SUBSTANCE IDENTIFICATION
Silane (SiH₄) is found as a gas with an unpleasant odor. Silane is used in semiconductor manufacture for the deposition of thin dielectric films. It is spontaneously combustible (pyrophoric) in air or may accumulate and detonate. The toxicity of silane is limited to its irritant properties. Chlorosilanes (e.g., trichlorosilane [SiCl₃H]) and organochlorosilanes (e.g., methylchlorosilane [CH₃SiCl₃]) are found as clear-to-white, fuming liquids with a sharp odor. They are used in chemical synthesis; in the production of silicon fluids, silicon resins, and amorphous silicon; and in semiconductor manufacture. Trichlorosilane is used to clean silicon wafer surfaces. Chlorosilanes or organochlorosilanes on contact with water form hydrochloric acid. There are limited human toxicity data on these compounds.

ROUTE OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

TARGET ORGANS
Primary
Skin
Eyes
Respiratory system
Gastrointestinal system
Blood
Secondary
Central nervous system
Cardiovascular system
Renal

LIFE THREAT
Respiratory tract irritation; pulmonary edema.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Tachycardia, hypotension, arrhythmias, and cardiovascular collapse.
Respiratory: Respiratory tract irritation, rhinitis, sinusitis, pharyngitis, coughing, dyspnea, and hypoxia. Pulmonary edema.
CNS: Headaches, dizziness, incoordination, decreased level of consciousness, seizures, and coma.
Gastrointestinal: Salivation, nausea, vomiting, diarrhea, and abdominal pain. GI tract irritation and mucosal burns.
Eye: Irritation, lacrimation, corneal damage, and chemical burns.
Skin: Irritant dermatitis and severe chemical burns.
Renal: Kidney damage.
Blood: Red blood cell destruction (hemolysis) may occur with exposure to tetrachlorosilane.
SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Some symptoms such as pulmonary edema may be delayed
CO-EXPOSURE CONCERNS
Other respiratory irritants
THERMAL DECOMPOSITION PRODUCTS INCLUDE
Carbon dioxide
Carbon monoxide
Hydrogen chloride
Silicon dioxide
Silicates
Silane exhibits almost complete combustion above 450° C
MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Respiratory system disorders
DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient's clothing, jewelry and shoes.
- Gently brush away dry particles and blot excess liquids with absorbent material.
- Rinse patient with warm water, 30°C/86°F, if possible.
- Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.
IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.
BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- Anticipate seizures and treat if necessary (refer to seizure protocol in Section Three).
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
· Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).
· Cover skin burns with sterile dressings after decontamination (refer to chemical burn protocol in Section Three).

**ADVANCED TREATMENT**

· Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious. Early intubation at the first sign of upper airway obstruction may be necessary.
· Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
· Start an IV with D5W TKO. Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of fluid overload.
· Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in Section Three).
· Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
· For hypotension with signs of hypovolemia, administer fluid cautiously. Consider vasopressors for hypotension with a normal fluid volume. Watch for signs of fluid overload (refer to shock protocol in Section Three).
· Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

**INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS**

· Useful initial laboratory studies include complete blood count, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including serum aminotransferases (ALT and AST), calcium, phosphorus, and magnesium. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
· Positive end-expiratory pressure (PEEP)-assisted ventilation may be necessary in patients with acute parenchymal injury who develop pulmonary edema or adult respiratory distress syndrome.
· Endoscopy may be needed to assess extent of gastrointestinal damage.
· Obtain toxicological consultation if necessary.

**SPECIAL CONSIDERATIONS**

· Products may be mixed in a variety of hydrocarbon solvents (e.g., methanol or toluene). The solvent may contribute to the overall toxicity. Identify solvent vehicle and consult appropriate guideline.
**Phosphine and Related Compounds**

**SUBSTANCE IDENTIFICATION**
A colorless gas with an odor of decaying fish. The reaction of hydrogen and various metal phosphides (e.g. aluminum, zinc, or gallium phosphide) forms phosphine gas ($\text{PH}_3$). Phosphides may also release phosphine gas on contact with water. Used in fumigation and as a doping agent in semiconductor manufacture, a polymerization inhibitor, and a chemical intermediate. Products may be toxic at air concentrations below the odor threshold of 1 to 2 ppm.

**ROUTES OF EXPOSURE**
Inhalation

**TARGET ORGANS**
*Primary*
Cardiovascular system
Respiratory system
*Secondary*
Central nervous system
Gastrointestinal system
Renal
Hepatic

**LIFE THREAT**
Severe pulmonary irritation leading to pulmonary edema.

**SIGNS AND SYMPTOMS BY SYSTEM**
**Cardiovascular:** Cardiac arrhythmias, hypotension, and cardiovascular collapse. Direct myocardial muscle damage with elevated MB-CPK myocardial enzyme release.
**Respiratory:** Acute pulmonary edema, respiratory tract irritation, chest tightness, cough, dyspnea and tachypnea.
**CNS:** Headache, dizziness, tremors, fatigue, ataxia, paresthesia, seizures, and coma.
**Gastrointestinal:** Nausea, vomiting, diarrhea, and abdominal pain. Intense thirst.
**Skin:** Diaphoresis.
**Renal:** Kidney damage.
**Hepatic:** Liver damage, jaundice with associated elevations in serum aminotransferases.
**Metabolism:** Metabolic acidosis.
**Other:** Products may spontaneously ignite.

**SYMPTOM ONSET FOR ACUTE EXPOSURE**
Immediate
Some respiratory symptoms (pulmonary edema) may be delayed

**THERMAL DECOMPOSITION PRODUCTS INCLUDE**
Hydrogen
Phosphorus

**MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE**
Respiratory disorders
Cardiovascular disorders
DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient’s clothing, jewelry, and shoes.
- If any concurrent liquid or solid contamination exists:
  - Gently brush away dry particles and blot excess liquids with absorbent material.
  - Rinse patient with warm water, 30° C/86° F, if possible.
  - Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.

BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- Anticipate seizures and treat if necessary (refer to seizure protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).

ADVANCED TREATMENT
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in respiratory arrest.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with D5W TKO. Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of fluid overload.
- Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in Section Three).
- For hypotension with signs of hypovolemia, administer fluid cautiously. Consider va-
sopressors for hypotension with a normal fluid volume. Watch for signs of fluid overload (refer to shock protocol in Section Three).

- Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

**INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS**

- Useful initial laboratory studies include complete blood count, prothrombin time, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including bilirubin, serum aminotransferases (ALT and AST), calcium, phosphorus, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Positive end-expiratory pressure (PEEP)-assisted ventilation may be necessary in patients with acute parenchymal injury who develop pulmonary edema or adult respiratory distress syndrome.
- Products may cause acidosis; hyperventilation and sodium bicarbonate may be beneficial. Bicarbonate therapy should be guided by patient presentation, ABG determination, and serum electrolyte considerations.
- Obtain toxicological consultation as necessary.
Phosphorus and Related Compounds

SUBSTANCE IDENTIFICATION
Found as solids and liquids. In solid form, phosphorus exists as a white-to-yellow, soft, waxy substance that spontaneously burns in air. It can be found as a yellow fuming liquid. Also found in a red granular form. Red phosphorus is relatively nontoxic, since it has low volatility and is not well absorbed. Used in the manufacture of many products, including fertilizers, water treatment products, food products, and explosives. Also used in rat poisons and roach powders. Many of these products can spontaneously burn in air.

ROUTES OF EXPOSURE
Skin and eye contact
Inhalation
Ingestion
Skin absorption

TARGET ORGANS
Primary
Skin
Eyes
Respiratory system
Gastrointestinal system
Hepatic
Renal
Secondary
Central nervous system
Cardiovascular system
Metabolism

LIFE THREAT
Hypovolemic shock and severe tissue burns. Severe respiratory irritant that can cause pulmonary edema and respiratory arrest. Cardiac rhythm and electrocardiogram changes leading to sudden death have also been reported.

SIGNS AND SYMPTOMS BY SYSTEM
Cardiovascular: Cardiac arrhythmias and hypovolemic shock.
Respiratory: Acute pulmonary edema, which may be delayed. Dyspnea, tachypnea, and irritation of the respiratory tract.
CNS: Headache, dizziness, fatigue, and photophobia. May cause seizures and coma.
Gastrointestinal: Mucosal burns. Nausea, vomiting, and abdominal pain. Increased salivation with tooth and jaw pain. Vomitus and feces may be phosphorescent, and the breath may exhibit a garlic odor (all are rare findings).
Eye: Lacrimation, eyelid spasm (blepharospasm), conjunctivitis, corneal damage, and photophobia.
Skin: Severe chemical and thermal burns. Irritant dermatitis.
Renal: Kidney damage, including renal failure.
Hepatic: Fatty degeneration of the liver and jaundice.
Metabolism: Hypoglycemia and hypocalcemia.

Other: After initial symptoms, a symptom-free period of several days may occur, followed by signs of severe systemic poisoning. Red phosphorus is less toxic than white or yellow. Although red phosphorous is poorly absorbed and nontoxic in a single dose, repeated doses may demonstrate enhanced absorption, causing toxicity. The ability to detect the product by smell may be lost after a short exposure time (olfactory nerve fatigue).

SYMPTOM ONSET FOR ACUTE EXPOSURE
Immediate
Some symptoms, especially respiratory and hepatic, may be delayed

THERMAL DECOMPOSITION PRODUCTS INCLUDE
Hydrogen
Hydrogen chloride
Phosphine
Phosphoric acid fumes
Phosphorus oxides

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE
Respiratory disorders (COPD)
Liver disorders

DECONTAMINATION
- Wear positive-pressure SCBA and protective equipment specified by references such as the DOT Emergency Response Guidebook or the CANUTEC Initial Emergency Response Guide. If special chemical protective clothing is required, consult the chemical manufacturer or specific protective clothing compatibility charts.
- Delay entry until trained personnel and proper protective equipment are available.
- Remove patient from contaminated area.
- Quickly remove and isolate patient’s clothing, jewelry, and shoes.
- Gently brush away dry particles and blot excess liquids with absorbent material.
- If phosphorus particles are embedded in the skin, continuous water irrigation, water emersion, or sterile water-soaked dressings should be applied during transport to hospital for surgical debridement. Do not use oil for phosphorus exposure because this may promote dermal absorption.
- Rinse patient with cool water.
- Wash patient with Tincture of Green soap or a mild liquid soap and large quantities of water.
- Refer to decontamination protocol in Section Three.

IMMEDIATE FIRST AID
- Ensure that adequate decontamination has been carried out.
- If victim is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask as trained. Perform CPR if necessary.
- Immediately flush contaminated eyes with gently flowing water.
- Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.
- Keep victim quiet and maintain normal body temperature.
- Obtain medical attention.
BASIC TREATMENT
- Establish a patent airway. Suction if necessary.
- Watch for signs of respiratory insufficiency and assist ventilations if necessary.
- Administer oxygen by nonrebreather mask at 10 to 15 L/min.
- Monitor for pulmonary edema and treat if necessary (refer to pulmonary edema protocol in Section Three).
- Monitor for shock and treat if necessary (refer to shock protocol in Section Three).
- Anticipate seizures and treat if necessary (refer to seizure protocol in Section Three).
- For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport (refer to eye irrigation protocol in Section Three).
- Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal (refer to ingestion protocol in Section Three and activated charcoal protocol in Section Four).

ADVANCED TREATMENT
- Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in respiratory arrest.
- Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial.
- Monitor cardiac rhythm and treat arrhythmias if necessary (refer to cardiac protocol in Section Three).
- Start an IV with D3W TKO. Use lactated Ringer’s if signs of hypovolemia are present. Watch for signs of fluid overload.
- Consider drug therapy for pulmonary edema (refer to pulmonary edema protocol in Section Three).
- For hypotension with signs of hypovolemia, administer fluid cautiously. Watch for signs of fluid overload (refer to shock protocol in Section Three).
- Treat seizures with diazepam (Valium) (refer to diazepam protocol in Section Four).
- Monitor for signs of hypoglycemia (decreased LOC, tachycardia, pallor, dilated pupils, diaphoresis, and/or dextrose stick or glucometer readings below 50 mg/dl) and administer 50% dextrose if necessary. Draw blood sample before administration (refer to 50% dextrose protocol in Section Four).
- Use proparacaine hydrochloride to assist eye irrigation (refer to proparacaine hydrochloride protocol in Section Four).

INITIAL EMERGENCY DEPARTMENT CONSIDERATIONS
- Useful initial laboratory studies include complete blood count, prothrombin time, serum electrolytes, blood urea nitrogen (BUN), creatinine, glucose, urinalysis, and baseline biochemical profile, including bilirubin, serum aminotransferases (ALT and AST), calcium, phosphorus, and magnesium. Determination of anion and osmolar gaps may be helpful. Arterial blood gases (ABGs), chest radiograph, and electrocardiogram may be required.
- Positive end-expiratory pressure (PEEP)-assisted ventilation may be necessary in patients with acute parenchymal injury who develop pulmonary edema or adult respiratory distress syndrome.
- Calcium supplementation (IV calcium gluconate) may be required to correct hypocalcemia. Therapy should be guided by clinical presentation and laboratory findings.
- Obtain toxicological consultation as necessary.

SPECIAL CONSIDERATIONS
- Products are extremely toxic; rapid transport is essential. If solids are embedded in the skin, keep area submerged in water during transport to hospital for surgical debridement.

- Three stages of acute phosphorus poisoning:
  Stage I: GI symptoms and shock (0 to 24 hours).
  Stage II: Quiescent period of 1 to 3 days.
  Stage III: Hepatic damage/failure, renal failure, arrhythmias, seizures, and coma.