



> 0.4% PHOSPHINE In SILANE

Material Safety Data Sheet

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name	> 0.4% PHOSPHINE In SILANE
Product Code(s)	G-199
UN-Number	UN1953
Recommended Use	Electronics.
Supplier Address*	<p>Linde Gas North America LLC - Linde Merchant Production Inc. - Linde LLC 575 Mountain Ave. Murray Hill, NJ 07974 Phone: 908-464-8100 www.lindeus.com</p> <p>Linde Gas Puerto Rico, Inc. Las Palmas Village Road No. 869, Street No. 7 Catano, Puerto Rico 00962 Phone: 787-641-7445 www.pr.lindegas.com</p> <p>Linde Canada Limited 5860 Chedworth Way Mississauga, Ontario L5R 0A2 Phone: 905-501-1700 www.lindecana.com</p>
	* May include subsidiaries or affiliate companies/divisions.
	For additional product information contact your local customer service.
Chemical Emergency Phone Number	Chemtrec: 1-800-424-9300 for US/ 703-527-3887 outside US

2. HAZARDS IDENTIFICATION

DANGER!	Emergency Overview	
	<p>Extremely flammable May form explosive mixtures with air. Fatal if inhaled. Irritating to eyes, respiratory system and skin May adversely affect liver and kidney. Contents under pressure Keep at temperatures below 52°C / 125°F</p>	
Appearance Colorless.	Physical State Gas.	Odor Repulsive

Potential Health Effects

Principle Routes of Exposure	Inhalation. Eye contact. Skin contact.
Acute Toxicity	
Inhalation	Fatal if inhaled. Severe respiratory irritant. May cause pulmonary edema. Symptoms of overexposure can include headache, coughing, shortness of breath, wheezing, phlegm, abdominal pain, nausea, vomiting, thirst, drowsiness, double vision, dizziness, tremors, and coma.
Eyes	Irritating to eyes.
Skin	Irritating to skin. Contact with moisture on the skin may form irritating materials such as phosphoric acid. Pain, burning and irritation may result from contact. Ignited gas can cause thermal burns.
Skin Absorption Hazard	No known hazard by skin absorption.
Ingestion	Not an expected route of exposure.
Chronic Effects	Chronic absorption of phosphine may be associated with disturbances of sight, speech and motor functions. May cause adverse liver and kidney effects.
Aggravated Medical Conditions	Kidney disorders. Liver disorders. Respiratory disorders. Skin disorders. Pre-existing eye disorders. Central nervous system.
Environmental Hazard	See Section 12 for additional Ecological Information.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS-No	Volume %	Chemical Formula
Silane	7803-62-5	< 99.6	SiH ₄
Phosphine	7803-51-2	> 0.4	PH ₃

Additional information: Composition listed covers broad ranges rather than exact percentages for specific products.

4. FIRST AID MEASURES

General Advice	Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.
Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Call a physician immediately.
Skin Contact	Wash off immediately with soap and plenty of water. Call a physician immediately.
Inhalation	PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF INHALATION OVEREXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Conscious inhalation victims should be assisted to an uncontaminated area and inhale fresh air. If breathing is difficult, administer oxygen. Unconscious persons should be moved to an uncontaminated area and, as necessary, given artificial resuscitation and supplemental oxygen. Treatment should be symptomatic and supportive.
Ingestion	Not an expected route of exposure.
Notes to Physician	Treat symptomatically.
Protection of First-aiders	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. FIRE-FIGHTING MEASURES

Flammable Properties	Extremely flammable. Pyrophoric gas. May be spontaneously flammable in air.
Suitable Extinguishing Media	It may be safer to allow the fire to burn itself out. Use water spray to knock down vapors and cool fire-exposed containers. DO NOT EXTINGUISH A LEAKING GAS FIRE UNLESS LEAK CAN BE STOPPED.
Unsuitable Extinguishing Media	Do not use halogenated extinguishing agents or foam.
Hazardous Combustion Products	Phosphorus oxides. Silicon Fumes and hydrogen (above 752°F)
<u>Explosion Data</u>	
Sensitivity to Mechanical Impact	None
Sensitivity to Static Discharge	Yes.
Specific Hazards Arising from the Chemical	Low ignition energy. Silane is a pyrophoric gas that will generally spontaneously ignite upon contact with air. For spontaneous ignition, however, certain silane concentrations, turbulence, and temperature of the mixture must be satisfied. The greatest hazard of Silane is its unpredictable behavior when released into the air. Continue to cool fire exposed cylinders until flames are extinguished. Cylinders may rupture under extreme heat. Damaged cylinders should be handled only by specialists.
Protective Equipment and Precautions for Firefighters	<p>If possible, stop the flow of gas. Do not extinguish the fire until supply is shut off as otherwise an explosive-ignition may occur. If the fire is extinguished and the flow of gas continues, use increased ventilation to prevent build-up of explosive atmosphere. Ventilation fans must be explosion proof. Use non-sparking tools to close container valves.</p> <p>Isolate spill or leak area for at least 100 meters (330 feet) in all directions. Vapors from liquefied gas are initially heavier than air and spread along ground. Vapors may accumulate in confined areas (basement, tanks, hopper/tank cars, etc.). For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn.</p> <p>Use water spray to cool surrounding containers. Be cautious of a Boiling Liquid Evaporating Vapor Explosion, BLEVE, if flame is impinging on surrounding containers.</p> <p>As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.</p>

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions	ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. All equipment used when handling the product must be grounded. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe.
Environmental Precautions	Beware of vapors accumulating to form explosive concentrations. Vapors can accumulate in low areas. Prevent spreading of vapors through sewers, ventilation systems and confined areas.
Methods for Containment	Stop the flow of gas or remove cylinder to outdoor location if this can be done without risk. If leak is in container or container valve, contact the appropriate emergency telephone number in Section 1 or call your closest Linde location.
Methods for Cleaning Up	Return cylinder to Linde or an authorized distributor.
Other Information	Refer to protective measures listed in Sections 7 and 8.

7. HANDLING AND STORAGE

Handling

Remove all sources of ignition. Ground and bond all lines and equipment associated with product system. All equipment should be non-sparking and explosion proof. Use only in ventilated areas. "NO SMOKING" signs should be posted in storage and use areas.

Never attempt to lift a cylinder by its valve protection cap. Protect cylinders from physical damage; do not drag, roll, slide or drop. When moving cylinders, even for short distance, use a cart designed to transport cylinders. Use equipment rated for cylinder pressure. Use backflow preventive device in piping.

Use an adjustable strap wrench to remove over-tight or rusted caps. Close valve after each use and when empty. Never insert an object (e.g. wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve, causing leak to occur. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier.

Never put cylinders into trunks of cars or unventilated areas of passenger vehicles. Never attempt to refill a compressed gas cylinder without the owner's written consent. Never strike an arc on a compressed gas cylinder or make a cylinder a part of an electrical circuit.

Storage

Protect from physical damage. Cylinders should be stored upright with valve protection cap in place and firmly secured to prevent falling. Store in cool, dry, well-ventilated area of non-combustible construction away from heavily trafficked areas and emergency exits. Keep at temperatures below 52°C / 125°F. Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders from being stored for excessive periods of time. Always store and handle compressed gas cylinders in accordance with Compressed Gas Association, pamphlet CGA-P1, Safe Handling of Compressed Gases in Containers. There should be no ignition sources in areas where this product is used or stored. Outside or detached storage is preferred.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Guidelines

Chemical Name	ACGIH TLV	OSHA PEL	NIOSH IDLH
Silane 7803-62-5	TWA: 5 ppm	(vacated) TWA: 5 ppm (vacated) TWA: 7 mg/m ³	TWA: 5 ppm TWA: 7 mg/m ³
Phosphine 7803-51-2	STEL: 1 ppm TWA: 0.3 ppm	TWA: 0.3 ppm TWA: 0.4 mg/m ³ (vacated) STEL: 1 ppm (vacated) STEL: 1 mg/m ³	IDLH: 50 ppm TWA: 0.3 ppm TWA: 0.4 mg/m ³ STEL: 1 ppm STEL: 1 mg/m ³

ACGIH TLV: American Conference of Governmental Industrial Hygienists - Threshold Limit Value. OSHA PEL: Occupational Safety and Health Administration - Permissible Exposure Limits. NIOSH IDLH: Immediately Dangerous to Life or Health.

Other Exposure Guidelines

Vacated limits revoked by the Court of Appeals decision in AFL-CIO v. OSHA, 965 F.2d 962 (11th Cir., 1992).

Engineering Measures

Showers. Eyewash stations. Explosion proof ventilation systems. Exhaust gas should be vented to a gas treatment system.

Ventilation

Use ventilation adequate to keep exposures below recommended exposure limits.

Personal Protective Equipment

Eye/Face Protection

Tightly fitting safety goggles.

Skin and Body Protection

Appropriate protective and chemical resistant gloves, clothing and splash protection, or fully encapsulating vapor protective clothing to prevent exposure. For materials of construction consult protective clothing manufacturer's specifications.

Respiratory Protection

General Use	If exposure limits are exceeded or irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn. Positive-pressure supplied air respirators may be required for high airborne contaminant concentrations. Respiratory protection must be provided in accordance with current local regulations.
Emergency Use	Use positive pressure air line respirator or self-contained breathing apparatus for exposure over exposure limits or emergency use. For exposures above IDLH, an additional escape bottle is required.
Hygiene Measures	When using, do not eat, drink or smoke. Remove and wash contaminated clothing before re-use. Provide regular cleaning of equipment, work area and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

Product Information

Appearance	Colorless.	Odor	Repulsive.
Odor Threshold	0.010 - 2.014 ppm (phosphine)	Physical State	Gas
Flash Point	No information available.	Autoignition Temperature	No information available.
Flammability Limits in Air	(For Silane)		
Upper	96 %		
Lower	1.4 %		

The following information is for the NON-INERT components of this mixture:

Chemical Name	Boiling Point	Melting Point	Molecular Weight	Evaporation Rate	Water Solubility	Vapor Pressure	Vapor Density (Air=1)	Gas Density Kg/m ³ @20°C
Silane	-112°C	-185°C (-301°F)	32.11	-	Negligible	Above critical temperature	1.11	1.342
Phosphine	-88 °C	-133.5 °C	33.99	-	0.26 (vol/vol@17°C and 1 atm)	510 PSIA @ 21°C	1.17	1.423

10. STABILITY AND REACTIVITY

Stability	Stable under recommended storage conditions.
Incompatible Products	Phosphine is incompatible with: Bases. Halogens. Nitrates. Nitrogen trichloride.
Conditions to Avoid	Silane will ignite spontaneously in air. Ignitions sources - heat, sparks and open flames. Combines violently with oxygen and halogens. Phosphine liberates hydrogen and forms phosphide when passed over heated metal.
Hazardous Decomposition Products	Phosphorus and hydrogen at approximately 1100°F (600°C). Silicon.
Hazardous Polymerization	Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Product Information

LD50 Oral:	No information available.
LD50 Dermal:	No information available.
LC50 Inhalation:	Refer to CGA P-20 for classification procedures for toxic gas mixtures.
Inhalation	Respiratory, gastrointestinal, and nervous system symptoms were noted in workers exposed to mean phosphine concentrations less than 10 ppm.
Repeated Dose Toxicity	No information available.

Component Information

Chemical Name	LD50 Oral	LD50 Dermal	LC50 Inhalation
Silane			= 9600 ppm (Rat) 4 h
Phosphine		-	per CGA P-20: 20 ppm/1hr (Rat) (time-adjusted)

Chronic Toxicity

Chronic Toxicity	Chronic absorption of phosphine may be associated with disturbances of sight, speech and motor functions. May cause adverse liver and kidney effects.
Carcinogenicity	Contains no ingredient listed as a carcinogen.
Irritation	No information available.
Sensitization	No information available.
Reproductive Toxicity	No information available.
Developmental Toxicity	No information available.
Synergistic Materials	None known.
Target Organ Effects	Central nervous system (CNS). Respiratory system.

12. ECOLOGICAL INFORMATION

Ecotoxicity

The environmental impact of this product has not been fully investigated.

Ozone depletion potential; ODP; (R-11 = 1): Does not contain ozone depleting chemical (40 CFR Part 82).

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods	Do not attempt to dispose of residual waste or unused quantities. Return in the shipping container PROPERLY LABELED WITH ANY VALVE OUTLET PLUGS OR CAPS SECURED AND VALVE PROTECTION CAP IN PLACE to Linde for proper disposal.
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Contaminated Packaging

Do not re-use empty containers.

14. TRANSPORT INFORMATION

DOT

Proper shipping name	Compressed gas, toxic, flammable, n.o.s.
Hazard Class	2.3
Subsidiary Class	2.1
UN-Number	UN1953
Description	UN1953,Compressed gas, toxic, flammable, n.o.s.(Phosphine,Silane),2.3,(2.1)
Additional Description:	Poison-Inhalation Hazard, Zone A, B, C or D depending on concentration of phosphine as follows: Zone A, >10.0% Zone B, 2.0 - 9.99% Zone C, 0.67 - 1.99%. Zone D, 0.4 - 0.669%
Additional Marking Requirements:	"Inhalation Hazard".
Emergency Response Guide Number	119

TDG

Proper Shipping Name	Compressed gas, toxic, flammable, n.o.s.
Hazard Class	2.3
Subsidiary Class	(2.1)
UN-Number	UN1953
Description	UN1953,COMPRESSED GAS, TOXIC, FLAMMABLE, N.O.S.(Phosphine,Silane),2.3(2.1)

MEX

Proper Shipping Name	Compressed gas, toxic, flammable, n.o.s.
Hazard Class	2.3
Subsidiary Class	2.1
UN-Number	UN1953
Description	UN1953 Compressed gas, toxic, flammable, n.o.s.(Phosphine,Silane),2.3(2.1)

IATA

UN-Number	UN1953
Proper Shipping Name	Compressed gas, toxic, flammable, n.o.s.
Hazard Class	2.3
Subsidiary Class	2.1
ERG Code	10P
Description	UN1953,Compressed gas, toxic, flammable, n.o.s.(Phosphine,Silane),2.3(2.1)
Maximum Quantity for Passenger	Forbidden
Maximum Quantity for Cargo Only	Forbidden
Limited Quantity	Forbidden

IMDG/IMO

Proper Shipping Name	Compressed gas, toxic, flammable, n.o.s.
Hazard Class	2.3
Subsidiary Class	2.1
UN-Number	UN1953
EmS No.	F-D, S-U

Description	UN1953, Compressed gas, toxic, flammable, n.o.s.(Phosphine,Silane),2.3(2.1)
<u>ADR</u>	
Proper Shipping Name	Compressed gas, toxic, flammable, n.o.s.
Hazard Class	2.3
UN-Number	UN1953
Classification Code	1TF
Description	UN1953 Compressed gas, toxic, flammable, n.o.s.(Phosphine,Silane),2.3(2.1),
ADR/RID-Labels	2.1

15. REGULATORY INFORMATION

International Inventories

TSCA	Complies
DSL	Complies
EINECS/ELINCS	Complies

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
 DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
 EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances

U.S. Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product contains a chemical or chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372:

Chemical Name	CAS-No	SARA 313 - Threshold Values %
Phosphine	7803-51-2	1.0

SARA 311/312 Hazard Categories

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	Yes
Sudden Release of Pressure Hazard	Yes
Reactive Hazard	Yes

Clean Water Act

This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

Risk and Process Safety Management Programs

This material, as supplied, contains one or more regulated substances with specified thresholds under 40 CFR Part 68 or regulated as a highly hazardous chemical pursuant to the 29 CFR Part 1910.110 with specified thresholds:

Chemical Name	U.S. - CAA (Clean Air Act) - Accidental Release Prevention - Toxic Substances	U.S. - CAA (Clean Air Act) - Accidental Release Prevention - Flammable Substances	U.S. - OSHA - Process Safety Management - Highly Hazardous Chemicals
Silane	-	10000 lbs	-
Phosphine	5000 lbs		100 lb

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product contains the following substances which are listed hazardous air pollutants (HAPS) under Section 112 of the Clean Air Act:

Chemical Name	CAS-No	HAPS data	VOC Chemicals	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Phosphine	7803-51-2				

CERCLA/SARA

This material, as supplied, contains one or more substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355):

Chemical Name	Hazardous Substances RQs	Extremely Hazardous Substances RQs	TPQ
Phosphine	100 lb	100 lb	500 lb TPQ

U.S. State Regulations

California Proposition 65

This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical Name	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Silane	X	X	X	-	X
Phosphine	X	X	X	X	X

International Regulations

Chemical Name	Carcinogen Status	Exposure Limits
Silane	-	Mexico: TWA 5 ppm Mexico: TWA 7 mg/m ³
Phosphine		Mexico: TWA 0.3 ppm Mexico: TWA 0.4 mg/m ³ Mexico: STEL 1 ppm Mexico: STEL 1 mg/m ³

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS Hazard Class

- A Compressed gases
- B1 Flammable gas
- D1A Very toxic materials



16. OTHER INFORMATION

Prepared By Product Stewardship
 23 British American Blvd.
 Latham, NY 12110
 1-800-572-6501

Issuing Date 26-May-2011

Revision Date

Revision Number 0

Revision Note Initial Release.

<u>NFPA</u>	Health Hazard 4	Flammability 4	Stability 2	Physical and Chemical Hazards -
<u>HMIS</u>	Health Hazard 4	Flammability 4	Physical Hazard 3	Personal Protection -

Note: Ratings were assigned in accordance with Compressed Gas Association (CGA) guidelines as published in CGA Pamphlet P-19-2009, CGA Recommended Hazard Ratings for Compressed Gases, 3rd Edition.

General Disclaimer

For terms and conditions, including limitation of liability, please refer to the purchase agreement in effect between Linde LLC, Linde Merchant Production, Inc. or Linde Gas North America LLC (or any of their affiliates and subsidiaries) and the purchaser.

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End of Safety Data Sheet