Trichloroethylene

sc-251310

Material Safety Data Sheet

Hazard Alert Code Key:	EXTREME	HIGH	MODERATE	LOW

Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME
Trichloroethylene

STATEMENT OF HAZARDOUS NATURE

CONSIDERED A HAZARDOUS SUBSTANCE ACCORDING TO OSHA 29 CFR 1910.1200.

NFPA

SUPPLIER
Santa Cruz Biotechnology, Inc.
2145 Delaware Avenue
Santa Cruz, California 95060
800.457.3801 or 831.457.3800

EMERGENCY
ChemWatch
Within the US & Canada: 877–715–9305
Outside the US & Canada: +800 2436 2255
(1–800-CHEMCALL) or call +613 9573 3112

SYNONYMS
C2-H-Cl3, H(Cl)C=CCl2, trichlorethylene, "acetylene trichloride", "ethylene trichloride", TRI, TRE, TCE, trichloroethene, "1, 1, 2-trichloroethene", "Trethylene Tri-clene", "1-chloro-2, 2-dichloroethylene", "1, 1-dichloro-2-chloroethylene", "Solvent 52"

Section 2 - HAZARDS IDENTIFICATION

CHEMWATCH HAZARD RATINGS

		Min	Max
Flammability:	0		
Toxicity:	2		
Body Contact:	2		
Reactivity:	2		
Chronic:	3		

Min/Nil=0
Low=1
Moderate=2
High=3
Extreme=4

CANADIAN WHMIS SYMBOLS

EMERGENCY OVERVIEW

RISK

May cause CANCER.
Possible risk of irreversible effects.
Irritating to eyes and skin.
Vapours may cause drowsiness and dizziness.
Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

POTENTIAL HEALTH EFFECTS

ACUTE HEALTH EFFECTS

SWALLOWED

■ Strong evidence exists that the substance may cause irreversible but non-lethal mutagenic effects following a single exposure.
■ Accidental ingestion of the material may be damaging to the health of the individual.
■ At sufficiently high doses the material may be nephrotoxic(i.
e.
■ At sufficiently high doses the material may be hepatotoxic(i.
e.

EYE

■ This material may produce eye irritation in some persons and produce eye damage 24 hours or more after instillation.
Moderate inflammation may be expected with redness; conjunctivitis may occur with prolonged exposure.

SKIN

■ The material may cause moderate inflammation of the skin either following direct contact or after a delay of some time.
Repeated exposure can cause contact dermatitis which is characterized by redness, swelling and blistering.
■ Skin contact with the material may damage the health of the individual; systemic effects may result following absorption.
■ Open cuts, abraded or irritated skin should not be exposed to this material.
■ Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects.
Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.

INHALED

■ Inhalation of vapours may cause drowsiness and dizziness.
This may be accompanied by narcosis, reduced alertness, loss of reflexes, lack of coordination and vertigo.
■ Inhalation of aerosols (mists, fumes), generated by the material during the course of normal handling, may be damaging to the health of the individual.
■ There is some evidence to suggest that the material can cause respiratory irritation in some persons.
The body's response to such irritation can cause further lung damage.
■ Inhalation hazard is increased at higher temperatures.
■ Inhalation of high concentrations of gas/vapor causes lung irritation with coughing and nausea, central nervous depression with headache and dizziness, slowing of reflexes, fatigue and inco-ordination.
■ Anesthetics and narcotic effects (with dulling of senses and odor fatigue) are a consequence of exposure to chlorinated solvents.
Individual response varies widely; odor may not be considered objectionable at levels which quickly induce central nervous system effects.
■ Systemic effects of trichloroethylene (TCE) exposure involve the central nervous system and produce headache, light-headedness, dizziness, ataxia, euphoria, confusion, drowsiness, and coma.
Other adverse findings include nausea, vomiting, hypotension, bradycardia or tachycardia and hepatitis.

CHRONIC HEALTH EFFECTS

■ There is ample evidence that this material can be regarded as being able to cause cancer in humans based on experiments and other information.
Exposure to the material may result in a possible risk of irreversible effects. The material may produce mutagenic effects in man. This concern is raised, generally, on the basis of
appropriate studies using mammalian somatic cells in vivo. Such findings are often supported by positive results from in vitro mutagenicity studies.
There is some evidence that human exposure to the material may result in developmental toxicity. This evidence is based on animal studies where effects have been observed in the absence of marked maternal toxicity, or at around the same dose levels as other toxic effects but which are not secondary non-specific consequences of the other toxic effects.
Halogenated oxiranes may arise following epoxidation of haloalkenes.
The metabolism of haloethylenes by microsomal oxidation leading to epoxide formation across the double bond has been proposed. The resulting oxiranes are highly reactive and may covalently bind to nucleic acids leading to mutations and possible cancers A measure of such potential carcinogenicity is the development of significant preneoplastic foci in livers of treated rats.
The carcinogenicity of halogenated oxiranes may lie in the reactivity of an epoxide intermediate. It is reported that 1,1-dichloroethylene, vinyl chloride, trichloroethylene, tetrachloroethylene and chloroprene, for example, are carcinogens in vivo - this may be a consequence of oxirane formation.
Symmetrically substituted oxiranes such as 1,2-dichloroethylene and 1,1,2-2-tetrachloroethylene are more stable and less mutagenic than unsymmetrical chlorinated oxiranes such as 1,1-dichloroethylene, 1,1,2-trichloroethylene and monochloroethylene (vinyl chloride).
The carcinogenicity of 1,1-dichloroethylene has primarily been associated with inhalation exposure while that of vinyl chloride, trichloroethylene and tetrachloroethylene occurs following exposure by both inhalation and oral routes. National Toxicology Program Toxicity Report Series Number 55; April 2002
Various studies report an association between cancer and industrial exposure to tetrachloroethylene; IARC concluded that this evidence is sufficient to assign appropriate warnings. Similar warnings have been issued by IARC for vinyl fluoride. Similarly vinyl bromide exhibited neoplastic and tumourigenic activity in rats exposed by inhalation and is classified by various bodies as potentially carcinogenic.
Substances such as chloroprene (2-chloro-1,3-butadiene), are reported to produce an increased frequency of chromosomal aberrations in the lymphocytes of Russian workers. Russian epidemiological studies also suggest an increased incidence of skin and lung cancer following exposure to chloroprene, a result which is not supported by other studies.
Generally speaking, the monohalogenated substances exhibit higher carcinogenic potential than their dihalogenated counterparts. Whether

additional substitution lessens such hazard is conjectural. Tetrafluoroethylene, for example, produced clear evidence of carcinogenic activity in a two-year inhalation study in rats and mice. National Toxicology Program Technical Report Series 450, April 1997.

Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

NAME	CAS RN	%
trichloroethylene	79-01-6	> 99
stabilizer		< 1

Section 4 - FIRST AID MEASURES

SWALLOWED
· If swallowed do NOT induce vomiting. · If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.

EYE
■ If this product comes in contact with the eyes: · Wash out immediately with fresh running water. · Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.

SKIN
■ If skin contact occurs: · Immediately remove all contaminated clothing, including footwear · Flush skin and hair with running water (and soap if available).

INHALED
· If fumes or combustion products are inhaled remove from contaminated area. · Lay patient down. Keep warm and rested.

NOTES TO PHYSICIAN
■ Treat symptomatically.
Following acute or short-term continued exposures to trichloroethylene:
· Trichloroethylene concentration in expired air correlates with exposure. 8 hours exposure to 100 ppm produces levels of 25 ppm immediately and 1 ppm 16 hours after exposure.
· Most mild exposures respond to removal from the source and supportive care. Serious toxicity most often results from hypoxemia or cardiac dysrhythmias so that oxygen, intubation, intravenous lines and cardiac monitoring should be started initially as the clinical situation dictates.

Section 5 - FIRE FIGHTING MEASURES

Vapor Pressure (mmHg):	59.03 @ 20C
Upper Explosive Limit (%):	90 cont. ign.
Specific Gravity (water=1):	1.47
Lower Explosive Limit (%):	12.5 cont.ign.

EXTINGUISHING MEDIA
· Water spray or fog.
· Foam.

FIRE FIGHTING
· Alert Emergency Responders and tell them location and nature of hazard.
· Wear breathing apparatus plus protective gloves.
When any large container (including road and rail tankers) is involved in a fire,
consider evacuation by 800 metres in all directions.

GENERAL FIRE HAZARDS/HAZARDOUS COMBUSTIBLE PRODUCTS
· Non flammable liquid.
· However vapor will burn when in contact with high temperature flame.
Decomposes on heating and produces acrid and toxic fumes of: carbon dioxide (CO_2), hydrogen chloride, phosgene, other pyrolysis products typical of burning organic material.
May emit poisonous fumes.

FIRE INCOMPATIBILITY
■ Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids,chlorine bleaches, pool chlorine etc. as ignition may result.

PERSONAL PROTECTION
Glasses:
Safety Glasses.
Chemical goggles.
Gloves:
1.PE/EVAL/PE 2.PVA 3.TEFLON
Respirator:
Type A Filter of sufficient capacity

Section 6 - ACCIDENTAL RELEASE MEASURES

MINOR SPILLS
· Clean up all spills immediately.
· Avoid breathing vapors and contact with skin and eyes.
MAJOR SPILLS
· Clear area of personnel and move upwind.
· Alert Emergency Responders and tell them location and nature of hazard.

Section 7 - HANDLING AND STORAGE

PROCEDURE FOR HANDLING
· DO NOT allow clothing wet with material to stay in contact with skin.
· Avoid all personal contact, including inhalation.
· Wear protective clothing when risk of exposure occurs.

RECOMMENDED STORAGE METHODS
■ DO NOT use aluminum or galvanized containers.
· Lined metal can, Lined metal pail/drum
· Plastic pail.
For low viscosity materials
· Drums and jerricans must be of the non-removable head type.
· Where a can is to be used as an inner package, the can must have a screwed enclosure.
Inhibited grades may be stored in metal drums.

STORAGE REQUIREMENTS
· Store in original containers.
· Keep containers securely sealed.

Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE CONTROLS

Source	Material	TWA ppm	TWA mg/m³	STEL ppm	STEL mg/m³	Peak ppm	Peak mg/m³	TWA F/CC	Notes
US - Minnesota Permissible Exposure Limits (PELs)	trichloroethylene (Trichloroethylene)	50	270	200	1080				
Canada - British Columbia Occupational Exposure Limits	trichloroethylene (Trichloroethylene Revised 2007)	10		25					A2, 2A
US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)	trichloroethylene (TRICHLOROETHYLENE)	0.1							
US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)	trichloroethylene (TRICHLOROETHYLENE)	2							
US ACGIH Threshold Limit Values (TLV)	trichloroethylene (Trichloroethylene)	10		25					TLV Basis: Central nervous system impairment; cognitive decrements; renal toxicity. See BEI NIC for new recommendations
US OSHA Permissible Exposure Levels (PELs) -	trichloroethylene (Trichloroethylene (Z37.19–1967))					200			

Table Z2							
Canada - Alberta Occupational Exposure Limits	trichloroethylene (Trichloroethylene)	50	269	100	537		
US NIOSH Recommended Exposure Limits (RELs)	trichloroethylene (Trichloroethylene)	25				2	See Appendix A; See Appendix C; Ca; (Ceiling (60 minute; as an anesthetic agent)); (TWA (10 hour; during all other expos
US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants	trichloroethylene (Trichloroethylene)	50	270	200	1080		
US - Idaho - Acceptable Maximum Peak Concentrations	trichloroethylene (Trichloroethylene (Z37.19-1967))	100				200	
US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants	trichloroethylene (Trichloroethylene*)	50	270	200	1080	200	
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants	trichloroethylene (Trichloroethylene)		See Table Z-2				
US - Idaho - Limits for Air Contaminants	trichloroethylene (Trichloroethylene)		[2]				
US - California Permissible Exposure Limits for Chemical Contaminants	trichloroethylene (Trichloroethylene; trichloroethene)	25	135	100	537	300	
US - Michigan Exposure Limits for Air Contaminants	trichloroethylene (Trichloroethylene)	50	270	200	1080		
US - Alaska Limits for Air Contaminants	trichloroethylene (Trichloroethylene)	50	270	200	1080		
Canada - Northwest Territories Occupational Exposure Limits (English)	trichloroethylene (Trichloroethylene)	100	537	150	806		
US - Washington Permissible exposure limits of air	trichloroethylene (Trichloroethylene)	50		200			

contaminants								
Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances	trichloroethylene (Trichloroethylene)	100	535	150	800			
US - Hawaii Air Contaminant Limits	trichloroethylene (Trichloroethylene)	50	270	200	1,080			
Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits	trichloroethylene (Trichloroethylene)	50		100				
Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)	trichloroethylene (Trichloroethylene)	50	269	200	1070			
US - Wyoming Toxic and Hazardous Substances Table Z-2 Acceptable ceiling concentration, Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift	trichloroethylene (Trichloroethylene (Z37.19-1967))	100				200		
Canada - Nova Scotia Occupational Exposure Limits	trichloroethylene (Trichloroethylene)	10		25				TLV Basis: Central nervous system impairment; cognitive decrements; renal toxicity. See BEI NIC for new recommendations
US - Oregon Permissible Exposure Limits (Z-2)	trichloroethylene (Trichloroethylene (Z37.19-1967))	100					200	
Canada - Prince Edward Island Occupational Exposure Limits	trichloroethylene (Trichloroethylene)	10		25				TLV Basis: Central nervous system impairment; cognitive decrements; renal toxicity. See BEI NIC for new recommendations
US TSCA New Chemical Exposure Limits (NCEL)	trichloroethylene (Halogenated alkene (P84-105))	0.05						

ENDOELTABLE

PERSONAL PROTECTION




RESPIRATOR

• type a filter of sufficient capacity.

EYE

· Safety glasses with side shields.
· Chemical goggles.

HANDS/FEET

■ Wear chemical protective gloves, eg. PVC.
Suitability and durability of glove type is dependent on usage. Important factors in the selection of gloves include: such as:
· frequency and duration of contact,
· chemical resistance of glove material,
· glove thickness and
· dexterity
Select gloves tested to a relevant standard (e.g. Europe EN 374, US F739).
· When prolonged or frequently repeated contact may occur, a glove with a protection class of 5 or higher (breakthrough time greater than 240 minutes according to EN 374) is recommended.
· When only brief contact is expected, a glove with a protection class of 3 or higher (breakthrough time greater than 60 minutes according to EN 374) is recommended.
· Contaminated gloves should be replaced.
Gloves must only be worn on clean hands. After using gloves, hands should be washed and dried thoroughly. Application of a non-perfumed moisturiser is recommended.
· Polyethylene gloves.

OTHER

· Employees working with confirmed human carcinogens should be provided with, and be required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers and gloves prior to entering the regulated area.
· Employees engaged in handling operations involving carcinogens should be provided with, and required to wear and use half-face filter-type respirators with filters for dusts, mists and fumes, or air purifying canisters or cartridges. A respirator affording higher levels of protection may be substituted.
· Emergency deluge showers and eyewash fountains, supplied with potable water, should be located near, within sight of, and on the same level with locations where direct exposure is likely.
· Prior to each exit from an area containing confirmed human carcinogens, employees should be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers must be identified with suitable labels. For maintenance and decontamination activities, authorized employees entering the area should be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood.
· Prior to removing protective garments the employee should undergo decontamination and be required to shower upon removal of the garments and hood.

ENGINEERING CONTROLS

· Employees exposed to confirmed human carcinogens should be authorized to do so by the employer, and work in a regulated area.
· Work should be undertaken in an isolated system such as a "glove-box" . Employees should wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.
· Within regulated areas, the carcinogen should be stored in sealed containers, or enclosed in a closed system, including piping systems, with any sample ports or openings closed while the carcinogens are contained within.
· Open-vessel systems are prohibited.
· Each operation should be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation.
· Exhaust air should not be discharged to regulated areas, non-regulated areas or the external environment unless decontaminated. Clean make-up air should be introduced in sufficient volume to maintain correct operation of the local exhaust system.
· For maintenance and decontamination activities, authorized employees entering the area should be provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood. Prior to removing protective garments the employee should undergo decontamination and be required to shower upon removal of the garments and hood.
· Except for outdoor systems, regulated areas should be maintained under negative pressure (with respect to non-regulated areas).
· Local exhaust ventilation requires make-up air be supplied in equal volumes to replaced air.
· Laboratory hoods must be designed and maintained so as to draw air inward at an average linear face velocity of 150 feet/ min. with a minimum of 125 feet/ min. Design and construction of the fume hood requires that insertion of any portion of the employees body, other than hands and arms, be disallowed.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL PROPERTIES

Liquid.

Does not mix with water.
Sinks in water.

State	Liquid	Molecular Weight	131.38
Melting Range (°F)	-87 -73	Viscosity	Not Available
Boiling Range (°F)	187- 190	Solubility in water (g/L)	Immiscible
Flash Point (°F)	Not applicable.	pH (1% solution)	Not applicable.
Decomposition Temp (°F)	Not Available	pH (as supplied)	Not applicable
Autoignition Temp (°F)	770	Vapor Pressure (mmHg)	59.03 @ 20C
Upper Explosive Limit (%)	90 cont. ign.	Specific Gravity (water=1)	1.47
Lower Explosive Limit (%)	12.5 cont.ign.	Relative Vapor Density (air=1)	4.54
Volatile Component (%vol)	100	Evaporation Rate	Not available

trichloroethylene	
log Kow (Sangster 1997):	2.42

APPEARANCE

Colourless liquid with a sweetish, chloroform-like odour; does not mix with water (solubility 0.11%), miscible with most organic solvents.

log Kow 2.2-3.3

Material	Value

Section 10 - CHEMICAL STABILITY

CONDITIONS CONTRIBUTING TO INSTABILITY

· Presence of incompatible materials.
· Product is considered stable.

STORAGE INCOMPATIBILITY

■ Haloalkenes are highly reactive. Some of the more lightly substituted lower members are highly flammable; many members of the group are peroxidizable and polymerizable.
· Haloacetylenes should be used with exceptional precautions.
· Explosions may occur during distillation when bath temperatures are too high or if air is admitted to a hot vacuum-distillation as evidenced by experience with bromoacetylenes.
BRETHERICK L.: Handbook of Reactive Chemical Hazards.
· Avoid strong bases.
· Avoid magnesium, aluminium and their alloys, brass and steel.
Avoid reaction with oxidizing agents.
Trichloroethylene:
· reacts violently with caustics (e.g. lye, potassium hydroxide, sodium hydroxide, etc.)
· produces spontaneously explosive dichloroacetylene in presence of caustics, epichlorohydrin, epoxides
· forms an explosive mixture with nitrogen tetroxide
· reacts violently with finely divided chemically active metals
· may undergo self-accelerating polymerisation in presence of magnesium, titanium, aluminium
· may ignite on contact with alkaline metal earths
· reacts explosively with sodium, potassium, lithium
· my decompose with formation of chlorine gas, hydrogen chloride gas and phosgene at high temperatures, in contact with hot metals, open flame and high intensity UV light
· slowly decomposes in light, in the presence of moisture, forming hydrochloric acid
· reacts, possibly violently, with aluminium tripropyl, antimony triethyl, antimony trimethyl, dimethylformamide, liquid oxygen, ozone, potassium nitrate, trimethylaluminium
· attacks metals, coatings, and plastics in presence of moisture
· attacks natural rubber
· may accumulate static charge and cause ignition of vapors
Avoid storage with strong oxidisers (particularly oxygen in gas or liquid form and nitrogen dioxide), strong bases, acetone, sodium/sodium-potassium alloys, zinc.

For incompatible materials - refer to Section 7 - Handling and Storage.

Section 11 - TOXICOLOGICAL INFORMATION

trichloroethylene

TOXICITY AND IRRITATION

TRICHLOROETHYLENE:
■ unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances.

TOXICITY	IRRITATION
Oral (human) LDLo: 7000 mg/kg	Skin(rabbit): 500 mg/24h - SEVERE

Oral (man) TDLo: 2143 mg/kg	Eye(rabbit): 20 mg/24h - SEVERE
Oral (rat) LD50: 5650 mg/kg	
Inhalation (man) LCLo: 2900 ppm	
Inhalation (human) TDLo: 812 mg/kg	
Inhalation (human) TCLo: 6900 mg/m³/10 m	
Inhalation (man) TCLo: 2900 ppm	
Inhalation (man) TCLo: 110 ppm/8h	
Inhalation (man) TCLo: 160 ppm/83 m	

■ The material may produce moderate eye irritation leading to inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

The material may cause severe skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin. Repeated exposures may produce severe ulceration.

for trichloroethylene:

Inhalation effects: Humans have died from breathing high concentrations of trichloroethylene fumes. Most of the reported deaths have been associated with accidental breathing of unusually high levels of trichloroethylene vapors in the workplace, often during its use in degreasing operations. These studies usually attributed death to ventricular fibrillation or central nervous system depression, since gross post-mortem abnormalities were not apparent. A number of the deaths occurred after the trichloroethylene exposure ended and involved physical exertion that may have contributed to the sudden deaths. Death associated with liver damage has also been reported in persons occupationally exposed to trichloroethylene for intermediate and chronic durations, followed by a high acute-duration exposure. Animal experimentation has revealed inhaled concentrations that result in death following acute, intermediate, and chronic exposure. Death was often caused by the central nervous system depression that occurs with very high exposure levels.

Cardiovascular effects: High doses of hydrocarbons such as trichloroethylene could act upon the heart to cause cardiac sensitization to catecholamines. This is supported by animal studies. For example, dogs and rabbits exposed to very high concentrations of trichloroethylene (5,000 or 10,000 ppm, and 3,000 ppm, respectively) for .1 hour showed increased arrhythmias when injected intravenously with epinephrine (adrenaline) . In animals, trichloroethylene itself, rather than its metabolites, is apparently responsible for the cardiac sensitization because chemicals that inhibit the metabolism of trichloroethylene increase its potency, while chemicals that enhance the metabolism of trichloroethylene decrease its potency.Gastrointestinal Effects:Case reports indicate that acute inhalation exposure to trichloroethylene results in nausea and vomiting Anorexia, nausea, and vomiting have also been reported as chronic effects of occupational exposure to trichloroethylene. The exposure levels were not measured. Anorexia and vomiting were reported in a woman chronically exposed to occupational levels between 40 and 800 ppm . Trichloroethylene-induced effects on the autonomic nervous system may contribute to these effects Cases of pneumatosis cystoides intestinalis (a rare condition characterised by gas-filled cysts in the submucosa of the small intestine) seen in Japanese lens cleaners and polishers were attributed to trichloroethylene exposure in the workplace.

Hepatic Effects. There is some evidence for trichloroethylene-induced hepatotoxic effects in humans. However, much of this information is limited by the fact that the exposure levels associated with these effects were usually not reported, and the individuals may have been exposed to other substances as well.

Renal Effects. Trichloroethylene may have effects in the kidney; however, studies in humans are limited by having poor or no exposure data and by concomitant exposure to other chemicals. There was no evidence of kidney damage in 250 neurosurgery patients who underwent prolonged trichloroethylene anaesthesia nor in 405 women who had caesarean sections and were exposed to trichloroethylene anaesthesia There are few reports of renal dysfunction in workers exposed to trichloroethylene. Exposure of rats to extremely high levels (1,000 ppm or higher) for periods of less than 1 day led to the dysfunction of the tubular and glomerular regions of the nephron, as indicated by increases in urinary glucose, proteins, glucosaminidase, gamma glutamyl transpeptidase, and serum urea nitrogen.

Dermal Effects. Stevens-Johnson syndrome, a severe erythema, was seen in five people occupationally exposed to trichloroethylene for 2-5 weeks at levels ranging from 19 to 164 ppm . The study authors suggested that the erythema was caused by a hypersensitivity reaction to trichloroethylene. An exfoliative dermatitis and scleroderma, also thought to have an immune component, have been reported in persons occupationally exposed to trichloroethylene.

Neurological Effects: Trichloroethylene has been used as a surgical anesthetic (Hewer 1943). Some patients were reported to have experienced trigeminal neuropathy following anesthesia using trichloroethylene in association with soda-lime. The reaction of trichloroethylene with the soda-lime was thought to have produced dichloroacetylene which triggered neuropathies in 13 patients over a 4-month period in a county hospital. No new cases were discovered for 3 months after the discontinuation of the use of soda-lime.

Acute exposure to trichloroethylene and its decomposition products (e.g., dichloroacetylene) has also led to residual neuropathy, characterized by nerve damage. This neuropathy is characterized by facial numbness, jaw weakness, and facial discomfort (indicating damage to cranial nerves V and VII) which can persist for several months . Chronic exposure in the workplace has also been associated with damage to the cranial nerves in several cases Persons who have died from overexposure have shown degeneration of cranial nuclei in the brain stem). Some of these effects may be attributed to dichloroacetylene, a decomposition product of trichloroethylene, which may form under nonbiological conditions of heat or alkalinity.

Intermediate and chronic exposures of workers to trichloroethylene have produced neurological effects similar to those found in acute exposure situations. Workers chronically exposed to levels between 38 and 172 ppm reported symptoms of sleepiness, dizziness, headache, and nausea, but no apparent trigeminal nerve disorders. Other reported neurological effects of chronic occupational exposure to unquantified trichloroethylene levels include memory loss mood swings , trigeminal neuropathy.

Reproductive Effects: Increases in miscarriages have been reported among nurses exposed to unspecified concentrations of trichloroethylene and other chemicals in operating rooms. The occurrence of miscarriages could not conclusively be attributed to trichloroethylene because there was concomitant exposure to other chemicals. A retrospective case-control study conducted in humans compared spontaneous abortion rates among women who had been exposed occupationally or non-occupationally to trichloroethylene and other solvents to rates among women without solvent exposure The authors observed approximately three times the risk of spontaneous abortion with exposure to trichloroethylene. This risk increased further when women with less than a half hour of exposure to trichloroethylene each week were excluded from the analysis. However, a consistent dose-response relationship was not observed, and most of the women were exposed to a variety of solvents, not just trichloroethylene.

Developmental Effects: No increase in malformed babies was observed among approximately 2,000 fathers and mothers exposed to unspecified concentrations of trichloroethylene in the workplace. A retrospective case-control study conducted in humans compared spontaneous abortion rates among women who had been exposed occupationally or nonoccupationally to trichloroethylene and other

solvents to rates among women without solvent exposure. The authors observed about a 3-fold increase in risk of spontaneous abortion associated with exposure to trichloroethylene (TCE). This risk increased further when women with less than l/2 hour of exposure to TCE per week were excluded from the analysis. However, a consistent dose-response relationship was not observed and most of the women were exposed to a variety of solvents other than TCE. In this same study, the relationship between exposure to halogenated solvents during the first 20 weeks of pregnancy and fetal growth were examined. No association between exposure to solvents and decreased fetal growth was observed. However, the number of small infants was too low to specifically analyze TCE exposures and most fetal growth would occur after the first 20 weeks of pregnancy.
Pregnant laboratory animals have been exposed to trichloroethylene vapors, but no conclusive studies have been encountered that clearly indicate teratogenic effects. Available data from animals suggest that the conceptus is not uniquely susceptible to trichloroethylene.
Genotoxic Effects: Investigations into the genotoxicity of trichloroethylene in humans have not been conclusive but are suggestive of clastogenic effects. A study of chromosomal aberrations among trichloroethylene-exposed workers detected an increase in hypodiploid cells but found no evidence of chromosomal breaks in lymphocytes. men using trichloroethylene as a degreasing agent were tested for lymphocyte chromosomal abnormalities- specifically, breaks, gaps, deletions, inversions, translocations, and hyperdiploidy. The same study also investigated the rate of nondisjunction for the Y chromosome in sperm. Positive results were observed for chromosomal aberrations and hyperdiploid cells, but the results were negative for chromosomal nondisjunction. Some authors suggest that smoking and trichloroethylene exposure may act together to produce increased sister chromatid exchange frequencies.
Carcinogenicity: Three European studies have found slight but statistically significant increases in cancer in workers exposed to trichloroethylene. A survey of Finnish workers exposed to primarily trichloroethylene found an association of limited statistical significance between exposure and incidence of stomach, liver, prostate, and lymphohematopoietic cancers.
A significant association between workplace exposure to trichloroethylene and kidney cancer was found in a retrospective cohort study of German cardboard factory workers. In a study of Swedish workers, a statistically significant increase in non-Hodgkin's lymphoma was observed. These workers were exposed to solvents in addition to trichloroethylene, and exposures were self-reported. A study of dry cleaners found a significant increase in the incidence of all malignant neoplasms combined as well as increased incidences of cancer at several sites (lung/bronchus/trachea, cervix, and skin).
Some laboratory studies with rats and mice have linked trichloroethylene exposure to various types of cancers. Several of these studies, however, should be viewed cautiously, since the tumorigenic activity might be influenced by the presence of direct-acting compounds, namely the epoxides (e.g., epichlorohydrin) added as stabilizers in trichloroethylene. Epoxides are known to be very reactive, and some, such as epichlorohydrin, are potent carcinogens themselves.

CARCINOGEN

	US - Rhode Island Hazardous Substance List	IARC	
TRICHLOROETHYLENE	US Environmental Defense Scorecard Recognized Carcinogens	Reference(s)	P65
TRICHLOROETHYLENE	US Environmental Defense Scorecard Suspected Carcinogens	Reference(s)	P65
Trichloroethylene (inhalation)	US Air Toxics Hot Spots TSD for Describing Available Cancer Potency Factors	IARC Class	2A
Trichloroethylene (oral)	US Air Toxics Hot Spots TSD for Describing Available Cancer Potency Factors	IARC Class	
VPVB_(VERY~	US - Maine Chemicals of High Concern List	Carcinogen	CA Prop 65; IARC; NTP 11th ROC

REPROTOXIN

trichloroethylene	ILO Chemicals in the electronics industry that have toxic effects on reproduction	Reduced fertility or sterility	H si

Section 12 - ECOLOGICAL INFORMATION

Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
This material and its container must be disposed of as hazardous waste.

Ecotoxicity

Ingredient	Persistence: Water/Soil	Persistence: Air	Bioaccumulation	Mobility
trichloroethylene	HIGH	HIGH	MED	HIGH

Section 13 - DISPOSAL CONSIDERATIONS

US EPA Waste Number & Descriptions

A. General Product Information
Toxicity characteristic: use EPA hazardous waste number D040 (waste code E) if this substance, in a solid waste, produces an extract containing greater than 0.5 mg/L of Trichloroethylene.

B. Component Waste Numbers
When trichloroethylene is present as a solid waste as a discarded commercial chemical product, off-specification species, as a container residue, or a spill residue, use EPA waste number U228 (waste code T).

Disposal Instructions

All waste must be handled in accordance with local, state and federal regulations.
¦ Puncture containers to prevent re-use and bury at an authorized landfill.
Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.
A Hierarchy of Controls seems to be common - the user should investigate:
· Reduction
· Reuse
· Recycling
· Disposal (if all else fails)
This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use. If it has been contaminated, it may be possible to reclaim the product by filtration, distillation or some other means. Shelf life considerations should also be applied in making decisions of this type. Note that properties of a material may change in use, and recycling or reuse may not always be appropriate.
DO NOT allow wash water from cleaning equipment to enter drains. Collect all wash water for treatment before disposal.
· Recycle wherever possible or consult manufacturer for recycling options.
· Consult Waste Management Authority for disposal.

Section 14 - TRANSPORTATION INFORMATION

DOT:
Symbols: None Hazard class or Division: 6.1
Identification Numbers: UN1710 PG: III
Label Codes: 6.1 Special provisions: IB3, N36,
T4, TP1
Packaging: Exceptions: 153 Packaging: Non- bulk: 203
Packaging: Exceptions: 153 Quantity limitations: 60 L
Passenger aircraft/rail:
Quantity Limitations: Cargo 220 L Vessel stowage: Location: A
aircraft only:
Vessel stowage: Other: 40
Hazardous materials descriptions and proper shipping names:
Trichloroethylene

Air Transport IATA:

ICAO/IATA Class: 6.1 ICAO/IATA Subrisk: None
UN/ID Number: 1710 Packing Group: III
Special provisions: None
Cargo Only
Packing Instructions: 220 L Maximum Qty/Pack: 60 L
Passenger and Cargo Passenger and Cargo
Packing Instructions: 663 Maximum Qty/Pack: 655
Passenger and Cargo Limited Quantity Passenger and Cargo Limited Quantity
Packing Instructions: 2 L Maximum Qty/Pack: Y642
Shipping Name: TRICHLOROETHYLENE

Maritime Transport IMDG:

IMDG Class: 6.1 IMDG Subrisk: None
UN Number: 1710 Packing Group: III
EMS Number: F-A , S-A Special provisions: None
Limited Quantities: 5 L
Shipping Name: TRICHLOROETHYLENE 1710

Section 15 - REGULATORY INFORMATION

trichloroethylene (CAS: 79-01-6) is found on the following regulatory lists;

"Canada - Alberta Occupational Exposure Limits","Canada - British Columbia Occupational Exposure Limits","Canada - Northwest Territories Occupational Exposure Limits (English)","Canada - Nova Scotia Occupational Exposure Limits","Canada - Prince Edward Island Occupational Exposure Limits","Canada - Prince Edward Island Occupational Exposure Limits - Carcinogens","Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)","Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits","Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances","Canada ARET (Accelerated Reduction / Elimination of Toxics) Substance List","Canada Domestic Substances List (DSL)","Canada Environmental Protection Act (CEPA) 1999 - Schedule 1 Toxic Substances List","Canada Environmental Quality Guidelines (EQGs) Water: Aquatic life","Canada Environmental Quality Guidelines (EQGs) Water: Community","Canada Ingredient Disclosure List (SOR/88-64)","Canada National Pollutant Release Inventory (NPRI)","Canada Priority Substances List (PSL1, PSL 2)","Canada Prohibited Toxic Substances, Schedule 2, Concentration Limits (English)","Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (English)","IMO IBC Code Chapter 17: Summary of minimum requirements","IMO MARPOL 73/78 (Annex II) - List of Noxious Liquid Substances Carried in Bulk","International Agency for Research on Cancer (IARC) - Agents Reviewed by the IARC Monographs","International Chemical Secretariat (ChemSec) REACH SIN* List (*Substitute It Now!) 1.0","OECD Representative List of High Production Volume (HPV)

Chemicals","US - Alaska Limits for Air Contaminants","US - California Air Toxics ""Hot Spots"" List (Assembly Bill 2588) Substances for which emissions must be quantified","US - California Code of Regulation; Identification and Listing of Hazardous Waste, Table 1 - Maximum Concentrations for the Toxicity Characteristics","US - California Occupational Safety and Health Regulations (CAL/OSHA) - Hazardous Substances List","US - California OEHHA/ARB - Chronic Reference Exposure Levels and Target Organs (CRELs)","US - California Permissible Exposure Limits for Chemical Contaminants","US - California Proposition 65 - Carcinogens","US - California Proposition 65 - No Significant Risk Levels (NSRLs) for Carcinogens","US - California Toxic Air Contaminant List Category II","US - Connecticut Hazardous Air Pollutants","US - Hawaii Air Contaminant Limits","US - Idaho - Acceptable Maximum Peak Concentrations","US - Idaho - Limits for Air Contaminants","US - Maine Chemicals of High Concern List","US - Massachusetts Oil & Hazardous Material List","US - Michigan Exposure Limits for Air Contaminants","US - Minnesota Hazardous Substance List","US - Minnesota Permissible Exposure Limits (PELs)","US - New Jersey Right to Know Hazardous Substances","US - Oregon Permissible Exposure Limits (Z-1)","US - Oregon Permissible Exposure Limits (Z-2)","US - Pennsylvania - Hazardous Substance List","US - Rhode Island Hazardous Substance List","US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants","US - Vermont Hazardous Constituents","US - Vermont Hazardous Waste - Maximum Contaminant Concentration for Toxicity","US - Vermont Hazardous wastes which are Discarded Commercial Chemical Products or Off-Specification Batches of Commercial Chemical Products or Spill Residues of Either","US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants","US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants","US - Washington Class A toxic air pollutants: Known and Probable Carcinogens","US - Washington Dangerous waste constituents list","US - Washington Discarded Chemical Products List - ""U"" Chemical Products","US - Washington Permissible exposure limits of air contaminants","US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants","US - Wyoming Toxic and Hazardous Substances Table Z-2 Acceptable ceiling concentration, Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift","US ACGIH Threshold Limit Values (TLV)","US ACGIH Threshold Limit Values (TLV) - Carcinogens","US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)","US CAA (Clean Air Act) - HON Rule - Organic HAPs (Hazardous Air Pollutants)","US CERCLA Priority List of Hazardous Substances","US CERCLA Top 20 Priority List of Hazardous Substances","US Clean Air Act - Hazardous Air Pollutants","US CWA (Clean Water Act) - Priority Pollutants","US CWA (Clean Water Act) - Reportable Quantities of Designated Hazardous Substances","US CWA (Clean Water Act) - Toxic Pollutants","US Department of Transportation (DOT) List of Hazardous Substances and Reportable Quantities - Hazardous Substances Other Than Radionuclides","US DOE Temporary Emergency Exposure Limits (TEELs)","US EPA Acute Exposure Guideline Levels (AEGLs) - Interim","US EPA High Production Volume Program Chemical List","US EPA Master Testing List - Index I Chemicals Listed","US EPA National Priorities List - Superfund Chemical Data Matrix (SCDM) - Hazard Ranking System - Hazardous Substance Benchmarks","US EPA Voluntary Children's Chemical Evaluation Program (VCCEP)","US EPCRA Section 313 Chemical List","US FDA Indirect Food Additives: Adhesives and Components of Coatings - Substances for Use Only as Components of Adhesives - Adhesives","US Food Additive Database","US List of Lists - Consolidated List of Chemicals Subject to EPCRA, CERCLA and Section 112(r) of the Clean Air Act","US National Toxicology Program (NTP) 11th Report Part B. Reasonably Anticipated to be a Human Carcinogen","US NFPA 30B Manufacture and Storage of Aerosol Products - Chemical Heat of Combustion","US NIOSH Recommended Exposure Limits (RELs)","US OSHA Permissible Exposure Levels (PELs) - Table Z1","US OSHA Permissible Exposure Levels (PELs) - Table Z2","US RCRA (Resource Conservation & Recovery Act) - Appendix IX to Part 264 Ground-Water Monitoring List 1","US RCRA (Resource Conservation & Recovery Act) - Hazardous Constituents - Appendix VIII to 40 CFR 261","US RCRA (Resource Conservation & Recovery Act) - List of Hazardous Inorganic and Organic Constituents 1","US RCRA (Resource Conservation & Recovery Act) - List of Hazardous Wastes","US RCRA (Resource Conservation & Recovery Act) - Phase 4 LDR Rule - Universal Treatment Standards","US Spacecraft Maximum Allowable Concentrations (SMACs) for Airborne Contaminants","US -Texas Air Monitoring Comparison Values for Evaluating Carbonyls","US Toxic Substances Control Act (TSCA) - Inventory","WHO Guidelines for Drinking-water Quality - Guideline values for chemicals that are of health significance in drinking-water"

Section 16 - OTHER INFORMATION

Reasonable care has been taken in the preparation of this information, but the author makes no warranty of merchantability or any other warranty, expressed or implied, with respect to this information. The author makes no representations and assumes no liability for any direct, incidental or consequential damages resulting from its use. For additional technical information please call our toxicology department on +800 CHEMCALL.

■ Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
A list of reference resources used to assist the committee may be found at:
www.chemwatch.net/references.

■ The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

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