

In an emergency, call CHEMTREC at 800-424-9300 or 703-527-3887.

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**Section 1: Chemical Product and Company Identification**

**Material Name:** Poisonous phosphine mixtures (2.2% or more in silane).

**Chemical Formula of principal gas:** PH<sub>3</sub>.

**Synonyms of principal gas:** Hydrogen phosphide, phosphoretted hydrogen, phosphorus trihydride, phosphorus hydride.

**Manufacturer:** Voltaix, LLC.: Post Office Box 5357, North Branch, New Jersey 08876-5357, USA  
Voice:: 908-231-9060 or 800-VOLTAIX, Facsimile: 908-231-9063

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**Section 2: Composition/Information on Ingredients**

Component	CAS Registry Number	Molar (volume) concentration	Exposure Guidelines
Phosphine	7803-51-2	2.2% or more	0.3 ppm TLV-TWA (ACGIH) 1 ppm TLV-STEL (ACGIH)
Silane	7803-62-5	balance	5 ppm TLV-TWA (ACGIH)

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**Section 3: Hazards Identification****Emergency Overview**

These phosphine mixtures are colorless gases with an odor that has been described, by various observers, as repulsive or similar to that of garlic, rotting fish or stale urine. As exposure deadens the sense of smell, do not use smell to determine phosphine concentration. The mixtures' immediate health hazards are that they are poison gases and may cause thermal burns. They are flammable gases that may be pyrophoric (autoigniting in air) and may form mixtures with air that do not autoignite, but are flammable or explosive. These phosphine mixtures are reactive with oxidizers, halogens, and nitric acid.

**NFPA 704 Rating (determined by Voltaix):** Health 4 Fire 4 Reactivity 1 Special none

**Note:** Section 3 is continued on Page 2.

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**Section 3: Hazards Identification (continued)****Potential Health Effects**

**Routes of Exposure:** At low concentrations, the primary route is inhalation. At high concentrations, these phosphine mixtures autoignite, creating a thermal burn risk, but reducing the toxic hazard.

**Lengths of Exposure:** Phosphine has been found to be a severe respiratory irritant in short term human exposures. It has been found in animal studies to be toxic in acute (4 hour) tests and subacute (4 hours/day for two months) tests. Silane data are available for only short term exposures. The LC<sub>50</sub>, 4 hour, rat and LC<sub>LO</sub>, 4 hour, mouse are both reported to be 9600 ppm. Six rats are reported to have "survived" a six hour exposure at 1400 ppm.

**Severity of Effect:** Depends on concentration and duration.

**Target Organs:** For phosphine: respiratory and cardiovascular systems. Neurological and gastrointestinal effects have also been reported, as have renal and hepatic toxicity. No target organs have been identified for silane.

**Type of Effect:** For phosphine: respiratory irritation and impairment, pulmonary edema, cardiovascular (including myocardial) injury, gastrointestinal irritation.

**Signs and Symptoms of Exposure:** For phosphine: shortness of breath; chest tightness; headache; vertigo; weakness; fatigue; and nausea, vomiting, and diarrhea. For silane: suspected to cause headache and nausea.

**Medical Conditions that may be Aggravated by Exposure:** None identified.

**Reported Carcinogenic and Reproductive Effects:** NTP has not reported genetic or long-term toxicology and carcinogenesis effects studies.

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### ***Section 4: First Aid Measures***

#### **Inhalation**

This is the primary route of exposure.

- 1) Remove the affected person from the gas source or contaminated area. Note: Personal Protective Equipment (PPE), including positive pressure, self contained breathing apparatus, may be required to assure the safety of the rescuer.
- 2) If the affected person is not breathing spontaneously, administer rescue breathing.
- 3) If the affected person does not have a pulse, administer CPR.
- 4) If medical oxygen and appropriately trained personnel are available, administer 100% oxygen to the affected person.
- 5) Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or poison control center for instruction.
- 6) Keep the affected person warm, comfortable, and at rest while awaiting professional medical care. *Monitor the breathing and pulse continuously.* Administer rescue breathing or CPR if necessary.

#### **Skin Contact**

Flush with a copious stream of water while removing contaminated clothing. Continue flushing until the professional medical assistance arrives, but for no less than fifteen minutes. Assume the patient has also been exposed by inhalation and obtain professional medical assistance immediately. Treat thermal burns by assuring that affected area is cool by flushing with cool water, then apply dry sterile dressings. If the patient is burned on the face, neck, head, or chest, assume that the airway may also have been burned and obtain professional medical assistance immediately.

#### **Eye Contact**

Flush continuously with clean water until the professional medical assistance arrives, but for no less than thirty minutes. Continuation of flushing until patient is transferred to an ophthalmologist or emergency physician is recommended.

#### **Ingestion**

Ingestion is not an observed route of exposure to gaseous hazardous materials.

#### **Chronic Effects**

None is known to Voltaix

#### **Note to Physicians:**

The reaction product of phosphine and moist air is phosphoric acid; the reaction product of silane and air is silicon oxide (silica). Therefore, skin and eye burns should be irrigated to the extent the physician feels necessary to remove the phosphoric acid and silicon oxide to an acceptable degree. Thereafter, treatment for burns is as usual.

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## **Section 5: Fire Fighting Measures**

### **Flammability and Explosivity**

**Flash Point:** Not applicable, these materials are gases.

**Flammability Limits in Air:** Depends on concentration and diluent. The flammable range of phosphine is unknown. The flammable range of silane is 0.8% to 98%.

**Autoignition Temperature:** : Depends on concentration and diluent. The autoignition temperature of pure phosphine is approximately 38 °C (100 °F). The autoignition temperature of silane is less than 54 °C (130 °F).

**Flammability Classification (per 29 CFR 1910.1200):** Flammable gas.

**Known or Anticipated Hazardous Products of Combustion:** Phosphorus oxide, which dissolves in water to form phosphoric acid, and silicon oxide.

**Properties that may Initiate or Intensify Fire:** Heating cylinder to the point of initiating decomposition of the phosphine or activating the pressure relief device.

**Reactions that Release Flammable Gases:** Thermal decomposition of phosphine or silane releases hydrogen.

### **Extinguishing Media**

None.

### **Fire Fighting Instructions**

The only safe way to extinguish a flammable gas fire is to stop the flow of gas. If the flow cannot be stopped, allow the entire contents of the cylinder to burn. Cool the cylinder and surroundings with water from a suitable distance. Extinguishing the fire without stopping the flow of gas may permit the formation of ignitable or explosive mixtures with air. These mixtures may propagate to a source of ignition.

Excessive pressure may develop in gas cylinders exposed to fire, which may result in explosion, regardless of the cylinder's content. Cylinders with pressure relief devices (PRD's) may release their contents through such devices if the cylinder is exposed to fire. Cylinders without PRD's have no provision for controlled release and are therefore more likely to explode if exposed to fire.

Positive pressure, self contained breathing apparatus is required for all fire fighting involving hazardous materials. Full structural fire fighting (bunker) gear is the *minimum* acceptable attire. The need for proximity, entry, and flashover protection and special protective clothing should be determined for each incident by a competent fire fighting safety professional.

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## ***Section 6: Accidental Release Measures***

### **Containment**

These materials are gases at atmospheric conditions. The only means of containment is the enclosure of the space into which the material is released. Such containment is described in Section 7.

### **Clean Up**

Clean up consists of passing the entire gas volume of the enclosure through appropriate exhaust gas treatment equipment (EGTE). Purge the enclosure with a non-reactive gas, such as nitrogen, through the EGTE until an acceptably low level of contamination remains. Equipment contaminated by this material must then be cleaned or decommissioned appropriately.

### **Evacuation**

If the release is not contained in an appropriate device or system, all personnel not appropriately protected (see Section 8) must evacuate the contaminated spaces. Consider evacuation of additional areas, as a precaution against the spread of the release or subsequent explosion or fire.

### **Special Instructions**

Some releases of these phosphine mixtures into air will autoignite. As not all leaks will autoignite, consider the formation of ignitable or explosive mixtures with air.

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## ***Section 7: Handling and Storage***

### **Handling**

Handle this material only in sealed, purged systems. The design of handling systems for hazardous materials is beyond the scope of this MSDS, and should be performed by a competent, experienced professional. Consider the use of doubly-contained piping; diaphragm or bellows sealed, soft seat valves; backflow prevention devices; flash arrestors; and flow monitoring or limiting devices. Gas cabinets, with appropriate exhaust treatment, are recommended, as is automatic monitoring of the secondary enclosures and work areas for release.

Handle sealed gas cylinders in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers*.

Some material may have accumulated behind the outlet plug. Face the outlet away from you and wear appropriate protective equipment when removing the plug to connect the cylinder to your system.

Never introduce any substance into a gas cylinder. If you believe your cylinder may have been contaminated, notify Voltaix immediately. Provide as much information as possible on the nature and quantity of contamination.

### **Storage**

Store cylinders in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers*, local building and fire codes and other relevant regulations. Materials should be segregated, by the hazards they comprise, for storage.

Protect the cylinders from direct sunlight, precipitation, mechanical damage, and temperatures above 55 °C (130 °F).

Ship and store cylinders with the outlet plug and valve protective cap in place.

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### **Section 8: Exposure Control/Personal Protection**

#### **Engineering Controls**

Local exhaust is required. Secondary containment, with appropriate exhaust gas treatment, is strongly encouraged and is required in some jurisdictions.

Monitor the work area and the secondary containment continuously for release of the material. Automatic alerting of personnel and automatic shutdown of flow are appropriate in most applications and are required in some jurisdictions.

Purge all primary containment systems with a nonreactive gas, such as nitrogen, before introducing a phosphine mixture.

#### **Personal Protective Equipment (PPE)**

**Respiratory Protection:** Positive pressure, full face, air supplied breathing apparatus should be used for work within the secondary containment equipment if a leak is suspected or the primary containment is to be opened, e.g., for a cylinder change. Air supplied breathing apparatus is required for response to demonstrated or suspected releases from the primary containment.

**Eye/Face Protection:** When using respiratory protection as described above, use a face mask that provides splash and impact protection for the face and eyes. For handling sealed cylinders, wear safety glasses.

**Skin Protection:** Wear appropriate gloves when handling sealed cylinders. Use gloves and other skin protection, as assigned by a competent safety professional, when working within the secondary enclosure with the primary enclosure compromised, e.g., cylinder changing, to protect both from exposure to the material and from fire that may result from its release to the air.

**Other Protection:** Wear appropriate protective footwear when moving cylinders.

#### **Exposure Guidelines**

##### **Phosphine:**

**TLV-TWA:** 0.3 ppm (ACGIH).

**TLV-STEL:** 1 ppm (ACGIH).

**PEL- TWA:** 0.3 ppm (0.4 mg/m<sup>3</sup>) (OSHA).

**PEL-STEL:** 1 ppm (1 mg/m<sup>3</sup>) (OSHA).

**REL-TWA (10 hour):** 0.3 ppm (NIOSH).

**REL-STEL:** 1 ppm (NIOSH).

**IDLH:** 50 ppm (Established by NIOSH).

##### **Silane:**

**TLV-TWA:** 5 ppm (ACGIH).

**PEL-TWA:** 5 ppm (7 mg/m<sup>3</sup>) (OSHA).

**REL-TWA (10 hour):** 5 ppm (NIOSH).

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### Section 9: Physical and Chemical Properties

Notes: 1) "N/A" means not applicable.

2) Unless otherwise specified, properties are reported at 0 °C (32 °F) and 1 atmosphere (1.0 bar, 14.7 psia).

Property	Phosphine	Silane
Appearance	colorless	colorless
Odor	garlic, decomposing fish, stale urine	repulsive
Physical state	gas	gas
pH	N/A	N/A
Vapor Pressure	35.6 bar (517 psia) at 20 °C (68 °F)	N/A
Vapor Density	1.53 g/L	1.342 g/L
Boiling point	-87.7 °C (-125 °F)	-111.5 °C (-168.7 °F)
Melting point	-133.8 °C (-208 °F)	-185 °C (-301 °F)
Solubility in water (v/v, at 20 °C)	0.27	Unknown
Specific gravity of liquid (water = 1)	0.74 at -87.7 °C (-125 °F)	N/A
Molecular weight	34.00	32.12

### Section 10: Stability and Reactivity

**Chemical Stability:** Phosphine and silane are stable at room temperature. At elevated temperature (above 150 °C), phosphine decomposes to phosphorus and hydrogen. Diphosphine may also result from thermal decomposition.

**Conditions to Avoid:** Temperatures above 55 °C, sources of ignition, exposure to air.

**Incompatibility with Other Materials:** Oxidizers, halogens, nitric acid.

**Hazardous Decomposition, Reaction and Oxidation (other than burning) Products:** Phosphorus oxide, phosphorus, hydrogen, diphosphine, silicon oxide.

**Hazardous Polymerization:** Not reported to occur.

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### **Section 11: Toxicological Information**

**Acute Data (by route):** For phosphine: exposure by inhalation: LC<sub>50</sub>, 4-hour, rat is reported both as 11 ppm and 57 ppm. The other data, summarized in the table below, are more consistent with the higher of these two values. The primary effect is respiratory irritation and pulmonary edema. Reaction with air may produce irritation or thermal burns to skin, eyes and mucous membranes. For silane: exposure by inhalation may cause headache or nausea. Reaction with air may produce irritation or thermal burns to skin, eyes and mucous membranes. LC<sub>50</sub>, 4-hour, rat 9600 ppm.

Effect	Species	Time	Concentration (ppm)	Concentration, adjusted to one hour
LC <sub>50</sub>	Rat	4 hour	11	22
LC <sub>50</sub>	Rat	4 hour	57	114
LC <sub>LO</sub>	Human	5 minutes	1000	289
LC <sub>LO</sub>	Mouse	2 hour	271	383
LC <sub>LO</sub>	Cat	2 hour	50	71
LC <sub>LO</sub>	Rabbit	20 minutes	2500	1443
LC <sub>LO</sub>	Guinea Pig	4 hour	100	200
LC <sub>LO</sub>	Mammal	5 minutes	1000	289

**Chronic and Subchronic Data for Phosphine:** Rats exposed to 4 ppm, 4 hr for 9 of 12 days exhibited reduced weight gain and some respiratory irritation, but returned to normal during 2 week recovery. Exposure of unspecified animals to 5 ppm for 4 hours per day for 2 months did not produce fatalities, similarly exposure to 10 ppm for seven days did, but to what fraction of the exposed population was not reported. Both materials are listed in the *Registry of Toxic Effects of Chemical Substances* (RTECS), but no information on their carcinogenicity is available.

Phosphine is suspected as the cause in an acetylene generator operator death; the exposure was estimated to be 8 ppm, for 1 to 2 hours per day. Other, more toxic, hydrides, e.g., arsine and hydrogen selenide, may have been present in that case.

Autopsy findings on humans believed to have died from phosphine exposure include pulmonary edema, diffuse cardiovascular injury, and focal myocardial necrosis.

Diarrhea, nausea and vomiting, chest tightness, cough, headache, dizziness have been reported in intermittent human exposure up to 35 ppm, averaging 10 ppm. No cumulative effects were observed.

**Special Studies:** None known to Voltaix

### **Section 12: Ecological Information**

**Ecotoxicity:** None known to Voltaix

**Environmental Fate:** None known to Voltaix

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### **Section 13: Disposal Considerations**

**Classification under RCRA, 40 CFR 261:** Phosphine has been assigned the Hazardous Waste Number P096. These mixtures may meet the criteria for an "acute hazardous waste".

**US EPA waste number and descriptions:** P096 (Phosphine), D001 (ignitability).

**Special Instructions and Limitations:** Treat process and other exhaust streams appropriately before release to the atmosphere.

**Notice:** The information above is derived from Voltaix's interpretation of the US federal laws, regulations and policies concerning the material, as shipped by Voltaix, at the time this MSDS was prepared. Federal controls are subject to change and state and local controls may also apply. Proper waste disposal is the responsibility of the owner of the waste. The user is encouraged to consult with appropriate experts in developing a disposal plan.

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### **Section 14: Transport Information**

**Basic Description:** Compressed Gas, Toxic, Flammable, n.o.s. (Phosphine x% in silane), Division 2.3 (Toxic Gas, Flammable Gas), UN 1953 Toxic - Inhalation Hazard, Inhalation Hazard Zone Z.

*Note:* Substitute the mixture concentration for x% and, for Z, "A" if the concentration is 57.0% or more "B" if the concentration is 11.4% or more, "C" if the concentration is 3.8% or more, or "D" if the concentration is less than 3.8%.

**Additional Information for shipment by water:** IMDG Page Number 2125-1.

**Additional Information for shipment by air:** Transportation by air is not permitted.

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### **Section 15: Regulatory Information**

**TSCA Status:** All of the component materials are listed in the index of chemical substances.

**CERCLA Reportable Quantity (40CFR302.40):** These materials are not listed. The Final Rule Reportable Quantity (RQ) for phosphine is 45.4 kg (100 lb). The Reportable Quantity (RQ) for "Unlisted Hazardous Wastes Characteristic of Ignitability" (D001) is 45.4 kg (100 lbs.).

**SARA Title III Status (Section 302 (40CFR355), Section 311/312, Section 313 (40CFR372)):** No Threshold Planning Quantity (TPQ) or Reportable Quantity (RQ) is listed for these substances. 40CFR355 lists phosphine as an Extremely Hazardous Substance with a Threshold Planning Quantity (TPQ) of 227 kg (500 lbs.) and a Reportable Quantity (RQ) of 45.4 kg (100 lb). Phosphine is listed in 40CFR372. The default federal MSDS submission and inventory requirement filing threshold of 4,540 kg (10,000 lbs.) may also apply.

*Note:* State and local requirements may be more stringent.

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**Section 16: Other Information**

**References**

*Book of SEMI Standards, Facilities Standards and Safety Guidelines.* Mountain View, CA: Semiconductor Equipment and Materials International, 1993.

Borak, Jonathan, M.D., Michael Callan and William Abbott, *Hazardous Materials Exposure: Emergency Response and Patient Care.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1991.

*Documentation of TLV's and BEI's.* Cincinnati, Ohio: American Conference of Government Industrial Hygienists, 1992.

*Effects of Exposure to Toxic Gases: First Aid and Treatment.* Lyndhurst, NJ: Matheson Gas Products, 1977.

*Fire Protection Guide on Hazardous Materials.* Quincy, MA: National Fire Protection Association, 1991.

*Safe Handling of Compressed Gases in Containers (Pamphlet P-1).* Arlington, VA: Compressed Gas Association, Inc., 1991.

**Revision Indication**

Revise to reflect company name change

**Disclaimer**

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