

Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name: Trichlorosilane (MSDS No. P-4823-H)	Trade Names: Praxair® Chlorosilane A-19
Chemical Name: Trichlorosilane	Synonyms: Silicochloroform, silicon trichloride, trichloromonosilane
Chemical Family: Silicon halide	Product Grades: 3.5 Semiconductor Process Gas
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! Flammable, corrosive liquid and vapor.
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.
Under ambient conditions, this is a colorless liquid with
an irritating, choking 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 vapor 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 inhalation of harmful and — because of injury to the nasal passages — larynx, and lungs, potentially lethal amounts of material.

Skin Contact. Brief contact causes itching or discomfort, with the development of local redness and possible swelling. Sustained contact will cause pain, local redness, swelling, ulceration, and possible bleeding into the inflamed site. Prolonged or widespread skin contact may result in absorption of potentially 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, vomiting, diarrhea, dizziness, drowsiness, faintness, weakness, thirst, circulatory collapse, and coma.

Eye Contact. Vapor causes discomfort or pain in the eye with excess tear production and blinking, and excess redness and possible 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 and adequately, could lead to permanent impairment of vision.

Effects of Repeated (Chronic) Overexposure. May discolor or erode the teeth, cause the nose and gums to bleed, and ulcerate the nasal mucosa.

Other Effects of Overexposure. None known.

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

CARCINOGENICITY: Trichlorosilane is not listed by NTP, OSHA, or 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
Trichlorosilane	10025-78-2	>99%*
Hydrogen chloride	7647-01-0	Trace

*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 as a result of giving mouth-to-mouth. If breathing is difficult, qualified personnel may give oxygen. Call a physician.

SKIN CONTACT: Remove contaminated clothing and wash skin with soap and water. Wash clothing before reuse. Discard contaminated shoes. If irritation persists, see a physician.

SWALLOWING: If patient is fully conscious, give two glasses of water or milk at once. Do not induce vomiting. Get medical attention without delay. Never give anything by mouth to an unconscious person.

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. Immediately see a physician, preferably an ophthalmologist.

NOTES TO PHYSICIAN:

Most of the effects from overexposure to trichlorosilane are due to liberation of hydrogen chloride.

- *Trichlorosilane is highly irritating 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 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 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.*

5. Fire Fighting Measures

FLAMMABLE PROPERTIES: May form explosive mixtures with air and oxidizing agents.

SUITABLE 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 percent solution in water of medium-expansion Hazmat II foam.

PRODUCTS OF COMBUSTION: See section 10.

PROTECTION OF FIREFIGHTERS: DANGER! Flammable, corrosive liquid and vapor.

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). Reapproach with extreme caution. Use remote spray monitors or fight fire from behind shields. Reduce corrosive vapors with fine 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. On-site fire brigades must comply with OSHA 29 CFR 1910.156.

Specific Physical and Chemical Hazards. May form explosive mixtures with air and oxidizing agents. Heat of fire can build pressure in cylinder and cause it to rupture. Trichlorosilane cylinders are not 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 trichlorosilane catches fire, do not extinguish flames. 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 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 as described in National Fire Protection Association document NFPA 77.

Vapor is extremely easy to ignite. Minimum ignition energy—0.017 millijoules (similar to hydrogen). Quenching distance—0.005 inch (0.127 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 a relatively low autoignition temperature of 219.92°F (104.4°C) (Matheson Tri-Gas, 7th Edition). May ignite on hot surfaces at about this temperature or greater. Vapor burns rapidly in air. Explosibility indices are $P_{max} = 136$ psia (938 kPa) and $KG = 544$ bar-m/s in a 20-liter vessel. Use of the Coke Gas or Hydrogen Deflagration Nomograph for venting is recommended (see NFPA document 68 "Venting of Deflagrations" Guidelines).

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! Flammable, corrosive liquid and vapor.

Personal Precautions. Immediately evacuate all personnel from danger area. Do not approach area without self-contained breathing apparatus and protective clothing. Vapors may form explosive mixtures with air. Before entering area, especially a confined area, check atmosphere with an appropriate device. Remove all sources of ignition if without risk. Reduce vapors with fine water spray. Reverse flow into cylinder may cause rupture. Shut off flow if without risk. Ventilate area or move cylinder to well-ventilated area. Prevent runoff from contaminating surrounding environment. Toxic, flammable, corrosive 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.

Small spills may be absorbed on an acid spill pillow or hydrolyzed with large quantities of water. If the product is absorbed on an acid spill pillow, place the pillow in a large quantity of water and allow it to dissolve (hydrolyze). In either case, ensure that the hydrolyzed product can be safely vented.

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. Refer to section 13 for emergency disposal.

7. Handling and Storage

PRECAUTIONS TO BE TAKEN IN HANDLING: Do not breathe vapor. Do not swallow liquid. Do not get vapors or liquid in eyes, on skin, or on clothing. Harmful if inhaled or absorbed through the skin. May be fatal if swallowed. Have safety showers and eyewash fountains immediately available. Wash thoroughly after handling. Keep away from heat, sparks, or open flame. Keep away from water or moist air. Use only spark-proof tools and explosion-proof equipment. 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 trichlorosilane, see section 16.

PRECAUTIONS TO BE TAKEN IN STORAGE: Store and use with adequate ventilation and use in closed systems. Separate cylinders containing this product from oxygen, chlorine, and other oxidizers by at least 20 ft (6.1 m) or use a barricade of noncombustible material. This barricade should be at least 5 ft (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 cylinder 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 further information on storage, handling, and use of this product, see section 16.

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 (2009)
Trichlorosilane	N.E.*	N.E.*
Hydrogen chloride	5 ppm (c)**	2 ppm (c)**

*N.E.-Not Established. Praxair recommends the 2 ppm TLV ceiling established for hydrogen chloride.

** (c) – ceiling. Ceiling values 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 corrosion-resistant, explosion-proof local exhaust ventilation with sufficient airflow to keep the trichlorosilane concentration below the applicable exposure limit in the worker's breathing zone.

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

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 PROTECTIVE EQUIPMENT:

Skin Protection. Wear work gloves when handling cylinders; neoprene when changing them out. Metatarsal shoes for cylinder handling and protective clothing where needed. Select in accordance with 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 and a face shield during cylinder changeout or wherever contact with product is possible. Select eye protection in accordance with OSHA 29 CFR 1910.133.

Respiratory Protection. A respiratory protection program that meet OSHA 29 CFR 1910.134, ANSI Z88.2, or MSHA 30 CFR 72.710 (where applicable) requirements must be followed whenever workplace conditions warrant respirator use. Use an air-supplied or air-purifying cartridge if the action level is exceeded. Ensure that the respirator has the appropriate protection factor for the exposure level. If cartridge type respirators are used, the cartridge must be appropriate for the chemical exposure (e.g., an organic vapor cartridge). For emergencies or instances with unknown exposure levels, use a self-contained breathing apparatus.

9. Physical and Chemical Properties

APPEARANCE:	Colorless liquid
ODOR:	Irritating, choking odor of hydrochloric acid
ODOR THRESHOLD:	Not available.
PHYSICAL STATE:	Liquid at normal temperature and pressure
pH:	Not applicable.
MELTING POINT at 1 atm:	-198.76°F (-128.2°C)
BOILING POINT at 1 atm:	89.33°F (31.85°C)
FLASH POINT (test method):	-18°F (-27.8°C) TCC, ASTM D56; 7°F(-13.9°C), TOC, ASTM 1310
EVAPORATION RATE (Butyl Acetate = 1):	40 (estimated)
FLAMMABILITY:	Flammable
FLAMMABLE LIMITS IN AIR , % by volume:	LOWER: 1.2% UPPER: 90.5%
VAPOR PRESSURE at 68°F (20°C):	9.67 psia (66.67 kPa, abs)
LIQUID DENSITY at 77°F (25°C):	82.9 lb/ft ³ (1.328 gm/cm ³)
VAPOR DENSITY at 70°F (21.1°C) and 1 atm:	0.3502 lb/ft ³ (5.610 kg/m ³)
SPECIFIC GRAVITY (H ₂ O = 1) at 77°F (25°C):	1.33
SPECIFIC GRAVITY (Air = 1):	4.7 (calculated)
SOLUBILITY IN WATER 68°F (20°C):	Reacts violently.
PARTITION COEFFICIENT: n-octanol/water:	Not available.
AUTOIGNITION TEMPERATURE:	220°F (104.4°C)
DECOMPOSITION TEMPERATURE:	Not available.
PERCENT VOLATILES BY VOLUME:	100
MOLECULAR WEIGHT:	135.45
MOLECULAR FORMULA:	SiHCl ₃

10. Stability and Reactivity

CHEMICAL STABILITY: Unstable Stable

CONDITIONS TO AVOID: None known.

INCOMPATIBLE MATERIALS: 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.

POSSIBILITY OF HAZARDOUS REACTIONS: May Occur Will Not Occur

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.

11. Toxicological Information

ACUTE DOSE EFFECTS: LC₅₀, 1 hr, rat = 1040 ppm

STUDY RESULTS: None known.

12. Ecological Information

ECOTOXICITY: No adverse ecological effects expected.

OTHER ADVERSE EFFECTS: This product 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.

Emergency Disposal. Do not discharge chlorosilanes directly to surface waters or sewer 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, state, and local regulations. Skim off and collect the insoluble liquid and dispose of it in suitable incineration facilities. Incineration will form fumed silica (SiO₂), 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.

14. Transport Information

DOT/IMO SHIPPING NAME: Trichlorosilane

HAZARD CLASS:	PACKING GROUP/Zone:	IDENTIFICATION NUMBER:	PRODUCT RQ:
4.3	I	UN1295	None

SHIPPING LABEL(s): DANGEROUS WHEN WET, FLAMMABLE LIQUID, CORROSIVE

PLACARD (when required): DANGEROUS WHEN WET, FLAMMABLE LIQUID, CORROSIVE

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: Trichlorosilane 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: Yes

REACTIVITY: Yes

FIRE: Yes

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

Trichlorosilane 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.

Trichlorosilane is listed as a regulated substance in quantities of 10,000 lb (4536 kg) or greater.

TSCA: TOXIC SUBSTANCES CONTROL ACT: Trichlorosilane 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.

Trichlorosilane is listed in Appendix A as a highly hazardous chemical in quantities of 5,000 lb (2268 kg) or greater.

STATE REGULATIONS:

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

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

16. Other Information

Read and understand all labels and instructions supplied with all containers of this product.

OTHER HAZARDOUS CONDITIONS OF HANDLING, STORAGE, AND USE: *Flammable, corrosive liquid and vapor.* Vapors may cause flash fire. Use piping and equipment adequately designed to withstand pressures to be encountered. May form explosive mixtures with air. Static ignition hazard can result from handling and use. Ground all equipment. Electrical equipment must be non-sparking or explosion-proof. 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. Prevent reverse flow. Reverse flow into cylinder may cause rupture. Use a backflow prevention device in any piping. Use a check valve or other protective device in any line or piping from the cylinder. Never work on a pressurized system. If there is a leak, close the cylinder valve. Blow down the system in an environmentally safe manner in compliance with all federal, state, and local laws; then repair the leak. Follow safe practices when returning cylinder to supplier. Ensure that the valve is closed; then install valve outlet cap or plug-tight. Never place a compressed gas cylinder where it may become part of an electrical circuit.

Trichlorosilane vapors react with moisture in air to produce dense white clouds of silica and hydrogen chloride. Therefore, this product should be confined within enclosed equipment and should not be vented directly to the air. Where venting is necessary, trichlorosilane should be vented through a scrubber system equipped to handle hydrogen chloride.

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 in outside process equipment operating under elevated pressure if a 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.

Mixtures. When you mix two or more chemicals, 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, chemicals 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 = 4
 INSTABILITY = 2
 SPECIAL = W

HMIS RATINGS:

HEALTH = 3
 FLAMMABILITY = 4
 PHYSICAL HAZARD = 2

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED:

CGA-678 and VCR type fittings are used; however, there are no standard or limited standard CGA conventional threaded connection assignments as such.

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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