene is volatile from the water column with an estimated half-life of 4.4 hours from a model river one meter deep flowing 1 m/sec with a wind velocity of 3 m/sec at 20 deg C; adsorption to sediment will attenuate volatilization. It has been suggested that the three dichlorobenzene isomers may undergo slow biodegradation in natural water. The dichlorobenzenes are not expected to be biotransformed in anaerobic water conditions found in aquifers.

1,2-Dichlorobenzene is not expected to undergo significant hydrolysis in environmental waters. It is reported to be resistant towards oxidation by peroxy radicals in aquatic media. In an isooctane solvent, 1,2-dichlorobenzene absorbs virtually no radiation above 300 nm; therefore, direct photolysis in the environment should not be significant.

If released to air, 1,2-dichlorobenzene will exist predominantly in the vapor-phase and will react with photochemically produced hydroxyl radicals at an estimated half-life rate of 24 days in a typical atmosphere. Direct photolysis in the troposphere is not expected to be important. The detection of 1,2-dichlorobenzene in rainwater suggests that atmospheric removal via wash-out is possible.

In a study of a representative green alga, the log10 bioconcentration factors (BCF) for 1,2-dichlorobenzene was 4.17. Experimental BCF values of 66-560 have been reported and 1,2-dichlorobenzene has been detected in trout from Lake Ontario. General population exposure to 1,2-dichlorobenzene may occur through oral consumption of contaminated drinking water and food (particularly fish) and through inhalation of contaminated air since 1,2-dichlorobenzene has been detected in widespread ambient air.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

United States Environmental Protection Agency
Office of Water 4601
EPA 811-F-95-004f- T
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EPA

National Primary Drinking Water Regulations

p-Dichlorobenzene

Chemical/ Physical Properties

CAS Number: 106-46-7

Color/ Form/Odor: White crystals with distinctive aromatic, mothball-like odor

M.P.: 53.1° C **B.P.:** 174° C

Vapor Pressure: 10 mm Hg at 54.8° C

Octanol/Water Partition (Kow): Log Kow = 3.37

Density/Spec. Grav.: 1.25 g/ml at 20° C

Solubilities: 65.3 mg/L of water at 25° C

Soil sorption coefficient: Koc estimates range from 409 to 1514

Odor/Taste Thresholds: N/A

Bioconcentration Factor (BCF): Low; Ranges from 100 to 250 in various species

Henry's Law Coefficient: 0.0015 atm-cu m/mole at 20° C

Trade Names/Synonyms: Paradichlorobenzene; Paradichlorobenzol; Paramoth; Di-Chloricide; Paradi; Paradow; Persia-Perazol; Evola; Parazene

Drinking Water Standards

MCLG: 0.075 mg/L

MCL: 0.075 mg/L

HAL(child): 1 day: 10 mg/L

Longer-term: 10 mg/L

Health Effects Summary

Acute: May cause nausea, vomiting, headaches, and irritation of the eyes and respiratory tract.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: upto a 7-year exposure to 10 mg/L.

Chronic: p-DCB has the potential to cause the following health effects from long-term exposures at levels above the MCL: anemia, skin lesions, appetite loss, yellow atrophy of the liver and adverse blood effects.

Cancer: There is some evidence that p-DCB has the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Available production data on p-DCB shows a decreasing trend down to 15 million lbs. in 1981. Demand however, was at 74 million lbs in 1986; rose to 77 million lbs. the following year, and was projected to continue increasing.

p-Dichlorobenzene is used as an insecticidal fumigant against clothes moths (35-40%); as a deodorant for garbage and restrooms (35-40%); as an insecticide for control of fruit borers and ants; may be applied to tobacco seed beds for blue mold control; for the control of peach tree borer; and mildew and mold on leather and fabrics.

It is also used as an intermediate in the manufacture of other organic chemicals such as 2,5-dichloroaniline, and in plastics, dyes, pharmaceuticals.

Release Patterns

Chemical waste dump leachates and direct manufacturing effluents are reported to be the major source of

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	33,675	4,482
Top Five States*		
WV	27,676	0
TX	1,280	3,132
DE	1,870	200
GA	750	0
LA	503	0
Major Industries		
Alkalies, chlorine	27,676	0
Industrial org. chem.	3,076	3,350
Agricultural chem.	750	0
Cyclic crudes, intermed.	600	0

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

pollution of the chlorobenzenes (including the dichlorobenzenes) to Lake Ontario. The major source of p-dichlorobenzene emission to the atmosphere is volatilization from use in toilet bowl deodorants, garbage deodorants and moth flakes.

In 1972, 70-90% of the annual USA production of p-dichlorobenzene was estimated to have been released into the atmosphere primarily as a result of use in toilet bowl and garbage deodorants and use in moth control as a fumigant.

In 1984 it was reported that 67% of the p-dichlorobenzene consumed in the USA is used for space deodorants and moth control with 33% used as an intermediate for polyphenylene sulfide resin production; volatilization from the deodorants and moth flakes will therefore be the major emission source to the atmosphere.

From 1987 to 1993, according to the Toxic Release Inventory, p-DCB releases to water totalled almost 34,000 lbs. Releases to land totalled nearly 4,500 lbs. These releases were primarily from a single chemical manufacturing plant in West Virginia.

Environmental Fate

If released to soil, p-dichlorobenzene can be moderately to tightly adsorbed. Leaching from hazardous waste disposal areas has occurred and the detection of p-dichlorobenzene in various groundwaters indicates that leaching can occur. Volatilization from soil surfaces may be an important transport mechanism. It is possible that p-dichlorobenzene will be slowly biodegraded in soil under aerobic conditions. Chemical transformation by hydrolysis, oxidation or direct photolysis are not expected to occur in soil.

If released to water, volatilization may be the dominant removal process. The volatilization half-life from a model river one meter deep flowing one meter/sec with a wind velocity of 3 m/sec is estimated to be 4.3 hours at 20 deg C. Adsorption to sediment will be a major environmental fate process based upon extensive monitoring data in the Great Lakes area and Koc values based upon monitoring samples. Analysis of Lake Ontario sediment cores has indicated the presence and persistence of p-dichlorobenzene since before 1940. Adsorption to sediment will attenuate volatilization. Aerobic biodegradation in water may be possible, however, anaerobic biodegradation is not expected to occur.

Aquatic hydrolysis, oxidation and direct photolysis are not expected to be important. If released to air, p-dichlorobenzene will exist predominantly in the vapor-phase and will react with photochemically produced hydroxyl radicals at an estimated half-life rate of 31 days in typical atmosphere. Direct photolysis in the troposphere is not expected to be important. The detection of p-dichlorobenzene in rain-water suggests that atmospheric washout is possible.

For the most part, experimental BCF values reported in the literature are less than 1000 which suggests that significant bioconcentration will not occur; however, a BCF of 1800 was determined for guppies in one study.

General population exposure to p-dichlorobenzene may occur through oral consumption of contaminated drinking water and food (particularly fish) and through inhalation of contaminated air.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

- **Initial Frequency-** 4 quarterly samples every 3 years
- **Repeat Frequency-** Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

United States Environmental Protection Agency
Office of Water 4601
EPA 811-F-95-004g-T
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EPA

National Primary Drinking Water Regulations

1,2-Dichloroethane

Chemical/ Physical Properties

CAS Number: 107-06-2

Color/ Form/Odor: Colorless, oily liquid with a pleasant, sweet, chloroform-like odor

M.P.: N/A **B.P.:** N/A

Vapor Pressure: N/A; highly volatile

Density/Spec. Grav.: 1.235 at 20° C

Octanol/Water Partition (Kow): Log Kow = 1.48

Solubilities: 8.7 g/L of water at 20° C;

Soil sorption coefficient: Koc measured at 33 for silt/loam; high to very high mobility in soil

Odor/Taste Thresholds: Taste threshold in water is 29 mg/L

Bioconcentration Factor: Log BCF is 0.30 in fish; not expected to bioconcentrate in fish.

Henry's Law Coefficient: N/A

Trade Names/Synonyms: 1,2-Ethylene dichloride; Glycol dichloride; Freon 150; Borer sol; Brocide; Destruxol borer-sol; Dichlor-mulsion; Dutch oil; Granosan

Drinking Water Standards

MCLG: zero mg/L

MCL: 0.005 mg/L

HAL(child): 1- to 10-day: 0.7 mg/L
Longer-term: 0.7 mg/L

Health Effects Summary

Acute: EPA has found acute oral exposures to 1,2-dichloroethane to potentially cause central nervous system disorders, and adverse lung, kidney, liver circulatory and gastrointestinal effects.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: upto a 7-year exposure to 0.7 mg/L.

Chronic: No reliable data are available concerning toxic effects from chronic exposures to 1,2-dichloroethane at levels above the MCL.

Cancer: There is some evidence that 1,2-Dichloroethane may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production of 1,2-dichloroethane has increased steadily: from about 14 billion lbs. in 1990 to 18 billion lbs. in 1993. In 1985 it was estimated that industries consumed 1,2-dichloroethane as follows: Vinyl chloride monomer, 97%; chlorinated solvents, 2%; miscellaneous, 1%.

The greatest use of 1,2-dichloroethane is in chemical manufacture, including: vinyl chloride, tri- & tetrachloroethylene, vinylidene chloride & trichloroethane, ethylene glycol, diaminoethylene, polyvinyl chloride, nylon, viscose rayon, styrene-butadiene rubber, and various plastics; as a lead scavenger in gasoline.

1,2-dichloroethane has a variety of uses as a solvent uses: for resins, asphalt, bitumen, rubber; for fats, oils, waxes, gums resins; used as pickling agent and a dry

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	433,056	22,616
Top Six States*		
NJ	192,700	231
LA	136,508	2,292
TX	36,459	7,028
MO	6,786	8,730
NY	11,330	0
KY	10,309	0
Major Industries		
Industrial organics	211,146	363
Alkalies, chlorine	120,283	3,254
Cyclic crudes, intermed.	32,945	119
Agricultural chemicals	11,918	8,980
Industrial gases	15,497	0
Plastics materials, resins	6,908	6,895
Photographic equip.	11,566	0
Other Chemicals	8,179	0
Pharmaceuticals	7,525	521

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs

clean agent; in photography, xerography, water softening & in production of cosmetics; for processing pharmaceutical products; in leather cleaning, degreaser compounds, rubber cement, and acrylic adhesives. It is also used in extracting spices such as annatto, paprika & turmeric.

Other uses include as a fumigant for harvested grain, in orchards, in mushroom houses; fumigant for upholstery and carpets.

Release Patterns

Major atmospheric releases of 1,2-dichloroethane are due to its production and use as a chemical intermediate, lead scavenger, extraction and cleaning solvent, diluent for pesticides, grain fumigant and in paint, coatings and adhesives. Other releases are from waste water, spills, and/or improper disposal primarily from its use as a cleaning solvent and chemical intermediates. Land release is primarily from its production and use as a cleaning solvent and diluent for pesticides. Chlorination of water does not appear to contribute to 1,2-dichloroethane in drinking water.

From 1987 to 1993, according to the Toxics Release Inventory, releases to water totalled over 433,000 lbs. Release to land totalled over 22,000 lbs. These releases were primarily from facilities classified as producing industrial organic chemicals, alkalies and chlorine. The largest releases occurred in New Jersey and Louisiana.

Environmental Fate

Releases to water will primarily be removed by evaporation (half-life several hours to 10 days). Although firm experimental data are lacking, the photooxidation of 1,2-dichloroethane in water is expected to be slow. The rate of hydrolysis is not significant, being much slower than other pertinent environmental processes such as volatilization and photooxidation.

Releases on land will dissipate by volatilization to air and by percolation into groundwater where it is likely to persist for a very long time. Little adsorption to soil is expected based upon an experimental Koc of 33 for silt loam which in agreement with values calculated from the water solubility. 1,2-Dichloroethane rapidly percolates through sandy soil.

Once in the atmosphere, it may be transported long distances and is primarily removed by photooxidation (half-life approx 1 month). The direct photolysis of 1,2-dichloroethane is not a significant loss process. It is primarily degraded in the atmosphere by reaction with hydroxyl radicals, having a half-life of a little over a month with a 1.9% loss for a 12 hour sunlit day. Indirect evidence for photooxidation of 1,2-dichloroethane comes from the observation that monitoring levels are highest during the night and early morning. The products of photooxidation are CO_2 and HCl.

Biodegradability tests with 1,2-dichloroethane resulted in little or no biodegradation in aerobic systems using sewage seed or activated sludge. The one river die-away test reported no degradation. The percent BOD produced in 5-10 days was 0-7%. Another investigator reported slow to moderate biodegradation activity. The extent of biodegradation is difficult to assess due to compounds' susceptibility to volatilization. No degradation occurred in an acclimated anaerobic system after 4 months incubation.

1,2-Dichloroethane is not expected to bioconcentrate in fish due to its low octanol/water partition function (1.48). The measured log BCF in bluegill sunfish is 0.30. Its presence in some food products is probably due to its use as an extractant.

Major human exposure is from urban air, drinking water from contaminated aquifers and occupational atmospheres.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0 0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

United States Environmental Protection Agency
Office of Water 4601
EPA 811-F-95-004h-T
October 1995

EPA

National Primary Drinking Water Regulations

1,1-Dichloroethylene

Chemical/ Physical Properties

CAS Number: 75-35-4

Color/ Form/Odor: Colorless liquid with a mild, sweet, chloroform-like odor

M.P.: -122.5° C **B.P.:** 31.7° C

Vapor Pressure: 591 mm Hg at 25° C; highly volatile

Octanol/Water Partition (Kow): Estimated log Kow= 1.32

Density/Spec. Grav.: 1.213 at 20° C

Solubilities: 2.5 g/L of water at 25° C

Soil sorption coefficient: Koc estimated at 150

Odor/Taste Thresholds: N/A

Bioconcentration Factor: N/A; not expected to bioconcentrate in fish.

Henry's Law Coefficient: N/A

Trade Names/Synonyms: 1,1-DCE; 1,1-Dichloroethene; Asym-dichloroethylene; Vinylidene chloride;

Drinking Water Standards

MCLG:	0.007 mg/L
MCL:	0.007 mg/L
HAL(child):	1 day: 2 mg/L
	Longer-term: 1 mg/L

Health Effects Summary

Acute: EPA has found 1,1-dichloroethylene to potentially cause adverse liver effects due to acute exposures at levels above the MCL.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: a one-day exposure of 2 mg/L; upto a 7-year exposure to 1 mg/L.

Chronic: Chronic exposure to 1,1-dichloroethylene at levels above the MCL has the potential to cause liver and kidney damage, as well as toxicity to the developing fetus.

Cancer: There is some evidence that 1,1-dichloroethylene may have the potential to cause cancer at levels above the MCL.

Usage Patterns

An estimated 90,700 tons/yr of the monomer were produced in the USA during the early 1980s. Virtually all of the 1,1-dichloroethylene produced is used in the production of copolymers with vinyl chloride or acrylonitrile. A small percentage (4%) of 1,1-dichloroethylene is used as chemical intermediates. These products are then used in adhesives, synthetic fibers, refrigerants, food packaging and coating resins such as the saran types.

Release Patterns

1,1-Dichloroethylene may be released into the environment as emissions or in wastewater during its production and use in the manufacture of plastic wrap, adhesives, and synthetic fiber. 1,1-Dichloroethylene is formed by a minor pathway during the anaerobic biodegradation of trichloroethylene and also by the hydrolysis of 1,1,1-trichloroethane. Therefore there is a potential for it to form in groundwater that has been contaminated by chlorinated solvents. 1,1-Dichloroethylene is also produced by the thermal decomposition of 1,1,1-trichloroethane, a reaction that is catalyzed by copper. 1,1,1-Trichloroethane is used as a degreasing agent in welding shops so there is a potential for 1,1-dichloroethylene to be formed in these shops as well as in other industrial environments

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	10,101	1,488
Top States:		
KY	2,880	286
TX	2,061	150
LA	2,079	3
Major Industries		
Plastics materials, resins	3,942	1,299
Alkalies, chlorine	4,173	154

where 1,1,1-trichloroethane is used near sources of heat.

From 1987 to 1993, according to the Toxics Release Inventory, releases to water totalled over 10,000 lbs. Releases to land totalled about 1,500 lbs. These releases were primarily from facilities classified as producing alkalies/chlorine and plastics materials/resins. The largest releases occurred in Kentucky.

Environmental Fate

Releases to water will primarily be lost to the atmosphere through evaporation. The mass transfer coefficient between water and the atmosphere of 1,1-dichloroethylene relative to oxygen has been measured to be 0.62. Using data for the oxygen re-aeration rate of typical bodies of water, one can calculate the half-life for evaporation of 1,1-dichloroethylene to be 5.9, 1.2 and 4.7 days from a pond, river and lake, respectively. In water, the photooxidation of 1,1-dichloroethylene is insignificant. A hydrolysis half-life of 6-9 months has been observed with no significant difference in hydrolysis rate between pH 4.5 and 8.5. This value differs markedly from the estimated hydrolytic half-life of 2 yr at pH 7.

If spilled on land, part of the 1,1-dichloroethylene will evaporate and part will leach into the groundwater where its fate is unknown, but degradation is expected to be slow based upon microcosm studies. No experimental data is available on the adsorption of 1,1-dichloroethylene. A low Koc of 150 are calculated from a regression equation based on its octanol/water partition coefficient (log Kow= 1.48).

Once in the atmosphere it will degrade rapidly by photooxidation with a half-life of 11 hours in relatively clean air or under 2 hours in polluted air.

Few studies on the biodegradation of vinylidene could be found In one study, 45-78% of the chemical was lost in 7 days when incubated with a wastewater inoculum; however, a sizeable fraction of the loss was due to volatilization. 97% of 1,1-dichloroethylene was reported to be removed in a municipal wastewater plant but again the fraction lost by evaporation is unknown.

Under anaerobic conditions in microcosms designed to simulate the anaerobic conditions in groundwater and landfills, 1,1-dichloroethylene undergoes reductive dechlorination to vinyl chloride. In the microcosms designed to simulate a groundwater environment, 50% of the 1,1-dichloroethylene disappeared in 5-6 mo.

Under the simulated landfill conditions, degradation occurred in 1-3 weeks. In another anaerobic biodegradation study that used materials from an aquifer that receive municipal landfill leachate and is known to support methanogenesis, the 1,1-dichloroethylene disappeared in 40 weeks. However, no significant degradation occurred for 16 weeks. 1,1-Dichloroethylene was formed as a degradation product.

No experimental data could be found on the bioconcentration of 1,1-dichloroethylene in fish or aquatic invertebrates. Based on its low octanol/water partition coefficient (log Kow= 1.48) one would not expect any significant bioconcentration.

The general population may be exposed to low levels of 1,1-dichloroethylene in ambient air, indoor air, contaminated drinking water, and food which has come in contact with plastic wrap which contains residual monomer.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

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National Primary Drinking Water Regulations

cis- and trans-1,2-Dichloroethylene

Chemical/ Physical Properties

CAS Number: cis- 156-59-2
trans- 156-60-5

Color/ Form/Odor:
Colorless, odorless liquid

M.P.: cis- -80° C; trans- -50° C

B.P.: cis- 60.3° C; trans- 48° C

Vapor Pressure:
cis- 273 mm Hg at 30° C;
trans- 395 mm Hg at 30° C

Octanol/Water Partition (Kow):
Log Kow = cis- 1.86; trans- 2.06

Density/Spec. Grav.:
cis- 1.26 at 20° C
trans- 1.28 at 20° C

Solubility: Soluble in water
cis- 3.5 g/L of water
trans- 6.3 g/L of water at 25° C

Soil sorption coefficient:
Kocs of cis and trans isomers are estimated at 36 to 49; high to very high mobility in soil

Odor/Taste Thresholds: N/A

Henry's Law Coefficient:
cis- 0.00337 atm-cu m/mole;
trans- 0.00672 atm-cu m/mole

Bioconcentration Factor:
BCFs of cis and trans isomers are estimated at 15 to 22; not expected to bioconcentrate in aquatic organisms.

Trade Names/Synonyms:
Both isomers- 1,2-DCE, Acetylene dichloride;
cis- Z-1,2-dichloroethene;
trans- E-1,2-dichloroethene,
sym-dichloroethylene

Drinking Water Standards (in mg/L)

	cis	trans
MCLG:	0.07	0.1
MCL:	0.07	0.1
HAL(child)-		
1 day:	4	20
Longer:	3	2

Health Effects Summary

Acute: EPA has found cis- and trans- 1,2-dichloroethylene to potentially cause central nervous system depression from short-term exposures at levels above the MCL.

Short-term exposures in drinking water which are considered "safe" for a 10-kg (22 lb.) child consuming 1 liter of water per day:

cis- a one-day exposure of 4 mg/L or upto a 7-year exposure to 3 mg/L.

trans- a one-day exposure of 20 mg/L or upto a 7-year exposure to 2 mg/L.

Chronic: Both cis- and trans-1,2-DCE have the potential to cause liver, circulatory and nervous system damage from long-term exposure at levels above the MCL. The trans isomer is approximately twice as potent as the cis- isomer in its ability to depress the central nervous system.

Cancer: There is inadequate evidence to state whether or not either cis- or trans-1,2-DCE have the potential to cause liver cancer from a lifetime exposure in drinking water.

Usage Patterns

Both the cis and trans forms - usually as a mixture - are used as a solvent for waxes, resins, and acetylcellulose; in the extraction of rubber; as a refrigerant; in the manufacture of pharmaceuticals and artificial pearls and in the extraction of oils and fats from fish and meat; as a chemical intermediate for making chlorinated compounds.

No data were available on recent production levels in the United States.

Release Patterns

Releases to the environment are expected to be limited to manufacturing plants in the Gulf Region of the United States. Since cis-and trans-1,2-DCE are not listed chemicals in the Toxics Release Inventory, data on releases during manufacture and handling are not available.

Trans-1,2-dichloroethylene may be released to the environment in air emissions and wastewater during its

production and use as a solvent and extractant, in organic synthesis, and in the manufacture of perfumes, lacquers, and thermoplastics.

An assessment of the sources of trans-1,2-dichloroethylene is complicated by the fact that it is a priority pollutant while the cis isomer is not and the standard EPA methods of analysis do not allow the isomers to differentiated. This has resulted in monitoring reports erroneously listing the trans isomer when the cis isomer is present. The Michigan Department of Health has the capability of distinguishing these isomers and claims that it frequently finds the cis isomer and, if concentrations are high, they occasionally find traces of the trans isomer.

Environmental Fate

Both the cis- and trans-1,2-dichloroethylenes may be released to the environment in air emissions and wastewater during its production and use. Under anaerobic conditions that may exist in landfills, aquifers, or sediment one is likely to find 1,2-dichloroethylenes that are formed as breakdown products from the reductive dehalogenation of common industrial solvents trichloroethylene, tetrachloroethylene, and 1,1,2,2-tetrachloroethane.

The cis-1,2-dichloroethylene is apparently the more common isomer found although it is mistakenly reported as the trans isomer. The trans-isomer, being a priority pollutant, is more commonly analyzed for and the analytical procedures generally used do not distinguish between isomers.

If 1,2-dichloroethylenes are released on soil, it should evaporate and leach into the groundwater where very slow biodegradation should occur.

If released into water, 1,2-dichloroethylenes will be lost mainly through volatilization.

In the atmosphere, 1,2-dichloroethylenes will be lost by reaction with photochemically produced hydroxyl radicals and scavenged by rain. Because it is relatively long-lived in the atmosphere, considerable dispersal from source areas should occur.

Biodegradation, adsorption to sediment, and bioconcentration in aquatic organisms should not be significant.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection.

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

United States Environmental Protection Agency
Office of Water 4601
EPA 811-F-95-004j- T
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EPA

National Primary Drinking Water Regulations

Dichloromethane

Chemical/ Physical Properties

CAS Number: 75-09-2

Color/ Form/Odor: A colorless liquid with a sweet, pleasant odor like chloroform.

M.P.: N/A **B.P.:** 39.75° C

Vapor Pressure: 400 mm Hg at 24.1° C

Octanol/Water Partition (Kow): Log Kow = 1.25

Density/Spec. Grav.: N/A

Solubility: N/A

Soil sorption coefficient: Log Koc estimated at 1.68; High to moderate mobility in soil

Odor/Taste Thresholds: N/A

Bioconcentration Factor: BCF = 5 (est.); not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: N/A; Reportedly high. Moderate evaporation from water.

Trade Names/Synonyms: DCM, Methylene chloride

Drinking Water Standards

MCLG: zero

MCL: 0.005 mg/L

HAL(child): 1 day: 10 mg/L
10-day: 2 mg/L

Health Effects Summary

Acute: EPA has found dichloromethane to potentially cause the following health effects from acute exposures at levels above the MCL: neurological (encephalosis) and blood cell damage.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: a one-day exposure to 10 mg/L or a ten-day exposure to 2 mg/L.

Chronic: Dichloromethane has the potential to cause the following health effects from long-term exposures at levels above the MCL: liver damage

Cancer: There is some evidence that dichloromethane may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production of DCM has been decreasing: from a high of 561 million lbs. in 1986, to 410 million lbs in 1993 (projected 1993 data). In 1988, industries consumed DCM for various uses as follows: paint stripper, 28%; aerosols, 18%; exports, 15%; chemical processing, 11%; urethane foam blowing agent, 9%; metal degreasing, 8%; electronics, 7%; other, 4%.

The greatest use of DCM is as a paint remover. Other uses include: solvent and cleaning agent in chemical manufacture, textiles, electronics, metals and plastics, pesticides industries; blowing and cleaning agent in the urethane foam industry; fumigant for strawberries and grains, and as degreener for citrus fruits; in pharmaceu-

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	1,544,694	556,830
Top Ten States*		
CT	940,158	0
NY	58,400	155,755
GA	166,700	0
NJ	138,302	2,721
WI	0	139,920
SC	20,860	52,810
MI	39,575	32,900
KS	0	33,489
MO	0	27,295
TX	15,910	823
Major Industries*		
Medicinals, botanicals	1,106,858	0
Photographic supplies	58,400	155,755
Misc Indust. organics	141,942	53,741
Custom plastics, resins	0	139,920
Pharmaceuticals	37,575	0
Potato/corn chips&snacks	2,000	32,900
Air conditioning/heating	0	33,489
Steel pipe, tubing	0	27,295

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

ticals and as an anesthetic; in extraction of caffeine, cocoa, fats, spices and beer hops; as a heat transfer agent in refrigeration products.

Release Patterns

Dichloromethane is released to the air from its use as an aerosol propellant, paint remover, metal degreaser and a urethane foam blowing agent. It is released in wastewater primarily from the following industries: Paint and ink, aluminum forming, coal mining, photographic equipment and supplies, pharmaceutical, organic chemical/plastics, rubber processing, foundries and laundries.

In a 1978 report, release of dichloromethane to the land totalled 61.6 million lbs, with a breakdown for its various uses as follows: production, 22,000 lbs; paint removers, 19.4 million lbs.; metal degreasing, 13.4 million lbs; aerosols, 8.4 million lbs.; foam blowing agent, 2.6 million lbs.; pharmaceutical solvent, 4.8 million lbs.; miscellaneous solvent uses, 13 million lbs. Release of dichloromethane to water totalled 8.1 million lbs., with breakdown: production, 66,000 to 132,000 lbs.; paint removers, 3.1 million lbs.; metal degreasing, 2.2 million lbs.; pharmaceutical solvent, 1 million lbs.; miscellaneous solvent uses, 1.7 million lbs.

Dichloromethane is also formed during the chlorination of water.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, DCM releases to land and water totalled over 2.1 million lbs., of which about 75 % percent was to water. These releases were primarily from medicinals and botanicals industries which use DCM as a solvent and extractive. The largest releases occurred in Connecticut and New York.

Environmental Fate

Most of the dichloromethane will be released to the atmosphere where it will degrade by reaction with photochemically produced hydroxyl radicals with a half-life of a few months. It will be subject to direct photolysis.

Releases to water will primarily be removed by evaporation. Half-lives for the evaporation from water of 3-5.6 hours have been determined at moderate mixing conditions. When released into a river, dichloromethane levels were non-detectable 3-15 miles from the source. Biodegradation is possible in natural waters but will probably be very slow compared with evaporation. Dichloromethane is reported to completely biodegrade under aerobic conditions with sewage seed or activated sludge between 6 hours to 7 days. It will not be expected to significantly adsorb to sediment. Hydrolysis is not an important process under normal environmental conditions, with a minimum reported half-life for hydrolysis of approximately 18 months.

Releases to soil will evaporate rapidly from near-surface soil and partially leach into groundwater where its fate is unknown. Little work has been done on the adsorption of dichloromethane to soil. It is adsorbed strongly to peat moss, less strongly to clay, only slightly to dolomite limestone, and not at all to sand. A log Koc of 1.68 can be calculated from a reported log Kom of 1.44.

Although experimental data are lacking, dichloromethane would not be expected to bioconcentrate due to its low octanol/water partition coefficient (log Kow is 1.25), from which an estimated BCF of 5 can be estimated using recommended regression equation.

The major route of human exposure is from air, which can be high near sources of emission, and contaminated drinking water.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

United States Environmental Protection Agency
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National Primary Drinking Water Regulations

1,2-Dichloropropane

Chemical/ Physical Properties

CAS Number: 78-87-5

Color/ Form/Odor: Colorless liquid with a chloroform-like odor

M.P.: -100.4° C **B.P.:** 96.4° C

Octanol/Water Partition (Kow): Log Kow = 2.28

Vapor Pressure: 50 mm Hg at 25° C

Density/Spec. Grav.: 1.16 at 25° C

Solubility: 26 percent by weight in water at 25° C; moderately soluble in water

Soil sorption coefficient: Koc = 47 in silt loam; very high mobility in soil

Odor/Taste Thresholds: Odor in air not noticeable at 15 to 23 ppm

Bioconcentration Factor: Log BCF is less than 1 in fish; not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 0.0021 atm-cu m/mole; highly volatile

Trade Names/Synonyms: Propylene dichloride; major component of Nematox, Vidden D, and Dowfume EB-5

Drinking Water Standards

Standards:

MCLG:	zero mg/L
MCL:	0.005 mg/L
HAL(child):	10-day: 0.09 mg/L

Health Effects Summary

Acute: EPA has found short-term exposures to 1,2-dichloropropane at levels above the MCL to potentially impair the functions of the liver, kidneys, adrenal glands, bladder, and the gastrointestinal and respiratory tracts.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: a ten-day exposure to 0.09 mg/L.

Chronic: Long-term exposures to 1,2-dichloropropane at levels above the MCL have been found to potentially affect the liver, kidneys, bladder, gastrointestinal tract and the respiratory tract.

Cancer: There is some evidence that 1,2-dichloropropane may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production of 1,2- dichloropropane has decreased greatly since a 1980 report of 77 million lbs. Dow Chemical, the only listed producer, discontinued its production in 1991.

The greatest use of 1,2-dichloropropane is as a chemical intermediate in the production of carbon tetrachloride and perchloroethylene, lead scavenger for antiknock fluids, solvent.

Other uses have included: ion exchange resin manufacture, paper coating, scouring, spotting, metal degreasing agent, soil fumigant for nematodes, and insecticide for stored grain.

Release Patterns

1,2-Dichloropropane may be released into the atmosphere or in wastewater during its production or use as an

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	98,504	5,470
Top Five States		
NY	30,000	3,205
LA	25,586	260
VA	14,629	250
TX	12,290	1,206
NJ	10,463	0
Major Industries		
Alkalies, chlorine	37,297	1,216
Photographic equip.	30,000	3,205
Gum, wood chemicals	14,629	250
Plastics, resins	10,463	0
Misc. Indust. Organics	4,793	250

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

intermediate in chemical manufacture. There were also significant releases during its former use as a soil fumigant. It may also be released as leachate from municipal landfills.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, 1,2-dichloropropane releases to land and water totalled nearly 104,000 lbs., of which over 98,000 lbs was released to water. These releases were primarily from chemical industries which use it as an intermediate in producing other chlorinated compounds. The largest releases occurred in New York.

Environmental Fate

If injected into soil 1,2-dichloropropane will be primarily lost by volatilization. 1,2-Dichloropropane has been detected in groundwater where its fate is unknown.

If released to surface water, 1,2-dichloropropane will be lost by volatilization with half-lives ranging from approximately 6 hr for a river to 10 days for a lake.

Adsorption to soil and bioconcentration in fish will not be significant.

In air it will react with photochemically generated hydroxyl radicals (half-life >23 days) and be washed out by rain. Therefore, there will be ample time for dispersal as is evidenced by its presence in ambient air.

Human exposure is primarily due to inhalation. Occupation exposure, both dermal and via inhalation, will occur during and after its application as a soil fumigant as well as during its production and other uses.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

♦ EPA can provide further regulatory and other general information:

· EPA Safe Drinking Water Hotline - 800/426-4791

♦ Other sources of toxicological and environmental fate data include:

· Toxic Substance Control Act Information Line - 202/554-1404

· Toxics Release Inventory, National Library of Medicine - 301/496-6531

· Agency for Toxic Substances and Disease Registry - 404/639-6000

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Office of Water 4601
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National Primary Drinking Water Regulations

Epichlorohydrin

Chemical/ Physical Properties

CAS Number: 106-89-8

Color/ Form/Odor: A colorless liquid with a pungent, garlic-like odor.

M.P.: -48° C **B.P.:** 116.5° C

Vapor Pressure: 10 mm Hg at 16.6° C

Density/Spec. Grav.: 1.18 at 20° C

Octanol/Water Partition (Kow): Log Kow = 0.26

Solubility: 6.5% miscible in water at 10° C; Moderately soluble in water

Soil sorption coefficient: Koc estimated at 123; high mobility in soil

Odor/Taste Thresholds: Odor threshold in water is 0.5 to 1.0 mg/L.

Bioconcentration Factor: log BCF of 0.66 (species not reported); not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: N/A

Trade Names/Synonyms: (Chloromethyl)ethylene oxide, 1,2-Epoxy-3-chloropropane, Chloromethyloxirane, Glycerol epichlorhydrin, Glycidyl chloride

Drinking Water Standards

MCLG: zero mg/L

MCL: Treatment technique

HAL(child): 1- to 10-day: 0.1 mg/L
Longer-term: 0.07 mg/L

Health Effects Summary

Acute: EPA has found epichlorohydrin to potentially cause the following health effects from acute exposures at levels above the MCL: skin irritation; detrimental effects on liver, kidneys, central nervous system.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: a one- or ten-day exposure to 0.1 mg/L; upto a 7-year exposure to 0.07 mg/L.

Chronic: Epichlorohydrin has the potential to cause the following health effects from long-term exposures at levels above the MCL: stomach, eye and skin irritation; chromosome aberrations; adverse changes in blood.

Cancer: There is some evidence that epichlorohydrin may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production and imports of epichlorohydrin increased from the late 1970s to the mid-1980s: from 294 million lbs. to 511 million lbs. In 1984 it was estimated that industries consumed epichlorohydrin as follows: Epoxy resins, 65%; glycerine, 25%; epichlorohydrin elastomers, 5%; miscellaneous, 5%

The greatest use of epichlorohydrin is as a monomer for epoxy resins, elastomers and other polymers.

Other uses include: a polymer coating material in water supply systems; an intermediate in organic synthesis, particularly glycerine; solvent for cellulose esters and ethers; high wet-strength resins for paper industry; in preparation of ion exchange resins; in the manufacture of pharmaceuticals; an insect fumigant.

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	42,705	22,849
Top Five States		
AL	29,385	18,476
LA	6,924	2,663
NJ	2,164	16
TX	200	1,396
AR	1,594	0
Major Industries		
Industrial organics	25,137	14,941
Plastics and resins	6,392	2,509
Industrial inorganics	4,200	1,600
Agricultural chemicals	2,207	1,532
Alkalis, chlorine	2,100	1,033

Release Patterns

Epichlorohydrin may be released to the atmosphere and in wastewater during its production and use in epoxy resins, glycerin manufacture, as a chemical intermediate in the manufacture of other chemicals, and other uses. Other uses which may lead to its release include textile treatment, coatings, solvent, surface active agent, stabilizer in insecticide, and elastomer manufacture.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, epichlorohydrin releases to land and water totalled over 65,000 lbs., of which about two-thirds was to water. These releases were primarily from industrial organic chemical industries. The largest releases occurred in Alabama.

Environmental Fate

Epichlorohydrin is relatively volatile and would therefore readily evaporate from near-surface soils and other solid surfaces. If released into water it will be lost primarily by evaporation (half-life 29 hr in a typical river) and hydrolysis (half-life 8.2 days). It will not adsorb appreciably to sediment. If spilled on land, it will evaporate and leach into the groundwater where it will hydrolyze. The Koc for epichlorohydrin, calculated from its water solubility, is 123 which indicates that it is not appreciably adsorbed. After a spill of 20,000 gal following a train accident, water in wells closest to the spill were highly contaminated.

Biodegradation and chemical reactions with ions and reactive species may accelerate its loss in soil and water but data from field studies are lacking. In the atmosphere, epichlorohydrin will degrade by reaction with photochemically produced hydroxyl radicals (est half-life 4 days).

It will not bioconcentrate appreciably in aquatic organisms. The log BCF has been estimated to be 0.66.

There is a lack of monitoring data for epichlorohydrin in all but occupational settings. Humans will primarily be exposed to epichlorohydrin in occupational settings.

Other Regulatory Information

Monitoring and Analysis:

No analytical methods are available so monitoring is not required. This contaminant is being regulated by requiring use of a treatment technique to limit its use by drinking water systems.

Treatment

Treatment technique: When acrylamide is used in drinking water systems, the combination of dose and monomer level may not exceed the following level:

0.01 % dosed at 20 mg/L

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791

- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

United States Environmental Protection Agency
Office of Water 4601
EPA 811-F-95-004mT
October 1995

EPA

National Primary Drinking Water Regulations

Ethylbenzene

Chemical/ Physical Properties

CAS Number: 100-41-4

Color/ Form/Odor: Colorless liquid with a sweet, gasoline-like odor

M.P.: -95° C **B.P.:** 136.2° C

Vapor Pressure: 10 mm Hg at 25.9° C

Density/Spec. Grav.: 0.87 at 20° C

Octanol/Water Partition (Kow): Log Kow = 3.15

Solubility: 0.14 g/L of water at 15° C; low solubility in water

Soil sorption coefficient: Koc measured at 164 silt loam; moderate mobility in soil

Odor/Taste Thresholds: Taste and odor threshold in water is 0.029 mg/L

Bioconcentration Factor: Measured log BCF values of 0.67 to 1.9 in fish; not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 0.0084 atm-cu m/mole; rapid evaporation from water

Trade Names/Synonyms: Ethylbenzol, Phenylethane

Drinking Water Standards

MCLG:	0.7 mg/L
MCL:	0.7 mg/L
HAL(child):	1 day: 30 mg/L
	10-day: 3 mg/L

Health Effects Summary

Acute: EPA has found ethylbenzene to potentially cause drowsiness, fatigue, headache and mild eye and respiratory irritation from short-term exposures at levels above the MCL.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: a one-day exposure to 30 mg/L; a ten-day exposure to 3 mg/L.

Chronic: Ethylbenzene has the potential to cause damage to the liver, kidneys, central nervous system and eyes from long-term exposure at levels above the MCL.

Cancer: There is inadequate evidence to state whether or not ethylbenzene has the potential to cause cancer from a lifetime exposure in drinking water.

Usage Patterns

Production of ethylbenzene has increased: from 6.9 billion lbs. in 1982 to 11.8 billion lbs in 1993. The greatest use - over 99 percent - of ethylbenzene is as an intermediate for styrene monomer production.

Other uses include: a solvent for coatings, and in the production of synthetic rubber and cellulose acetate.

Release Patterns

Ethylbenzene will enter the atmosphere primarily from fugitive emissions and exhaust connected with its use in gasoline. More localized sources will be emissions, waste water and spills from its production and industrial use.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, ethylbenzene releases to water totalled over 47,293 lbs., while releases to land totalled

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	47,293	714,580
Top Ten States		
TX	9,870	480,164
VI	1,233	72,245
IL	31	44,789
PR	0	23,980
VA	17,997	1,950
DE	3,460	13,324
NJ	1,892	11,510
NM	0	13,076
WY	250	12,755
LA	4,383	4,552
Major Industries		
Petroleum refining	55,201	718,884
Plastics, resins	12,384	9,212
Indust. Organics	10,683	9,781
Pharmaceuticals	14,090	0
Metal containers	0	11,510

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

over 714,000 lbs. These releases were primarily from petroleum refining industries. The largest releases occurred in Texas. The largest direct releases to water occurred in Virginia.

Environmental Fate

If ethylbenzene is released to the atmosphere, it will exist predominantly in the vapor phase, based on its vapor pressure. There it will photochemically degrade by reaction with hydroxyl radicals (half-life 0.5 to 2 days) and partially return to earth in rain. It will not be subject to direct photolysis.

Evaporation and biodegradation are significant in water. Ethylbenzene will evaporate rapidly from water: a half-life for evaporation from moving, shallow water is 3.1 hr. After a period of inocula adaptation, ethylbenzene is biodegraded fairly rapidly by sewage or activated sludge inoculua. As a component of gas oil, it is completely degraded in groundwater in 8 days and seawater in 10 days. No degradation was observed in anaerobic reactors or at low concentrations in batch reactors under denitrifying conditions. Ethylbenzene is resistant to hydrolysis. Some ethylbenzene may be adsorbed by sediment.

Ethylbenzene is only adsorbed moderately by soil. The measured Koc for silt loam was 164. Its presence in bank infiltrated water suggests that there is a good probability of its leaching through soil. It will not significantly hydrolyze in water or soil.

Significant bioconcentration in fish is not expected to occur. Experimental data on the bioconcentration of ethylbenzene include a log BCF of 1.9 in goldfish and 0.67 for clams exposed to the water-soluble fraction of crude oil. This, with a calculated log BCF of 2.16 in fish, indicate that ethylbenzene should not significantly bioconcentrate in aquatic organisms.

The primary source of exposure is from the air especially in areas of high traffic. However, ethylbenzene is a contaminant in many drinking water supplies and levels can be quite high for wells near leaking gasoline storage tanks and for many drinking waters taken from surface waters.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

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EPA

National Primary Drinking Water Regulations

Styrene

Chemical/ Physical Properties

CAS Number: 100-42-5

Color/ Form/Odor: Colorless or yellowish oily liquid with aromatic, almost floral odor; available as polymer grade.

M.P.: -30.63° C **B.P.:** 145.2° C

Vapor Pressure: 4.5 mm Hg at 25° C; highly volatile

Octanol/Water Partition (Kow): Log Kow = 2.95

Density/Spec. Grav.: 0.906 at 20° C

Solubility: 310 mg/L at 25° C; Slightly soluble in water

Soil sorption coefficient: Koc estimated at 520 to 555; low mobility in soil

Odor/Taste Thresholds: Taste threshold in water is 0.73 mg/L

Bioconcentration Factor: BCF = 13.5 in fish; not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 0.00275 atm-cu m/mole at 25° C; rapid evaporation from water.

Trade Names/Synonyms: Vinyl benzene, Phenethylene, Cinnamene, Diarex HF 77, Styrolene, Styron, Styropol,

Drinking Water Standards

MCLG: 0.1 mg/L

MCL: 0.1 mg/L

HAL(child): 1 day: 20 mg/L
Longer-term: 2 mg/L

Health Effects Summary

Acute: EPA has found styrene to potentially cause the following health effects from acute exposures at levels above the MCL: nervous system effects such as depression, loss of concentration, weakness, fatigue and nausea.

Drinking water levels which are considered "safe" for short-term exposures: For a 22 lb. child consuming 1 liter of water per day: a one-day exposure to 20 mg/L; upto a 7-year exposure to 2 mg/L.

Chronic: Styrene has the potential to cause the following health effects from long-term exposures at levels above the MCL: liver and nerve tissue damage.

Cancer: There is some evidence that styrene may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production of styrene has increased: from 8.5 billion lbs. in 1988 to 10.7 billion lbs in 1993. In 1989, it was estimated that industries consumed styrene as follows: Polystyrene, 55%; acrylonitrile-butadiene-styrene (ABS), 10%; styrene-butadiene rubber (SBR), 5%; styrene-butadiene latex, 5%; unsaturated polyester resins, 5%; miscellaneous uses, including other copolymers, 7%; exports, 13%.

Initially, styrene was used primarily in the synthetic rubber industry, but most styrene is currently consumed

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	275,888	1,796,451
Top Eight States*		
TX	160,411	572,294
WV	1,600	555,360
IN	0	124,794
WI	0	102,973
OH	0	90,358
GA	0	79,000
LA	53,430	0
FL	0	38,800
Major Industries*		
Adhesives, sealants	0	537,360
Concrete products	0	398,424
Synthetic rubber	152,215	149,147
Misc. plastic products	515	201,713
Plastics and resins	25,133	71,363
Boatbuilding, repair	220	83,256
Car parts, access.	0	79,250
Misc. Indust. organics	34,275	43,290
Travel trailers, campers	0	45,129
Custom plastic resins	720	44,320

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

in plastics, resins, coatings, and paints. To date, all commercial uses are based on chemical reactions that polymerize or copolymerize styrene.

Release Patterns

Styrene is released into the environment by emissions and effluents from its production and its use in polymer manufacture. It has been found in exhausts from spark-ignition engines, oxy-acetylene flames, cigarette smoke and gases emitted by pyrolysis of brake linings. Stack emissions from waste incineration have been found to contain styrene. Styrene is emitted in automobile exhaust. Consumers may be exposed to potentially high levels of styrene monomer through contact with unsaturated polyester resin products used in fiberglass boat construction and repair, and as auto body fillers and casting plastics. These products may contain styrene at concentrations of 30 to 50%. Its presence in various food products is due to monomer leaching from polystyrene containers.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, styrene releases to land and water totalled over 2 million lbs., of which about 85 percent was to land. These releases were primarily from adhesives and sealants industries. The largest releases occurred in Texas. The largest direct releases to water occurred in Louisiana.

Environmental Fate

If released to the atmosphere, styrene will react rapidly with both hydroxyl radicals and ozone with a combined, calculated half-life of about 2.5 hours. If released to environmental bodies of water, styrene will volatilize relatively rapidly and may be subject to biodegradation. Five day aqueous theoretical BOD (TBOD) of 80% in acclimated sewage seed and 42% TBOD in an unacclimated seed have been observed. Styrene is not expected to hydrolyze.

If released to soil it will biodegrade, with reports of 95% degradation from a landfill soil and 87% degradation from a sandy loam soil in 16 weeks. It is expected to leach with a low-to-moderate soil mobility, based upon a Koc of 520 to 555 estimated using regression-derived equations or structure estimation methods.

Styrene is not expected to bioaccumulate or bioconcentrate in organisms and food chains to any measurable extent. A BCF of 13.5 was experimentally determined in a bioconcentration study using goldfish. Based upon its measured water solubility and log Kow, the BCF of styrene can be estimated to be approximately 24 and 100, respectively, from regression-derived equations.

While styrene has been detected in various drinking waters, it was not detected in a groundwater supply survey of 945 finished water supplies which use groundwater sources. Styrene has been detected in various chemical, textile, latex, oil refinery and industrial wastewater effluents. Styrene has been frequently detected in the ambient air of source dominated locations and urban areas, has been detected in the air of a national forest in Alabama, and has been detected in the vicinity of oil fires. Food packaged in polystyrene containers has been found to contain small amounts of styrene.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

United States Environmental Protection Agency
Office of Water 4601
EPA 811-F-95-004o-T
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EPA

National Primary Drinking Water Regulations

Tetrachloroethylene

Chemical/ Physical Properties

CAS Number: 127-18-4

Color/ Form/Odor: Colorless liquid with mildy sweet, chloroform-like odor; available in many forms, from worm pills to dry-cleaning grades containing various stabilizers.

M.P.: -19° C **B.P.:** 121° C

Vapor Pressure: 18.47 mm Hg at 25° C

Octanol/Water Partition (Kow): Log Kow = 3.40

Density/Spec. Grav.: 1.62 at 20° C

Solubility: 0.15 g/L of water at 25° C; Slightly soluble in water

Soil sorption coefficient: Koc = 210 (exp.) to 238 (est.); low to moderate mobility in soil

Odor/Taste Thresholds: Taste threshold in water is 0.3 mg/L

Bioconcentration Factor: BCFs of 39 to 49 reported in fish; not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: N/A

Trade Names/Synonyms: Ethylene tetrachloride, Perchloroethylene, PCE, Ankilostin, Didakene, Fedal-un, Nema, Perclene, Persec, Tetlen, Tetracap, Tetraleno, Tetropil, Antisal 1, Dow-per, Perawin, Perchlor, Percosolv, Perk, Perklone, Tetraguer, Tetralex, Tetravec

Drinking Water Standards

MCLG: zero mg/L

MCL: 0.005 mg/L

HAL(child): 1- to 10-day: 2 mg/L
Longer-term: 1 mg/L

Health Effects Summary

Acute: EPA has found tetrachloroethylene to potentially cause the following health effects from acute exposures at levels above the MCL: detrimental effects to liver, kidney, and central nervous system.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: a one- to ten-day exposure to 2 mg/L; upto a 7-year exposure to 1 mg/L.

Chronic: Tetrachloroethylene has the potential to cause the following health effects from long-term exposures at levels above the MCL: detrimental effects to liver, kidney, and central nervous system.

Cancer: There is some evidence that tetrachloroethylene may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production of tetrachloroethylene has decreased: from 736 million lbs. in 1978 to 405 million lbs in 1986.

In 1989 it was estimated that industries consumed tetrachloroethylene as follows: Dry cleaning and textile processing, 50%; chemical intermediate (mostly fluorocarbon F-113), 28%; industrial metal cleaning, 9%; exports, 10%; other, 3%.

The greatest use of tetrachloroethylene is in the textile industry for processing, finishing, sizing, and as a component of aerosol dry-cleaning products.

Other uses include: an intermediate in the synthesis of

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	297,602	750,104
Top Seven States*		
LA	23,639	610,518
SC	104,728	0
NH	62,150	0
NC	42,192	13,102
IL	0	40,500
TX	36,144	720
OH	0	32,170
Major Industries*		
Alkalis, chlorine	63,472	611,242
Leather tanning,finishing	62,150	0
Cotton fabric finishing	51,577	0
Misc textile finishing	48,082	2,000
Knit outwear mills	45,808	0
Misc. apparel, access.	0	40,500
Transportation Equip.	3,750	27,000
Ammunition	0	20,575

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

fluorocarbons, an insulating/cooling fluid in electric transformers, in typewriter correction fluids, as veterinary medication against worms, once used as grain protectant/fumigant.

Release Patterns

Major releases of tetrachloroethylene are: via vaporization losses from dry cleaning and industrial metal cleaning; wastewater, particularly from metal finishing, laundries, aluminum forming, organic chemical/plastics manufacturing and municipal treatment plants. It is also estimated that emissions account for approximately 90% of the tetrachloroethylene produced in the United States.

Water pollution can occur from tetrachloroethylene leaching from vinyl liners in asbestos-cement water pipelines for water distribution, and during chlorination water treatment, where it can be formed in small quantities.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, tetrachloroethylene releases to land and water totalled over 1 million lbs., of which about 75 percent was to land.

These releases were primarily from alkali and chlorine industries which use tetrachloroethylene in making other chemicals. The largest releases occurred in Louisiana and South Carolina.

Environmental Fate

If PCE is released to soil, it will be subject to evaporation into the atmosphere and to leaching to the groundwater. Tetrachloroethylene was slightly adsorbed on sand and clay minerals. The Henry's adsorption coefficients were approximately in proportion to the organic content of the soil samples. Based on the reported and estimated Koc's (209 to 1685), tetrachloroethylene will be expected to exhibit low to medium mobility in soil and therefore may leach slowly to the groundwater.

There is evidence that slow biodegradation of PCE occurs under anaerobic conditions when the microorganisms have been acclimated. In experiments using continuous-flow laboratory methanogenic column with well acclimated mixed cultures and a 2-day detention time, there was an average PCE removal rate of 76%. Removal of 86% PCE occurred in a methanogenic biofilm column (8 weeks of activation followed by 9-12 weeks ofacclimation). In a microcosm containing muck from an aquifer recharge basin, 72.8% loss was observed in 21 days against 12-17% in controls. In one field ground water recharge project, degradation was observed in the 50 day recharge period.

If PCE is released to water, it will be subject to rapid volatilization with estimated half-lives ranging from <1 day to several weeks. Measured volatilization half-lives in a mesocosm simulating Narraganset Bay, RI were 11 days in winter, 25 days in spring, and 14 days in summer.

PCE will not be expected to significantly biodegrade in water or adsorb to sediment. PCE will not be expected to significantly hydrolyze in soil or water under normal environmental conditions (half-life 9 months at 25 deg C).

If PCE is released to the atmosphere, it will exist mainly in the gas-phase and it will be subject to photooxidation with estimates of degradation time scales ranging from an approximate half-life of 2 months to complete degradation in an hour. Some of the PCE in the atmosphere may be subject to washout in rain based on the solubility of PCE in water and the fact that PCE has been detected in rain.

Based on the reported and estimated BCF's, tetrachloroethylene will not be expected to significantly bioconcentrate in aquatic organisms. BCFs of 39 to 49 were measured in fish; a BCF of 226 was estimated from octanol water partition coefficient.

Major human exposure is from inhalation of contaminated urban air, especially near point sources such as dry cleaners, drinking contaminated water from contaminated aquifers and drinking water distributed in pipelines with vinyl liners, and inhalation of contaminated occupational atmospheres in metal degreasing and dry cleaning industries.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2; 551

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

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EPA 811-F-95-004p-T
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EPA

National Primary Drinking Water Regulations

Toluene

Chemical/ Physical Properties

CAS Number: 108-88-3

Color/ Form/Odor: Colorless liquid with a sweet, benzene-like odor

M.P.: -95° C **B.P.:** 111° C

Vapor Pressure: 36.7 mm Hg at 30° C

Density/Spec. Grav.: 0.866 at 20° C

Octanol/Water Partition (Kow): Log Kow = 2.69

Solubility: N/A; Slightly soluble in water

Soil sorption coefficient: Koc measured at 37 to 178 in several soils; very high to moderate mobility in soil

Odor/Taste Thresholds: Odor and taste thresholds in water are reported as 0.04 and 1 mg/L

Bioconcentration Factor: BCFs: <100 in fish; <10 in shellfish; 380 in algae; not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: N/A

Trade Names/Synonyms: Methylbenzene, Methacide, Phenylmethane, Toluol, Antisal 1A

Drinking Water Standards

MCLG: 1 mg/L

MCL: 1 mg/L

HAL(child): 1 day: 20 mg/L
Longer-term: 2 mg/L

Health Effects Summary

Acute: EPA has found toluene to potentially cause the following health effects from acute exposures at levels above the MCL: low oral toxicity to central nervous system, may cause fatigue, nausea, weakness, confusion.

Drinking water levels which are considered "safe" for short-term exposures: For a 22 lb. child consuming 1 liter of water per day: a one-day exposure to 20 mg/L; upto a 7-year exposure to 2 mg/L.

Chronic: Toluene has the potential to cause the following health effects from long-term exposures at levels above the MCL: spasms, tremors, imbalance; impairment of speech, hearing, vision, memory, coordination; liver and kidney damage.

Cancer: There is inadequate evidence to state whether or not toluene has the potential to cause cancer from lifetime exposures in drinking water.

Usage Patterns

Production of toluene has increased: from 5.1 billion lbs. in 1985 to 6.4 billion lbs in 1993. In 1985, it was estimated that industries consumed toluene as follows: Benzene, 46%; gasoline blending, 37%; solvent, 8%; toluene diisocyanate, 7%; miscellaneous chemicals, 2%.

The largest chemical use for toluene is the production of benzene and urethane via hydrodealkylation.

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS* (in pounds)	732,310	3,672,041
Top Ten States*		
TX	16,285	969,210
CA	0	930,000
CT	316,068	0
OK	0	287,000
VA	27,500	216,000
VI	2,970	191,504
IL	56	180,824
MI	0	129,226
WV	117,523	1,377
SC	6,000	89,578
Major Industries*		
Petroleum refining	227,196	2,580,941
Medicinals, botanicals	301,585	1,108
Petroleum/coal prods.	38,856	287,000
Misc Ind. Chemicals	179,576	107,159
Gaskets, sealing devices	4,002	216,000
Wood office furniture	0	129,226
Plastics, resins	57,661	39,139
Wood home furniture	30,000	65,444
Paints, allied products	5,927	88,024

* Water/Land totals only include facilities with releases greater than 10,000 lbs.

Other uses include; manufacture of benzoic acid, benzaldehyde, explosives, dyes, and many other organic compounds; as a solvent for paints, lacquers, gums, resins; in the extraction of various principles from plants; as gasoline additive; as a diluent for photogravure inks; in cements, solvents, spot removers, cosmetics, antifreezes; an asphalt and naphtha constituent; in detergent manufacture; in fuel blending

Release Patterns

Toluene is released into the atmosphere principally from the volatilization of petroleum fuels and toluene-based solvents and thinners and from motor vehicle exhaust. Considerable emissions are from: its discharge into waterways or spills on land during the storage, transport and disposal of fuels and oils; from its production from petroleum and coal; as a by-product from styrene production, and from its use as a chemical intermediate.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, toluene releases to land and water totalled over 4 million lbs., of which about 83 percent was to land. These releases were primarily from petroleum refining industries. The largest releases occurred in Texas and California. The largest releases directly to water occurred in Connecticut and West Virginia.

Environmental Fate

If toluene is released to soil, it will be lost by evaporation from near-surface soil and by leaching to the groundwater. Based on the reported Koc values, toluene will be expected to exhibit very high to moderate in soil and therefore may leach to the groundwater. Field data from infiltration sites is conflicting; in one study toluene is eliminated during bank infiltration, while in other studies it penetrates infiltration sites. These results may bear on site-related factors such as load, flow rate, soil characteristics, and other loss factors such as evaporation and biodegradation. Reported Koc values: Wendover silty loam, 37, Grimsby silt loam, 160, Vaudreil sandy loam, 46; sandy soil, 178; 100 and 151.

Biodegradation occurs both in soil and groundwater, but it is apt to be slow especially at high concentrations, which may be toxic to microorganisms. The presence of acclimated microbial populations may allow rapid biodegradation. Toluene completely degraded in groundwater in 8 days including a lag of 3-4 days while microbial populations became acclimated. Other investigators found that only 1-2% of toluene degraded in the subsurface environment and less than 90% degraded in 4 weeks in soil cores at various depths both above and below the water table. It will not significantly hydrolyze in soil or water under normal environmental conditions.

If toluene is released into water, its removal can be rapid or take several weeks, depending on temperature, mixing conditions, and acclimation of microorganisms. Toluene evaporates rapidly from water with an experimentally determined half-life of 2.9 to 5.7 hr for evaporation from 1 m of water with moderate mixing conditions. In a mesocosm experiment with simulated conditions for Narragansett Bay, RI, the loss was primarily by evaporation in winter with a half-life of 13 days. It will not significantly adsorb to sediment.

If toluene is released to the atmosphere, it will degrade by reaction with photochemically produced hydroxyl radicals (half-life 3 hr to slightly over 1 day) or be washed out in rain. It will not be subject to direct photolysis.

It will not significantly bioconcentrate in aquatic organisms. Reported BCFs: eels, 13.2; Manila clam, 1.67; mussel, 4.2; algae, 380; golden ide fish, 90.

The primary source of human exposure is from inhalation of contaminated ambient air, especially in traffic or near filling stations, or in occupational atmospheres where toluene-based solvents are used.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

United States Environmental Protection Agency
Office of Water 4601
EPA 811-F-95-004q-T
October 1995

EPA

National Primary Drinking Water Regulations

1,2,4-Trichlorobenzene

Chemical/ Physical Properties

CAS Number: 120-82-1

Color/ Form/Odor: Aromatic, colorless liquid

M.P.: 17° C **B.P.:** 213.5° C

Vapor Pressure: 0.29 mm Hg at 25° C

Octanol/Water Partition (Kow): Log Kow = 4.02

Density/Spec. Grav.: 1.45 at 20° C

Solubility: 30 mg/L of water at 20° C; Slightly soluble in water

Soil sorption coefficient: Koc ranges from 1000 to 5000; moderate to high mobility in soil

Odor/Taste Thresholds: Odor threshold in water is 3 mg/L

Bioconcentration Factor: BCFs range from 490 to 2800 in fish; expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 3.9×10^{-3} atm-cu m/mole

Trade Names/Synonyms: 1,2,4-Trichlorobenzol, Hostetex L-PEC

Drinking Water Standards

MCLG: 0.07 mg/L

MCL: 0.07 mg/L

HAL(child): 1 day: 0.1 mg/L
Longer term: 0.1 mg/L

Health Effects Summary

Acute: EPA has found 1,2,4-trichlorobenzene to potentially cause the following health effects from acute exposures at levels above the MCL: changes in liver, kidneys and adrenal glands

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: upto a 7-year exposure to 0.1 mg/L.

Chronic: 1,2,4-Trichlorobenzene has the potential to cause the following health effects from long-term exposures at levels above the MCL: increased adrenal gland weights

Cancer: There is presently no evidence that 1,2,4-Trichlorobenzene has the potential to cause cancer from a lifetime exposure in drinking water.

Usage Patterns

Current production figures on 1,2,4-trichlorobenzene are not available. EPA estimated 1983 production to be in the range of 3 to 8 million lbs. 1983 imports were reportedly over 3 million lbs.

1,2,4-Trichlorobenzene is primarily used as a dye carrier. Other uses include: an intermediate in the manufacture of herbicides and higher chlorinated benzenes; dielectric fluid; solvent; heat-transfer medium; degreasing agents; septic tank and drain cleaners; wood preservatives; and abrasive formulations. It was once used as a soil treatment for termite control.

Release Patterns

Major environmental releases of 1,2,4-trichlorobenzene are due to its manufacture and use as a dye carrier. 1,2,4-Trichlorobenzene is also a product of hexachlorobenzene dechlorination by anaerobic sewage sludge.

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	157,541	22,835
Top Five States*		
NC	80,253	13,209
VA	36,970	0
GA	17,639	8,951
WV	20,300	0
NY	1,150	1
Major Industries*		
Finishing plants, misc	52,249	0
Finishing plants, synth.	47,976	0
Weaving, finishing mills	20,139	8,951
Alkalies, chlorine	21,773	1
Knitting mills, misc	9,077	9,994
Knit outerwear mills	1,300	3,200

* Water/Land totals only include facilities with releases greater than 100 lbs.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, 1,2,4-trichlorobenzene releases to land and water totalled over 180,000 lbs., of which about 87% was to water. These releases were primarily from textile finishing industries. The largest releases occurred in North Carolina and Virginia.

Environmental Fate

If 1,2,4-trichlorobenzene (1,2,4-TCB) is released to the soil it will probably adsorb to the soil and therefore will not leach appreciably to the groundwater. However, 1,2,4-TCB has been detected in some groundwater samples which indicates that it can be transported there by some process. 1,2,4-TCB will not hydrolyze or biodegrade in groundwater, but it may biodegrade slowly in the soil based upon the data from one experiment.

If released to water it will adsorb to the sediments. It will not hydrolyze in surface waters but it may be subject to significant biodegradation. It is expected to significantly evaporate from water with half-lives of 11-22 days for evaporation from a seawater microcosm and a half-life of 4.2 hr predicted for evaporation from a model river. Adsorption to sediments or absorption by microorganisms may minimize the rate of evaporation. A half-life of 450 years has been reported for sunlight photolysis in surface waters at 40 deg latitude in summer.

If 1,2,4-trichlorobenzene is released to the atmosphere, it may react with photochemically produced hydroxyl radicals with a resulting estimated vapor phase half-life in the atmosphere of 18.5 days.

Bioconcentration in aquatic organisms has been measured and values for fish ranging from 51 to 2800 have been reported.

Exposure to 1,2,4-trichlorobenzene will result mainly from occupational exposure during its manufacture and use, while general population exposure will result from the ingestion of contaminated drinking water and food, especially contaminated fish.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791

- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

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Office of Water 4601
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EPA

National Primary Drinking Water Regulations

1,1,1-Trichloroethane

Chemical/ Physical Properties

CAS Number: 71-55-6

Color/ Form/Odor: Colorless liquid with sweet, chloroform-like odor

M.P.: -30.4° C B.P.: 74.1° C

Vapor Pressure: 127 mm Hg at 25° C

Octanol/Water Partition (Kow): Log Kow = 2.49

Density/Spec. Grav.: 1.34 at 20° C

Solubility: Soluble in water; 4.4 g/L of water at 20° C;

Soil sorption coefficient: Koc is 81in silty clay, 89 in sandy loam.

Odor/Taste Thresholds: N/A

Bioconcentration Factor: Low; 8.9 in fish

Henry's Law Coefficient: 0.008 atm-cu m/ mole;

Trade Names/Synonyms: Chloroethene; Methylchloroform; Aerothene TT; Algylen; Alpha-T; Chlorten; Gemalgene; Genklene; Dowclene; Solvent 111; Trichloran; Inhibisol

Drinking Water Standards

MCLG: 0.2 mg/L

MCL: 0.2 mg/L

HAL(child): 1 day: 100 mg/L

Longer-term: 40 mg/L

Health Effects Summary

Acute: EPA has found that 1,1,1-trichloroethane has the potential to cause damage to the liver, nervous system and circulatory system from acute exposures above the MCL.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter per day, a one-day exposure of 100 mg/L; upto a 7-year exposure to 40 mg/L.

Chronic: 1,1,1-trichloroethane has the potential to cause liver, nervous system and circulatory system damage from a lifetime exposure at levels above the MCL.

Cancer: There is inadequate evidence to state whether or not 1,1,1-trichloroethane has the potential to cause cancer from exposures in drinking water.

Usage Patterns

Demand for 1,1,1-trichloroethane in 1988 was 700 million lb., increased to 705 million in 1989, and was projected (in 1989) to reach 735 million lb. in 1993.

Solvent uses include vapor degreasing of metal products; for cleaning precision instruments; for textile processing and dyeing; in aerosols, in which it acts both as a vapor pressure depressant and as a solvent and carrier for many of the active ingredients used in aerosols.

It is also used as an intermediate in the manufacture of organic chemicals, as a coolant and lubricant in metal cutting oils; as a component of inks and drain cleaners. Agricultural uses have included postharvest fumigation of strawberries; for degreening citrus fruits; as a solvent for various insecticides.

Proportions consumed for various uses in 1989 were: vapor degreasing, 34%; cold cleaning, 12%; aerosols, 10%; adhesives, 8%; intermediate, 7%; coatings, 5%; electronics, 4%; other, 5%; exports, 15%.

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	222,403	812,873
Top Six States*		
CA	0	109,070
GA	0	73,258
AR	0	67,000
IN	15,000	46,096
VA	0	51,822
UT	40,000	0
Major Industries		
Gray iron foundries	1,084	76,158
Aircraft	546	73,258
Manufacturing industries	1,018	72,572
Wood furniture	0	53,038
Fabricated structural metal	0	51,425
Plating, polishing	6,152	41,647
Turbines, generators	40,317	966

* State totals only include facilities with releases greater than 10,000 lbs.

Release Patterns

1,1,1-Trichloroethane is likely to enter the environment from air emissions or in wastewater from its production or use in vapor degreasing, metal cleaning, etc. It can also enter the environment in leachates and volatile emissions from landfills.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, releases to water totalled over 222,000 lbs. Releases to land totalled over 812,000 lbs. These releases were primarily from metal fabrication industries. The largest releases occurred in California and Georgia. The largest direct releases to water occurred in Utah and Indiana.

Environmental Fate

1,1,1-Trichloroethane has a high Henry's Law constant (8X10-3 atm-cu m/mole(4)) and will volatilize rapidly from water and soil with diffusion through the liquid phase controlling volatilization from water. Half-life for evaporation from water obtained from laboratory systems range from a fraction of an hour to several hours. Various estimates of volatilization half-lives range from 5.1-10.6 days for ponds, 3-29 hr for rivers, and 3.8-12 days for lakes.

The adsorption of 1,1,1-trichloroethane to soil is proportional to the organic carbon content of the soil(4-6). The mineral content of the soil is not a contributing factor(5). 1,1,1-Trichloroethane is adsorbed strongly to peat moss, less strongly to clay, very slightly to dolomite limestone and not at all to sand(2). It has a low adsorption to silt loam (Koc = 183)(3). From the fact that it is not retained in the soil during bank infiltration, and that it is frequently found in groundwater in high concentrations, one can safely conclude that it is not adsorbed strongly by soils, especially subsurface soils(1). Based upon experimental measurement, the mean Koc range of 1,1,1-trichloroethane in a silty clay soil and sandy loam soil is 81-89(8,SRC).

There is no or very slow degradation in soils. No degradation has been observed in subsurface soils in 27 weeks. However in loamy sand, slow degradation has been observed under acclimated conditions. Slow degradation may occur in water under anaerobic or aerated conditions; degradation may take several weeks and acclimation is important. No degradation in river water has been found. 1,1,1-Trichloroethane degraded to vinylidene chloride as a first step in its biotransformation in microcosms containing aquifer water and sediment collected from uncontaminated sites in the Everglades. Considerable degradation occurred within two weeks. Field evidence of biodegradation in aquifers indicates a half-life of 231 days.

1,1,1-Trichloroethane has been shown to undergo biotransformation by a reductive dechlorination to 1,1-dichloroethane and chloroethane under methanogenic conditions. Laboratory reactors have demonstrated that 1,1,1-trichloroethane can be biodegraded under anaerobic simulations; it was suggested that in-situ anaerobic biodegrdation may be a viable alternative for clean-up for various contaminated soil and groundwater sites.

Hydrolysis is not a significant degradation process having a half-life of approximately 6 months. The product of hydrolysis is vinylidene chloride. Direct photolysis is not important in the troposphere, but is in the stratosphere, and leads to the chemical's rapid degradation. Photodegradation is not observed in water.

The BCF in bluegill sunfish in a 28 day test was 8.9. This indicates that 1,1,1-trichloroethane has little tendency to bioconcentrate in fish. Although the amount of experimental data for 1,1,1-trichloroethane is limited, confidence in this result is increased because values of BCFs in related compounds are similar.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2; 551

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

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EPA

National Primary Drinking Water Regulations

1,1,2-Trichloroethane

Chemical/ Physical Properties

CAS Number: 79-00-5

Color/ Form/Odor: Clear liquid with a pleasant, chloroform-like odor

M.P.: -36.6° C **B.P.:** 113.8° C

Vapor Pressure: 23 mm Hg at 25° C

Octanol/Water Partition (Kow): Log Kow = 2.17

Density/Spec. Grav.: 1.4 at 20° C

Solubility: 4.4 g/L of water at 20° C; Soluble in water

Soil sorption coefficient: Koc measured at 83 to 209; moderate to high mobility in soil

Odor/Taste Thresholds: N/A

Bioconcentration Factor: BCF <1 in fish; not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 8.24×10^{-4} atm-cu m/mole;

Trade Names/Synonyms: Beta-trichloroethane; Beta-T; Vinyl trichloride

Drinking Water Standards

MCLG: 0.003 mg/L

MCL: 0.005 mg/L

HAL(child): 1 day: 0.6 mg/L
Longer-term: 0.4 mg/L

Health Effects Summary

Acute: EPA has found 1,1,2-trichloroethane (1,1,2-TCE) to potentially cause the following health effects from acute exposures at levels above the MCL: irritation of gastrointestinal tract; red or hemorrhaged lungs; pale liver.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: a one-day exposure of 0.6 mg/L; upto a 7-year exposure to 0.4 mg/L.

Chronic: 1,1,2-TCE has the potential to cause the following health effects from long-term exposures at levels above the MCL: damage to liver and kidneys.

Cancer: There is some evidence that 1,1,2-TCE may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

1,1,2-Trichloroethane is only important as an intermediate in the production of 1,1-dichloroethylene (vinylidene chloride) and to some extent for the synthesis of tetrachloroethanes. It is also used in adhesives, production of teflon tubing, in lacquer and coating formulations, and as a solvent for fats, oils, waxes, etc.

An estimated 124 million lbs. of 1,1,2-TCE was produced in the US during 1974, based on the manufacture of vinylidene chloride.

Release Patterns

1,1,2-Trichloroethane will enter the atmosphere from its use in the manufacture of vinylidene chloride and its use as a solvent. It will also be discharged in wastewater associated with these uses and in leachates and volatile emissions from landfills. The EPA estimates the gross annual discharge of 1,1,2-TCE waste in the US to be 4 million lbs.

From 1987 to 1993, according to EPA's Toxic Chemi-

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	30,326	756
Top Five States*		
LA	14,481	332
TX	9,699	294
NY	4,570	130
MD	750	0
KY	447	0
Major Industries*		
Alkalies, chlorine	21,783	361
Photograph equipment	4,570	130
Meat packing plants	981	0
Petroleum refining	959	0
Blast furnaces, steelworks	750	0

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

cal Release Inventory, 1,1,2-TCE releases to land and water totalled over 30,000 lbs., of which about 98 percent was to water. These releases were primarily from alkalis and chlorine industries which use it as an intermediate in chemical manufacture. The largest releases occurred in Louisiana and Texas.

Environmental Fate

When released into water, 1,1,2-trichloroethane should primarily evaporate. Little of the chemical will be lost by adsorption to sediment or by biodegradation. Aquatic hydrolysis is not expected to be important.

Once in the atmosphere, 1,1,2-trichloroethane will photodegrade slowly by reaction with hydroxyl radicals (half-life 24-50 days in unpolluted atmospheres to a few days in polluted atmospheres).

When released to land 1,1,2-trichloroethane should partially volatilize and partially leach into the groundwater. Experimentally determined Koc values of 83-209 indicated that 1,1,2-trichloroethane will be moderately to highly mobile in soil. Several biodegradation screening studies have determined that 1,1,2-trichloroethane is resistant to biodegradation. Other screening studies have observed biotransformation under anaerobic conditions. Biodegradation in groundwater or subsurface regions may occur, but appears to be very slow.

1,1,2-Trichloroethane would not be expected to bioconcentrate since the experimental log BCF in fish was reported to be <1.

Primary human exposure is from occupational exposure and from ambient air in the vicinity of industrial sources and contaminated drinking water.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

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EPA

National Primary Drinking Water Regulations

Trichloroethylene

Chemical/ Physical Properties

CAS Number: 79-01-6

Color/ Form/Odor: Clear, colorless or blue mobile liquid with sweet chloroform-like odor

M.P.: -73° C B.P.: 87° C

Vapor Pressure: 57.8 mm Hg at 20° C

Density/Spec. Grav.: 1.465 at 20° C

Octanol/Water Partition (Kow): Log Kow = 2.29

Solubilities: 1.1 mg/L of water at 25° C

Soil sorption coefficient: Log Koc = 2 for many soil types; high to very high mobility in soil

Bioconcentration Factor: 17 to 39 in fish; moderate.

Odor/Taste Thresholds: N/A

Henry's Law Coefficient: 0.01 atm-cu m/mole

Trade Names/Synonyms: 1,1,2-Trichloroethylene; Acetylene trichloroethylene; Algylen; Anameth; Benzinol; Chlorilen; CirCosolv; Germalgene; Lethurin; Perm-a-chlor; Petzinol; Philex; TRI-Plus M; Vitran

Drinking Water Standards

MCLG: zero

MCL: 0.005 mg/L

HAL(child): none

Health Effects Summary

Acute: EPA has found trichloroethylene to potentially cause vomiting and abdominal pain from acute exposures at levels above the MCL.

No Health Advisories have been established for short-term exposures.

Chronic: Trichloroethylene has the potential to cause liver damage from a lifetime exposure at levels above the MCL.

Cancer: There is some evidence that trichloroethylene may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production of trichloroethylene has increased from just over 260,000 lbs in 1981 to 320 million lbs. in 1991. Vapor degreasing of fabricated metal parts and some textiles accounts for 80% of its use.

Five percent is used as an intermediate in the production of organic chemicals and pharmaceuticals. Miscellaneous uses (5%) include solvents for dry cleaning, extraction and as a refrigerant/heat exchange liquid. An estimated 10% is exported.

Release Patterns

Major environmental releases of trichloroethylene are due to air emissions from metal degreasing plants. Wastewater from metal finishing, paint and ink formulation, electrical/electronic components, and rubber processing industries also may contain trichloroethylene.

From 1987 to 1993, according to the Toxics Release Inventory, trichloroethylene releases to water totalled over 100,000 lbs. Releases to land totalled over 191,000 lbs. These releases were primarily from steel pipe and tube manufacturing industries. The largest releases oc-

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	100,293	191,088
Top Six States*		
PA	0	33,450
IL	0	30,711
GA	3,742	17,532
TX	0	21,000
MA	0	19,920
WV	12,822	0
Major Industries		
Steel pipe, tubes	31	39,288
Misc. Indust. Organics	27,708	0
Car parts, access.	4,405	19,920
Plating, polishing	3,342	20,100
Wool fabric mills	3,942	18,081

* State totals only include facilities with releases greater than 10,000 lbs.

curred in Pennsylvania and Illinois. The largest direct releases to water occurred in West Virginia.

Environmental Fate

Relatively high vapor pressure and low adsorption coefficient to a number of soil types indicates ready transport through soil and low potential for adsorption to sediments. The mobility in soil is confirmed in soil column studies and river bank infiltration studies. Four to six percent of environmental concentrations of trichloroethylene adsorbed to two silty clay loams (Koc = 87 and 150). No adsorption to Ca-saturated montmorillonite and 17% adsorption to Al-saturated montmorillonite was observed.

The high Henry's Law Constant indicates rapid evaporation from water. Half-lives of evaporation have been reported to be on the order of several minutes to hours, depending upon the turbulence. Field studies also support rapid evaporation from water. Trichloroethylene is not hydrolyzed by water under normal conditions. It does not adsorb light of less than 290 nm and therefore should not directly photodegrade. However, slow (half-life -l0.7 months) photooxidation in water has been noted.

Trichloroethylene is relatively reactive under smog conditions with 60% degradation in 140 min and 50% degradation in 1 to 3.5 hours reported. Atmospheric residence times based upon reaction with hydroxyl radical is 5 days(6-8) with production of phosgene, dichloroacetyl chloride, and formyl chloride.

Marine monitoring data only suggest moderate bioconcentration (2-25 times). Bioconcentration factors of 17 to 39 have been reported in bluegill sunfish and rainbow trout.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2; 551

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

United States Environmental Protection Agency
Office of Water 4601
EPA 811-F-95-004u-T
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EPA

National Primary Drinking Water Regulations

Vinyl Chloride

Chemical/ Physical Properties

CAS Number: 75-01-4

Color/ Form/Odor: Colorless gas, sweet odor

M.P.: -13.37° C **B.P.:** -153.2° C

Vapor Pressure: 2600 mm Hg at 25° C

Density/Spec. Grav.: 0.91 at 20° C

Octanol/Water Partition (Kow): Log Kow = 0.6 (calculated)

Solubility: 2.7 g/L of water; Slightly soluble in water

Soil sorption coefficient: Koc estimated at 56; highly mobile in soil

Odor/Taste Thresholds: N/A

Bioconcentration Factor: Estimated BCF = 7; not expected to bioconcentrate in aquatic organisms.

Henry's Law Coefficient: 0.0560 atm-cu m/mole;

Trade Names/Synonyms: Chlorethene; Chlorethylene; monochloroethene; Monovinyl chloride (MVC); Trovidur

Drinking Water Standards

MCLG:	zero mg/L
MCL:	0.002 mg/L
HAL(child):	1- to 10-day: 3 mg/L
	Longer-term: 0.01 mg/L

Health Effects Summary

Acute: EPA has found vinyl chloride to potentially cause neurological effects from acute exposures at levels above the MCL.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: a one- to ten-day exposure of 3 mg/L; upto a 7-year exposure to 0.01 mg/L.

Chronic: Vinyl chloride has the potential to cause neurological and liver effects from long-term exposure at levels above the MCL.

Cancer: Vinyl chloride has the potential to cause cancer from a lifetime exposure at levels above the MCL.

Usage Patterns

Production of vinyl chloride in 1993 was nearly 14 billion lbs.

Vinyl chloride is used in the manufacture of numerous products in building and construction, automotive industry, electrical wire insulation and cables, piping, industrial and household equipment, medical supplies, and is depended upon heavily by the rubber, paper, and glass industries.

Limited quantities of vinyl chloride were used in the United States as an aerosol propellant, a refrigerant, an extraction solvent and as an ingredient of drug and cosmetic products.

Proportions consumed for various uses in 1989 were: polyvinyl chloride products, 91%; exports, 7%; other, including chlorinated solvents, 2%.

Release Patterns

Although vinyl chloride is produced in large quantities, almost all of it is used captively for the production of polyvinyl chloride (PVC) and other polymers. Therefore, its major release to the environment will be as emissions and wastewater at these production and manufacturing facilities. Vinyl chloride is also a product of anaerobic degradation of chlorination solvents such as would be expected to occur in groundwater and landfills.

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	21,693	17,038
Top Five States		
LA	12,600	0
DE	86	8,829
OH	3,360	0
PA	0	3,290
SC	0	3,100
Major Industries		
Plastics, resins	19,489	13,375

Small quantities of vinyl chloride can be released to food by migration of vinyl chloride monomer present in polyvinyl chloride food wrappings and containers. Major human exposure will be from inhalation of occupational atmospheres and from ingestion of contaminated food and drinking water which has come into contact with polyvinyl chloride packaging material or pipe which has not been treated adequately to remove residual monomer.

From 1987 to 1992, according to EPA's Toxic Release Inventory, vinyl chloride releases to land totalled over 17,000 lbs., and releases to water totalled over 21,000 lbs. These releases were primarily from plastics materials and resins industries. The largest releases occurred in Louisiana and Delaware.

Environmental Fate

If vinyl chloride is released to soil, it will be subject to rapid volatilization with reported half-lives of 0.2 and 0.5 days for evaporation from soil at 1 and 10 cm incorporation, respectively, based on a high vapor pressure of 2,600 mm Hg at 25 degrees C. Based on a reported water solubility of 2,700 mg/L, a Koc of 56 was estimated. According to estimated Koc values, vinyl chloride will be expected to be highly mobile in soil and it may leach to the groundwater. It may be subject to biodegradation under anaerobic conditions such as exists in flooded soil and groundwater.

If released to water, vinyl chloride will rapidly evaporate. Using a reported Henry's Law constant of 0.0560 atm/cu m-mole, a half-life of 0.805 hr was calculated for evaporation from a model river 1 m deep with a current of 3 m/sec and with a wind velocity of 3 m/sec. In waters containing photosensitizers such as humic acid, photodegradation will occur fairly rapidly. Limited existing data indicate that vinyl chloride is resistant to biodegradation in aerobic systems and therefore, it may not be subject to biodegradation in aerobic soils and natural waters. It will not be expected to hydrolyze in soils or natural waters under normal environmental conditions.

If vinyl chloride is released to the atmosphere, it can be expected to exist mainly in the vapor-phase in the ambient atmosphere and to degrade rapidly in air by gas-phase reaction with photochemically produced hydroxyl radicals with an estimated half-life of 1.5 days.

Some data indicate that vinyl chloride is too readily volatilized to undergo bioaccumulation, except perhaps in the most extreme exposure conditions. Based on a reported water solubility of 2,700 mg/l, a BCF of 7 was estimated, indicating that vinyl chloride will not be expected to significantly bioconcentrate in aquatic organisms.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000

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National Primary Drinking Water Regulations

Xylenes (Total)

Chemical/ Physical Properties

CAS Number: 1330-20-7

Color/ Form/Odor: Clear liquid with a sweet odor; The commercial product "mixed xylenes" generally contains approximately 40% m-xylene and 20% each of o-xylene, p-xylene, and ethylbenzene, as well as small quantities of toluene

M.P.: N/A **B.P.:** 137-140° C

Vapor Pressure: N/A

Octanol/Water Partition (Kow): Log Kow = 3.12-3.20

Density/Spec. Grav.: 0.864 at 20° C

Solubility: N/A; Insoluble in water

Henry's Law Coefficient: 0.22 to 0.32 atm-cu m/mole;

Odor/Taste Thresholds: Odor threshold in air is $5x10^{-5}$ mg/L

Soil sorption coefficient: Koc = 48 -68; high to moderate mobility in soil

Bioconcentration Factor: Log BCF=2.14 in fish (calc.); not expected to bioconcentrate in aquatic organisms.

Trade Names/Synonyms: Dimethyl benzene, Xylol, Methyltoluene, Violet 3

Drinking Water Standards

MCLG: 10 mg/L

MCL: 10 mg/L

HAL(child): 1 day: 40 mg/L
Longer-term: 40 mg/L

Health Effects Summary

Acute: EPA has found xylenes to potentially cause the following health effects from acute exposures at levels above the MCL: disturbances in the central nervous system, such as changes in cognitive abilities, balance, and coordination.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day: upto a 7-year exposure to 40 mg/L.

Chronic: Xylenes have the potential to cause the following health effects from long-term exposures at levels above the MCL: damage to the central nervous system, liver and kidneys. Compared with benzene and toluene, very much less is known of the human health hazards, particularly the chronic effects of xylenes, either as mixed xylenes, as individual isomers or in admixture with other alkylbenzenes.

Cancer: There is inadequate evidence to state whether or not xylenes have the potential to cause cancer from lifetime exposures in drinking water.

Usage Patterns

The commercial product mixed xylenes (a technical product generally containing 20% each of o-xylene, p-xylene and ethylbenzene, as well as small quantities of

Toxic Release Inventory - Releases to Water and Land: 1987 to 1993

	Water	Land
TOTALS (in pounds)	875,943	3,897,738
Top Ten States*		
TX	30,853	2,099,734
NJ	294,437	280,759
IL	36	206,990
IN	0	145,079
AL	34,361	59,022
CA	0	91,500
MI	0	86,774
GA	68,310	15,000
VA	50,100	33,000
WA	27,860	52,360
Major Industries*		
Petroleum refining	131,817	2,678,958
Metal barrels, drums	5	289,542
Textile finishing, misc.	278,454	0
Misc. Industrial chems.	95,706	69,696
Extruded Aluminum prod.	1,265	138,798
Furniture, fixtures	0	91,500
Cotton fabric finishing	68,310	15,000
Wood office furniture	0	67,677
Pharmaceuticals	52,285	3,100
Paper mills	52,480	2,122

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

toluene) analogously to toluene is an agent of major chemical and occupational significance.

It is produced in very large quantities and is extensively employed in a broad spectrum of applications, primarily as a solvent for which its use is increasing as a safe replacement for benzene, and in gasoline as part of the BTX component (benzene-toluene-xylene); xylenes are also frequently used in the rubber industry with other solvents such as toluene and benzene.

Most consumption of xylene mixtures is to produce the individual isomers, particularly p-xylene. As individual isomers they are extensively employed in the synthesis of synthetic agents. For example, phthalic acid, isophthalic acid, terephthalic acid, and diemthylterephthalate have very broad applications in the further preparation of phthalate ester plasticizers and components of polyester fiber, film and fabricated items.

Production of xylenes has increased: from about 5 billion lbs. in 1982 to 6.84 billion lbs in 1993. In 1982 it was estimated that industries consumed xylenes as follows: production of ortho-xylene, 15%; production of para-xylene, 60%; miscellaneous, 14%; exports, 11%

Release Patterns

Major environmental releases of xylenes are due to: emissions from petroleum refining, gasoline and diesel engines; emissions from its use as a solvent for alkyl resins, lacquers, enamels, rubber cement, pesticide sprays and in organic synthesis; leaks and evaporation losses during the transport and storage of gasoline and other fuels and from carburetor losses; agricultural spraying. Xylenes are a natural products of many plants, and are a component of petroleum and coal tar.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, xylene releases to land and water totalled nearly 4.8 billion lbs., of which about 81 percent was to land. These releases were primarily from petroleum industries which produce xylenes as by-products of gasoline refining. The largest releases occurred in Texas. The largest direct releases to water occurred in New Jersey and Georgia.

Environmental Fate

Most of the xylenes are released into the atmosphere where they may photochemically degrade by reaction with hydroxyl radicals (half-life 1-18 hr).

The dominant removal process in water is volatilization. Xylenes are resistant to hydrolysis, since there are no hydrolyzable functions. Xylenes are volatile compounds with relatively high Henry's Law constant (0.22 for the ortho isomer and 0.32 for the m- and p- isomers). The half-life for evaporation from water is 3.2 hr for o-xylene and will be 2% higher for the m- and p-xylene.

Measures of the rate of evaporation of xylenes from a 1:1000 jet fuel:water mixture found that this rate averaged approximately 0.6 times the oxygen reaeration rate. Combining this ratio with oxygen reaeration rates for typical bodies of water, one estimates that the half-life for evaporation of xylenes from a typical river or pond is 29 and 144 hr, respectively.

Xylenes are moderately mobile in soil and may leach into groundwater where they are known to persist for several years, despite some evidence that they biodegrade in both soil and groundwater. This evidence includes standard biodegradability tests using various inocula including sewage, activated sludge and sea water, where mixtures are completely degraded in 8 days in groundwater with an acclimation period of 3-4 days.

Xylenes have low to moderate adsorption to soil based on the KOC of o-xylene(48-68) and similar chemicals. Xylenes have been observed to pass through soil at a dune-infiltration site on the Rhine River and to leach into groundwater under a rapid infiltration site.

Bioconcentration is not expected to be significant. Based on the log octanol/water partition coefficient of 3.12-3.20 for the individual isomers and using a regression relation, the log BCF for fish is calculated to be 2.14-2.20. The log BCF for eels is 1.3.

The primary source of exposure is from air, but, xylenes are a low level contaminant of both ground and surface public water supplies.

Other Regulatory Information

Monitoring:

For Ground/Surface Water Sources:

Initial Frequency- 4 quarterly samples every 3 years

Repeat Frequency- Annually after 1 year of no detection

Triggers - Return to Initial Freq. if detect at > 0.0005 mg/L

Analysis:

Reference Source	Method Numbers
EPA 600/4-88-039	502.2; 524.2

Treatment:

Best Available Technologies

Granular Activated Charcoal and Packed Tower Aeration

For Additional Information:

- EPA can provide further regulatory and other general information:
  - EPA Safe Drinking Water Hotline - 800/426-4791
- Other sources of toxicological and environmental fate data include:
  - Toxic Substance Control Act Information Line - 202/554-1404
  - Toxics Release Inventory, National Library of Medicine - 301/496-6531
  - Agency for Toxic Substances and Disease Registry - 404/639-6000