

Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name: Dichlorosilane	Trade Name: Praxair Chlorosilane A-199
Product Use: Not available.	
Chemical Name: Dichlorosilane	Synonym: DCS
Chemical Formula: H ₂ SiCl ₂	Chemical Family: Chlorosilane
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)
Dichlorosilane	>99%	4109-96-0	Not available.	157ppm	Not available.
Hydrogen chloride	Trace	7647-01-0	Not available.	1560ppm	5ppm

3. Hazards Identification

Emergency Overview

DANGER! Toxic, flammable, corrosive, high-pressure liquid & gas. May be fatal if inhaled. Can cause eye, skin and respiratory tract burns. Water can cause violent reaction. Symptoms may be delayed. Self-contained breathing apparatus must be worn by rescue workers.

ROUTES OF EXPOSURE: Inhalation.

THRESHOLD LIMIT VALUE: TLV-TWA Data from 2004 Guide to Occupational Exposure Values (ACGIH). TLV-TWAs should be used as a guide in the control of health hazards and not as fine lines between safe and dangerous concentrations.

EFFECTS OF A SINGLE (ACUTE) OVEREXPOSURE:

INHALATION: Low vapour concentrations will irritate the nose, throat and chest causing discomfort or pain with coughing, excess sputum, runny nose and difficulty with breathing. Higher concentrations may result in the inhalation of harmful and possibly lethal, amounts of material. The nasal passages, larynx and lungs may be injured.

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. Prolonged or widespread skin contact may result in absorption of potentially harmful amounts of material.

SKIN ABSORPTION: Prolonged or widespread skin contact may result in the absorption of potentially harmful amounts of material.

SWALLOWING:

An unlikely route of exposure. This product is a gas at normal temperature and pressure. Highly to seriously 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, vomiting, diarrhea, dizziness, drowsiness, faintness, weakness, thirst, circulatory collapse, and loss of consciousness.

EYE CONTACT:

Vapor will cause discomfort or pain in the eye, with excess tear production and blinking, and excess redness and possibly swelling of the conjunctiva. If high concentrations of hydrogen chloride are formed, then injury to the cornea may develop. Splashes of liquid into the eye will cause pain, excess tear production and blinking, and marked excess redness and swelling of the conjunctiva. Severe corneal injury may occur, which, if not adequately treated, could permanently impair vision.

EFFECTS OF REPEATED (CHRONIC) OVEREXPOSURE:

CARCINOGENIC EFFECTS: Classified A4 (Not classifiable for human or animal.) by ACGIH, 3 (Not classifiable for human.) by IARC [Hydrogen chloride].

Prolonged or repeated exposure to hydrogen chloride vapor may discolor and erode the teeth, ulcerate the nasal mucosa, and cause the nose and gums to bleed.

OTHER EFFECTS OF OVEREXPOSURE:

None known.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE:

Inhalation may aggravate asthma and inflammatory or fibrotic pulmonary disease. The skin irritating effects of the material may aggravate an existing dermatitis.

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

In a short-term (9-day) repeated-exposure study with vapor from dichlorosilane, evidence of lung injury was present down to a nominal vapor concentration of 2.7 ppm. (The equivalent of HCl concentration was 8.0 ppm.) These findings indicate that lung injury is not solely due to HCl formed from dichlorosilane.

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 immediately.

WARNING: Rescuer may receive chemical burns from giving mouth-to-mouth resuscitation. If breathing is difficult, qualified personnel may give oxygen. Get immediate medical attention, even if no symptoms are present. Call a physician.

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:

An unlikely route of exposure. This product is a gas at normal temperature and pressure. If patient is fully conscious, give two glasses of water or milk at once. Do not induce vomiting. Get medical attention without delay.

EYE CONTACT:

Check for and remove all contact lenses. Immediately flush eyes thoroughly with water for at least 15 minutes. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. Seek the advice of a physician, preferably an ophthalmologist, immediately. Get medical attention.

NOTES TO PHYSICIAN:

Part of the effects from overexposure to dichlorosilane are due to liberation of hydrogen chloride.

- Dichlorosilane is highly irritant and corrosive to mucosae.
- Swallowed dichlorosilane 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 vapor, 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 necessary to evacuate the stomach contents, then this should be undertaken by means 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?** Not available.

FLASH POINT (test method)	CLOSED CUP: -52.2°C (-62°F). (Tag)	AUTOIGNITION TEMPERATURE	44°C (111.2°F)
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FLAMMABLE LIMITS IN AIR, % by volume:	LOWER: 4.6-4.8%	UPPER: 94.0-98.0%
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EXTINGUISHING MEDIA:

No known fire extinguishing methods. Coarse water spray or all-purpose type foams applied in accordance with manufacturer's recommendations for large fires.

SPECIAL FIRE FIGHTING PROCEDURES:

DANGER! DANGER! Toxic, flammable, corrosive liquid and gas under pressure. Evacuate all personnel from danger area. Do not approach area without self-contained breathing apparatus and protective clothing. Immediately cool cylinders with water spray from maximum distance, taking care not to extinguish flames. Remove ignition sources if without risk. If flames are accidentally extinguished, explosive reignition may occur. Take appropriate measures, e.g., total evacuation. Withdraw immediately in case of rising sound from the venting safety device or any discoloration of tank due to fire. Reapproach with extreme caution. Reduce corrosive vapors with coarse water spray. Reverse flow into cylinder may cause rupture. (See section 16.) Stop flow of gas if without risk, while continuing cooling water spray. Remove all containers from area of fire if without risk. Allow fire to burn out. On-site fire brigades must comply with OSHA 29 CFR 1910.156.

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. Dichlorosilane cylinders may be equipped with a pressure relief device. No part of cylinder should be subjected to a temperature higher than 125° F (52°C). If leaking or spilled dichlorosilane catches fire, do not extinguish flames. Poisonous, flammable, and corrosive vapors may spread from leak and could explode if reignited by sparks, flames, or other sources of ignition including imperceptible static sparks. Explosive atmospheres may linger. Before entering area, especially confined areas, check with an appropriate device. To protect persons from cylinder fragments and toxic fumes should a rupture occur, evacuate the area if the fire cannot be brought under immediate control.

This product has a low autoignition temperature. Exposure to heat from a fire or from the waterdichlorosilane reaction can cause the dichlorosilane to autoignite. The acidic decomposition products formed by burning dichlorosilane 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 as described in National Fire Protection Association document NFPA 77.

Extremely easy to ignite vapor. Minimum ignition energy—0.0154 millijoules (similar to carbon disulfide). Quenching distance—0.005-inch (12.7 mm, less than hydrogen). (ASTM E582-76.) Vapor may require special precautions beyond Group A of Article 500-2 of National Electrical Code. Vapor has very low autoignition temperature of $111 \pm 5^\circ \text{C}$ ($44 \pm 3^\circ \text{C}$) in dry air (ASTM E659-78). May ignite spontaneously in hot air or if it contacts a hot body of about this temperature or greater. Vapor burns extremely rapidly in air. Deflagrates significantly faster than hydrogen. Explosibility indices are $P_{\text{max}} = 149 \text{ psia}$ (1027 kPa) and $KG = 1990 \text{ bar-m/s}$ in a 5.28-gal (20-liter) vessel. It may not be possible to successfully vent a deflagration. Dichlorosilane may detonate in confinement.

HAZARDOUS COMBUSTION PRODUCTS:

These products are halogenated compounds. Some metallic oxides.

SENSITIVITY TO IMPACT:

Avoid impact against container.

SENSITIVITY TO STATIC DISCHARGE:

Not available.

6. Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

DANGER! DANGER! Toxic, flammable, corrosive liquid and gas under pressure. Immediately evacuate all personnel from danger area. Do not approach area without self-contained breathing apparatus and protective clothing. Gas forms explosive mixtures with air. (See section 5). Before entering area, especially a confined area, check atmosphere with an appropriate device. Remove all sources of ignition if without risk. A dichlorosilane fire will usually result if a spill contacts a small amount of water. Reduce vapors with coarse water spray. Reverse flow into cylinder may cause rupture. (See section 16.) Shut off flow if without risk. Ventilate area or move cylinder to well-ventilated area. Prevent runoff from contaminating surrounding environment. Poisonous, flammable vapors may spread from spill. Do not turn on any ignition source until the area is determined to be free of fire or explosion hazard.

WASTE DISPOSAL METHOD:

Prevent waste from contaminating the surrounding environment. Keep personnel away. Discard and product, residue, disposable container, or liner in an environmentally acceptable manner, in full compliance with federal, provincial, and local regulations. If necessary, call your local supplier for assistance.

EMERGENCY DISPOSAL: Dichlorosilane can be disposed of by first reacting it with water, then neutralizing the acid (HCl) that is formed by the reaction. This reaction proceeds rapidly and liberates heat, hydrogen, and hydrogen chloride. Wear suitable protective equipment (section 8) and observe all other precautions set forth in this MSDS. Use plenty of water to absorb the heat and hydrogen chloride. The dichlorosilane should be discharged below the surface of the water and bubbled into water slowly enough to avoid discharge of vapors to the atmosphere. For more effective scrubbing, the water could contain some soda ash or caustic soda. After neutralization and dilution, the waste solution can be discharged to a biological wastewater treatment system.

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 20 feet or use a barricade of non-combustible material. This barricade should be at least 5 feet high and have a fire resistance rating of at least $\frac{1}{2}$ 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 125°F (52°C). Store full and empty cylinders separately. Use a first-in, first-out inventory system to prevent storing full cylinders for long periods. For full details and requirements, see NFPA 50A, published by the National Fire Protection Association.

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. Electrical equipment must be non-sparking or explosion-proof. Leak check system with soapy water; never use a flame. 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:

Be sure to read and understand all labels and instructions supplied with all containers of this product.

OTHER HAZARDOUS CONDITIONS OF HANDLING, STORAGE, AND USE: *Toxic,*

flammable, corrosive liquid and gas under pressure. Vapor may cause flash fire. Do not breathe gas. Do not get vapors or liquid in eyes, on skin or clothing (see section 3). Harmful or fatal if inhaled. Corrosive and harmful or fatal if swallowed. ***Causes eye and skin burns.*** Harmful if absorbed through skin. Aspiration may cause lung damage. Do not induce vomiting. Have safety showers and eyewash fountains immediately available. Use piping and equipment adequately designed to withstand pressures to be encountered. ***May form explosive mixtures with air.*** Keep away from heat, sparks, or open flame. Ground all equipment. Use only spark-proof tools and explosion-proof equipment. Static ignition hazard can result from handling and use. ***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. ***Store and use in a dry environment with adequate ventilation at all times.*** Use only in a closed system constructed of corrosion-resistant materials. Close valve after each use; keep closed even when empty. Keep away from oxidizing agents and from other flammables. Be sure to read and understand all labels and instructions supplied with all containers of this product. ***Never work on a pressurized system.*** If there is a leak, close the cylinder valve. Blow the system down in an environmentally safe manner in compliance with all federal, state, and local laws; then repair the leak. ***When returning cylinder to supplier,*** be sure valve is closed; then install valve outlet plug tightly. ***Never place a compressed gas cylinder where it may become part of an electrical circuit.***

WARNING: Hot organic chemical vapors or mists are susceptible to sudden spontaneous combustion when mixed with air. Ignition may occur at temperatures below those published in the literature as "autoignition" or "ignition" temperatures. Ignition temperatures decrease with increasing vapor volume and vapor/air contact time, and are influenced by pressure changes.

Ignition may occur at typical elevated-temperature process conditions, especially in processes operating under vacuum if subjected to sudden ingress of air, or outside process equipment operating under elevated pressure if sudden escape of vapors or mists to the atmosphere occurs.

Any proposed use of this product in elevated-temperature processes should be thoroughly evaluated to ensure that safe operating conditions are established and maintained.

NOTE: Prior to using any plastics, confirm their compatibility with dichlorosilane.

Recommended Equipment: In semiconductor process gas and other suitable applications, Praxair recommends the use of engineering controls such as gas cabinet enclosures, automatic gas panels (used to purge systems on cylinder changeout), excess-flow valves throughout the gas distribution system, double containment for the distribution system, and continuous gas monitors.

8. Exposure Controls/Personal Protection

VENTILATION/ENGINEERING CONTROLS:

LOCAL EXHAUST: Use explosion-proof local exhaust ventilation with sufficient air flow to keep the dichlorosilane concentrations below the TLV in the worker's breathing zone.

MECHANICAL (general): Inadequate.
See SPECIAL.

SPECIAL: Use only in a closed system.
A corrosion-resistant, forced-draft fume hood is preferred. A canopy type of forced-air fume hood equipped with an explosion-proof device may be more desirable for certain applications.

OTHER: See SPECIAL.

PERSONAL PROTECTION:

RESPIRATORY PROTECTION: Use air-supplied respirators for concentrations up to 10 times the applicable permissible exposure limit. For higher concentrations, a full-face, self-contained breathing apparatus is required.

Select in accordance with provincial regulations, local bylaws or guidelines. Selection should also be based on the current CSA standard Z94.4, "Selection, Care and Use of Respirators". Respirators should also be approved by NIOSH and MSHA.

SKIN PROTECTION: Wear neoprene work gloves when handling cylinders.

EYE PROTECTION: Wear safety glasses when handling cylinders.

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: Gas. (Compressed Gas.)	FREEZING POINT: -122°C (-187.6°F)	pH: Not applicable.
BOILING POINT 8.2°C (46.8°F)	VAPOUR PRESSURE 166.8 kPa (@ 20°C)	MOLECULAR WEIGHT: 101 g/mole
SPECIFIC GRAVITY: 1.22 (Water = 1) LIQUID (Water = 1)	SOLUBILITY IN WATER, Insoluble in cold water.	
SPECIFIC GRAVITY: 3.48 VAPOUR (air = 1)	EVAPORATION RATE 82 compared to (Butyl Acetate=1):	COEFFICIENT OF WATER/OIL DISTRIBUTION: N/A
VAPOUR DENSITY: N/A	% VOLATILES BY VOLUME: 100% (v/v).	ODOUR THRESHOLD: Not available.

APPEARANCE & ODOUR: Colorless. Irritating. Choking. (Strong.)

10. Stability and Reactivity

STABILITY: Unstable.

CONDITIONS OF CHEMICAL INSTABILITY: Not available.

INCOMPATIBILITY (materials to avoid):

At room temperatures, this product may explode on contact with nitrates; other oxidizing agents may cause similar behavior. It reacts violently with water. It reacts rapidly (exothermically) with alcohols, primary and secondary amines, ammonia, and other compounds containing active hydrogen atoms. It will react violently with the water in aqueous acid solutions. When it reacts with moisture in the air, it produces dense white clouds of silica and large volumes of hydrogen chloride. Hydrogen, which can pose fire and explosion hazards, may also be evolved. The solid hydrolysis products are also reported to be flammable. Dichlorosilane may redistribute under the influence of heat or catalysts, such as amines, rust, or aluminum chloride, to form mixtures of silane, monochlorosilane, trichlorosilane, and silicon tetrachloride. These mixtures may be pyrophoric (may ignite spontaneously when exposed to air or oxygen).

HAZARDOUS DECOMPOSITION PRODUCTS:

Burning can produce chlorine, hydrogen chloride, hydrogen, and oxides of silicon. Acute overexposure to the products of combustion may irritate the respiratory tract. Fires resulting from chlorosilane leaks in steel equipment present a special hazard. The acidic decomposition products may rapidly attack the steel at the leak area, especially if the steel is hot.

HAZARDOUS POLYMERIZATION:

Yes.

CONDITIONS OF REACTIVITY:

See Above.

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:** Dichlorosilane**HAZARD CLASS:**

Class 2.3: Poisonous gas. Class 2.1: Flammable gas. Class 8: Corrosive material

IDENTIFICATION #:

UN2189

PRODUCT RQ:

All

SHIPPING LABEL(s): Poison gas, Flammable gas, Corrosive material**PLACARD (when required):** Poison gas, Flammable gas, Corrosive material**SPECIAL SHIPPING INFORMATION:**

Cylinders should be transported in a secure position, in a well-ventilated vehicle. Cylinders transported in an enclosed, nonventilated compartment of 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.

WHMIS (Canada)

Class A: Compressed gas.
Class B-1: Flammable gas.
Class D-1A: Material causing immediate and serious toxic effects (VERY TOXIC).
Class D-2B: Material causing other toxic effects (TOXIC).
Class E: Corrosive gas.
Class F: Dangerously reactive material.

International Regulations**EINECS** Not available.**DSCL (EEC)** R23- Toxic 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

PHYSICAL HAZARD 2

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:**THREADED:** CGA-678**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.

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

For more indepth information for each component, refer to the pure product MSDS.

The information contained in this MSDS is generated from technical sources using the Chemmate Mixture MSDS system and the pure-product MSDS for each component. These mixtures are not tested as a whole for chemical, physical, or health effects.

PREPARATION INFORMATION:

DATE: 2/15/2005

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 nformation, (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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