

Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name: Trichlorosilane	Trade Name: Trichlorosilane
Product Use: Many.	
Chemical Name: Trichlorosilane	Synonym: Silicochloroform, trichloromonosilane, Praxair Chlorosilane A-19
Chemical Formula: HSiCl ₃	Chemical Family: Silicon Halide
Telephone: Emergencies: * 1-800-363-0042	Supplier /Manufacture: Praxair Canada Inc. 1 City Centre Drive Suite 1200 Mississauga, ON L5B 1M2
	Phone: 905-803-1600
	Fax: 905-803-1682

**Call emergency numbers 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier or Praxair sales representative.*

2. Composition and Information on Ingredients

INGREDIENTS	% (VOL)	CAS NUMBER	LD ₅₀ (Species & Routes)	LC ₅₀ (Rat, 4 hrs.)	TLV-TWA (ACGIH)
Trichlorosilane	100	10025-78-2	Not available.	520 ppm	None currently established.

3. Hazards Identification

Emergency Overview

DANGER! Flammable, corrosive liquid and gas under pressure. Harmful or fatal if inhaled. Can cause eye, skin, and respiratory tract burns. Can form explosive mixtures with air. Water can cause violent reaction. Contact with water or moist air liberates irritating gas. Self-contained breathing apparatus and protective clothing must be worn by rescue workers.

ROUTES OF EXPOSURE: Inhalation. Ingestion. Skin contact. Skin absorption. Eye contact.

EFFECTS OF A SINGLE (ACUTE) OVEREXPOSURE:

INHALATION: Low vapor concentrations will irritate the nose, throat, and chest, causing discomfort and pain with coughing, excess sputum, runny nose, and difficulty breathing. Higher concentrations may result in inhalation of harmful and, because of injury to the nasal passages, larynx, and lungs, potentially lethal, amounts of material.

SKIN CONTACT: Brief contact will cause itching or discomfort, with the development of local redness and possibly swelling. Sustained contact will cause pain, local redness, swelling, ulceration, and possibly bleeding into the inflamed site.

SKIN ABSORPTION:	Prolonged or widespread skin contact with the liquid may result in the absorption of harmful amounts of material.
SWALLOWING:	Highly to severely toxic. May cause severe burns of the mouth, throat, esophagus, and stomach. There may be pain in the mouth, throat, chest, and abdomen and possible swelling of the tissues in the mouth and throat. Effects may include nausea, diarrhea, vomiting, dizziness, drowsiness, faintness, weakness, thirst, circulatory collapse, and coma.
EYE CONTACT:	Vapour causes discomfort or pain in the eye, with excess tear production and blinking, and excess redness and possibly swelling of the conjunctiva (the connective tissues surrounding the eye). If high concentrations of hydrogen chloride are formed, then injury to the cornea may develop. Liquid splashed into the eye will cause pain with excess blinking and tear production. There will be marked excess redness and swelling of the conjunctiva and corneal injury, which if not treated promptly an adequately could lead to permanent impairment of vision.

EFFECTS OF REPEATED (CHRONIC) OVEREXPOSURE:

Prolonged or repeated exposure may cause discoloration or erosion of teeth, bleeding of nose and gums, and ulceration of the nasal mucosa.

OTHER EFFECTS OF OVEREXPOSURE:

None known.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE:

Inhalation may aggravate asthma and inflammatory or fibrotic pulmonary disease. Because of its irritating properties, this material may aggravate an existing dermatitis.

SIGNIFICANT LABORATORY DATA WITH POSSIBLE RELEVANCE TO HUMAN HEALTH HAZARD EVALUATION:

None known.

CARCINOGENICITY:

Not listed as carcinogen by OSHA, NTP or IARC.

4. First Aid Measures

INHALATION:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

SKIN CONTACT:

In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

SWALLOWING:

If patient is fully conscious, give two glasses of water. Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

EYE CONTACT:

For contact with the liquid, immediately flush eyes thoroughly with warm water for at least 15 minutes. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. See a physician, preferably an ophthalmologist, immediately.

NOTES TO PHYSICIAN:

- ✍ Most of the effects from overexposure to trichlorosilane are due to liberation of hydrogen chloride.
- ✍ Trichlorosilane is highly irritant to skin and mucosal surfaces.
- ✍ Swallowed trichlorosilane may produce ulceration and possibly perforation in the upper alimentary tract. Mediastinitis or peritonitis and the complications thereof may develop.
- ✍ With massive overexposure to the vapour, delayed onset pulmonary edema may develop. Secondary infection may develop in the inflamed respiratory tract. Individuals having significant overexposure to the vapor should be kept under observation.
- ✍ Aspirated material may produce lung injury. Emesis should not be induced mechanically or pharmacologically. If it is considered that gastric lavage is necessary, then it should be carried out in a manner least likely to result in aspiration, e.g., in the presence of airway intubation. Caution should be taken to avoid perforation of an acutely inflamed or

ulcerated area of the alimentary tract.

Contact the Poison control Center in your area for additional information on patient management and follow-up.

5. Fire Fighting Measures

FLAMMABLE :	Yes.	IF YES, UNDER WHAT CONDITIONS?	Forms explosive mixtures with air and oxidizing agents.
FLASH POINT (test method)	CLOSED CUP: -27.778°C (-18°F). (Tag.) OPEN CUP: -14°C (6.8°F) (Tag.).	AUTOIGNITION TEMPERATURE	182°C (359.6°F)
FLAMMABLE LIMITS IN AIR, % by volume:	LOWER: 7	UPPER:	80

EXTINGUISHING MEDIA:

For small fires, use copious quantities of water spray to react with the chlorosilane, which reacts violently with water to form hydrogen chloride fumes. Despite the reaction with water, trichlorosilane fires can be extinguished with a 6% solution in water of medium-expansion Hazamat II foam.

SPECIAL FIRE FIGHTING PROCEDURES:

DANGER! Flammable, corrosive liquid, insoluble in water. Evacuate all personnel from danger area. Do not approach area without self-contained breathing apparatus and protective clothing. Immediately cool containers with water spray from maximum distance taking care not to extinguish flames. Remove ignition sources if without risk. If flames are accidentally extinguished, explosive re-ignition may occur; therefore. Appropriate measures should be taken; e.g., total evacuation. Re-approach with extreme caution. Reduce corrosive vapours with water spray or fog. Stop flow of gas if without risk while continuing water spray. Remove all containers from area if without risk. Allow fire to burn out. Use remote spray monitors or fight fire from behind shields. Reduce corrosive vapours with coarse water spray. Hydrolysis will overcome combustion. Stop flow of gas if without risk, while continuing cooling water spray. Remove all containers from area of fire if without risk.

UNUSUAL FIRE AND EXPLOSION HAZARD:

Forms explosive mixtures with air and oxidizing agents. Heat of fire can build pressure in cylinder and cause it to rupture. No part of a cylinder should be subjected to a temperature higher than 52°C. Cylinders are not equipped with a pressure-relief device. If venting or leaking gas catches fire, do not extinguish flames. Flammable gas may spread from leak, creating an explosive re-ignition hazard. Vapors can be ignited by pilot lights, other flames, smoking, sparks, heaters, electrical equipment, static discharge, or other ignition sources at locations distant from product handling point. Explosive atmospheres may linger. Before entering area, especially confined areas, check atmosphere with an appropriate device.

This product has a low autoignition temperature. Exposure to heat from a fire or from the water-trichlorosilane reaction can cause the trichlorosilane to autoignite. The acidic decomposition products formed by burning trichlorosilane from leaks may rapidly attack the metal at the leak area, especially if the metal is hot. Use proper bonding and grounding during liquid transfer.

Vapour is extremely easy to ignite. Minimum ignition energy – 0.017 millijoules (similar to hydrogen). Quenching distance – 0.127 mm (less than hydrogen). (ASTM E582-76) Vapour has a relatively low autoignition temperature of 182 ± 2 °C (ASTM E659-78)> May ignite on hot surfaces at about this temperature or greater. Vapour burns rapidly in air. Explosibility indices are Pmax = 136 psia and KG = 544 bar-m/s in a 20 litre vessel.

HAZARDOUS COMBUSTION PRODUCTS:

These products are halogenated compounds. Some metallic oxides. See Section 10.

SENSITIVITY TO IMPACT:

Avoid impact against container.

SENSITIVITY TO STATIC DISCHARGE:

Susceptible to static discharge.

6. Accidental Release Measures**STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:**

DANGER! **Flammable, corrosive liquid, insoluble in water.** Forms explosive mixtures with air. Immediately evacuate all personnel from danger area. Use self-contained breathing apparatus operated in the pressure demand mode and appropriate protective clothing. Remove all sources of ignition if without risk. Reduce vapours with fog or fine water spray. Shut off leak if without risk. Ventilate area of leak or move leaking container to well ventilated area. Flammable vapours may spread from spill. Before entering area, especially confined areas, check atmosphere with appropriate device. Reverse flow into cylinder may cause rupture. Prevent runoff from contaminating surrounding environment. Corrosive, toxic vapours may spread from spill.

WASTE DISPOSAL METHOD:

Do not discharge chlorosilanes directly to surface waters or sewers systems. Instead, try to dike or contain any spilled liquid. To diminish fumes either 1) gently cap the liquid surface with No. 6 fuel oil or 2) apply an appropriate solution of vapor-suppression foam expanded per manufacturer's instructions. Periodic reapplication of the foam may be necessary.

Trichlorosilane can be disposed of by first reacting it with water (hydrolysis), then neutralizing the acid (HCl) formed by the reaction. These processes will produce corrosive hydrochloric acid and may produce flammable hydrogen gas and other toxic, corrosive gases. Wear suitable protective equipment and observe all other precautions set forth in this MSDS. First, add the chlorosilane to water, always using more than 5 parts water to one part chlorosilane. The exothermic reaction produces hydrochloric acid and either an insoluble liquid or a solid. Next neutralize the acid by reacting it with an alkali base to adjust the pH of the solution to approximately 7. (Neutralization is an exothermic reaction and should be carried out only after technical consultation.) Dispose of the neutralized solution in accordance with federal, provincial, and local regulations. Skim off and collect the insoluble liquid and dispose of it in suitable incineration facilities. Incineration will form fumed silica (SiOs), which, upon burning, produces a white smoke. If this is objectionable, use an incineration facility capable of handling silicon dioxide particulates. The solids, once neutralized, are non-hazardous and can be disposed of in a landfill.

7. Handling and Storage**PRECAUTIONS TO BE TAKEN IN STORAGE:**

Store and use with adequate ventilation. Separate flammable cylinders from oxygen, chlorine, and other oxidizers by at least 6.1 m or use a barricade of non-combustible material. This barricade should be at least 1.53 m high and have a fire resistance rating of at least ½ hour. Firmly secure cylinders upright to keep them from falling or being knocked over. Screw valve protection cap firmly in place by hand. Post "No Smoking or Open Flames" signs in storage and use areas. There must be no sources of ignition. All electrical equipment in storage areas must be explosion-proof. Storage areas must meet national electric codes for Class 1 hazardous areas. Store only where temperature will not exceed 52°C. Store full and empty cylinders separately. Use a first-in, first-out inventory system to prevent storing full cylinders for long periods.

PRECAUTIONS TO BE TAKEN IN HANDLING:

Protect cylinders from damage. Use a suitable hand truck to move cylinders; do not drag, roll, slide, or drop. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. Never insert an object (e.g., wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Open valve slowly. If valve is hard to open, discontinue use and contact your supplier. For other precautions, see Section 16.

For additional information on storage and handling, refer to Compressed Gas Association (CGA) pamphlet P-1, *Safe Handling of Compressed Gases in Containers*, available from the CGA. Refer to Section 16 for the address and phone number along with a list of other available publications.

OTHER HAZARDOUS CONDITIONS OF HANDLING, STORAGE, AND USE:

Toxic, flammable, corrosive liquid and gas under pressure. May be fatal if inhaled. Do not breathe gas. Do not get liquid or vapours in eyes, on skin, or clothing. Safety showers and eyewash fountains should be immediately available. Use only in a closed system constructed of corrosion resistant materials. Use piping and equipment adequately designed to withstand pressures to be encountered. Use only spark-proof tools and explosion-proof equipment. Keep away from heat, sparks, and open flame. **May form explosive mixtures with air.** Ground all equipment. Store and use with adequate ventilation at all times. Close valve after each use; keep closed even when empty. **Prevent reverse flow.** Reverse flow into cylinder may cause rupture. Use a check valve or other protective device in any line or piping from the cylinder. **When returning cylinder to supplier,** be sure valve is closed, then install valve outlet plug tightly. **Never work on a pressurized system.** If there is a leak, close the cylinder valve. Vent the system down in a safe and environmentally sound manner in compliance with all federal, provincial, and local laws; then repair the leak. **Never place a compressed gas cylinder where it may become part of an electrical circuit.**

8. Exposure Controls/Personal Protection

VENTILATION/ENGINEERING CONTROLS:

LOCAL EXHAUST: Explosion-proof, corrosion resistant, forced draft fume hood is preferred.

MECHANICAL (general): Inadequate. See SPECIAL.

SPECIAL: A canopy type of forced-air fume hood equipped with an explosion-proof device may be more desirable for certain applications.

OTHER: None.

PERSONAL PROTECTION:

RESPIRATORY PROTECTION: For concentrations up to 10 times the applicable exposure limit any NIOSH/MSHA approved supplied air respirator is recommended. Up to 50 times the TLV, a NIOSH/MSHA approved respirator with a full-face piece or self-contained breathing apparatus is recommended. For higher concentrations use only self-contained breathing apparatus operated in the pressure demand mode. Selection should be based on the current CSA standard Z94.4, "Selection, care and Use of Respirators".

SKIN PROTECTION: Wear work gloves when handling cylinders. Wear neoprene gloves when changing out cylinders.

EYE PROTECTION: Wear safety glasses when handling cylinders; vapour-proof goggles and a full face shield during cylinder changeout or wherever contact with product is possible.

Select in accordance with the current CSA standard Z94.3, "Industrial Eye and Face Protection", and any provincial regulations, local bylaws or guidelines.

OTHER PROTECTIVE EQUIPMENT: Metatarsal shoes for cylinder handling. Protective clothing where needed. Cuffless trousers should be worn outside the shoes. Select in accordance with the current CSA standard Z195, "Protective Foot Wear", and any provincial regulations, local bylaws or guidelines.

9. Physical and Chemical Properties

PHYSICAL STATE: Liquid.	FREEZING POINT: -126.6°C (-195.9°F)	pH: Not applicable.
BOILING POINT: 31.9°C (89.4°F)	VAPOUR PRESSURE: 69.5 kPa (@ 20°C)	MOLECULAR WEIGHT: 135.44 g/mole
SPECIFIC GRAVITY: LIQUID (Water = 1) : 1.33 (Water = 1)	SOLUBILITY IN WATER: Reacts.	
SPECIFIC GRAVITY: VAPOUR (air = 1) : 1.33	EVAPORATION RATE (Butyl Acetate=1): 40 compared to (Butyl Acetate = 1)	COEFFICIENT OF WATER/OIL DISTRIBUTION: Not applicable.
VAPOUR DENSITY: >1 (Air = 1)	% VOLATILES BY VOLUME: 100% (v/v).	ODOUR THRESHOLD: Not available.

APPEARANCE & ODOUR: Colourless. Choking, Irritating. (Strong.)

10. Stability and Reactivity

STABILITY:	The product is stable.
CONDITIONS OF CHEMICAL INSTABILITY:	Not available.
INCOMPATIBILITY (materials to avoid):	Water, oxidizing agents, bases, organic materials, aqueous acids, alkalis, ketones, and aldehydes. Reacts very rapidly with alcohols, amines, acetone, and ammonia.
HAZARDOUS DECOMPOSITION PRODUCTS:	Thermal decomposition or burning can produce chlorine, hydrogen chloride, hydrogen, and oxides of silicon. Acute overexposure to the products of combustion may irritate the respiratory tract. Trichlorosilane reacts violently with water to form hydrogen chloride fumes. Halocarbons react strongly with it, and the mixture may explode given a source of ignition. Under some conditions, the reaction of this product with acids or alkalis can release flammable hydrogen gas. Trichlorosilane is also a reducing agent that may react explosively with some oxidizing agents. Under the influence of heat or catalysts, such as amines, rust, or aluminum chloride, trichlorosilane may redistribute to form mixtures of silane, monochlorosilane, dichlorosilane, and silicon tetrachloride. These mixtures may be pyrophoric.
HAZARDOUS POLYMERIZATION:	Will not occur.
CONDITIONS OF REACTIVITY:	None known.

11. Toxicological Information

See section 3.

12. Ecological Information

No adverse ecological effects expected. This product does not contain any Class I or Class II ozone-depleting chemicals. The components of this mixture are not listed as marine pollutants by TDG Regulations.

13. Disposal Considerations

WASTE DISPOSAL METHOD: Do not attempt to dispose of residual or unused quantities. Return cylinder to supplier.

14. Transport Information

TDG/IMO SHIPPING NAME: Trichlorosilane

HAZARD CLASS:	IDENTIFICATION #:	PRODUCT REPORTABLE QUANTITY (PRQ):
Class 4.3: Dangerous when wet material. Class 3: Flammable liquid. Class 8: PG I, Corrosive material.	UN1295	25 kg

SHIPPING LABEL(s): Material that emits flammable gases on contact with water, Flammable liquid, Corrosive material

PLACARD (when required): Material that emits flammable gases on contact with water, Flammable liquid, Corrosive material

SPECIAL SHIPPING INFORMATION:

Cylinders should be transported in a secure position, in a well-ventilated vehicle. Cylinders transported in an enclosed, non-ventilated compartment of a vehicle can present serious safety hazards.

15. Regulatory Information

The following selected regulatory requirements may apply to this product. Not all such requirements are identified. Users of this product are solely responsible for compliance with all applicable federal, provincial, and local regulations.

- DSL (Canada)** This product is on the DSL list
- WHMIS (Canada)**
 - Class B-2: Flammable liquid with a flash point lower than 37.8°C (100°F).
 - Class B-6: Reactive and very flammable material.
 - Class D-1A: Material causing immediate and serious toxic effects (VERY TOXIC).
 - Class D-2B: Material causing other toxic effects (TOXIC).
 - Class E: Corrosive liquid.

International Regulations

- EINECS** Not available.
- DSCL (EEC)** R12- Extremely flammable.
R20- Harmful by inhalation.

International Lists No products were found.

16. Other Information

MIXTURES:

When two or more gases, or liquefied gases are mixed, their hazardous properties may combine to create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an Industrial Hygienist, or other trained person when you make your safety evaluation of the end product. Remember, gases and liquids have properties which can cause serious injury or death.

HAZARD RATING SYSTEM:

HMIS RATINGS:

HEALTH 3

FLAMMABILITY 4

REACTIVITY 2

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED: CGA-678 VCR type fittings are used; however, there is no standard or limited standard CTA conventional threaded connection assignment.

PIN-INDEXED YOKE: Not available.

ULTRA-HIGH-INTEGRITY CONNECTION: CGA-636

Use the proper CGA connections. **DO NOT USE ADAPTERS.** Additional limited-standard connections may apply. See CGA pamphlets V-1 and V-7 listed below.

Ask your supplier about free Praxair safety literature as referred to in this MSDS and on the label for this product. Further information about this product can be found in the following pamphlets published by the Compressed Gas Association, Inc. (CGA), 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923, Telephone (703) 788-2700, Fax (703) 961-1831, website: www.cganet.com.

AV-1 Safe Handling and Storage of Compressed Gas
P-1 Safe Handling of Compressed Gases in Containers
V-1 Compressed Gas Cylinder Valve Inlet and Outlet Connections
--- Handbook of Compressed Gases, Fifth Edition

PREPARATION INFORMATION:

DATE: October 15, 2013
DEPARTMENT: Safety and Environmental Services
TELEPHONE: 905-803-1600

The opinions expressed herein are those of qualified experts within Praxair Canada Inc. We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of use of the product are not within the control of Praxair Canada Inc., it is the user's obligation to determine the conditions of safe use of the product.

Praxair Canada Inc. requests the users of this product to study this Material Data Sheet (MSDS) and become aware of product hazards and safety information. To promote safe use of this product, a user should (1) notify its employees, agents and contractors of the information on this MSDS and any product hazards and safety information, (2) furnish this same information to each of its customers for the product, and (3) request such customers to notify their employees and customers for the product of the same product hazards and safety information.

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Product Name: Trichlorosilane

MSDS# E-4823-E

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