

Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name: Silicon tetrachloride (MSDS No. P-4824-E)	Trade Names: Praxair® Chlorosilane A-160
Chemical Name: Silicon Tetrachloride	Synonyms: Silicon Chloride, Tetrachlorosilane
Chemical Family: Chlorosilanes	Product Grades: 3.0 - Semiconductor Process Gas, 3.8
Telephone:	Company Name: Praxair, Inc.
Emergencies: 1-800-645-4633*	39 Old Ridgebury Road
CHEMTREC: 1-800-424-9300*	Danbury, CT 06810-5113
Routine: 1-800-PRAXAIR	

*Call emergency numbers 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier, Praxair sales representative, or call 1-800-PRAXAIR (1-800-772-9247).

2. Hazards Identification

EMERGENCY OVERVIEW

DANGER! Corrosive liquid and gas under pressure.
May be fatal if inhaled in high concentrations.
Causes eye and skin burns.
Causes severe irritation of the respiratory tract.
Symptoms may be delayed.
Contact with water may cause violent reaction.
Self-contained breathing apparatus and protective clothing
must be worn by rescue workers
Under ambient conditions, this is a clear liquid with a
pungent, suffocating odor.

OSHA REGULATORY STATUS: This material is considered hazardous by the OSHA Hazard Communications Standard (29 CFR 1910.1200).

POTENTIAL HEALTH EFFECTS:

Effects of a Single (Acute) Overexposure

Inhalation. Low concentrations will irritate the eyes and respiratory tract, experienced as eye discomfort, cough, excess sputum, and chest discomfort. Exposure to higher concentrations is likely to result in inhalation of enough harmful material to cause potentially lethal lung injury.

Skin Contact. Silicon tetrachloride is corrosive and causes chemical burns. Prolonged or widespread skin contact may result in absorption of potentially harmful amounts of material.

Swallowing. Highly to seriously toxic. May cause severe burns of the mouth, throat, esophagus, and stomach, with severe abdominal and chest pain. Nausea, vomiting, diarrhea, dizziness, drowsiness, faintness, circulatory collapse, and coma will occur.

Eye Contact. Vapor severely irritates the eyes causing pain, excess lachrymation (tears), closure of the eyelids, marked excess redness, and swelling of the conjunctiva. High concentrations of hydrogen chloride vapor, if formed, could injure the cornea. Splash contamination may cause severe conjunctivitis, seen as marked excess redness and swelling of the conjunctiva, discharge, iritis, and severe corneal injury, that if untreated, could result in permanent blindness.

Effects of Repeated (Chronic) Overexposure. 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. (See section 8.)

Other Effects of Overexposure. None known.

Medical Conditions Aggravated by Overexposure. Inhalation may aggravate asthma and inflammatory of or fibrotic pulmonary disease. Skin irritation may aggravate an existing dermatitis.

CARCINOGENICITY: Silicon tetrachloride is not listed by NTP, OSHA, and IARC.

POTENTIAL ENVIRONMENTAL EFFECTS: None known. For further information, see section 12, Ecological Information.

3. Composition/Information on Ingredients

See section 16 for important information about mixtures.

COMPONENT	CAS NUMBER	CONCENTRATION
Silicon Tetrachloride	10026-04-7	>99%*

*The symbol > means "greater than."

4. First Aid Measures

INHALATION: Immediately remove to fresh air. If not breathing, give artificial respiration.

WARNING: Rescuer may receive chemical burns from giving mouth-to-mouth resuscitation. If breathing is difficult, qualified personnel may give oxygen. Call a physician.

SKIN CONTACT: Avoid breathing vapor. Remove contaminated clothing and flush skin with water. Call a physician. Wash clothing before reuse.

SWALLOWING: Do not induce vomiting. If patient is conscious, give large quantities of milk or water. Call a physician and get medical attention immediately.

EYE CONTACT: 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: *The primary hazard from silicon tetrachloride results from formation of hydrochloric acid upon contact with moisture. Vapors may produce delayed corneal and pulmonary injury. Delayed onset pulmonary edema may occur upon massive overexposure, and secondary infection may occur in the chemically inflamed respiratory tract. Cases of overexposure should be kept under observation. Mediastinitis from esophageal perforation or peritonitis from gastric perforation may occur upon ingestion. Aspirated silicon tetrachloride can*

produce severe lung damage. Due to the severely irritant nature of this material, gastric lavage should be carried out with caution.

5. Fire Fighting Measures

FLAMMABLE PROPERTIES: Nonflammable.

SUITABLE EXTINGUISHING MEDIA: See Protection of Firefighters below.

PRODUCTS OF COMBUSTION: See section 10.

PROTECTION OF FIREFIGHTERS: DANGER! Corrosive liquid and gas under pressure. Reacts vigorously with water to form hydrogen chloride fumes. Immediately evacuate all personnel from danger area. Do not approach area without self-contained breathing apparatus and protective clothing. Small fires close to stored silicon tetrachloride may be extinguished using carbon dioxide, dry chemical extinguishers, or dry sand, properly applied. In large fires where silicon tetrachloride leakage may occur, water spray may be used if applied in quantities sufficient to absorb the heat of reaction with silicon tetrachloride and knock down the hydrogen chloride fumes. On-site fire brigades must comply with OSHA 29 CFR 1910.156.

Specific Physical and Chemical Hazards. Reaction of silicon tetrachloride with water or its decomposition in the presence of heat and air can form dense white clouds of silica particles and hydrogen chloride. These vapors are extremely irritating and may burn skin and eyes on contact. Fire fighters should be protected by full-face, air-supplied mask and full protective clothing. Heat of fire can build pressure in cylinder and cause it to rupture. Silicon tetrachloride 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).

Protective Equipment and Precautions for Firefighters. Firefighters should wear self-contained breathing apparatus and full fire-fighting turnout gear.

6. Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

DANGER! Corrosive liquid and gas under pressure.

Personal Precautions. Reacts vigorously with water to form hydrogen chloride fumes. Immediately evacuate all personnel from danger area. Do not approach area without self-contained breathing apparatus and full protective clothing. Reduce vapors with large amounts of water spray. Shut off flow if without risk. Ventilate area or move cylinder to a well-ventilated area.

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

7. Handling and Storage

PRECAUTIONS TO BE TAKEN IN HANDLING: Corrosive liquid and gas. Do not breathe gas. Do not get vapor or liquid in eyes, on skin, or on clothing. Have safety showers and eyewash fountains immediately available. **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 in using silicon tetrachloride, see section 16.

PRECAUTIONS TO BE TAKEN IN STORAGE: Store and use with adequate ventilation. **Firmly secure cylinders upright** to keep them from falling or being knocked over. Screw valve protection cap firmly in place by hand. 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.

RECOMMENDED PUBLICATIONS: For further information on storage, handling, and use, see Praxair publication P-14-153, *Guidelines for Handling Gas Cylinders and Containers*. Obtain from your local supplier.

8. Exposure Controls/Personal Protection

COMPONENT	OSHA PEL	ACGIH TLV-TWA (2007)
Silicon Tetrachloride	Not established.	Not established.
Hydrogen Chloride*	5 ppm (ceiling)**	2 ppm (ceiling)**

*Praxair recommends compliance with the OSHA and ACGIH limits for hydrogen chloride, formed by the hydrolysis of silicon tetrachloride.

**Ceiling limits are not Time Weighted Average (TWA).

TLV-TWAs should be used as a guide in the control of health hazards and not as fine lines between safe and dangerous concentrations.

IDLH =50 ppm (hydrogen chloride)

ENGINEERING CONTROLS:

Local Exhaust. Use a corrosion-resistant local exhaust ventilation system with sufficient air flow velocity to maintain concentration below all applicable exposure limits in the worker's breathing zone.

Mechanical (General). Not recommended as a primary ventilation system to control worker's exposure.

Special. A corrosion-resistant, canopy-type forced-draft fume hood may be more desirable for certain applications.

Other. None

PERSONAL PROTECTIVE EQUIPMENT:

Skin Protection. Neoprene. Metatarsal shoes for cylinder handling. Protective clothing to include a full face shield and apron where needed. Select per OSHA 29 CFR 1910.132 and 1910.133. Regardless of protective equipment, never touch live electrical parts.

Eye/Face Protection. Wear safety glasses when handling cylinders; vapor-proof goggles or face mask where needed. Select per OSHA 29 CFR 1910.133.

Respiratory Protection. Use air-supplied respirators or a full-face, positive-pressure, self-contained breathing apparatus. Respiratory protection must conform to OSHA 29 CFR 1910.134. Select per OSHA 29 CFR 1910.134 and ANSI Z88.2.

9. Physical and Chemical Properties

APPEARANCE:	Clear liquid
ODOR:	Pungent, suffocating
ODOR THRESHOLD:	Not available.
PHYSICAL STATE:	Clear liquid at normal temperature and pressure
pH:	Not applicable.
MELTING POINT at 1 atm:	-91.93°F (-68.85°C)
BOILING POINT at 1 atm:	134.33°F (56.85°C)
FLASH POINT (test method):	Not applicable.
EVAPORATION RATE (Butyl Acetate = 1):	20 (estimated)
FLAMMABILITY:	Not applicable.
FLAMMABLE LIMITS IN AIR , % by volume:	LOWER: Not applicable. UPPER: Not applicable.
VAPOR PRESSURE at 70°F (21.1°C):	3.89 psia (26.82 kPa, abs)
VAPOR DENSITY at 70°F (21.1°C) and 1 atm:	0.4393 lb/ft ³ (7.063 kg/m ³)
LIQUID DENSITY at 70°F (21.1°C) and 1 atm:	92.76 lb/ft ³ (1485.87 kg/m ³)
SPECIFIC GRAVITY (H ₂ O = 1) at 70°F (21.1°C):	1.483
SPECIFIC GRAVITY (Air = 1) at 70°F (21.1°C) and 1 atm:	Not available.
SOLUBILITY IN WATER:	Reacts violently
PARTITION COEFFICIENT: n-octanol/water:	Not available.
AUTOIGNITION TEMPERATURE:	Not available.
DECOMPOSITION TEMPERATURE:	Not available.
PERCENT VOLATILES BY VOLUME:	100
MOLECULAR WEIGHT:	169.89
MOLECULAR FORMULA:	SiCl ₄

10. Stability and Reactivity

CHEMICAL STABILITY: Unstable Stable

NOTE: If kept dry and uncontaminated, silicon tetrachloride is considered stable in transport and storage. Avoid all contact with water including moisture in the air.

CONDITIONS TO AVOID: Silicon tetrachloride is not a monomer in the usual sense and, therefore, will not condense or polymerize under normal conditions of handling or storage.

INCOMPATIBLE MATERIALS: Water, bases, organic materials, potassium, and sodium. Reacts very rapidly with alcohols, primary and secondary amines, ammonia, and other compounds containing active hydrogen atoms.

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition or burning may produce hydrochloric acid and silicon oxides. Reacts vigorously with water to form hydrogen chloride fumes.

POSSIBILITY OF HAZARDOUS REACTIONS: May Occur Will Not Occur

Thermal decomposition or burning may produce hydrochloric acid and silicon oxides. Reacts vigorously with water to form hydrogen chloride fumes.

11. Toxicological Information

ACUTE DOSE EFFECTS: LC₅₀, 1 hr, rat = 750 ppm

STUDY RESULTS: Undiluted silicon tetrachloride produced corrosive eye irritation in rabbits (0.1 ml) and corrosive skin irritation following application to intact rabbit skin.

Gastrointestinal tissue corrosion has been observed in animals given a single oral dose. Health effects are expected to resemble those of hydrogen chloride due to rapid hydrolysis in air. Chronic exposure may cause corrosion of the teeth.

12. Ecological Information

ECOTOXICITY: No known effects.

OTHER ADVERSE EFFECTS: Silicon tetrachloride does not contain any Class I or Class II ozone-depleting chemicals.

13. Disposal Considerations

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

14. Transport Information

DOT/IMO SHIPPING NAME: Silicon tetrachloride

HAZARD CLASS:	PACKING GROUP/Zone:	IDENTIFICATION NUMBER:	PRODUCT RQ:
8	II/NA*	UN1818	None

SHIPPING LABEL(s): CORROSIVE

PLACARD (when required): CORROSIVE

*NA = Not applicable.

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position, in a well-ventilated vehicle. Cylinders transported in an enclosed, nonventilated compartment of a vehicle can present serious safety hazards.

Shipment of compressed gas cylinders that have been filled without the owner's consent is a violation of federal law [49 CFR 173.301(b)].

MARINE POLLUTANTS: Silicon tetrachloride is not listed as a marine pollutant by DOT.

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, state, and local regulations.

U.S. FEDERAL REGULATIONS:

EPA (ENVIRONMENTAL PROTECTION AGENCY)

CERCLA: COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (40 CFR Parts 117 and 302):

Reportable Quantity (RQ): None

SARA: SUPERFUND AMENDMENT AND REAUTHORIZATION ACT:

SECTIONS 302/304: Require emergency planning based on Threshold Planning Quantity (TPQ) and release reporting based on Reportable Quantities (RQ) of Extremely Hazardous Substances (EHS) (40 CFR Part 355):

TPQ: None

EHS RQ (40 CFR 355): None

SECTIONS 311/312: Require submission of MSDSs and reporting of chemical inventories with identification of EPA hazard categories. The hazard categories for this product are as follows:

IMMEDIATE: Yes

DELAYED: Yes

PRESSURE: No

REACTIVITY: Yes

FIRE: No

SECTION 313: Requires submission of annual reports of release of toxic chemicals that appear in 40 CFR Part 372.

Silicon tetrachloride is not subject to reporting under Section 313.

40 CFR 68: RISK MANAGEMENT PROGRAM FOR CHEMICAL ACCIDENTAL RELEASE PREVENTION: Requires development and implementation of risk management programs at facilities that manufacture, use, store, or otherwise handle regulated substances in quantities that exceed specified thresholds.

Silicon tetrachloride is not listed as a regulated substance.

TSCA: TOXIC SUBSTANCES CONTROL ACT: Silicon tetrachloride is listed on the TSCA inventory.

OSHA: OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:

29 CFR 1910.119: PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS: Requires facilities to develop a process safety management program based on Threshold Quantities (TQ) of highly hazardous chemicals.

Silicon tetrachloride is not listed in Appendix A as a highly hazardous chemical.

STATE REGULATIONS:

CALIFORNIA: Silicon tetrachloride is not listed by California under the SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (Proposition 65).

PENNSYLVANIA: Silicon tetrachloride is subject to the PENNSYLVANIA WORKER AND COMMUNITY RIGHT-TO-KNOW ACT (35 P.S. Sections 7301-7320).

16. Other Information

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: *Corrosive liquid and gas under pressure.* Use piping and equipment adequately designed to withstand pressures to be encountered.

NOTE: *Provided moisture is excluded, steel, including stainless steel, is normally an acceptable material of construction for storage tanks, piping, and other equipment in silicon tetrachloride service. Aluminum is not suitable.*

Gas reacts with trace amounts of water to form highly corrosive acid. Use only in a closed system constructed of corrosion-resistant materials and kept scrupulously dry. **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. **Purge system with a dry, inert gas before and after use.** Close cylinder valve after each use; keep closed even when empty. 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. **Never ground a compressed gas cylinder or allow it to become part of an electrical circuit.**

NOTE: Silicon tetrachloride vapors react with moisture in air to produce dense white clouds of silica and hydrogen chloride. This product should be confined within enclosed equipment and should not be vented in to air. Where venting is necessary, silicon tetrachloride should be vented through a scrubber system equipped to handle hydrogen chloride.

Mixtures. When you mix two or more gases or liquefied gases, you can 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 evaluate the end product. Remember, gases and liquids have properties that can cause serious injury or death.

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.

HAZARD RATING SYSTEMS:

NFPA RATINGS:

HEALTH = 3
FLAMMABILITY = 0
INSTABILITY = 2
SPECIAL = W

HMIS RATINGS:

HEALTH = 3
FLAMMABILITY = 0
PHYSICAL HAZARD = 2

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED: No standard CGA assignment
(CGA-330 may be encountered)

PIN-INDEXED YOKE: Not applicable.

ULTRA-HIGH-INTEGRITY CONNECTION: CGA-636

Use the proper CGA connections. **DO NOT USE ADAPTERS.** Additional limited-standard connections may apply. See CGA pamphlet V-1 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 can be found in the following materials published by the Compressed Gas Association, Inc. (CGA), 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923, Telephone (703) 788-2700, <http://www.cganet.com/Publication.asp>.

AV-1 *Safe Handling and Storage of Compressed Gases*
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*

Praxair asks users of this product to study this MSDS and become aware of product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents, and contractors of the information in this MSDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information.

The opinions expressed herein are those of qualified experts within Praxair, 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, Inc., it is the user's obligation to determine the conditions of safe use of the product.

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