

VAPORPH30S®



Phosphine Fumigant

Product Stewardship

**Applicator
Training
Manual**



CYTEC INDUSTRIES INC.

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1. INTRODUCTION

A. Product Stewardship of VAPORPH₃OS[®]

The people of Cytec are committed to making safety, health and environmental protection an integral part of the entire product life cycle including designing, manufacturing, marketing, distribution, using, recycling, and disposing of their products on a worldwide basis.

B. What is Product Stewardship?

Product Stewardship is the responsible and ethical management of the health, safety and environmental aspects of a product such as VAPORPH₃OS[®] from its inception through production to its ultimate use and disposition. As Product stewards, we improve the health and safety of people and the environment. The cornerstone of Product Stewardship is working with customers. We must sufficiently understand their process and provide them with accurate, reliable, and up-to-date information to foster effective health, safety and environmental handling of VAPORPH₃OS[®].

Product Stewardship is part of the Responsible Care initiative of the Chemical Manufacturers' Association, of which Cytec is a member. Product Stewardship extends our concerns about the health, safety and environmental impact on each and every stage of VAPORPH₃OS[®]'s life cycle.

1. How Does Product Stewardship Work?

Being Product Stewards involves teamwork to continuously review all VAPORPH₃OS[®] processes and applications for ways to improve them and reduce waste. All of us make sure that fellow employees, suppliers, contractors, and customers around the world are part of the process. This training is in support of those activities.

2. What is Product Stewardship's Benefits?

A better future for our customers, our children, and our communities. Product Stewardship helps us become more efficient by reducing the cost of waste disposal and conserving energy. It enhances the value of our products to our customers. And, it is the foundation for meeting the many locals, state, and federal environmental regulations that relate to the operation of all of our companies. It is important for us to be good neighbors in our local communities and around the world. It is the right thing to do.

3. What's My Part in Product Stewardship?

Always think about how you can improve health, safety and the environment. That applies to all of us. In one way or another, each of us participates in product responsibility. We have to develop a constant focus on that responsibility, and use it on a daily basis. The best way to do this is to learn more about VAPORPH₃OS[®] and its proper use at each stage of its life cycle, from cradle to grave.

And, we must always be thinking about how to improve upon each aspect of VAPORPH₃OS[®]'s life cycle: customer need, product research and development, shipment, customer use and ultimate disposal or recycle.

The VAPORPH₃OS[®] Product Stewardship Training Manual for use with VAPORPH₃OS[®] Phosphine Fumigant has been prepared as part of a continuing Product Stewardship Program for VAPORPH₃OS[®] provided by Cytec.

Each fumigator using VAPORPH₃OS[®] is responsible for complying with all federal, state, and local regulations or codes regulating the use of this product. Although the Product Stewardship Program covers regulatory issues, these regulations can change and it is the ultimate responsibility of the end user to keep current on any regulatory changes.

It is a violation of federal law to use this product in a manner inconsistent with its labeling. Cytec and its distributors reserve the right to withhold future sales of VAPORPH₃OS[®] to any persons who fail to follow the guidelines of the product label or who go outside of the guidelines given in the Product Stewardship Training.

C. What is Phosphine?

Phosphine (PH₃) or hydrogen phosphide has typically been known as the gas released from fumigants known as metal phosphides. Aluminum phosphide and magnesium phosphide are the metal phosphides which generate phosphine gas when exposed to water molecules in the atmosphere. The chemical reaction when aluminum phosphide (AIP) is acted upon by atmospheric moisture is:



Cytec manufactures phosphine directly from elemental phosphorus. There is no waste byproduct from this process. The phosphine is then liquified and filled into high pressure cylinders for shipment.

Phosphine is highly toxic to insects, as well as humans and other forms of animal life. In addition to its toxic properties, the gas will corrode certain metals and may ignite spontaneously in air at concentrations above its lower flammable limit of 1.8%(v/v) (17,900 ppm). In 1985, seventy percent of the phosphine used in the United States was used to fumigate grain and rice while twenty percent was used on tobacco and ten percent was used on peanuts, dried fruits and tree nuts.

The exact mode of action of phosphine is not clearly known; however, four theories exist:

1. The molecules that gain quick access to the nervous system may act on it to paralyze the insects. (Kashi, 1981)
2. The paralysis of the spiracular muscles prevent active respiration to continue.
3. The enzyme cytochrome oxidase is attacked by phosphine to cause toxic action in the insect. (Kashi and Chefurka, 1976)
4. The cellular membrane can act as a sieve and prevent the PH₃ molecule from entering the cell. (Bell, 1975)

D. What is Carbon Dioxide?

Carbon Dioxide (CO₂) is a colorless gas having a faint, sharp odor and a sour taste. It is a minor component of the Earth's atmosphere (about 3 volumes in 10,000), formed in combustion of carbon-containing materials, in fermentation, and in respiration of animals and employed by plants in the photosynthesis of carbohydrates.

CO₂ was recognized as a gas different from others early in the 17th century by a Belgian chemist, Jan Baptist van Helmont, who observed it as a product of both fermentation and combustion. It liquefies upon compression to 75 kilograms per square centimeter (1,071 pounds per square inch) at 31°C (87.4°F). If the liquid is allowed to expand to atmospheric pressure, it cools and partially freezes to a snow-like solid called Dry Ice.

Besides its uses as a fumigant, CO₂ is used as a refrigerant, in fire extinguishers, for inflating life rafts and life jackets, blasting coal, foaming rubber and plastics, promoting the growth of plants in greenhouses, and in carbonated beverages.

An increased interest in the insecticidal potential of CO₂ has been generated because of the need to reduce pesticide residues in food materials, while still controlling pests effectively and economically. CO₂ also has synergistic properties when used as a fumigant. Effectiveness of a fumigant may be increased six-fold or more in some cases when CO₂ is used as a synergist. (Bond, 1978)

E. History of Phosphine

Fluck (1973) mentions that the discovery of phosphine was by Gengembre and Kirwan in the late 1700s. It was further investigated by Guy-Lussac and Thenard in 1811. Not until the 1930's, however, was the behavior of this chemical systematically studied. A German chemical company patented phosphine in 1952 and the first uses in the United States occurred in 1958 on grain in Kansas.

F. History of VAPORPH₃OS[®]

VAPORPH₃OS[®] has been used to protect stored products in Australia since 2000. VAPORPH₃OS[®] Phosphine Fumigant is a cylinderized source of 100% (wt) phosphine that is highly effective in sealed storage facilities. It has been designed to be blended on-site with carbon dioxide (CO₂) in conjunction with Cytec designed and approved blending equipment to produce a 2% (wt) phosphine mixture in CO₂. This breakthrough fumigation management system is available to professional applicators that seek an environmentally friendly alternative that is easy to use with improved worker safety.

CYTEC INDUSTRIES INC.

VAPORPH₃OS[®] Phosphine Fumigant is a product of CYTEC INDUSTRIES INC. A global leader in innovative stored product protection, Cytec Industries Inc. continues to provide its customers with the latest in phosphine technology, service and solutions. Cytec is the largest producer of phosphine in the world.

G. Advantages of VAPORPH₃OS[®]

Advantages: VAPORPH₃OS[®] offers numerous advantages over the solid metal phosphide fumigants. Some of these advantages are:

1. Nonflammable

VAPORPH₃OS[®] can be used in two methods for fumigation of stored products. The first method involves the on-site blending of VAPORPH₃OS[®] with CO₂. When VAPORPH₃OS[®] is blended on-site with CO₂ using Cytec designed and approved equipment the resulting gaseous mixture of 2% phosphine (wt) in carbon dioxide is non flammable. Carbon dioxide is an excellent carrier for phosphine and diluting phosphine to this concentration ensures it remains nonflammable in all proportions with air.

Research has shown a synergistic effect when CO₂ is used in combination with phosphine. Although these studies were conducted with higher levels of CO₂, they suggest there may be a synergistic effect at the CO₂ concentrations achieved when using VAPORPH₃OS[®]. Because of this possible synergistic effect a registered source of CO₂ for fumigations must be used when blending with VAPORPH₃OS[®]. The CO₂ has the tendency to increase respiration and open insect's breathing spiracles which results in the insect and rodent pests taking in lethal doses of phosphine in an accelerated manner. This leads to using less phosphine to achieve desired results. Also, the time frame of the fumigation may be somewhat shortened because of the synergistic reaction.

The second method involves the on-site dilution of phosphine with the surrounding air through the use of Cytec-approved dilution equipment. This equipment known as the Horn Diluphos System (HSD), is manufactured by FOSFOQUIM.

Two models are commercially available and differ in the rate of phosphine delivered. The HDS80 model dispenses phosphine at up to 19 g/min. The HRS200 model delivers phosphine at up to 50 g/min. Both systems dilute the phosphine stream and generate an output stream of 10,000 ppm (1%) phosphine. This concentration is well below the LFL of 1.8% (v/v) PH₃ in air.

2. Gas Levels Remain Constant

Through monitoring lines and detection equipment, a constant gas level of phosphine can be maintained throughout a fumigation. When using solid metal phosphides, a typical graphed curve of phosphine levels would start very low and reach a peak about 20 hours after the fumigant was introduced into a structure. The curve would then slowly come down to lower levels before the time of aeration 72+ hours later. With VAPORPH₃OS[®], a constant lethal dose over the period of the fumigation can be held by monitoring and injecting additional gas as needed to maintain lethal levels. With this method, a fumigator will not experience the initial “spike” of fumigant in the first 20 hours, which often leads to corrosion problems. Also, if the initial dose of phosphine was too low, it can be corrected well into the fumigation without sacrificing the effectiveness. With metal phosphides and their disposal problems, one would not want to add gas 1 – 2 days into a fumigation, because there would be a considerable amount of unreacted fumigant to dispose of upon aeration.

3. A Better Controlled Atmosphere Can Lead to Less Corrosion

Corrosion of metals (copper and copper alloys) from exposure to phosphine occurs significantly when the levels of phosphine are over 200 ppm. VAPORPH₃OS[®]'s phosphine levels should never reach levels over 500 ppm due to the applicator's ability to precisely control gas levels with cylinders. By not experiencing the initial “spike” of phosphine like the metal phosphide products produce, VAPORPH₃OS[®] should considerably reduce metal corrosion during a phosphine fumigation.

4. Decreases in Amounts of Phosphine Used

With the ability to precisely control phosphine gas, the total amount of phosphine released should be less when using VAPORPH₃OS[®] compared to metal phosphides. The reduction of the amount of phosphine required is further influenced by the differences in recommended dosage between VAPORPH₃OS[®] and metallic phosphides. The maximum dosage for VAPORPH₃OS[®] is 500 ppm, which is the equivalent to 20g/1000ft³. This same dosage is the minimum required dosage of metallic phosphides, which can have a maximum dosage of up to 140g/1000ft³ or 3500 ppm.

5. No Messy Disposal Problems

Metal phosphide fumigants are notorious for messy and sometimes dangerous disposal of spent or partially spent fumigant. The solid aluminum and magnesium phosphide products leave a gray, powdery ash after releasing the phosphine. This ash must be stirred in a water and detergent solution to be deactivated. The spent dust can easily get blown around and end up in places where it shouldn't be. Also, if some of the material has not broken down completely, the wet disposal dust can spontaneously combust. Since the use of VAPORPH₃OS[®] releases pure phosphine as either a 2% blend in Carbon Dioxide or 1% in air, there is no material to dispose of. Cylinders are simply returned for refilling.

6. Reduced Cylinder Handling

The use of VAPORPH₃OS[®] greatly reduces the number of cylinders to handle, store and transport. One VAPORPH₃OS[®] cylinder once blended on site with either CO₂ or air produces the equivalent of 23 ECO₂FUME[®] fumigant gas cylinders.

2. PRODUCTION INFORMATION

A. Product Description

VAPORPH₃OS[®] Phosphine Fumigant is a cylinderized source of Phosphine gas and is packaged in high-pressure gas cylinders. VAPORPH₃OS[®] Phosphine Fumigant cylinders contain 100% wt Phosphine as liquefied gas under pressure. Phosphine is pyrophoric and will spontaneously ignite in air. With the use of proper equipment VAPORPH₃OS[®] can be safely blended with Carbon Dioxide to less than 3% vol. or diluted with the surrounding air to 1% vol. in order to eliminate the flammability hazard.

Phosphine, under sufficient pressure, can exist in a liquid state. It is this “liquefied gas” that is stored in the cylinder. The product is dispensed as a gas from the cylinder and blended with Carbon Dioxide or diluted with air. The on-site blending or dilution of VAPORPH₃OS[®] greatly reduces the number of cylinders that are required. In expanding from a liquid to a gas, it increases in volume by hundreds of times. Cytec approved blending or dilution equipment is necessary to ensure a safe and effective fumigation.

Unlike metallic phosphide fumigants, Phosphine is not generated through a chemical reaction and its release is instantaneous. The choice of dispensing methods will depend on the type and duration of the fumigation planned.

B. Product Packaging

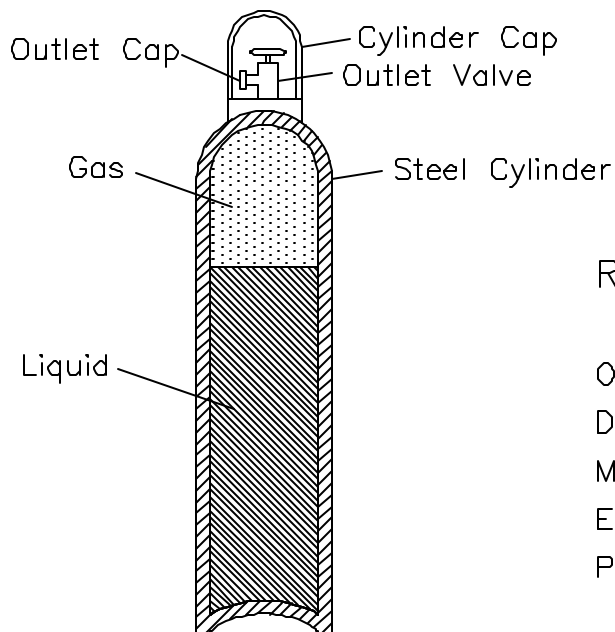
VAPORPH₃OS[®] Phosphine Fumigant is packaged in a steel compressed gas cylinder, designed, manufactured, maintained and filled in compliance with regulations established by the United States Department of Transportation (DOT). The product flows to the blending or dilution equipment through the cylinder outlet valve. As gas is withdrawn from the cylinder, some of the product vaporizes to fill the remaining space in the cylinder. Through this vaporization, the cylinder pressure is maintained.

The valve outlet fitting is a CGA350, which was established by the Compressed Gas Association (CGA). The valve outlet is protected by a threaded gas-tight outlet cap, which must be secured whenever the cylinder is not in use. Attach only CYTEC provided (or approved) blending or dilution equipment to the cylinder valve outlet to dispense VAPORPH₃OS[®] Phosphine Fumigant at the time of fumigation. Use of any other blending equipment is prohibited.

Most compressed gas cylinder valves are equipped with a safety device that releases the cylinder contents due to fire exposure or overpressurization. Because VAPORPH₃OS[®] Phosphine Fumigant is a poisonous gas, DOT regulations prohibit the use of such a device.

Each cylinder is supplied with a cylinder cap, which is designed to protect the outlet valve. This cap must be secured whenever a cylinder is not in use. It is unlawful to transport a VAPORPH₃OS[®] Phosphine Fumigant gas cylinder without the valve outlet cap and the cylinder cap securely in place.

VAPORPH₃OS[®] Phosphine Fumigant gas cylinders can only be refilled through authorized distributors. They can be filled countless times within a five-year period. Every five years, however, the cylinder is required by law to be tested by a qualified facility.



Representative Package

Overall Height: 60 inches (1.52 m)

Diameter: 9 1/4 inches (23.5 cm)

Material: Steel

Empty Weight: 138 pounds (62.6 kg)

Product Weight: 30.9 pounds (14.0 kg)

VAPORPH₃OS[®]
Fumigant Gas

WARNING: VAPORPH₃OS[®] cylinders are painted yellow. If you receive a cylinder of a different colour or without a VAPORPH₃OS[®] label do not use the cylinder. Contact your distributor or Cytec with the cylinder serial number.

3. SAFETY REQUIREMENTS AND HAZARD INFORMATION

RESTRICTED USE PESTICIDE

DUE TO ACUTE INHALATION TOXICITY OF HIGHLY TOXIC PHOSPHINE (HYDROGEN PHOSPHIDE, PH₃) GAS

For retail sale to and use only by certified applicators for those uses covered by the applicator's certification or persons trained in accordance with this product manual working under the direct supervision and in the physical presence of the certified applicator. Physical presence means on-site or on the premises. Read and follow the label and the product's Application Manual, which contains complete instructions for the safe use of this pesticide.

A. General

1. Carefully read the label and Application Manual and follow instructions explicitly.
2. Never work alone when applying fumigant.
3. Never allow untrained personnel to handle VAPORPH₃OS[®].
4. A NIOSH approved self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode must be worn in confined spaces and in fumigation structures. At least one or more employees equipped with a SCBA and trained to provide effective rescue must remain outside when employees are inside confined spaces and fumigation structures. Visual, voice or signal line communication must be maintained between these employees. This is commonly referred to as the "Buddy System". Respiratory protection devices must be used according to local regulations, including training, fit testing and medical clearance for respirator use.
5. Post VAPORPH₃OS[®] warning placards on fumigated areas, including all entrances/ exits. See Section VI of the Application Manual for specific wording that must appear on these placards. Ensure that no personnel are inside any of the structures to be fumigated prior to initiating fumigation.
6. Notify appropriate company employees and provide relevant safety information to local officials annually for use in the event of an emergency.
7. Worker exposure to phosphine must not exceed the 8-hour TWA of 0.3 ppm during application or a maximum concentration of 0.3 ppm after application is completed. This includes reentry into a structure.
8. Worker exposure to carbon dioxide must not exceed the TLV of 5,000 ppm (0.5 % by volume) during application or a maximum concentration of 5000 ppm after application is completed. This includes reentry into a structure.
9. Exposure screening of employees should be conducted to detect impaired pulmonary function. Any employees developing the above condition should be referred for medical attention.
10. Protect or remove materials containing metals such as copper, silver, gold and their alloys and salts from corrosive exposure to phosphine.
11. Do not connect cylinders to dispensing equipment until all warning placards have been posted and the space to be fumigated is clear and secured.
12. Wear protective clothing and respiratory protection as described in Section V of the Application Manual.
13. Fence-line concentrations of phosphine must never be allowed to exceed the TLV of 0.3 ppm. Large leaks must be repaired to minimize loss of fumigant and reduce risk of exposure to bystanders and/or occupants of nearby buildings.

***VAPORPH₃OS[®] does not have an expiration date. Contact CYTEC Industries Inc. for any questions ***

B. Health Hazards

VAPORPH₃OS[®] Phosphine Fumigant cylinders contain 100% wt Phosphine as liquefied gas under pressure. Phosphine is pyrophoric and will spontaneously ignite in air. With the use of Cytec approved equipment, VAPORPH₃OS[®] can be safely blended with Carbon Dioxide to less than 3% vol. or diluted with surrounding air to 1% (vol.) in order to eliminate the flammability hazard.

The current U.S. OSHA Permissible Exposure Limit (PEL) for phosphine is 0.3 ppm as an eight-hour time weighted average. The American Conference of Governmental Industrial Hygienists (ACGIH) has established a Short Term Exposure Limit (STEL) for phosphine of 1 ppm as a 15-minute time weighted average exposure. The current U.S. OSHA Permissible Exposure Limit (PEL) for carbon dioxide is 5000 ppm as an eight-hour time weighted average.

1. Phosphine

Phosphine is a colorless, flammable gas. It has been reported to have the odor of decaying fish, or the odor of garlic at concentrations below the TWA OSHA PEL. It has also been reported that workers noticed no odor when they worked in concentrations as great as 50 ppm for several minutes with no respiratory protection. This lack of detectable odor may be due to olfactory fatigue.

Phosphine gas irritates mucous membranes of the deep lungs and upper airways. Because phosphine gas reacts with moisture to form phosphoric acid when it contacts deep lung tissues, it tends to cause fluid in the lungs, known as pulmonary edema. Pulmonary irritation and pulmonary edema are the main toxic effects of phosphine inhalation exposure. Intermittent low concentration exposure may cause headaches, malaise, ringing of ears, fatigue, nausea and pressure in the chest. Moderate exposure causes weakness, vomiting, and pain just above the stomach, chest pain, diarrhea and difficulty breathing. Symptoms of severe poisoning may occur within a few hours or up to several days, resulting in pulmonary edema and may lead to dizziness, cyanosis (lack of oxygen in the blood), unconsciousness and death.

2. Carbon Dioxide

Carbon dioxide, in a liquefied state, can cause frostbite and freeze burns with contact. Carbon dioxide gas is an asphyxiant that depletes the amount of available oxygen in breathing air. Overexposure to carbon dioxide at low levels can cause headache, nausea, weakness, confusion and labored breathing. Overexposure to higher concentrations can cause excitation, euphoria, dizziness, drowsiness, and loss of consciousness, coma, and death.

C. Physical Property Hazards

Phosphine may ignite spontaneously at levels above its lower flammability limit of 1.8% (v/v). It is important not to exceed this concentration. Ignition of high concentration of phosphine can produce a very energetic reaction. Explosions can occur under these conditions and may cause severe personal injury. **Never allow the buildup of phosphine to exceed explosive concentrations.**

Phosphine gas has a low solubility in water and oils and is stable at normal fumigation temperatures. However, it may react with certain metals and cause corrosion, especially at higher temperatures and relative humidities. Metals such as copper, brass and other copper alloys, and precious metals such as gold and silver are susceptible to corrosion. Thus, small electric motors, smoke detectors, brass sprinkler heads, batteries and battery chargers, fork lifts, temperature monitoring systems, switching gears, communication devices, computers, calculators and other electronic or electrical equipment should be protected or removed before fumigation. In most cases all electronic equipment must be removed. Phosphine gas will also react with certain metallic salts and therefore, sensitive items such as photographic film, some inorganic pigments, etc., should not be exposed.

Carbon dioxide gas is colorless and odorless, and not easily detectable. Gaseous carbon dioxide is 1.5 times denser than air, and therefore will be found in greater concentrations in confined areas or low elevations. Aeration and ventilation should be designed to exhaust from the lowest level and allow make-up air to enter from the higher point. Do not depend on measuring the oxygen content of the air alone because elevated levels of carbon dioxide can be toxic, even with adequate oxygen for life support.

D. Poison Gas Hazards

Because VAPORPH₃OS[®] is a poisonous gas, care must be taken to avoid direct exposure. Although the blending equipment is designed to contain the gas, small leaks can occur. A phosphine detector must be used at

the beginning of each application to check the integrity of the equipment and any leaks must be corrected immediately. Carbon dioxide should be used to pressurize and leak-check equipment with soap solution prior to use in the field. The HDS equipment used for dilution of VAPORPH₃OS[®] with surrounding air incorporates the use of nitrogen for a variety of safety-related functions including leak-checking.

If any leak is encountered while using VAPORPH₃OS[®] Phosphine Fumigant, clear the immediate area of all personnel.

Only persons who are wearing a self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode or its equivalent are permitted in the area to address the leak. The "buddy system" described under Safety Requirements - General should be employed. Once the leak has been stopped, the area must be thoroughly ventilated and the air tested with a phosphine detector. Only after the phosphine level has dropped below the TWA of 0.3 ppm or the short-term exposure limit (STEL) of 1 ppm for 15 minutes, are unprotected personnel permitted to enter.

E. Compressed Gas Hazards

VAPORPH₃OS[®] Phosphine Fumigant cylinders and blending equipment can achieve pressures of over 1000 pounds per square inch. Because of this high pressure, care must be taken to avoid unintentional releases of the product.

1. Gas Discharge

The release of high-pressure gas can be forceful and there is potential for personal injury. High-speed discharge from unsecured flexible components such as hoses or tubing can result in a whipping action. The gas released can also propel small objects in the area. Such airborne objects can injure the eyes and bodies of people in the area.

2. Temperature

The rapid discharge of VAPORPH₃OS[®] Phosphine Fumigant through blending equipment can result in a chilling effect on parts of the equipment and cylinders. This thermodynamic effect can create temperatures low enough to cause frostbite if touched by unprotected skin. While this chilling is typically evidenced by the formation of ice on the equipment and cylinders, the cold hazard may exist without the formation of ice.

3. Residual Pressure

The chilling of cylinders is the result of the liquefied gas boiling to maintain the pressure in the gas space of the cylinder.

When the cylinder is allowed to warm, the pressure in the cylinder may rise accordingly. For this reason, all cylinders must be treated as if they contain high-pressure gas. Cylinder valves should always be closed before disconnecting the blending equipment.

Prior to the dismantling of VAPORPH₃OS[®] Phosphine Fumigant blending or dilution equipment at the conclusion of fumigation, all residual gas in the equipment should be vented to atmospheric pressure. The cylinder valve should be closed and the remaining product within the supply line discharged through the dispensing equipment. Cylinders should not be disconnected before ensuring that the line is fully vented and purged. This process is automated on the HDS equipment.

4. Liquid Expansion

VAPORPH₃OS[®] blending equipment is only designed to blend gas. Never invert the cylinder or lay the cylinder down when dispensing the gas. This may result in liquid product flowing into the blending equipment. Always ensure the cylinder is secured in an upright position.

F. First Aid Measures

IF INHALED: Remove to fresh air, to lie down and rest. If not breathing, call 911 or an ambulance, and then give artificial respiration, preferably mouth-to-mouth if possible. Keep warm. Transport to hospital or doctor. Take the label to doctor or hospital.

IF ON SKIN: May cause frostbite if contact is made with skin; treat as thermal burn. Immediately remove all contaminated clothing, including footwear. Transport to hospital or doctor.

IF IN EYES: Hold eyes open and immediately rinse continuously with cool water for at least 15 minutes. Transport to hospital or doctor.

Symptoms of overexposure to phosphine are headache, dizziness, nausea, difficult breathing, vomiting and diarrhea. In all cases of overexposure get medical attention immediately. Take victim to a doctor or emergency treatment facility.

NOTE TO PHYSICIAN: - THIS IS PHOSPHINE; IT IS NOT PHOSGENE

VAPORPH₃OS[®] **must be blended with Carbon Dioxide or diluted with air on site to produce a non-flammable mixture**. Mild exposure to this mixture by inhalation causes malaise (indefinite feeling of sickness), ringing of ears, fatigue, nausea and pressure in chest, which are relieved by removal to fresh air. Moderate poisoning causes weakness, vomiting, epigastric pain (pain just above the stomach), chest pain, diarrhea and dyspnea (difficulty in breathing). Symptoms of severe poisoning may occur within a few hours or up to several days, resulting in pulmonary edema (fluid in lungs) and may lead to dizziness, cyanosis (blue or purple skin color), unconsciousness and death.

In sufficient quantity phosphine affects the liver, kidneys, lungs, nervous system, and circulatory system. Inhalation can cause lung edema (fluid in lungs) and hyperemia (excess of blood in a body part), small perivascular brain hemorrhages and brain edema (fluid in brain). Ingestion can cause lung and brain symptoms, but damage to the viscera (body cavity organs) is more common. Poisoning may result in (1) pulmonary edema, (2) liver elevated serum GOT, LDH and alkaline phosphatase reduced prothrombin, hemorrhage and jaundice (yellow skin color) and (3) kidney hematuria (blood in urine) and anuria (abnormal or lack of urination). Pathology is characteristic of hypoxia (oxygen deficiency in body tissue). Frequent exposure over a period of days or weeks may cause poisoning. Treatment is symptomatic.

The following measures are suggested for use by the physician in accordance with the physician's own judgment:

1. Exposure of skin to rapidly evaporating liquid CO₂ may cause cryogenic "burn." Treat the "burn" in a similar manner as a thermal burn.
2. In case of freezing or cryogenic "burns" to eyes by rapidly evaporating liquid CO₂, RINSE EYES WITH COOL WATER. Do not rinse eyes with hot or even tepid water.
3. In its milder to moderate forms (symptoms of poisoning may take up to 24 hours to appear), the following is suggested:

- Complete rest 1-2 days during which the patient must be kept quiet and warm. If the patient suffers from vomiting or increased blood sugar, appropriate solutions should be administered. Treatment with oxygen is recommended, as is the administration of cardiac and circulatory stimulants.
4. In cases of severe poisoning (intensive care unit recommended):
- Where pulmonary edema is observed, steroid therapy should be considered and close medical supervision is recommended. Blood transfusions may be necessary.
 - In case of manifest pulmonary edema, venesection should be performed under vein pressure control. Heart glycosides (I.V.) can be used in case of hemoconcentration. Venesection may result in shock. In the case of progressive edema of the lungs, immediately intubate and remove edema fluid and administer oxygen over-pressure respiration, as well as any measures required for shock treatment. In case of kidney failure, extracorporeal hemodialysis is necessary. There is no specific antidote known for this poisoning.

G. Personal Protective Equipment

1. **Gloves:** It is recommended that leather work gloves or leather-faced cotton gloves be used when connecting to or disconnecting VAPORPH₃OS[®] Phosphine Fumigant cylinders from the dispensing equipment.
2. **Safety Glasses:** When working with pressurized equipment, safety glasses should be worn. Eye protection must be worn to prevent freezing or cryogenic “burns” to the eyes by rapidly evaporating liquid.
3. **Safety Shoes:** It is recommended that steel-toed safety shoes be worn by anyone handling compressed gas cylinders.

NOTE: Hand trucks are the recommended means of moving individual VAPORPH₃OS[®] Phosphine Fumigant cylinders about the fumigation site. The hand truck should be designed specifically for compressed gas cylinders and equipped with a suitable chain or strap to ensure the cylinder remains in place. Never move a VAPORPH₃OS[®] cylinder without valve cap and cylinder cap in place.

Respiratory Protection:

Respiratory protection should be available at the site when applying VAPORPH₃OS[®]. An adequate number of NIOSH approved self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode should be available. SCBA must be worn during exposure to concentrations in excess of permitted limits or when concentrations are unknown. Respiratory protection (SCBA) must be worn during trouble shooting for leaks if the concentration of phosphine is unknown or known to exceed the STELs for phosphine (1 ppm for 15 minutes) and/or carbon dioxide. Respiratory protection must be used according to local regulations, including regular training of workers in the proper use of respiratory protection equipment, medical clearance for respirator use, fit testing, inspection, maintenance, cleaning and storage of respiratory protection equipment.

4. SAFE STORAGE, HANDLING AND TRANSPORT OF CYLINDERS

A. General

The first consideration when planning a storage area for VAPORPH₃OS[®] Phosphine Fumigant cylinders is the needs of the local authorities. It is important that emergency response professionals are aware of all hazardous materials stored in their jurisdiction. They should be provided with an MSDS and detailed information on the quantities of product stored and the nature and location of the storage area.

B. Emergency Response Plan

A clearly defined emergency response plan should be developed for the site. This plan should define procedures and outline responsibilities in addressing emergency situations involving VAPORPH₃OS[®]. All site personnel should be trained in the plan and it should be practiced periodically.

Proper handling procedures as outlined in this manual must be followed. Storing cylinders with the valve discharge cap securely in place will minimize the potential for leaks. Outside storage of cylinders in a secure, well-ventilated, and preferably covered area is recommended. See Part D of this section for further information.

C. Indoor Storage

The storage of poison gases in occupied spaces is not recommended. However, indoor storage in a separate building with no other occupancy is suitable. The building should be of non-combustible construction (1 hour fire rating), adequately ventilated and equipped with a continuous phosphine monitoring and alarm system that is activated at the TLV of 0.3 ppm. Operating personnel must not enter a building, when the alarm is activated, without wearing a SCBA with full facepiece and operated in pressure-demand mode. In some jurisdictions, the indoor storage of toxic gases is prohibited.

D. Outdoor Storage

It is recommended that both full and used VAPORPH₃OS[®] cylinders be stored outdoors in a dedicated and properly designed and labeled storage area. Outdoor storage is defined as a fenced area where all sides consist of fence material or where not more than one exterior wall obstructs the flow of air with the other three sides unobstructed and open to the atmosphere.

The following are recommended for outdoor storage:

1. A firm and level surface, preferably reinforced concrete, well drained.
2. Chain link fence topped with three strands of barbed wire, with gate and lock.
3. Covered, if snow accumulation is likely to cause handling problems. Non-combustible construction.
4. Shaded, if high temperatures are expected. Non-combustible construction.
5. Protected from vehicle traffic.
6. A means of securing all cylinders.
7. Away from building ventilation intakes.
8. Equipped with a windsock to indicate wind direction.
9. Away from incompatible materials.
10. Away from flammable materials.
11. Adequate means of egress.

E. Temperature Limitations

VAPORPH₃OS[®] Phosphine Fumigant cylinders should never be stored where the temperature will exceed 125°F (51.7°C). Low temperatures will not affect VAPORPH₃OS[®].

F. Securing Cylinders

Cylinders must be stored in an upright position and protected from falling. Protection against falls can include the use of cylinder pallets with straps, walls and securing chains, or pens constructed from steel handrail or like construction.

G. Labeling of Storage

The labeling of the VAPORPH₃OS[®] cylinder storage area should take into account the needs of a variety of organizations. These should include, but not be limited to: corporate policy, insurance carrier, Occupational Safety and Health Administration (OSHA), Right to Know and local emergency response professionals. As a minimum, it is suggested that the storage be clearly marked with the following signs:

1. Danger, Poison placard (with skull and crossed bones)
2. Flammable placard
3. Authorized Personnel Only
4. NFPA Hazard Identification Symbols

The National Fire Protection Association (NFPA) developed NFPA Hazard Identification Symbols. This standardized symbol system is designed to provide, at a glance, information regarding the health, fire, and reactivity hazards associated with hazardous materials. The following are the hazard categories and degree of hazard for VAPORPH₃OS[®].

<u>Category</u>	<u>Degree of Hazard</u>
Health	3 (Extremely Hazardous)
Flammability	4 (Very Flammable Gases or Liquids)
Reactivity	1 (Unstable at High Temperatures)

Materials to properly label the storage area in compliance with NFPA standards can be purchased through most safety supply companies.

NOTE: When using the NFPA Hazard Identification System, the characteristics of all hazardous materials stored in a particular area must be considered. The local fire protection district should be consulted for guidance on the selection and placement of such signs.

H. Transportation

1. General

VAPORPH₃OS[®] Phosphine Fumigant is classified as a poison gas and flammable gas by the United States Department of Transportation (DOT) and it shall only be transported in accordance with DOT regulations. All persons involved in the transport of or the preparation of cylinders for transport should be trained in and familiar with the specifications of 49 CFR (Code of Federal Regulations).

2. Transport Designations

The following transport designations apply to VAPORPH₃OS[®]:

Proper Shipping Name:	Phosphine
Hazard Class:	2.3
Subsidiary Class	2.1
Identification Number:	UN 2199
Shipping Label:	Poison Gas Flammable Gas
Additional Description	Poison Inhalation Hazard, Zone A

3. Transport Requirements

a) Package Preparation

VAPORPH₃OS[®] Phosphine Fumigant cylinders shall not be transported unless:

- The cylinder valve is fully closed.
- The gas tight outlet cap is secured on the valve outlet.
- The cylinder cap is secured.
- The cylinder has a readable, proper shipping label.

b) Cylinder Contents

Used VAPORPH₃OS[®] cylinders can still contain residual gas, and shall be offered for transport and transported as if they are full. Check with your distributor if you have questions about shipping VAPORPH₃OS[®] cylinders.

c) Documents

Proper documentation is required by law, for the transport of any hazardous material. The documents accompanying the shipment of Phosphine (whether full, partially full, or empty) must include the labeling, a bill of lading, placard, and the MSDS. The documents must clearly identify the quantity and nature of all hazardous materials being transported or offered for transport by a second party. All persons generating such documents should be trained in their preparation.

d) Vehicle Loading

VAPORPH₃OS[®] Phosphine Fumigant cylinders shall only be loaded into unoccupied spaces of vehicles. All cylinders shall be secured from movement during transport.

e) Vehicle Placarding

Vehicles transporting VAPORPH₃OS[®] shall be placarded in accordance with Table I of 172.504 of 49 CFR. Consideration should be made for other hazardous materials that are concurrently being transported. Proper placarding should take into account all hazardous materials on board.

f) Use of Common Carriers

Shipment of VAPORPH₃OS[®] Phosphine Fumigant cylinders by common carrier is permitted, provided the carrier meets certain criteria. Contact an authorized VAPORPH₃OS[®] distributor for an approved list of common carriers.

g) Driver Qualifications

Anyone operating a vehicle that is carrying hazardous materials must be in possession of a current Commercial Drivers License (CDL) with Hazardous Material Endorsement.

5. DOSAGE AND EXPOSURE TIMES

I. Approved Target Pests

VAPORPH₃OS[®] Phosphine Fumigant will control the following pests:

Almond Moth	Angoumois Grain Moth	Bean Weevil
Cadelle	Carpet Beetle	Cereal Leaf Beetle
Cigarette Beetle	Confused Flour Beetle	Dermeid Beetle
Dried Fruit Beetle	Dried Fruit Moth	European Grain Moth
Flat Grain Beetle	Fruit Fly	Granary Weevil
Greater Wax Moth	Hairy Fungus Beetle	Hessian Fly
Khapra Beetle	Indian Meal Moth	Lesser Grain Borer
Maize Weevil	Mediterranean Flour Moth	Pea Weevil
Pink Bollworm	Raisin Moth	Red Flour Beetle
Rice Weevil	Rusty Grain Beetle	Saw-toothed Grain Beetle
Spider Beetle	Tobacco Moth	Warehouse Beetle
Yellow Meal Worm	Africanized and honeybee infested with tracheal mites	

J. Commodities

The following food commodities can be fumigated with VAPORPH₃OS[™] Phosphine Fumigant:

1. Raw Agricultural Commodities

Almonds	Pecans	Avocado
Alfalfa	Barley	Banana (includes Plantains)
Pistachio Nuts	Brazil Nuts	Popcorn
Cashews	Cabbage, Chinese	Rice
Cocoa Beans	Citrus Citron	Coffee Beans
Corn	Eggplant	Cottonseed
Dates	Endive	Filberts
Flower Seed	Grapefruit	Grass Seed
Millet	Kumquat	Dill
Okra	Lemon	Oats
Peanuts	Lettuce	Rye
Safflower Seed	Lime	Sesame Seed
Pepper	Mango	Sorghum
Soybeans	Orange	Sunflower Seeds
Triticale	Papaya	Walnuts
Wheat	Persimmon	Pimento
Salsify Tops	Sweet Potato	Tangelo
Tangerine	Tomato	
Legume Vegetables (succulent or dried)		

2. Processed Foods

The listed processed foods may be fumigated with VAPORPH₃OS[®]:

- Processed candy and sugar
- Cereal flours and bakery mixes
- Cereal foods (including cookies, crackers, macaroni, noodles, pasta, pretzels, snack foods and spaghetti)
- Processed cereals (including milled fractions and packaged cereals)
- Cheese and cheese by-products
- Chocolate and chocolate products (such as assorted chocolate, chocolate liquor, cocoa, cocoa powder, dark chocolate coating and milk chocolate)
- Processed coffee
- Corn grits
- Cured, dried and processed meat products and dried fish
- Dates
- Dried eggs and egg yolk solids
- Dried milk, dried powdered milk, nondairy creamers, and nonfat dried milk
- Dried or dehydrated fruits (such as apples, dates, figs, peaches, pears, prunes, raisins and sultanas)
- Dried and dehydrated vegetables (such as beans, carrots, lentils, peas, potato flour, potato products and spinach)
- Figs
- Malt
- Peanuts
- Processed herbs, spices, seasonings and condiments
- Processed nuts (almonds, apricot kernels, Brazil nuts, cashews, filberts, peanuts, pecans, pistachio nuts, walnuts and other processed nuts)
- Processed oats (including oatmeal)
- Rice (brewers rice grits, enriched and polished, wild rice)
- Soybean flour and milled fractions
- Processed tea
- Yeast (including primary yeast)
- Wild rice

3. Animal Feed and Feed Ingredients

All animal feed and feed ingredients.

4. Nonfood Commodities Including Tobacco

The listed nonfood items may be fumigated with VAPORPH₃OS[®]:

- Animal hide
- Processed or unprocessed cotton, wool and other natural fibers or cloth
- Clothing, feathers, furs, human hair, rubberized hair, vulcanized hair, mohair
- Leather products
- Tobacco
- Wood, cut trees, wood chips and wood and bamboo products
- Paper and paper products
- Non-food flour

- Dunnage
- Non-food starch
- Dried plants and flowers
- Seeds (grass seed, ornamental herbaceous plant seed, and vegetable seed)
- Straw or hay
- Psyllium seed and psyllium seed husks*

*Psyllium seed and Psyllium seed husks destined for shipment to pharmaceutical manufacturers may be fumigated. Such dedicated lots may be fumigated in transport vehicles (truck trailers, railcars and containers) prior to shipment. In addition, psyllium seed and husks may be fumigated at other locations only under direct instructions from the pharmaceutical company.

K. Dosage Guide

1. Recommended Dosages for VAPORPH₃OS^o

Temperature	Phosphine Concentration Maintained	Duration
Below 32°F (0°C)	Do not fumigate	Do not fumigate
32-39°F (0-4°C)	200-500 ppm	6-14 days
40-53°F (5-12°C)	200-500 ppm	4-10 days
54-59°F (12-15°C)	200-500 ppm	3-5 days
60° F-above (16°C)	200-500 ppm	2-3 days

The above table may be used as a guide in determining the minimum length of the exposure at the indicated temperatures. These are the temperatures found within the immediate surroundings of the target pest (cold walls, center of grain mass, etc.). For example, this means that 200 parts per million of phosphine from VAPORPH₃OS^o is necessary for 2-3 days at 60-68° F at the location of the pest insect. This does not mean the ambient temperature the fumigator is experiencing but the localized concentration and temperature next to the pest insects.

Some insect species and life stages are harder to kill than others. It is important that you know and understand your target pest(s). For example, over-wintering dormant larva may be more difficult to kill than an active larva of the same species. Use the maximum duration on the above table when possible. Insects, in general, are more difficult to control at lower temperatures because their respiration is slower.

Certain stored product insects are more tolerant and harder to kill. Here is a partial list of those insect species: Rice weevil, Granary weevil, Maize weevil (*Sitophilus* spp.), Lesser grain borer (*Rhyzopertha dominica*), Warehouse beetle (*Trogoderma* spp.), Carpet beetle (*Attagenus/Anthrenus* spp.), Cigarette beetle (*Lasioderma serricorne*).

Consequently, exposure periods recommended in the table are minimum periods and may not be adequate to control all stages of stored product pests under all conditions. This is particularly true at lower temperatures (below 60 degrees F) due to the lower activity and respiration levels of insects. Fumigators should be aware that different types of packaging will influence the penetration rate of the gas. Selection of appropriate exposure should be considered accordingly. The key to a successful fumigation remains with correct dosage, adequate exposure periods, proper application procedures and well-sealed enclosures.

2. Calculating the amount of VAPORPH₃OS⁰ and CO₂ required for on-site blending

The amount of VAPORPH₃OS⁰ Phosphine Fumigant and CO₂ required to perform a fumigation will depend on the tightness of the space to be treated, and the tendency for the space to lose fumigant through the duration of the fumigation. An initial dose of VAPORPH₃OS⁰ and CO₂ is used to establish a pesticidal atmosphere in the fumigation space, and through active monitoring of the phosphine concentrations, additional VAPORPH₃OS⁰ Phosphine Fumigant and CO₂ is added as required to maintain the target concentration for the prescribed time period.

The initial dose of fumigant is based on the total volume of the space to be fumigated and the target phosphine concentration desired. When blending VAPORPH₃OS⁰ Phosphine Fumigant with CO₂, it is sometimes easier to speak in terms of the amount of phosphine that is required rather than the amount of blended gas required.

One gram of phosphine (PH₃) will produce a concentration of 25 parts per million (ppm) in a volume of 1000 cubic feet (ft³). This is the fundamental conversion used when calculating the amount of VAPORPH₃OS⁰ needed to dose a space.

1 gram PH ₃ = 25 ppm PH ₃ /1000 ft ³
1 pound VAPORPH ₃ OS ⁰ = 454 grams PH ₃

To calculate the total amount of phosphine or VAPORPH₃OS⁰ required to dose a space:

Grams of PH ₃ (Target x Volume) / 25,000
“Target” is the desired phosphine concentration in parts per million (ppm).
“Volume” is the empty volume of the space to be fumigated in cubic feet (ft ³).

To calculate the amount of phosphine or VAPORPH₃OS⁰ to be added to a space to reestablish the Target concentration:

Grams of PH ₃ = (Target - Actual) x Volume / 25,000
“Target” is the desired phosphine concentration in parts per million (ppm).
“Volume” is the empty volume of the space to be fumigated in cubic feet (ft ³).
“Actual” is the measured phosphine concentration in parts per million (ppm).

As a general rule, 200 ppm of PH₃ from VAPORPH₃OS⁰ when blended with Carbon Dioxide will produce 8,000 ppm of carbon dioxide in the fumigation space.

Once the amount of Phosphine has been determined, the appropriate amount of Carbon Dioxide required can be calculated. The lower explosion limit for a blend of Phosphine in CO₂ is 3% vol Phosphine or 2.3% wt. The blending equipment is designed to produce a blend of 2.5% vol (1.9% wt) Phosphine in Carbon Dioxide. Engineering controls have been designed into the blending equipment that will prevent the Phosphine concentration from going outside the range of 2.0 – 2.9% vol (1.6 – 2.2% wt). It is recommended that twice this amount of Carbon Dioxide be available to ensure that an adequate supply is available for initial dose, redosing, and equipment purging.

$\text{lb CO}_2 \text{ requires} = \frac{\text{gms PH}_3 \text{ required} \times 2}{454 \text{ gms/lb} \times 0.019}$

When adding VAPORPH₃OS[®] to a space, the phosphine concentration should be actively monitored. This can be accomplished from outside the space by use of plastic sample tubing run through an opening and securely attached to a point inside the space. If the desired concentration is achieved before the calculated amount of VAPORPH₃OS[®] has been added, the blending of VAPORPH₃OS[®] Phosphine Fumigant with CO₂ should be stopped and the calculations should be checked. It is possible that a localized higher concentration has been detected and the gas requires more time to evenly disperse.

When a partial cylinder of VAPORPH₃OS[®] is required, the cylinder can be placed on a scale and the amount of fumigant released can be measured. The scale should have a maximum capacity for at least 200 lb (90.7 kg) to accommodate the cylinder weight. It should also have an accuracy of ± 10% of the phosphine dosage. Example: if 2.2 lb (1000 gm) of phosphine is required, the scale should have an accuracy of ± 0.22 lb (100 gm). This should ensure that the target phosphine concentration can be maintained within 10% of the desired value. The scale can also be used to check how much VAPORPH₃OS[®] Phosphine Fumigant is left in the cylinder by comparing this weight to the tare weight. The tare weight is stamped near the top of the cylinder and distinguished with the letters "TW". Subtract the tare weight from the measured weight and the difference is the amount of product left in the cylinder.

3. Calculating the amount of VAPORPH₃OS[®] required for on-site dilution with surrounding air

The amount of VAPORPH₃OS[®] Phosphine Fumigant required to perform a fumigation will depend on the tightness of the space to be treated, and the tendency for the space to lose fumigant through the duration of the fumigation. An initial dose of VAPORPH₃OS[®] is used to establish a pesticidal atmosphere in the fumigation space, and through active monitoring of the phosphine concentrations, additional VAPORPH₃OS[®] Phosphine Fumigant is added as required to maintain the target concentration for the prescribed time period.

The initial dose of fumigant is based on the total volume of the space to be fumigated and the target phosphine concentration desired. When diluting VAPORPH₃OS[®] Phosphine Fumigant with air, it is sometimes easier to speak in terms of the amount of phosphine that is required rather than the amount of blended gas required.

One gram of phosphine (PH₃) will produce a concentration of 25 parts per million (ppm) in a volume of 1000 cubic feet (ft³). This is the fundamental conversion used when calculating the amount of VAPORPH₃OS[®] needed to dose a space.

1 gram PH ₃ = 25 ppm PH ₃ /1000 ft ³
1 pound VAPORPH ₃ OS [®] = 454 grams PH ₃

To calculate the total amount of phosphine or VAPORPH₃OS[®] required to dose a space:

Grams of PH ₃ (Target x Volume) / 25,000
“Target” is the desired phosphine concentration in parts per million (ppm).
“Volume” is the empty volume of the space to be fumigated in cubic feet (ft ³).

To calculate the amount of phosphine or VAPORPH₃OS⁰ to be added to a space to reestablish the Target concentration:

$\text{Grams of PH}_3 = (\text{Target} - \text{Actual}) \times \text{Volume} / 25,000$
“Target” is the desired phosphine concentration in parts per million (ppm).
“Volume” is the empty volume of the space to be fumigated in cubic feet (ft ³).
“Actual” is the measured phosphine concentration in parts per million (ppm).

When adding VAPORPH₃OS⁰ to a space, the phosphine concentration should be actively monitored. This can be accomplished from outside the space by use of plastic sample tubing run through an opening and securely attached to a point inside the space. If the desired concentration is achieved before the calculated amount of VAPORPH₃OS⁰ has been added, the blending of VAPORPH₃OS⁰ Phosphine Fumigant with CO₂ should be stopped and the calculations should be checked. It is possible that a localized higher concentration has been detected and the gas requires more time to evenly disperse.

The HDS equipment can dispense VAPORPH₃OS⁰ based upon a preset amount of time or weight, or by weight in one gram intervals. For this reason, a scale is not required at anytime.

USAGE CHART

Grams of VAPORPH₃OS \hat{O} and CO₂ Required

Volume ft ₃	200 ppm	200 ppm	250 ppm	250 ppm	300 ppm	300 ppm	350 ppm	350 ppm	400 ppm	400 ppm	450 ppm	450 ppm	500 ppm	500 ppm
	gms Vap	lbs co2	gms Vap	lbs co2	gms Vap	lbs co2	gms Vap	lbs co2	gms Vap	lbs co2	gms Vap	lbs co2	gms Vap	lbs co2
1000	8	2	10	2	12	3	14	3	16	4	18	4	20	5
2000	16	4	20	5	24	6	28	6	32	7	36	8	40	9
3000	24	6	30	7	36	8	42	10	48	11	54	13	60	14
4000	32	7	40	9	48	11	56	13	64	15	72	17	80	19
5000	40	9	50	12	60	14	70	16	80	19	90	21	100	23
6000	48	11	60	14	72	17	84	19	96	22	108	25	120	28
7000	56	13	70	16	84	19	98	23	112	26	126	29	140	32
8000	64	15	80	19	96	22	112	26	128	30	144	33	160	37
9000	72	17	90	21	108	25	126	29	144	33	162	38	180	42
10000	80	19	100	23	120	28	140	32	160	37	180	42	200	46
20000	160	37	200	46	240	56	280	65	320	74	360	83	400	93
30000	240	56	300	70	360	83	420	97	480	111	540	125	600	139
40000	320	74	400	93	480	111	560	130	640	148	720	167	800	185
50000	400	93	500	116	600	139	700	162	800	185	900	209	1000	232
60000	480	111	600	139	720	167	840	195	960	223	1080	250	1200	278
70000	560	130	700	162	840	195	980	227	1120	260	1260	292	1400	325
80000	640	148	800	185	960	223	1120	260	1280	297	1440	334	1600	371
90000	720	167	900	209	1080	250	1260	292	1440	334	1620	376	1800	417
100000	800	185	1000	232	1200	278	1400	325	1600	371	1800	417	2000	464
200000	1600	371	2000	464	2400	556	2800	649	3200	742	3600	835	4000	927
300000	2400	556	3000	696	3600	835	4200	974	4800	1113	5400	1252	6000	1391
400000	3200	742	4000	927	4800	1113	5600	1298	6400	1484	7200	1669	8000	1855
500000	4000	927	5000	1159	6000	1391	7000	1623	8000	1855	9000	2087	10000	2319
600000	4800	1113	6000	1391	7200	1669	8400	1948	9600	2226	10800	2504	12000	2782
700000	5600	1298	7000	1623	8400	1948	9800	2272	11200	2597	12600	2921	14000	3246
800000	6400	1484	8000	1855	9600	2226	11200	2597	12800	2968	14400	3339	16000	3710
900000	7200	1669	9000	2087	10800	2504	12600	2921	14400	3339	16200	3756	18000	4173
1000000	8000	1855	10000	2319	12000	2782	14000	3246	16000	3710	18000	4173	20000	4637

6. FUMIGATION MANAGEMENT PLAN

A. Purpose

The United States Environmental Protection Agency will soon require all people using Phosphine to implement and maintain a Fumigation Management Plan (FMP). The certified applicator is responsible for working with the owners and/or responsible employees of the site to be fumigated to develop a FMP. The FMP is intended to ensure a safe and effective fumigation. The FMP must address characterization of the site, and include appropriate monitoring and notification requirements, consistent with, but not limited to, the following:

1. Inspect the site to determine its suitability for fumigation.
2. When sealing is required, consult previous records for any changes to the structure, seal leaks, and monitor any occupied adjacent buildings to ensure safety.
3. Prior to each fumigation, review any existing FMP, MSDS, Applicators' Manual and other relevant safety procedures with company officials and appropriate employees.
4. Consult company officials in the development of procedures and appropriate safety measures for nearby workers that will be in and around the area during application and aeration.
5. Consult with company officials to develop an appropriate monitoring plan that will confirm that nearby workers and bystanders are not exposed to levels above the allowed limits during application/aeration. This plan must also demonstrate that nearby residents will not be exposed to concentrations above the allowable limits.
6. Consult with company officials to develop procedures for local authorities to notify nearby residents in the event of an emergency.
7. Confirm the placement of placards to secure entrance into any area under fumigation.
8. Confirm the required safety equipment is in place and the necessary manpower is available to complete a safe, effective fumigation.

Extinguish **all** flames from areas to be fumigated as well as adjoining areas. When Phosphine is burned phosphoric acid can be generated.

These factors should be considered in putting a FMP together. It is important to note that some plans will be more comprehensive than others. All plans should reflect the experience and expertise of the applicator and circumstances at and around the site.

In addition to the plan, the applicator must read the entire label and follow its directions carefully. If the applicator has any questions about the development of a FMP, contact Cytec Canada Inc. for further assistance.

The FMP and related documentation, including monitoring records, must be maintained for a minimum of 2 years.

B. Materials Sensitive to Phosphine

- Soft metals: copper, copper alloys, gold, silver, brass, bronze
- Equipment containing soft metals: telephones, phone boards, computers, copy machines, fax machines, and all other devices with circuit boards
- Activated charcoal
- Live plants

- Animals and fish
- Brass sprinkler heads
- Welding rods
- Film: undeveloped film and video tapes

This list does not identify all equipment and materials sensitive to Phosphine. Please inventory all supplies, equipment, and materials and cross check the above materials. If you have any questions regarding the sensitivity of equipment and materials to Phosphine, please feel free to contact Cytec Canada Inc. or an approved distributor. See Appendix 1 for contact list.

C. Guidance For Preparation of a Fumigation Management Plan

A Fumigation Management Plan (FMP) is an organized, written description of the required steps involved to help ensure a safe, legal, and effective fumigation. It will also assist you and others in complying with pesticide product label requirements. The guidance that follows is designed to help assist you in addressing all the necessary factors involved in preparing for and fumigating a site.

This guidance is intended to help you organize any fumigation that you might perform **PRIOR TO ACTUAL TREATMENT**. It is meant to be somewhat prescriptive, yet flexible enough to allow the experience and expertise of the fumigator to make changes based on circumstances which may exist in the field. By following a step-by-step procedure, yet allowing for flexibility, safe and effective fumigation can be performed.

Before any fumigation begins, carefully read and review the label and the Applicator's manual. This information must also be given to the appropriate company officials (supervisors, foreman, safety officer, etc.) in charge of the site. Preparation is the key to any successful fumigation. If the type of fumigation that you are to perform is not listed in this Guidance document you will want to construct a similar set of procedures. Finally, before any fumigation begins you must be familiar with and comply with all applicable state and local laws. The success and future of fumigation are not only dependent on your ability to do your job but also by carefully following all rules, regulations, and procedures required by governmental agencies.

D. A Checklist For a Fumigation Management Plan

This checklist is provided to help you take into account factors that must be addressed prior to performing all fumigations. It emphasizes safety steps to protect people and property. The checklist is general in nature and cannot be expected to apply to all types of fumigation situations. It is to be used as a guide to prepare the required plan. Each item must be considered, however, it is understood that each fumigation is different and not all items will be necessary for each fumigation site.

A. Preliminary Planning and Preparation

1. Determine the purpose of the fumigation
 - a. Elimination of insect infestation
 - b. Elimination of rodent infestation
 - c. Plant pest quarantine
2. Determine the type of fumigation, for example:
 - a. Space: tarp, mill, warehouse, food plant
 - b. Vehicle: railcar, truck, van, container

- c. Commodity: raw agricultural or processed foods
- d. Grain: vertical silo, farm storage, flat storage
- e. Vessels: ship or barge. In addition to the Applicator's Manual, read the US Coast Guard Regulations 46CFR 147A

3. Fully acquaint yourself with the site and commodity to be fumigated, including:
 - a. The general structure layout, construction (materials, design, age, maintenance) of the structure, fire or combustibility hazards, connecting structures and escape routes, above and below ground, and other unique hazards or structure characteristics. Prepare, with the owner/operator/person in charge. Draw or have a drawing or sketch of structure to be fumigated, delineating features, hazards, and other structural issues.
 - b. The number and identification of persons who routinely enter the area to be fumigated (i.e., employees, visitors, customers, etc.)
 - c. The specific commodity to be fumigated, its mode of storage, and its condition
 - d. The previous treatment history of the commodity, if available
 - e. Accessibility of utility service connections
 - f. Nearest telephone or other means of communication, and mark the location of these items on the drawing/sketch
 - g. Emergency shut-off stations for electricity, water and gas. Mark the location of these items on the drawing/sketch
 - h. Current emergency telephone numbers of local health, fire, police, hospital and physician responders
 - i. Name and phone number (both day and night) of appropriate company officials
 - j. Check, mark and prepare the points of fumigation dispensing location
 - k. Review labeling
 - l. Exposure time considerations:
 - Fumigant to be used
 - Minimum fumigation period, as defined and described by the label use directions
 - Down time required to be available
 - Aeration requirements
 - Equipment cleanup requirements
 - Measured and recorded commodity temperature and moisture
 - m. Determination of dosage
 - cubic footage or other appropriate space/location
 - structure sealing capability and methods
 - label recommendations
 - temperature, humidity, wind
 - commodity/space volume
 - past history of fumigation of structure
 - exposure time

B. Personnel

1. Confirm in writing that all personnel in and around the area to be fumigated have been notified prior to application of the fumigant. Consider using a checklist each one initials indicating they have been notified.
2. Instruct all fumigation personnel about the hazards that may be encountered; and about the selection of personal protection devices, including detection equipment
3. Confirm that all personnel are aware of and know how to proceed in case of an emergency situation

4. Instruct all personnel on how to report any accident and/or incidents related to fumigant exposure. Provide a telephone number for emergency response reporting
5. Instruct all personnel to report to proper authorities any theft of fumigant and/or equipment related to fumigation
6. Establish a meeting area for all personnel in case of emergency

C. Monitoring

1. Safety
 - a. Monitoring must be conducted in areas to prevent excessive exposure and to determine where exposure may occur. Document where monitoring will occur.
 - b. Keep a log or manual of monitoring records for each fumigation site. This log must at a minimum contain the timing, number of readings taken and level of concentrations found in each location.
 - c. When monitoring log records, document there is no phosphine present above the safe levels; subsequent monitoring is not routinely required. However, spot checks should be made occasionally, especially if conditions significantly change
 - d. Monitoring must be conducted during aeration and corrective action take if gas levels exceed the allowed levels in an area where bystanders and/or nearby residents may be exposed.
2. Efficacy
 - a. Gas readings should be taken from within the fumigated structure to insure proper gas concentrations. If the phosphine levels have fallen below the targeted level the fumigators should dispense additional VAPORPH₃OS[®] to maintain the desired levels.
 - b. Document readings

D. Notification

1. Confirm all local authorities (fire departments, police departments, etc.) have been notified as per label instructions, local ordinances if applicable, or instructions of the client.
2. Prepare written procedure (“Emergency Response Plan”) which contains explicit instructions, names, and telephone numbers so as to be able to notify local authorities if phosphine levels are exceeded in an area that could be dangerous to bystanders.

E. Sealing Procedures

1. Sealing must be complete
2. If the site has been fumigated before, review the previous FMP for previous sealing information
3. Make sure that construction/remodeling has not changed the building
4. Warning placards must be placed on every possible entrance to the fumigation site

F. Application Procedures and Fumigation Period

1. Plan carefully and apply VAPORPH₃OS[®] in accordance with the label requirements
2. When entering into the area under fumigation, always work with two or more people under the direct supervision of a certified applicator wearing appropriate respirators
3. Apply fumigant from the outside where appropriate
4. Provide watchmen when a fumigation site cannot otherwise be made secure from entry by unauthorized persons
5. When entering structures always follow OSHA rules for confined spaces

6. Document that the receiver of in-transit fumigation has been notified and is trained to receive commodity under fumigation

G. Post-Application Operations

1. Provide watchmen when you cannot secure the fumigation site from entry by unauthorized persons during the aeration process
2. Ventilate and aerate in accordance with structural limitations
3. Turn on ventilating or aerating fans where appropriate
4. Use a suitable gas detector before reentry to determine fumigant aeration
5. Keep written records of monitoring to document completion of aeration
6. Consider temperature when aerating
7. Insure aeration is complete before moving vehicle into public roads
8. Remove warning placards when aeration is complete
9. Inform business/client that employees/other persons may return to work or otherwise be allowed to reenter

Sample Fumigation Notice

NOTICE OF FUMIGATION

The purpose of this notice is to inform you of the upcoming fumigation at your facility. The treatment will be performed with phosphine. We will use the utmost care in performing a safe and effective fumigation. If you have any questions regarding the fumigation please contact your supervisor. MSDS forms have been provided to your company.

SAFETY: _____ will make sure your work environment is safe for you to re-enter after the fumigation. Never enter a building with fumigation warning signs taped to the door. If you see these signs contact your supervisor immediately but **do not enter**. Gas monitoring devices are used to test your work areas and document clearance.

VEHICLES: You must remove your vehicle from the company parking areas prior to the fumigation.

BUILDING ACCESS: By no means will someone be allowed to enter any of the buildings being treated or structures connected to buildings being treated until after complete aeration.

FUMIGATION DATES:

FROM: _____ **TO** _____

7. SEALING OF FUMIGATION SPACE

Good sealing is necessary for an effective fumigation. Turn off all ventilation, supply air, air conditioning, and any other air moving systems which could negatively effect the fumigation. Thoroughly inspect the fumigation chamber/area and seal all cracks, holes and openings. These areas could include, but are not limited to: windows, doors, vents, chimneys and structural flaws. Sealing techniques can vary, but most often include polyethylene sheeting, adhesive tapes and adhesive sprays. Expandable foam or caulking material can work well on structural flaws. Proper sealing will insure

sufficient gas levels within the fumigated area and will decrease the chance of unwanted exposure outside of the fumigated area.

A. Tapes

The material most useful in sealing windows, doors, etc. in structures is masking tape. Masking tape is sold in varying widths and materials. It can be a paper, cloth or vinyl material and can be 2" – 6" in width. The larger widths are extremely useful in sealing large gaps around doors etc. Tapes have a great advantage of adhering to all types of surfaces and can usually be removed without damaging them. Upon removing masking tape from a protected surface, care should be taken not to damage the finish.

B. Polyethylene Sheeting

Polyethylene sheeting is one of the most common materials used in the process of making a structure gas-tight. The polyethylene sheeting can be easily cut to any size and attached to most openings leading to the outdoors or non-fumigated areas. Although a 6-mil thick plastic will contain gas better than a 4 mil or a 2-mil plastic, generally speaking, anything over a 2-mil thickness of polyethylene sheeting will be sufficient to contain lethal doses of fumigant. None of these thicknesses of polyethylene sheeting completely block off the escape of fumigant, they merely slow down the escape of the fumigant.

Polyethylene sheeting can be attached to structures, chimneys, vents and windows in many different ways. The most common way of attaching polyethylene sheeting to a flat surface is with the assistance of an aerosol spray adhesive and tape. The area around the opening to be sealed is lightly coated with spray adhesive. The polyethylene sheeting is cut to size slightly larger than the opening being covered and placed over the opening. Another light coating of spray adhesive is applied around the edges of the polyethylene sheeting. Finally, a 2"+ cloth, vinyl or thick paper tape is applied to connect the polyethylene sheeting to the flat surface. The area of adhesion is smoothed out by hand to insure it is adequately connected.

In order to seal off chimneys or smoke stacks, the polyethylene sheeting can be placed over the horizontal opening and secured to the smokestack or chimney with strapping tape. Again, a spray adhesive will help hold the sheeting in place. The strapping tape should be wrapped 6"– 12" below the stack opening and should be wrapped around 10 or more times depending on the wind and weather conditions. **We must note here that polyethylene sheeting is an unacceptable sealing material for areas that will reach temperatures high enough to melt the polyethylene. Particularly, smoke stack which just recently been in use or active steam pipes. A non-flammable foil batting can be used in these extremely hot conditions.

The fumigator should make certain that there are no conduits, openings, pipes, etc., which lead from the building. Since it is often difficult to determine if two or more structures are connected to one sewer or electrical conduit line, any sewer drains or conduit lines leading out of the structure should be sealed with tape or water filled balloons.

C. Other Materials

Expandable foam or other building materials can be used to permanently seal off structural flaws or openings. Rather than individually sealing openings to a structure, an alternate method is to cover the structure with large vinyl laminated nylon tarpaulins. Although these tarps are heavy and can be difficult to work with, they are reusable and more manageable in the wind. Tarps are usually laid out

and adjoining edges are rolled together and clamped. Sand snakes (Tubes filled with sand or water) are used to affect a seal to the ground.

CAUTION: The dispensing of VAPORPH₃OS[®] can cause a pressure increase in a tightly sealed fumigation space. A perfectly sealed space will see an increase of 8 inches of water pressure (0.3 psi) when blending VAPORPH₃OS[®] and CO₂ at 500 ppm phosphine concentration. When diluting VAPORPH₃OS[®] with air, this pressure can reach a maximum of 20 inches of water pressure (0.7 psi). This pressure increase can cause failure of the seal material and bonding areas. It is advisable to have a vent area in one or more of the openings to the space to allow air to escape as VAPORPH₃OS[®] is applied. This space can be sealed after the target concentration has been achieved.

8. BLENDING VAPORPH₃OS[®] PHOSPHINE FUMIGANT

A. General Statement

The following instructions are intended to provide general guidelines for typical fumigation. There are a number of critical factors involved in the design of blending equipment. As such, blending equipment must meet both high-pressure standards and chemical compatibility requirements. Improper or inappropriate use of blending equipment may result in severe injury or death. Application inconsistent with the labeling and Application Manual is a violation of Federal law. Buyer assumes all risk should the product be used contrary to label or Application Manual instructions.

B. Equipment Specification and Use

1. General

The equipment used to blend VAPORPH₃OS[®] on-site with CO₂ or dilute with surrounding air into a non-flammable gas mixture provides a means of containing the gas during the application and controlling the release of the product into the desired space. While some blending equipment has been developed and used to date, it cannot be expected to cover all possible fumigation scenarios. The development of suitable blending equipment is an ongoing process, based on the needs of the users and available technology.

The design of blending equipment must account for a number of technical issues, including pressure rating, material compatibility, temperature limitations and operator safety, and controlling the phosphine concentration between 2.0 - 2.9% vol. for CO₂ blending and less than 10,000 ppm (1% vol) for dilution with air. For this reason, only Cytec-approved equipment should be used in the blending of VAPORPH₃OS[®]. Only persons trained in the proper use of VAPORPH₃OS[®] and the dispensing equipment shall be permitted to use VAPORPH₃OS[®] for fumigation. These persons must also be licensed pesticide applicators.

The instruction materials provided with the blending equipment or dilution equipment should be consulted for their proper use and maintenance. FOSFOQUIM will provide training and written instructions for the use and maintenance of their HDS equipment.

2. Unapproved Dispensing Methods

It has been common practice, with other cylinderized fumigants, to place the cylinder in the space to be fumigated and the cylinder outlet valve opened to allow the fumigant to release. This is not an

approved dispensing method and should not be used with VAPORPH₃OS[®]. VAPORPH₃OS[®] Phosphine Fumigant is pyrophoric and will spontaneously ignite in air. VAPORPH₃OS[®] must be properly blended with Carbon Dioxide or diluted with air to eliminate the flammability hazard.

3. Approved Blending Methods

VAPORPH₃OS[®] and approved dispensing equipment is generally used for mid-to-large scale fumigations that would otherwise require the use of multiple ECO₂FUME[®] preblended cylinders. Some facilities may have bulk Carbon Dioxide storage tanks on site.

The approved blending equipment has incorporated required safety features to properly blend Phosphine and Carbon Dioxide into a non-flammable mixture with a Phosphine concentration between 2.0 – 2.9% vol.

Fumigant grade Phosphine gas (VAPORPH₃OS[®]) from high-pressure cylinders flows into the blender unit where it combines with Carbon Dioxide gas sourced from bulk storage, mobile bulk truck, semi-bulk or cylinders.

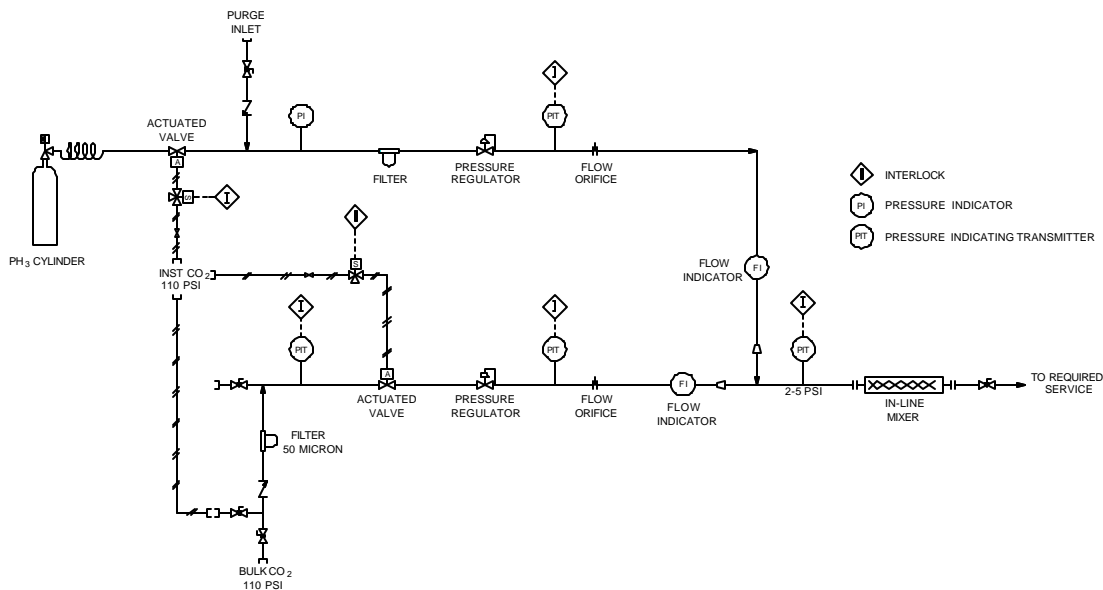
Various models of on-site blending equipment have been designed, built and tested. All of the designs have incorporated engineering safeguards to ensure that the blended product is a non-flammable mixture.

One design (see diagram that follows) uses a pressure regulator and flow control orifice on both the VAPORPH₃OS[®] and CO₂ gases to control the flow rate and properly blend VAPORPH₃OS[®] with Carbon Dioxide. The size of each orifice is engineered for a specific fixed flow rate and therefore the blending rate cannot be adjusted. By controlling the pressure drop across the orifice plates, the Phosphine concentration can be controlled around 2.5% vol. Engineering controls have been designed into the blending units that will prevent the Phosphine concentration from going outside the range of 2.0 – 2.9% vol (1.6 – 2.2% wt).

A more sophisticated design uses mass meters, control valves and the electronics to allow an adjustable blending rate while maintaining the proper blend of Phosphine. Engineering controls have been designed into the blending units that will prevent the Phosphine concentration from going outside the range of 2.0 – 2.9% vol (1.6 – 2.2% wt). Mass meters are employed in the design, therefore, the concentration can be precisely controlled to 2.6% vol (2.0% wt). The product from this equipment is equivalent to Cytec's ECO₂FUME[®] fumigant gas.

Blending equipment is intended for use at large facilities that have on-site CO₂ bulk storage and vaporizing equipment, or at facilities where it is feasible to bring in bulk CO₂ and vaporizing equipment for the fumigation. The blending equipment is designed for use only with Carbon Dioxide gas, therefore, a bulk supply of liquid CO₂ must be equipped with suitable vaporizing equipment. Contact Cytec Industries Inc. for blending equipment design specifications and recommendations. For smaller fumigation jobs, it is recommended that pre-blended ECO₂FUME[®] cylinders be used.

DIAGRAM OF A REPRESENTATIVE TYPE OF VAPORPH₃OS⁰ BLENDING EQUIPMENT FOR USE WITH CO₂



The HDS equipment is designed to dilute pure phosphine gas in a moving air stream to a concentration of 10,000 ppm (1% vol.) or less. This will ensure that the delivered fumigant is well below the LFL of 1.8% (v/v) for phosphine. The equipment is designed to be portable and requires a source of electricity and a Nitrogen cylinder for purging and pressure checking the equipment. The system is controlled by a PLC and has numerous automatic safeguards built-in to prevent incidents. Contact FOSFOQUIM for HDS equipment design specifications and recommendations.

4. Cylinder Valve Connection

The CGA 350 cylinder valve connection is a metal to metal seal. NO gasket is required. NO teflon tape is required. The recommended “sealing” torque is 35 ft-lb. to a maximum of 50 ft-lb. torque. Applied “sealing” torques significantly less than 35 ft-lb. may not be sufficient to consistently accomplish a leak-tight connection. Applied torques greater than 50 ft-lb. may shorten the life of the connecting parts. It is the responsibility of the end user to verify the leak integrity of a connection before opening the cylinder valve.

5. Leak Testing

It is the responsibility of the end user to verify the leak integrity of all connections and fittings before opening the cylinder valve. A soap solution such as “snoop” must be used to check the integrity of the cylinder connection and all other fittings in the dispensing equipment. Using a cylinder of CO₂,

nitrogen, helium or other inert gas, the appropriate regulator and a flexible connection, the dispensing equipment may be pressurized to several hundred psig. Apply the soap solution to all possible leak points and observe any formation of bubbles that would indicate a leak. Repair all leaks before opening the cylinder valve. If phosphine is detected in the area after the cylinder valve is opened, close the cylinder valve and leak test the system again. Repair all leaks before proceeding.

6. Troubleshooting

This section is provided to assist in addressing problems that may be encountered while using VAPORPH₃OS[®] Phosphine Fumigant cylinders. When troubleshooting leaking cylinders, SCBA is required when levels of phosphine are unknown, or known to exceed the short-term exposure limits (STEL; 1 ppm for phosphine). Troubleshooting assistance for a particular piece of dispensing equipment is addressed in the respective equipment manual. Questions for problems other than those listed below, should be directed to the authorized VAPORPH₃OS[®] distributor.

a) Condensation is forming on the outside of the cylinder

This is normal. As the fumigant is removed from the cylinder, the liquefied phosphine boils to maintain the pressure in the cylinder gas space. This results in a chilling of the cylinder, and the condensing of moisture from the air.

b) Ice has formed on the bottom of the cylinder

This is normal. The liquid Phosphine that remains in the cylinder must vaporize in order to be released. If the withdrawal rate is high enough, the temperature that results from chilling can be below the freezing point for water. Instead of ambient moisture simply condensing, it freezes on the cylinder surface.

c) There is a leak at the cylinder valve

REFER TO SECTION 12 EMERGENCY RESPONSE.

(a) There is a leak at the cylinder valve outlet.

- i) If the cylinder is attached to the dispensing equipment: The connection to the valve outlet might be the problem. If tightening (but not over-tightening) the outlet connection does not solve the problem, close the cylinder valve and use the blending equipment to vent the remaining fumigant in the line. Purge the equipment, then disconnect the connection to the cylinder and inspect the fitting and valve outlet for damage. If the fitting is damaged, replace it. If the valve outlet is damaged, do not use the cylinder. Install the valve outlet plug and attach a tag to the cylinder conspicuously indicating “Bad Valve Outlet” and return it.
- (ii) If the cylinder is not attached to the blending equipment: Check to see if the cylinder valve is fully closed. If it is fully closed and the leak continues, the cylinder should be moved to a well-ventilated area, away from personnel. Refer to Spill and Leak Procedures, , Section XIV

(a) The leak is not at the cylinder valve outlet.

Assistance is required. Refer to Spill and Leak Procedures, Section XIV.

d) Gas is not dispensing

Check to see if the cylinder is empty. Weigh the cylinder (without the cap) and compare it to the cylinder tare (empty) weight. The tare weight is stamped near the top of the cylinder and distinguished with the letters "TW". Subtract the tare weight from the measured weight. The difference is the amount of product in the cylinder. If there is a weight difference, then the cylinder has product and the outlet valve is faulty. Do not attempt to use the cylinder. Attach a tag to the cylinder indicating "bad valve" and return it to your distributor. Consult the blending equipment instructions for troubleshooting.

e) Loss of CO₂ Supply

The CO₂ blending equipment is designed to automatically shut down if the Carbon Dioxide supply pressure is lost or is insufficient. Close the phosphine cylinder discharge valve and discontinue operating the blending equipment until problems with the CO₂ supply are resolved. Contact the CO₂ equipment supplier for help in troubleshooting supply problems.

C. Application to Bulk Commodities

1. General

VAPORPH₃OS[®] Phosphine Fumigant can be used to fumigate any type of storage used to hold listed bulk commodities. These include, but are not limited to bins, tanks, flat storage, and bunkers. The most important aspects of a successful fumigation, as with any fumigant, are the degree to which the space is sealed and the assurance that the minimum fumigant concentrations are maintained for the required time.

2. Procedure for Fumigating Bulk Commodities

1. Prepare a Fumigation Management Plan.
2. Determine the target phosphine concentration desired and the duration of the fumigation based on area fumigated, the insect pest(s) involved, and the prevailing temperatures.
3. Calculate the empty volume space to be treated.
4. Calculate how much VAPORPH₃OS[®] (and CO₂, if applicable), will be required
5. Determine where the fumigant will be dispensed into the space, and plan for and install required equipment.
6. Gas monitoring should be performed from outside the fumigated structure. Polyethylene tubing is used for remote monitoring. This tubing can be run from each area of the fumigation to an outside location where gas samples can be taken safely. At least one monitoring line should be run in each fumigated structure. In the event of multi-floored structures or compartmentalized buildings, monitoring should be performed in all major areas of the fumigated structure. Fans can be used to help distribute gas into smaller areas and the outer reaches of these structures.
7. Isolate and seal all connections to other storage and spaces that are not intended for fumigation.
8. Seal all openings including cracks, windows, doors, vents, eaves, hatches, loading and unloading connections and ventilation fans. Seal all penetrations used for fumigant dispensing and monitoring. Use proper safety equipment and entry procedures if confined space entry is required.
9. Lock all entrances to the space.

10. Ensure that all personnel, animals, and damageable goods are clear of the space to be treated and post fumigation placards on all points of access and any unloading penetrations.
11. Verify that all required safety equipment is available and in good working order.
12. Notify all personnel in nearby buildings at the facility that fumigant release is about to commence.
13. Connect the VAPORPH₃OS[®] cylinders (and CO₂ source if applicable) to the dispensing equipment.
14. Purge and leak test the blending equipment.
15. Dispense the initial dose of fumigant.
16. Periodically monitor the phosphine concentrations within the space, using suitable gas detection equipment, to ensure that the minimum concentrations are being maintained. During and immediately after dispensing VAPORPH₃OS[®] Phosphine Fumigant with either CO₂ or air, the fumigation area should be monitored hourly for Phosphine concentrations until stabilized. If concentration is falling rapidly, the applicator should investigate the structure for possible leak points. Seal any leak points found. In a well-sealed structure, the Phosphine concentration should stabilize quickly and monitoring frequency can be reduced to daily measurements. The sampling frequency should be adjusted and additional VAPORPH₃OS[®] Phosphine Fumigant added as required to ensure the desired Phosphine concentrations are maintained during the fumigation period.
17. Blend and dispense additional fumigant as required to maintain the desired phosphine concentrations.
18. When no further fumigant is required, close all cylinder valves (and CO₂ source if applicable). Depressurize the dispensing equipment and disconnect all VAPORPH₃OS[®] cylinders (and CO₂ source if applicable). Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
19. When the fumigation is complete, unseal the space and aerate (see VIII, AERATION OF FUMIGATED COMMODITIES and IX.E. AERATION AND REENTRY). Recheck barricades and placards at all open entries into the space to prevent entry by unauthorized personnel. Use suitable gas detection equipment to check both the carbon dioxide and phosphine concentrations before allowing entry into the space. Use appropriate breathing apparatus and entry procedures to avoid undue worker exposure.

Additional Considerations:

1. Dispensing and monitoring lines should be installed with loading, unloading and other operations in mind. If frequent fumigations are expected, permanently mounted lines should be secured within the space. If temporary lines are to be used, they should be installed so they can easily be removed at the end of the fumigation.
2. The use of additional tarpaulins or plastic sheeting atop the commodity should be considered, if there is a substantial open space above the stored product. This will help minimize the loss of phosphine from the commodity and the total amount of fumigant required.
3. Recirculation of fumigant by specially installed small blowers is an excellent means of distributing the fumigant gas throughout the space being treated. The use of existing aeration blowers is not suggested since their capacity is often so high that it assists in the loss of the fumigant. Small commercial blowers can be used to recirculate the atmosphere within the space being treated. Blended or diluted VAPORPH₃OS[®] can be dispensed into the discharge of recirculation blowers. The blowers should not be run continuously, but long enough to ensure good fumigant distribution and each time fumigant is added.

4. For large storage facilities, multiple dispensing points should be considered to assist in the distribution of the fumigant.

D. Application to Space Fumigations

1. General

VAPORPH₃OS[®] Phosphine Fumigant can be used to fumigate any type of space (empty or full) where listed commodities are stored or processed, except barges. These include, but are not limited to mills, warehouses, processing facilities, packaging plants and other empty structures. The most important aspects of a successful fumigation, as with any fumigant, are the degree to which the space is sealed and the assurance that the minimum fumigant concentrations are maintained for the required time.

2. Procedure for Fumigating Spaces

1. Prepare a Fumigation Management Plan.
2. Determine the target phosphine concentration desired and the duration of the fumigation. This should be based on the target pests and the temperature of the space.
3. Calculate the empty volume of the space to be treated.
4. Calculate how much VAPORPH₃OS[®] (and carbon dioxide if applicable) will be required.
5. Determine where the fumigant will be dispensed into the space, and plan for and install required components. Dispensing points should not be located in or attached to commodity packages. Direct the discharge toward the center of the space being treated and away from equipment if possible.
6. Determine the number and location of circulating fans. Low speed fans should be placed on the floor and angled upwards. A means of turning the fans off from outside the treated space should be provided.
7. Determine where the fumigant concentrations will be measured (if used) and plan for and install required gas sampling lines.
8. Identify one access door and lock all others. Lock all ground level and other accessible windows if possible.
9. Except for the access door, seal all openings including cracks, windows, doors, vents, eaves, ventilation fans and points of material transfer. Seal all penetrations used for fumigation dispensing and monitoring. Isolate and seal all connections to other spaces that are not intended for fumigation.
10. Remove from the space or protect sensitive equipment, material and food.
11. Ensure that all personnel, animals and damageable goods are clear of the space to be treated and post fumigation placards on and lock all points of access. The only exception to this is silo complexes connected by tunnels. Separate ventilation and monitoring must be in place to protect workers in adjacent areas.
12. Close, lock, seal, and placard the access door.
13. Verify that all required safety equipment is available and in good working order.
14. Notify all personnel that fumigant release is about to commence.
15. Connect the VAPORPH₃OS[®] cylinder (and CO₂ source if applicable) to the blending equipment.
16. Purge and leak test the blending equipment.
17. Dispense the initial required dose of fumigant.
18. Periodically monitor the phosphine concentrations within the space using suitable gas detection equipment, to ensure that the minimum concentrations are being maintained.
19. Blend and dispense additional fumigant as required to maintain the desired phosphine concentrations.

20. When no further fumigant is required close all cylinder valves. Depressurize and purge the blending equipment and disconnect all VAPORPH₃OS[®] cylinders (and CO₂ source if applicable). Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
21. When the fumigation is complete, unseal the space and aerate (see VIII AERATION OF FUMIGATED COMMODITIES and IX.E. AERATION AND REENTRY). Barricade and placard all open entries into the space to prevent entry by unauthorized personnel. Use suitable gas detection equipment to check both the carbon dioxide and phosphine concentrations before allowing entry into the space. Use appropriate breathing apparatus and entry procedures to avoid undue worker exposure.
22. Remove all dispensing and gas monitoring lines.
23. Workers should be aware that some residual gas may be entrapped within the fumigated commodity container (i.e., bagged product such as SUPERSACKS). Adequate monitoring and aeration must be performed to reduce any residual phosphine levels to below 0.3 ppm.

E. Application to Tarpaulin Fumigations

1. General

VAPORPH₃OS[®] Phosphine Fumigant can be used to fumigate stacked materials by covering the material with a tarpaulin made from plastic sheeting. This allows the fumigant to be contained to the treated material only. The most important aspects of a successful fumigation, as with any fumigant, are the degree to which the space is sealed and the assurance that the minimum fumigant concentrations are maintained for the required time.

2. Procedure for Tarpaulin Fumigations

1. Prepare a Fumigation Management Plan.
2. Determine the target phosphine concentration desired and the duration of the fumigation. This should be based on the target pests and the temperature of the material being treated.
3. Since the volume of tarped materials can vary widely, it is important to make a good estimate of the volume enclosed by the tarp. Calculate the volume taken up by the material itself (palletized stacks for example) or any containers used to hold it. After tarping is complete, revise the volume estimate based on the additional space contained within the tarp.
4. Calculate how much VAPORPH₃OS[®] Phosphine fumigant gas (and carbon dioxide if applicable) will be required, based on the volume calculation.
5. Determine where the fumigant will be dispensed into the space, and plan for and install required components. Dispensing points should not be located in or attached to commodity packages or within containers.
6. Determine where the fumigant concentrations will be measured and plan for and install required gas sampling lines. Sampling points should not be located near dispensing points to avoid incorrect readings.
7. Cover the material with plastic sheeting using tape, glue or clamps to join individual sheets. If the flooring on which the material is placed is wood or other porous material, it should be covered first with plastic sheeting. Seal the plastic covering to the floor using tape, glue, sand or water “snakes”, shoveling sand or soil onto the ends of the plastic, or by other suitable means. Reinforce by tape or other means, any sharp corners or edges to reduce the risk of tearing the plastic. Plastic sheeting should be a minimum of 2-mil thickness for indoor applications however, 4-mil is preferred and is more suitable for outdoor use. Ensure that tarp penetrations for dispensing and monitoring are well sealed.

8. Placard the tarped material.
9. Verify that all required safety equipment is available and in good working order.
10. Notify all personnel that fumigant release is about to commence. For the case of indoor tarp fumigations, the area surrounding the material being treated should be monitored for phosphine and carbon dioxide concentrations to ensure that workers are not unduly exposed. It is required that all personnel not trained or involved in execution of the fumigation be restricted from entering the area, until the work is complete. Workers under a continuous roof, connected buildings or those working near an adjacent outside wall should be vacated.
11. Connect the VAPORPH₃OS[®] cylinder to the dispensing equipment.
12. Purge and leak test the blending equipment.
13. Dispense the initial dose of blended VAPORPH₃OS[®] (and CO₂ gas if applicable).
14. Periodically monitor the phosphine concentrations within the space, using suitable gas detection equipment, to ensure that the minimum concentrations are being maintained for the required time.
15. Dispense additional fumigant as required to maintain the desired phosphine concentrations.
16. When no further fumigant is required, close all cylinder valves. Depressurize and purge the blending equipment and disconnect all VAPORPH₃OS[®] cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
17. When the fumigation is complete, remove the tarp and aerate as appropriate using precautions to prevent exposure to workers (see VIII. AERATION OF FUMIGATED COMMODITIES and IX. E. AERATION AND REENTRY).

Additional Considerations:

1. Do not walk on tarped material once it has been sealed and fumigant has been dispensed.
2. Placard each access to the area where treatment is occurring.
3. Seal off doors, windows and other connections to adjacent areas that may be occupied and placard on the occupied side.

F. Application to Containers and Trailers

1. General

This section addresses fumigation of transport vehicles fumigated in place. Trailers and containers must not be fumigated over public roads, highways or railroads until they are aerated. See appropriate sections of this manual for recommendations on placarding, commodity aeration and training of persons authorized to remove placarding (Section VI) and commodity aeration (Section VIII).

Containers, trucks, and other transport vehicles loaded with bulk commodities, to which VAPORPH₃OS[®] may be added are treated in essentially the same way as any other storage facility.

Blended VAPORPH₃OS[®] Phosphine fumigant dispensing lines shall not be placed in or attached to commodity packages containing processed food.

Trailers and containers require small amounts of fumigant. Fumigators should evaluate if cylinders of preblended ECO₂FUME[®] fumigant gas should be used.

2. Procedure for Container and Trailer Fumigation

1. Prepare a Fumigation Management Plan.

2. Determine the target phosphine concentration and exposure time desired. This should be based on the target pests and the commodity temperature.
2. Determine the empty volume of the trailer or container.
3. Calculate how much VAPORPH₃OS[®] phosphine fumigant gas (and carbon dioxide if applicable) will be required, and the dispensing time needed.
4. Inspect all sidewalls, roof, floor, and doors for cracks, holes or defects. Seal all openings with tape or caulk. Particular attention should be paid to any drain holes in the floor.
5. Install the fumigant gas dispensing line and secure it to the door, wall or floor with tape.
6. Close the door and seal with tape, caulk or polyethylene sheeting to prevent gas loss.
7. Affix fumigation placards to all sides of the container or trailer.
8. Verify that all required safety equipment is available and in good working condition.
9. Notify all personnel that fumigant release is about to commence. When trailers attached to tractors and trucks are fumigated, drivers should not be allowed to enter the vehicle until fumigation has ended and the truck is aerated.
10. Purge and leak test the blending equipment
11. Blend and dispense the predetermined quantity of VAPORPH₃OS[®] into the container or trailer.
12. Disconnect dispensing lines from dispenser.
13. Remove all gas dispensing lines entering the space and seal the penetrations used.

G. Application to Ships (not for use on barges)

a) General

1. Important – shipboard, in transit ship or ship hold fumigation is also governed by U.S. Coast Guard Regulation 46 CFR 147A. *Interim regulations for shipboard fumigation.* Refer to this regulation prior to fumigation. For further information contact:

Commandant
U.S. Coast Guard
Hazardous Materials Standards Division
GMSO-3
Washington, DC 20593-0001

2. VAPORPH₃OS[®] Phosphine Fumigant is classified by EPA as a restricted use pesticide due to the acute inhalation toxicity of phosphine gas. This product is for retail sale to, and use only by, certified applicators for those uses covered by the applicator’s certification or persons trained in accordance with the Applicator’s Manual working under the direct supervision and in the physical presence of the certified applicator. Physical presence means on-site or on the premises. Read and follow the label and the VAPORPH₃OS[®] Phosphine Fumigant Application Manual that contains complete instructions for the safe use of this pesticide.
3. In addition to the ship fumigation procedures outlined in the following paragraphs (b, c, d, e, and f), applicators must follow the general procedures for fumigating bulk commodities (see IV. G. 3. b), spaces (see IV. G. 4. b), or containers (see IV.G. 6. b), as appropriate. Gas circulation assistance may be needed to ensure complete penetration with VAPORPH₃OS[®] Phosphine Fumigant for bulk commodity fumigations. Suggestions are provided under “Additional Considerations” in Section IV.G.3.b, “Application to Bulk Commodities.”

b) Pre-Voyage Fumigation Procedures

1. Prior to fumigating a vessel for in-transit cargo fumigation, the master of the vessel, or his representative, and the fumigator must determine if the vessel is suitably designed and configured to allow for safe occupancy by the ship's crew throughout the duration of the fumigation. If it is determined that the design and configuration of the vessel does not allow for safe occupancy by the ship's crew throughout the duration of the fumigation, then the vessel will not be fumigated unless all crew members are removed from the vessel. The crew members must not be allowed to reoccupy the vessel until it has been properly aerated and a determination has been made by the master of the vessel and the fumigator that the vessel is safe for occupancy.
2. The person responsible for the fumigation must notify the master of the vessel or his representative of the requirements relating to personal protection equipment** and detection equipment, and that a person qualified in the use of this equipment must accompany the vessel with cargo under fumigation. Emergency procedures, cargo ventilation, periodic monitoring and inspections, and first aid measures must be discussed with and understood by the master of the vessel or his representative.

**Personal protection equipment means a NIOSH/MSHA approved air purifying full face gas-mask with a chin style mounted canister approved for phosphine, OR a NIOSH/MSHA approved supplied-air respirator with a full face piece for phosphine up to 15 ppm. Although respiratory protection is not required for CO₂ exposure up to 5000 ppm, a canister respirator will not provide protection from CO₂ at any concentration. A self-contained breathing apparatus (SCBA) must be worn and operated in a positive pressure mode when phosphine levels are above 15 ppm or at unknown concentrations.

1. Seal all openings to the cargo hold or tank and lock or otherwise secure all openings, manways, etc., that might be used to enter the hold. The overspace pressure relief system of each tank aboard tankers must be sealed by closing the appropriate valves and sealing the openings into the overspace with gas-tight materials.
2. Placard all entrances to the treated spaces with fumigation warning signs.
3. If the fumigation is not completed and the vessel aerated before the manned vessel leaves port, the person in charge of the vessel shall ensure that at least two units of personal protection equipment and one gas or vapor detection device, and a person qualified in their operation be on board the vessel during the voyage. **The VAPORPH₃OS^o Phosphine Fumigant cylinders (and the CO₂ source if applicable) must be disconnected and removed from the vessel before it leaves port.**
4. During the fumigation or until a manned vessel leaves port or the cargo is aerated, the person in charge of the fumigation shall ensure that a qualified person using gas or vapor detection equipment tests spaces adjacent to spaces containing fumigated cargo and all regularly occupied spaces for fumigant leakage. If leakage of the fumigant is detected, the person in charge of the fumigation shall take action to correct the leakage or shall inform the master of the vessel, or his representative, of the leakage so that corrective action can be taken.
5. The person in charge of the fumigation shall review with the master, or his representative, the precautions and procedures to be followed during the voyage.

a) Application Procedures for Bulk Dry Cargo Vessels and Tankers

Immediately after application of the fumigant, close and secure all hatch covers, tank tops, butterworth valves, manways, etc.

1. If the fumigation is not completed and the vessel aerated before the manned vessel leaves port, the person in charge of the vessel shall ensure that at least two units of personal protection equipment and one gas or vapor detection device, and a person qualified in their operation be on board the vessel during the voyage. **The VAPORPH₃OS⁰ Phosphine Fumigant cylinders (and the CO₂ source if applicable) must be disconnected and removed from the vessel before it leaves port.**
2. During the fumigation or until a manned vessel leaves port or the cargo is aerated, the person in charge of the fumigation shall ensure that a qualified person using gas or vapor detection equipment tests spaces adjacent to spaces containing fumigated cargo and all regularly occupied spaces for fumigant leakage. If leakage of the fumigant is detected, the person in charge of the fumigation shall take action to correct the leakage or shall inform the master of the vessel, or his representative, of the leakage so that corrective action can be taken.

d) In-transit Fumigation of Transport Units (Containers) Aboard Ships

In-transit fumigation of transport units on ships is also governed by the U.S. Department of Transportation (DOT). RSPA 49 CFR 176.76 (h) transport vehicles, freight containers, and portable tanks containing hazardous materials and International Maritime Dangerous Goods Code P9025-1 Amdt. 30-00.

1. If the fumigation is not completed and the vessel aerated before the manned vessel leaves port, the person in charge of the vessel shall ensure that at least two units of personal protection equipment and one gas or vapor detection device, and a person qualified in their operation be on board the vessel during the voyage. **The VAPORPH₃OS⁰ Phosphine Fumigant cylinders (and the CO₂ source if applicable) must be disconnected and removed from the vessel before it leaves port.**
2. During the fumigation or until a manned vessel leaves port or the cargo is aerated, the person in charge of the fumigation shall ensure that a qualified person using gas or vapor detection equipment tests spaces adjacent to spaces containing fumigated cargo and all regularly occupied spaces for fumigant leakage. If leakage of the fumigant is detected, the person in charge of the fumigation shall take action to correct the leakage or shall inform the master of the vessel, or his representative, of the leakage so that corrective action can be taken.

e) Precautions and Procedures During Voyage

1. Using appropriate gas detection equipment, monitor spaces adjacent to areas containing fumigated cargo and all regularly occupied areas for fumigant leakage. If leakage is detected, the area should be evacuated of all personnel, ventilated, and action taken to correct the leakage before allowing the area to be occupied.

2. Do not enter fumigated areas except in an emergency. If necessary to enter a fumigated area, appropriate personal protection equipment must be used. Never enter fumigated areas alone. At least one other person, wearing personal protection equipment, should be available to assist in case of an emergency.

f) Precautions and Procedures During Discharge

If necessary to enter holds prior to discharge, test spaces directly above the cargo surface for fumigant concentration using appropriate gas detection and personal safety equipment. Do not allow entry to fumigated areas without personal safety equipment, unless fumigant concentrations are at safe levels, as indicated by a suitable detector.

9. PHOSPHINE/CARBON DIOXIDE MONITORING

A. Detection Equipment

At each site and operation, monitoring of airborne Phosphine concentrations (and Carbon Dioxide concentrations if applicable) must be performed in all areas where fumigators and other workers have access during fumigation and aeration. As well, perimeter testing must be done to ensure downwind exposures do not exceed permissible levels for offsite personnel.

There are a number of devices on the market for the measurement of PHOSPHINE gas as well as CARBON DIOXIDE levels. These devices are portable, simple to use, do not require extensive training and are relatively inexpensive and accurate, but must be used in accordance to manufacturer's direction.

1. Hand Pump Monitors

The basic idea behind hand pump monitors is that a bellows type hand pump is squeezed to evacuate all air, it then draws in an exact volume of air (approx. 100 cc's) through a glass tube filled with a reactive granular chemical. The glass tube has a scale on the side. An exact reading depends on how far down the tube the granular chemical reacts. There are tubes available for reading high and low phosphine and carbon dioxide levels.

- 1) **PHOSPHINE DETECTOR TUBES:**
MEASURING RANGE- 0.1 to 4.0 ppm
STROKES- 10 (hand pump)
COLOUR CHANGE- white to grayish-violet
ACCURACY- +/- 15-20%
PERMISSIBLE EXPOSURE LEVEL (PEL)- 0.3 ppm

- 2) **CARBON DIOXIDE DETECTOR TUBES:**
MEASURING RANGE- 1% to 20%
STROKES- 1 (hand pump)
COLOUR CHANGE- white to bluish-violet
ACCURACY- +/- 5 to 10%
PERMISSIBLE EXPOSURE LEVEL (PEL)- 5000

2. Electronic Monitors

Electronic monitors are small, portable and very precise if they are maintained well and calibrated regularly. Their biggest benefit is the fact that they offer the best available technology at the Limit of Detection (LOD) and give accurate readings using “Real Time” Direct-read Devices with a LOD of at least 0.05 ppm. Other benefits include:

- They fit easily into the hand and some have an optional belt carrying case to wear with you all day.
- Some can read up to 4 different gases including phosphine
- Most have rechargeable batteries
- Some have the ability to retrieve remote sampling data from up to 30’ away.
- Computer interface available
- Audible alarm

Sensors may need to be replaced on an annual basis. Check with the manufacturer’s specifications for each sensor type. Follow the manufactures' recommendations for calibration of portable electronic monitors. Calibration is essential to ensure a correct reading.

The following are examples of some readily available detection devices on the market:

1) **NATIONAL DRAGER INC PAC III- ELECTRONIC PERSONAL GAS DETECTOR (phosphine)**

DESIGN-continuously monitor one gas in ambient air

ALARM- audio and visual

RANGE- 0 to 20 ppm

ALARM SET POINT- 0.1 ppm (this can be set higher/lower manually)

2) **PORTASENS (ANALYTICAL TECHNOLOGY INC.)**

Portable gas detector for measuring phosphine concentration in ambient air.

RANGE-0 to 1000 ppm

ALARM SET POINT- adjustable

3) **INDUSTRIAL SCIENTIFIC**

Multi- gas monitor- continuous detection of oxygen and combustible gas.

Can be outfitted with two additional gas detector sensors (H₂S & CO,CL,NO₂,SO₂)

Internal pump can draw sample from as far as 100 feet.

3. Monitoring Hoses and Air Sampling Pumps

For safety purposes, it is recommended that gas monitoring during a fumigation be performed through monitoring hoses from a fresh air site outside of the fumigated area. Air sampling pumps are available to pull air samples through monitoring hoses from several hundred feet away.

B. Phosphine exposure limits

Exposure to phosphine must not exceed the permissible exposure level (TWA) of 0.3 ppm based on an 8 hour time weighted average (TWA) exposure. The short-term exposure level (STEL) for phosphine is 1.0 ppm not to exceed 15 minutes.

C. Carbon Dioxide exposure limits

Exposure to carbon dioxide must not exceed the permissible exposure level (TWA) of 5000 ppm based on an 8 hour time weighted average (TWA) exposure. The short-term exposure level (STEL) for carbon dioxide is 30,000 ppm not to exceed 15 minute.

D. Indoor monitoring

If, for any reason, a fumigator must enter the fumigation area, a self contained breathing apparatus (SCBA) with full-face piece pressure demand must be worn at all times when the phosphine and carbon dioxide concentrations exceed their PEL's or the concentrations are unknown. The fumigation area is a confined space and must be treated as such; therefore, a buddy system or back-up system must be utilized by anyone entering the fumigation area.

Initial monitoring of the interior of the fumigation area, if entered, regardless of remote sample readings, should be done wearing an SCBA due to the possibility of areas of high PH₃ and CO₂ concentrations.

If initial monitoring indicates worker exposure to concentrations in excess of the PELs, then engineering controls, such as forced air ventilation should be implemented to reduce personal exposures.

E. Perimeter monitoring

Monitoring of the perimeter of the fumigation area, especially downwind, must be done to ensure phosphine and carbon dioxide concentrations are kept within acceptable levels outside the fumigation area. This involves walking around the structure with a personal monitoring device and seeing if excessive amounts of fumigant are escaping. If a leakage point is discovered, the appropriate PPE should be worn and the leak should be sealed off. Perimeter readings will indicate any leaks from the sealed fumigation area or the phosphine/carbon dioxide concentrations in the surrounding area during aeration.

Perimeter readings should be performed as follows:

- (a) initial dispensing to area
- (b) 15 minutes after dispensing
- (c) if greater than 0.3 ppm phosphine or 5000 ppm carbon dioxide determine leak point and seal, if during aeration dilution air should be added to reduce levels.
- (d) if less than PEL's , retest every 15 minutes
- (e) if zero, retest in one hour, if still zero retest every 4 hours.

10. AERATION OF FUMIGATED COMMODITIES AND SPACES

A. Commodities

Aerate all commodities to 0.3 ppm of phosphine. Continue to monitor densely packed commodities carefully, even after initial gas levels have dropped to acceptable levels. When stored in an unventilated area, densely packed commodities which have been recently fumigated and considered aerated, can bleed out enough fumigant to exceed the threshold limit values for the fumigant. Forced

aeration with the use of portable or permanent fans will greatly decrease the amount of time necessary to aerate a commodity to acceptable gas levels. Be extremely cautious and aware of where the fumigant is being directed. Make sure gas concentrations are below the threshold limit values at the property lines. Closely monitor any inhabited structures adjacent to the fumigated area.

A. AUTHORIZED TRAINING FOR AERATION AT FUMIGATION SITES

Persons responsible for aeration of commodities (including receipt of transport vehicles under fumigation) must be trained following the EPA accepted product applicators manual or by other training that is accepted by local and/or state authorities. The manual must be available at fumigation and aeration sites. This training must cover the following items found in this manual:

- a. How to aerate the area under fumigation and verify that it contains no more than 0.3 ppm phosphine, or
- b. How to transfer the commodity to another storage area without prior aeration and ensure that worker safety limits are not being exceeded in the work zone during transfer.
- c. How to determine when respiratory protection must be worn.
- d. How to protect workers and nearby person from exposure to levels above the 8-hour TWA of 0.3 ppm phosphine or the 15 minute short-term exposure limit (STEL) of 1.0 ppm phosphine.
- e. Proper removal of placards from the site.

B. FOODS AND FEEDS

Tolerances for Phosphine residues have been established at 0.1 ppm for animal feeds, grains, nuts, and dates; 0.01 ppm for processed foods, fresh fruits and vegetables. To guarantee compliance with these tolerances, it is necessary to aerate these commodities for 48 hours prior to offering them to the end-customer. As an alternative to this aeration period each container of the treated commodity may be analyzed for residues using accepted analytical methods.

C. NON-FOOD COMMODITIES

Aerate all non-food commodities to less than 0.3 ppm of Phosphine. Continue to monitor densely packed commodities carefully.

D. Tobacco

Tobacco must be aerated to less than 0.3 ppm. When plastic liners are used, longer aeration periods will probably be required to aerate the commodity down to less than 0.3 ppm. A minimum aeration period of 48 hours is required.

E. Residue Analysis

As an alternative to these aeration periods, each container of a treated commodity may be analyzed for residues using accepted analytical methods (e.g., Norwicke Method). If residues are less than tolerance levels, the commodity may be shipped to the consumer.

11. CYLINDER RETURN AND TRACKING

Once used, VAPORPH₃OS[®] cylinders are to be returned only to an authorized distributor or their designated point of return. This applies to all cylinders, regardless of the quantity of material remaining in the package.

The production facility tracks all VAPORPH₃OS[®] cylinders by the cylinder serial number. Our computer system records the serial numbers of the cylinders as they are filled and shipped from the plant. The same serial numbers are recorded as cylinders are returned to the plant. It is recommended that the end user track the use of cylinders by the same serial number. This will help resolve any billing inquiries and serve as a record of how many and exactly which cylinders were used for a fumigation job. The serial numbers can be found stamped into the shoulder of the cylinders.

12. EMERGENCY RESPONSE

A. Spill and Leak Procedures

Releases can produce high levels of both toxic phosphine and carbon dioxide gas, and therefore, attending personnel must wear SCBA with full facepiece and operated in a pressure demand mode when the concentration of phosphine gas is unknown. If the concentration is known, other NIOSH/MSHA approved respiratory protection may be worn.

This material is spontaneously flammable in air and may form an explosive mixture in air. In case of fire, stop flow of gas if without risk. Use water spray, alcohol foam, carbon dioxide or dry chemical to extinguish fires. Use water to keep cylinders cool.

In the event of an accidental release, evacuate the area immediately. Only trained emergency responders should attempt a response into the leak area. If it is possible to shut off the source of the leak from a remote area, it should be done. Otherwise, evacuate the area and call for assistance.

Cytec Industries Inc. operates a 24-hour EMERGENCY RESPONSE and INCIDENT MANAGEMENT system (ERIM). For emergencies involving spills, call CHEMTREC; 1-800-424-9300. For emergencies involving, leak, fire or exposure call 911 or local Fire and Rescue or Cytec's Emergency Phone No. 1-800-424-9300. Outside the US or Canada call 703-527-3887:

B. Emergency Responders

In the event of a leak or fire, evacuate immediate area and isolate leak area 700 feet in all directions. Sample downwind of leak for phosphine and carbon dioxide; the isolation area may need to be lengthened if levels exceed TWAs. Keep the isolation area clear at all times and monitoring the phosphine and carbon dioxide levels at the isolation perimeter to ensure the safety of adjacent personnel. If possible, the best response may be to close valve to isolate cylinder and stop the fire and/or leak. If isolation is not possible, the use of a cylinder over-pack may be necessary.

All emergency responses, should be made in level B protection, which includes neoprene, butyl rubber or PVC, gloves; Seranex coated Tyvek suit, rubber boots and an air-supplied respirator.

Safety Watcher (buddy system): After fumigation has begun no person shall enter a confined space or fumigation area without a safety watcher or buddy. The watcher will be outfitted with the same protective equipment as the entrant (ie. SCBA). The safety watcher will be responsible for the following:

- 1) Be aware of the possible behavioral effects of hazard exposures to entrants.
- 2) Continuously maintain count of entrants as well as visual contact at all times.
- 3) Remain outside the fumigation area at all times during entry operations.
- 4) Perform no other duties that will interfere with the monitoring of the entrants.
- 5) Summon rescue/emergency assistance immediately if the entrants need assistance to escape the fumigation area.
- 6) Safety watcher **must not enter** the fumigation area to perform rescue until he is relieved from his post by another watcher. Unprotected. rescuers account for over 60% of confined space fatalities. Do not attempt to remove anyone exposed to high concentrations of phosphine or carbon dioxide without using the proper rescue equipment or you may also become a casualty. Obtain assistance and use the established emergency procedures.

APPENDIX I Contact List

CYTEC INDUSTRIES INC. CONTACTS

Randy Deskin, Ph.D., DABT Director, Toxicology and Regulatory Compliance, Toxicology and Product Regulatory Compliance Department	CYTEC INDUSTRIES INC. Five Garrett Mountain Plaza West Patterson, NJ 07424 USA	Bus: (973) 357-3372 Fax: (973) 357-3057 E-Mail: randy.deskin@cytec.com Website: www.cytec.com
Patricia Vernon Manager, Product Regulatory Compliance, North America Toxicology and Product Regulatory Compliance Department	CYTEC INDUSTRIES INC. Five Garrett Mountain Plaza West Patterson, NJ 07424 USA	Bus: (973) 357-3375 Fax: (973) 357-3057 E-Mail: patti.vernon@cytec.com Website: www.cytec.com
Roger Cavasin, P.Eng. Product Manager, Global Phosphine Gases	Cytec Canada Inc. 9061 Garner Road P.O. Box 240 Niagara Falls, Ontario L2E 6T4 Canada	Bus: (905) 356-9000; 1-800-606-0498 Direct: (905) 374-5828 Fax: (905) 374-5939 E-Mail: roger.cavasin@cytec.com Website: www.cytec.com
Michael DePalo Sales Manager, North America Fumigation	Cytec Canada Inc. 9061 Garner Road P.O. Box 240 Niagara Falls, Ontario L2E 6T4 Canada	Bus: (905) 356-9000; 1-800-606-0498 Direct: (905) 374-5918 Fax: (905) 374-5879 E-Mail: mike.depalo@cytec.com Website: www.cytec.com

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John Mueller President	Fumigation Service and Supply Inc. 16950 Westfield Park Road Westfield, IN 46074 USA	Bus: 1-800-992-1991 Direct: (317) 896-9300 Fax: (317) 867-5757 E-Mail: insectltd@aol.com Website: www.insectslimited.com
A. Chris Mueller VP of Marketing and Business Development	Industrial Fumigant Company 19745 W. 159th Street P.O.Box 1200 Olathe, KS 66051-1200 USA	Bus: 913-782-7600 Fax: 913-782-6299 E-Mail: indfumco@toto.net Website: www.indfumco.com
Vince Geiger Industry Manager	Univar 740 Alverna Dr. Indianapolis, IN 46260	Bus: 317-257-2889 Fax: 317-255-4536 E-Mail: vince.geiger@univarusa.com Website: www.univarusa.com.com

APPENDIX II CGA SAFE HANDLING

1. The user is responsible for the safe use of the container and Its contents and for returning the container to the gas manufacturer or distributor in the same safe condition as it was received.
2. The user shall not modify, tamper with, obstruct, remove or repair any part of the cylinder package. Only trained personnel under direction of the container owner or authorized representative shall perform maintenance of the container and its valve.
3. The prescribed stamped marking on the container shall be made and kept in a legible condition. The user shall not remove or alter any of these markings.
4. The labels applied by the gas manufacturer to identify the container contents shall not be defaced or removed by the user.
5. Compressed gas containers shall not be exposed to temperature extremes.
6. Leaking or defective containers shall not be offered for shipment.
7. Any damage that might impair the safety of the container shall be called to the attention of the gas supplier before returning the container.
8. The user shall keep the supplied cap and gas tight outlet cap on the cylinder at all times, except when cylinders are secured and connected to dispensing equipment. Both of these caps must be in place prior to shipment. The outlet cap shall be tightened.
9. The cylinder valve shall be kept closed at all times (charged or empty) except when the cylinder is in use. Wrenches, hammers or other tools shall not be used in attempting to open or close a valve.
10. Cylinders shall not be rolled in the horizontal position or dragged. A suitable hand truck should be used for individual cylinders and as appropriate, a forklift truck for use with palletized cylinders. Cylinders shall never be lifted by the cap, valve or by use of magnets.
11. Caution should be used when handling cylinders to guard against dropping or permitting them to violently strike against each other and other surfaces.
12. Compressed gases shall not be transferred from one cylinder to another except by the gas manufacturer using qualified, trained personnel with the appropriate equipment and operating procedures.
13. Cylinder valve connections that do not fit shall not be forced.
14. Gas tight connections including piping, regulators and other apparatus shall be kept gas tight to prevent leakage. DO NOT tighten connections or leaking fittings or attempt other repairs while the system is under pressure.
15. Prior to disconnecting a cylinder from dispensing equipment, the cylinder valve shall be closed and the dispensing equipment relieved of pressure.
16. Transportation of compressed gas cylinders in automobiles or closed-bodied vehicles can present serious safety hazards and should not be done. Shipping compartments should be adequately ventilated.
17. An emergency response plan shall be implemented whenever compressed gas containers are used, handled or stored.

APPENDIX III U.S. STATE REGISTRATIONS

Arizona	Kansas	Nevada	South Carolina
Arkansas	Kentucky	New Hampshire	South Dakota
Colorado	Maine	New Jersey	Vermont
Connecticut	Maryland	New Mexico	Virginia
Delaware	Minnesota	North Carolina	Washington
Florida	Mississippi	North Dakota	West Virginia
Idaho	Missouri	Ohio	Wisconsin
Illinois	Montana	Oregon	Wyoming
Indiana	Nebraska	Pennsylvania	
Iowa		Rhode Island	