

RESTRICTED USE PESTICIDE

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

For retail sale to and use only by provincially licensed 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. Consult local pesticide regulatory authorities about use permits which may be required. Read and follow the label and the product's Application Manual, which contains complete instructions for the safe use of this pesticide.

APPLICATION MANUAL

FOR

ECO₂FUME[®] Fumigant Gas

A phosphine-containing fumigant for use in controlling pests in listed raw agricultural commodities, processed foods, stored tobacco, animal feeds, and nonfood products. Refer to the Application Manual for a list of commodities and pests controlled.

GUARANTEE:

By Weight

ACTIVE INGREDIENTS: Phosphine Gas (PH₃).....2%*

* 2.6% by volume

Registration No. 27684
Pest Control Products Act



POISON



EXPLOSIVE

DANGER

LIQUID IS CORROSIVE TO EYES AND SKIN

**KEEP OUT OF REACH OF CHILDREN AND UNAUTHORIZED PERSONNEL
READ THE LABEL AND APPLICATION MANUAL BEFORE USING**

FIRST AID

Symptoms of exposure to this product are headache, dizziness, nausea, difficult breathing, vomiting and diarrhea. In all cases of overexposure, get medical attention immediately. Take victim to doctor, hospital or emergency treatment facility. Take container, label or product name and Pest Control Product Registration Number with you when seeking medical attention.

If Inhaled	<ul style="list-style-type: none">• Move person to fresh air• If person is not breathing, immediately call for emergency medical support, then begin cardiopulmonary resuscitation including artificial respiration, preferably with a bag-valve-mask device, if possible. Rescuers within the areas of potentially unsafe levels of this product (the "HOT ZONE") should employ appropriate personal protective equipment such as SCBA during the resuscitation of the victim. Keep person warm.• Call a poison control center or doctor for further treatment advice.
If on Skin	<ul style="list-style-type: none">• May cause frostbite to unprotected skin upon contact with dispensing equipment while gas is discharged rapidly. Treat as a thermal burn.• Take off contaminated clothing and allow clothes to aerate in ventilated room prior to laundering.• Call a poison control center or doctor for treatment advice.
If in Eyes	<ul style="list-style-type: none">• Hold eye open and rinse slowly and gently with cool water for 15-20 minutes in case of freezing or cryogenic "burns." Do not rinse eyes with hot or even tepid water.• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing.• Call a poison control center or doctor for treatment advice.• Never introduce oil or ointment into eyes without medical advice.

SEE SIDE PANEL OF LABEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS

CYTEC Canada Inc., 9061 Garner Road, Niagara Falls, Ontario L2E 6T4 Canada

Emergency Phone: 905/356-8310; US 1-800/424-9300 or 703/527-3887

Net Contents: 31 Kg (68.3 lbs.)

AN APPROVED LABEL AND AN APPLICATION MANUAL ACCOMPANY THIS PRODUCT. READ AND UNDERSTAND THE ENTIRE LABEL AND APPLICATION MANUAL BEFORE USE. ALL PARTS OF THE LABEL AND APPLICATION MANUAL ARE EQUALLY IMPORTANT FOR SAFE AND EFFECTIVE USE OF THIS PRODUCT. CALL CYTEC INDUSTRIES INC. IF YOU HAVE ANY QUESTIONS OR DO NOT UNDERSTAND ANY PART OF THE PRODUCT LABEL OR APPLICATION MANUAL.

REFER TO THE APPLICATION MANUAL FOR DETAILED PRECAUTIONS, RECOMMENDATIONS AND DIRECTIONS FOR USE.

Seller's guarantee shall be limited to the terms set out on the label and, subject thereto, the buyer assumes the risk to persons or property arising from the use or handling of this product and accepts the product on that condition.

[6/3/04]

APPLICATION MANUAL
FOR
ECO₂FUME[®] Fumigant Gas

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I. INTRODUCTION

A. **PRODUCT DESCRIPTION**

ECO₂FUME[®] Fumigant Gas is a cylinderized source of phosphine. A mixture of phosphine and carbon dioxide gases, it is packaged in compressed gas cylinders. Phosphine makes up 2 percent (by weight) of the product. ECO₂FUME[®] Fumigant Gas cylinders contain carbon dioxide as liquefied gas under pressure. Pressurized carbon dioxide serves as a propellant for delivering the product and retards flammability.

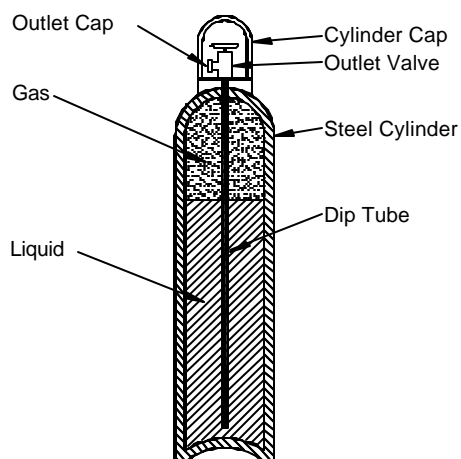
Phosphine and carbon dioxide are both gases that, under sufficient pressure, can exist in a liquid state. It is this “liquefied gas” that is stored in the cylinder. The product is withdrawn from the cylinder as a liquid, but dispensed as a gas. In expanding from a liquid to a gas, it increases in volume by hundreds of times. Proper dispensing 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**

1. **Packaging**

ECO₂FUME[®] Fumigant Gas is packaged in a steel compressed gas cylinder, designed, manufactured, maintained and filled in compliance with regulations established by Transport Canada. The product flows to the dispensing equipment through the cylinder outlet valve, which is equipped with a “dip tube”. This tube extends to the bottom of the cylinder to facilitate the withdrawal of the liquefied gas mixture. As liquid is withdrawn from the cylinder, some of the product vapourizes to fill the remaining space in the cylinder.



ECO₂FUME[®]
Fumigant Gas

Representative Package:

Overall Height: 152.4 cm (60 inches)
Diameter: 23.5 cm (9 1/4 inches)
Material: Steel
Empty Weight: 62.6 kg (138 pounds)
Product Weight: 31 kg (68.34 pounds)
- 0.61 kg (1.34 pounds) phosphine
- 30.39 kg (67 pounds) carbon dioxide

Through this vapourization, 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) dispensing equipment to the cylinder valve outlet to dispense ECO₂FUME[®] Fumigant Gas at the time of fumigation. Use of any other dispensing 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 ECO₂FUME[®] Fumigant Gas is a poisonous gas, Transport Canada 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 an ECO₂FUME[®] Fumigant Gas cylinder without the valve outlet cap and the cylinder cap securely in place.

ECO₂FUME[®] Fumigant Gas cylinders can only be refilled through authorized distributors. They can be filled repeatedly within a five year period. Every five years, however, the cylinder is required by law to be tested by a qualified facility.

2. Dispensing Equipment

A typical ECO₂FUME[®] Fumigant Gas dispensing unit (see diagram on next page) uses a heating vapourizer to provide the energy required to vapourize the liquid fumigant. This regulator is limited to a dispensing rate of approximately 11 kg (24 lb) of ECO₂FUME[®] Fumigant Gas per hour. The equipment is designed for a service pressure up to 20,685 kPa (3000 psig).

From the cylinder the liquid mixture flows down a flexible hose or pigtail through a filter and into a heater. The heater is thermostatically controlled. Exiting the heater ECO₂FUME[®] Fumigant Gas flows through an actuated valve that can be used for emergency shutdown purposes. ECO₂FUME[®] Fumigant Gas then flows through a gas regulator that drops the pressure to less than 690 kPa (100 psig).

A diaphragm valve is used to control the gas flow at any desired value up to 100 litres/minute as indicated by the flow rotameter. The heater provides 1000 watts of power that can vapourize a maximum of 100 ppm. Lower rotameter ranges are possible.

ECO₂FUME[®] Fumigant Gas regulator assemblies, equipped with basic features, are available through authorized ECO₂FUME[®] Fumigant Gas distributors. Multiple dispensers may be used together to achieve higher fumigant flows than available through a single dispensing unit and custom equipment can be developed for specific types of applications.

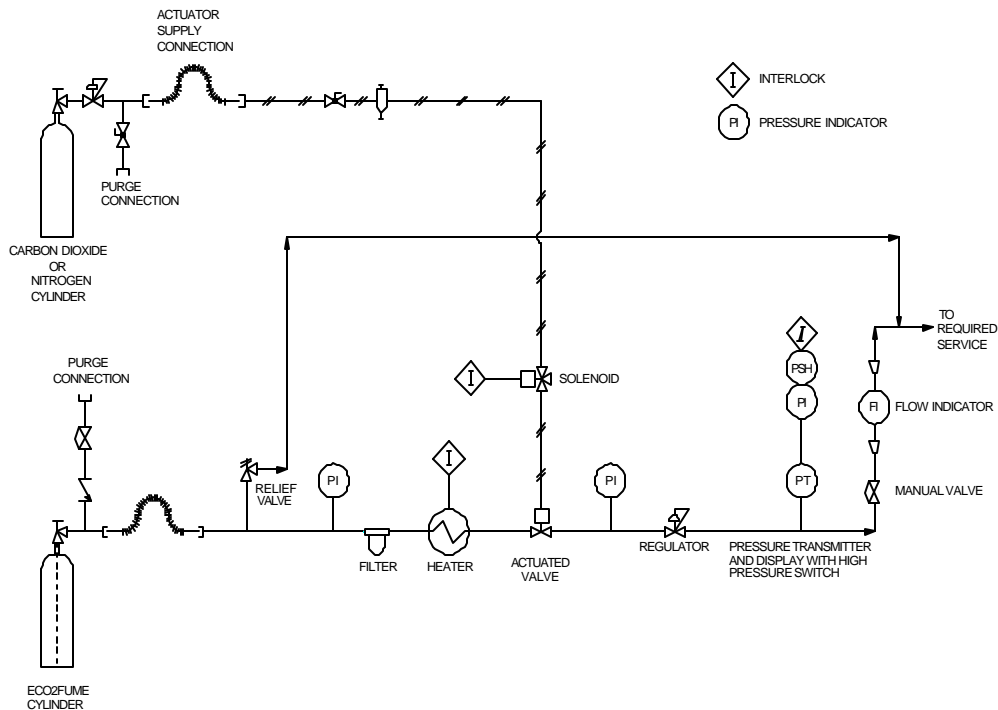


Diagram of a Representative Type of ECO₂FUME[®] Fumigant Gas Dispensing Equipment

C. PHOSPHINE AND CARBON DIOXIDE

Phosphine is a colourless gas, which is toxic to insects, humans and other forms of animal life. It is very mobile with a high vapour pressure. Thus, the penetrating capability of phosphine is great. The combination of high molecular activity, vapour pressure and toxicity to insects at low dosages accounts for its wide acceptance as a fumigant.

Carbon dioxide is colourless, non-flammable gas, which at elevated concentrations is toxic. For worker safety, the monitoring for carbon dioxide and phosphine gas is required and suitable breathing apparatus must be used. Sometimes phosphine may have an odour due to the presence of impurities in the product; however, this odour cannot always be relied upon as an adequate indicator of phosphine exposure.

*** ECO₂FUME[®] Fumigant Gas does not have an expiration date. Contact CYTEC Industries Inc. for any questions ***

D. ENVIRONMENTAL FATE

ECO₂FUME[®] Fumigant Gas is a volatile gaseous mixture. The environmental fate is effected by being dispersed, diluted and decomposed in ambient air after aeration from fumigated commodities where it is present in rapidly decaying low concentrations that are oxidized to non-toxic degradation products.

On airing the commodity after fumigation the volatile gaseous phosphine is dispersed to the atmosphere where it decomposes. On irradiation with UV-light, phosphine reacts with the oxygen in the atmosphere in the presence of water vapour to produce traces of H₃PO₄ (phosphoric acid). Phosphine is slightly soluble in water, 26 cm³ phosphine in 100 mL of water at 20°C, in which it gradually decomposes into phosphorus, hydrogen, and the lower hydrides of phosphorus.

II. SAFETY REQUIREMENTS

ECO₂FUME[®] Fumigant Gas is a restricted use product for retail sale to and use only by provincially licensed 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.

A. GENERAL

1. Carefully read the label and Application Manual and follow instructions explicitly.
2. Never work alone when applying fumigant from within the storage structure or aerating commodities after the fumigation is over.
3. Person supervising must be a licensed fumigator and personnel assisting must be trained and appropriately licensed in the use of phosphine. Never allow uninstructed personnel to handle phosphine. Observe all provincial pesticide legislation requirements.
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.
5. Post ECO₂FUME[®] Fumigant Gas fumigation placards on fumigated areas, including all entrances/exits. See Section VI 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 owners, employees, and/or operators at the facility where the fumigation will occur and provide relevant safety, health, and environmental information to local fire and rescue officials annually for use in the event of an emergency.
7. Worker exposure to phosphine must not exceed the 8-hour Time-Weighted Average (TWA) of 0.3 ppm or the 15-minute Time-Weighted Short-Term Exposure Limit (STEL) of 1.0 ppm. This includes reentry into a structure.
8. Worker exposure to carbon dioxide must not exceed the Threshold Limit Value (TLV) of 5,000 ppm (0.5 % by volume) at any time, either during or after application.
9. Workers required to use SCBA should be assessed for impaired pulmonary function prior to initial use and at least annually thereafter. Any employees found to have impaired pulmonary function 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 fumigation notice placards have been posted and the space to be fumigated is clear and secured.
12. Wear protective clothing as described in Section V. Respiratory protection requirements are discussed in Section V. E.
13. The perimeter of the fumigation area, especially downwind, must be monitored to ensure that phosphine and carbon dioxide concentrations are kept within acceptable levels outside the fumigation area. Large leaks must be repaired to minimize loss of fumigant and reduce risk of exposure to bystanders and/or occupants of nearby buildings.
14. Hydrogen phosphide fumigants are not to be used for vacuum fumigations.
15. Transport of incompletely aerated commodities to a new site is permissible by rail or ship only, and the new storage site must be placarded if its concentration of phosphine is above 0.3 ppm. Trucks, vans, trailers and similar transport vehicles cannot be moved over public roads or highways until they are aerated and the warning placards removed. If workers must handle an incompletely aerated commodity, or are indoors (e.g., an enclosed elevator head) they are to wear appropriate respiratory protection (see Section V.E. – Personal Protective Equipment (PPE) – Respirators).

B. SECURING CYLINDERS

Cylinders must be secured upright at all times to prevent their being inadvertently knocked over. When cylinder is not connected to dispensing equipment, the valve cap and cylinder cap must be securely installed.

C. POISON GAS HAZARDS – LEAK DETECTION AND REPAIR

Because ECO₂FUME[®] Fumigant Gas is comprised of poisonous gases, care must be taken to avoid direct exposure. Appropriate procedures must be followed to detect and repair leaks in dispensing equipment and structures. These are discussed below. Also, see section XIV. of this manual, “SPILL AND LEAK PROCEDURES.”

1. Dispensing Equipment

Although the dispensing 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. Nitrogen or Carbon Dioxide should be used to pressurize and leak check equipment with soap solution prior to use.

If any leak is encountered while using ECO₂FUME[®] Fumigant Gas 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. 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 eight-hour TWA of 0.3 ppm or the STEL of 1 ppm for 15 minutes, are unprotected personnel permitted to enter.

If a cylinder leak is detected, refer to section IV.G. 2.g.(3) of this manual for guidance on troubleshooting. Further troubleshooting assistance for a particular piece of dispensing equipment is addressed in the respective equipment manual.

2. Storage Structures

To reduce the potential for leakage, careful attention should be given to inspection of the storage structure and proper sealing prior to fumigation. Refer to the DIRECTIONS FOR USE, sections IV A. (“GENERAL”) and IV F. (“SEALING”) in this manual, for related guidance.

The perimeter of the fumigation area, especially downwind and in adjacent or nearby buildings, must be monitored to ensure that 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 to determine whether excessive amounts of fumigant are escaping.

If a high level of phosphine is detected outside the fumigation area, the addition of fumigant must be stopped. Large leaks must be repaired to minimize loss of fumigant and reduce risk of exposure to bystanders and/or occupants of nearby buildings. Appropriate personal protective equipment must be worn when sealing leaks. These repairs must be made from the exterior of the structure whenever possible. If it is necessary to seal a leak from the interior of the structure, the applicator must follow all proper procedures for confined space entry including wearing SCBA with full facepiece and operated in pressure-demand mode.

D. COMPRESSED GAS HAZARDS

ECO₂FUME[®] Fumigant Gas cylinders and dispensing equipment can achieve pressures of over 6900 kPa (1000 psig). 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 ECO₂FUME[®] Fumigant Gas through fast dispensing equipment will result in a chilling effect on parts of the equipment and cylinders. This thermodynamic effect can create temperatures low enough to cause frostbite to unprotected skin, if touched. 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 mixture boiling to maintain the pressure in the gas space of the cylinder.

A small amount of dry ice (solid carbon dioxide) may form in the cylinder when the product is dispensed very quickly and the liquid product level falls below the bottom of the dip tube. The pressure in a cylinder that has formed dry ice will be very low. When the cylinder is allowed to warm, this ice will again turn to liquid or gas and the pressure in the cylinder will 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 dispensing equipment.

Prior to the dismantling of ECO₂FUME[®] Fumigant Gas dispensing equipment at the conclusion of fumigation, all residual gas in the equipment must be vented to atmospheric pressure. The cylinder valve must be closed and the remaining product within the supply line discharged through the dispensing equipment. Cylinders must not be disconnected before ensuring that the line is fully vented.

4. Liquid Expansion

Liquefied gases expand rapidly when they are warmed. Because of this characteristic, liquid ECO₂FUME[®] Fumigant Gas should never be trapped between the shutoff valve on the cylinder and the shutoff valve on the dispensing equipment, without adequate safety relief devices in place. Only approved application equipment should be used because of this hazard.

III. PRECAUTIONARY STATEMENTS

ECO₂FUME[®] Fumigant Gas is a restricted use product for retail sale to and use only by provincially licensed 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.

A. HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER – POISON, KEEP OUT OF REACH OF CHILDREN AND UNAUTHORIZED PERSONNEL. Fatal if inhaled. Do not inhale vapour. Contains Extremely Hazardous Vapour. The liquid may cause burns. Do not get in eyes, on skin or on clothing. Do not eat, drink or smoke while handling ECO₂FUME[®] Fumigant Gas. Use in well ventilated areas. Contains flammable and toxic phosphine (hydrogen phosphide) gas. Phosphine gas may deaden the sense of smell. Do not depend solely on the odour to detect ECO₂FUME[®] Fumigant Gas. Appropriate respiratory protection must be worn during all following operations: application of the fumigant from within a structure, initiation of aeration and after aeration when testing prior to re-entry, attending to spills and leaks. Fumigated areas must be aerated to 0.3 ppm hydrogen phosphide or less prior to re-entry by unprotected workers. For hydrogen phosphide levels between 0.3 – 15 ppm, the minimum protection required is a NIOSH/MSHA approved air-purifying full-face gas mask with a chin style, front- or back-mounted canister approved for phosphine OR any NIOSH/MSHA approved self-contained breathing apparatus with a full face-piece. For hydrogen phosphide levels up to 50 ppm, any NIOSH/MSHA approved supplied air respirator with a full face piece and is operated in a positive pressure mode may be worn. In situations where the hydrogen phosphide concentration is unknown, or to escape from conditions which are Immediately Dangerous to Life or Health (IDLH), a NIOSH/MSHA approved self-contained breathing apparatus (SCBA) with a full face-piece must be worn and operated in a positive pressure mode. If a beard or long sideburns interfere with the fit of respiratory protection, they must be shaven.

RESIDUE STATEMENT

If this pest control product is to be used on a commodity that may be exported to the U.S. and you require information on acceptable residue levels in the U.S., contact 1-866-375-4648 or www.cropro.org.

EXPOSURE TO CONCENTRATIONS ABOVE PERMISSIBLE LEVELS MAY CAUSE POISONING.

B. FIRST AID

Symptoms of overexposure to this product are headache, dizziness, nausea, difficult breathing, vomiting and diarrhea. In all cases of overexposure get medical attention immediately. Take victim to doctor, hospital or emergency treatment facility. Take container, label or product name and Pest Control Registration Number with you when seeking medical attention.

IF INHALED: Move person to fresh air. If person is not breathing, immediately call for emergency medical support, then begin cardiopulmonary resuscitation including artificial respiration, preferably with a bag-valve-mask device if possible. Rescuers within the areas of potentially unsafe levels of this product (the “HOT ZONE”) should employ appropriate personal protective equipment such as SCBA during the resuscitation of the victim. Keep person warm. Call a poison control center or doctor for further treatment advice.

IF ON SKIN: May cause frostbite to unprotected skin upon contact with dispensing equipment while gas is discharged rapidly. Treat as thermal burn. Take off contaminated clothing and allow clothes to aerate in ventilated room prior to laundering. Call a poison control center or doctor for further treatment advice.

IF IN EYES: Hold eye open and rinse slowly and gently with cool water for 15-20 minutes in case of freezing or cryogenic “burns. Do not rinse eyes with hot or even tepid water. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. Call a poison control center or doctor for treatment advice. Never introduce oil or ointment into eyes without medical advice.

C. NOTE TO PHYSICIAN - THIS IS PHOSPHINE; IT IS NOT PHOSGENE TOXICOLOGICAL INFORMATION

ECO₂FUME[®] Fumigant Gas is a gaseous mixture of phosphine and carbon dioxide. Mild exposure 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 colour), 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. Phosphine poisoning may result in (1) pulmonary edema, (2) liver elevated serum GOT, LDH and alkaline phosphatase, reduced prothrombin, hemorrhage and jaundice (yellow skin colour) 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 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, 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 make their appearance), the following is suggested:
 - a. Complete rest 1-2 days during which the patient must be kept quiet and warm.
 - b. 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):
 - a. Where pulmonary edema is observed, steroid therapy should be considered and close medical supervision is recommended. Blood transfusions may be necessary.
 - b. 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.

D. ENVIRONMENTAL HAZARDS

Phosphine gas is highly toxic to fish and wildlife. Exposure to non-target organisms should be avoided. Phosphine gas may be hazardous to birds nesting on or near structures being fumigated. Carefully inspect the outside of the structure prior to application of the fumigant to ensure the absence of nesting birds. The aeration phase should be initiated early in the day to allow for maximum phosphine dissipation, which will occur during daylight hours.

E. PHYSICAL AND CHEMICAL HAZARDS

Phosphine may ignite spontaneously at levels above its lower flammability limit of 1.8% v/v (18,000 ppm). 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. For this reason, the ratio of phosphine and carbon dioxide in ECO₂FUME[®] Fumigant Gas was specifically chosen to ensure the mixture is nonflammable in all proportions with air.

Contents under pressure. Do not use or store near heat or open flame. Do not puncture or incinerate container. Exposure to temperatures above 54°C (130°F) may cause bursting. Do not drop the container.

Never open cylinder in a confined space without a SCBA with full facepiece operated in pressure-demand mode. Never enter a space under fumigation with ECO₂FUME[®] Fumigant Gas without first checking the gas

concentration levels and wearing the appropriate breathing apparatus. 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. Under high vacuum conditions, phosphine gas may cause an explosive hazard. Do not apply fumigant in vacuum chambers.

IV. DIRECTIONS FOR USE

A. GENERAL

- 1. It is an offence under the Pest Control Products Act to use this product in a manner inconsistent with its labelling.** ECO₂FUME[®] Fumigant Gas is a Restricted Use Pesticide due to the acute inhalation toxicity of phosphine, PH₃ gas. For retail sale to and use only by provincially licensed personnel 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 certified applicators. Physical presence means on-site or on the premises. Read and follow the label and this Application Manual which contains complete instructions for the safe use of this pesticide.
- ECO₂FUME[®] Fumigant Gas is a hazardous material and may be used only by individuals trained in its proper use. Before using, read and follow the label precautions and directions on the label and in the ECO₂FUME[®] Fumigant Gas Application Manual. Persons working with phosphine must be knowledgeable of the hazards of this product and trained in the use of required respiratory equipment and detector devices, emergency procedures and use of the fumigant.
- Two trained persons must be present during reentry into fumigated or partially aerated structures. Only one trained person is required to be present when phosphine is applied from outside the area to be treated, unless Provincial pesticide regulations require otherwise. Large scale (permit) fumigations may require the posting of guards to prevent entry into the area under fumigation. Refer to Provincial pesticide regulations.
- Prior to applying this product, the storage structure must be inspected to determine if it can be made sufficiently gas tight. The storage structure should be sealed so as to maintain a suitable gas concentration over the time period required for control of insects and rodents. Personal exposure monitoring should be conducted by use of personal electronic monitors or low level detection tubes, as appropriate. Notify appropriate owners, employees, and/or operators at the facility where and when the fumigation will occur, and provide relevant safety, health and environmental information to local fire and rescue officials for use in the event of an emergency. For additional information consult the manufacturer manuals and training information about safe and effective use of ECO₂FUME[®] Fumigant Gas. Observe all Provincial pesticide regulations.

5. Protect or remove copper, silver, gold and their alloys from corrosive exposure to phosphine. Sensitive equipment and items containing these elements should be removed or protected prior to fumigation with ECO₂FUME[®] Fumigant Gas.
6. Shipholds, containers on ships, railroad cars, and containers shipped piggyback by rail may be fumigated in transit. However, trucks, vans, trailers and similar transport vehicles cannot be moved over public roads or highways until they are aerated and warning placards removed.

B. EFFICACY

Complete control of listed pests may not always be achieved. Factors contributing to less than 100% control include gas leakage, poor gas distribution, unfavorable exposure conditions, etc. In addition, some insects are less susceptible to phosphine than others. To maximize control, extreme care must be observed in sealing, higher dosages must be used, exposure periods must be lengthened, proper application procedures must be followed, and temperature and humidity must be favourable.

C. USE PATTERN

1. Pests

ECO₂FUME[®] Fumigant Gas will control the following pests:

a) Rodents

including: Rats, mice, and other rodent pests in structures (not for use in burrows)

b) Insects

Almond Moth	Hessian Fly
Angoumois Grain Moth	Khapra Beetle
Bean Weevil	Indian Meal Moth
Cadelle	Lesser Grain Borer
Carpet Beetle	Maize Weevil
Cereal Leaf Beetle	Mediterranean Flour Moth
Cigarette Beetle	Pea Weevil
Confused Flour Beetle	Pink Bollworm
Dermestid Beetle	Raisin Moth
Dried Fruit Beetle	Red Flour Beetle
Dried Fruit Moth	Rice Weevil
European Grain Moth	Rusty Grain Beetle
Flat Grain Beetle	Saw-toothed Grain Beetle
Fruit Fly	Spider Beetle
Granary Weevil	Tobacco Moth
Greater Wax Moth	Warehouse Beetle

Hairy Fungus Beetle

Honeybees with tracheal mites

Yellow Meal Worm

2. Commodities

The following food commodities can be fumigated with ECO₂FUME[®] Fumigant Gas:

a) Raw Agricultural Commodities

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

b) Processed Foods

The listed processed foods may be fumigated with ECO₂FUME[®] Fumigant Gas.

- 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)

c) Animal Feed and Feed Ingredients

d) Nonfood Commodities Including Tobacco

The listed nonfood items may be fumigated with ECO₂FUME[®] Fumigant Gas:

- 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.

D. DOSAGE GUIDE

Recommended Dosages For ECO ₂ FUME [®] Fumigant Gas		
Phosphine		
Temperature	Concentration Maintained	Duration
Below 0° C (32 °F)	Do not fumigate	Do not fumigate
0-4° C (32-39° F)	200 - 500 ppm	6-14 days
5-12°C (40-53° F)	200 - 500 ppm	4-10 days
12-15°C (54-59° F)	200 - 500 ppm	3-5 days
16° C (60° F)-above	200-500 ppm	2-3 days

E. EXPOSURE GUIDELINES

Hydrogen phosphide is a mobile gas and will penetrate to all parts of the storage structure. Therefore, dosage must be based upon the total volume of the space being treated and not on the amount of commodity it contains.

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, centre of grain mass, etc.). For example, this means that 200 parts per million of phosphine from ECO₂FUME[®] Fumigant Gas is necessary for 2-3 days at 15-20° C (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, overwintering 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 15°C (60°F)) due to the lower activity and respiration levels of insects.

Fumigators also 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.

F. SEALING

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.

As with all fumigations, perimeter monitoring for leaks and potential exposures is required. If a high level of phosphine (greater than the TLV of 0.3 ppm) is detected outside the structure, the addition of fumigant must be stopped. Using the proper protective equipment, the applicator must attempt to seal the leak from the exterior of the structure. Failing this, the applicator must follow all proper procedures for confined space entry including wearing SCBA with full facepiece and operated in pressure-demand mode, and seal the leak from the interior. At times the applicator may find that all the calculated amount of fumigant has been added, however the target concentration has not been reached. In this case, the fumigator must first check the calculations. It is possible the phosphine concentration is localized and has not had enough time to disperse evenly. Continue to monitor the inside concentration while checking for leaks as above. All structures will leak to some degree. Large leaks must be repaired to minimize loss of fumigant to the environment and reduce risk of potential exposure to personnel. Fence-line concentrations must never be allowed to exceed the TLV of 0.3 ppm.

Do not fumigate a structure which is connected to other occupied structures. All people must be removed from structures connected to fumigated structures.

G. APPLICATION PROCEDURES

1. 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 dispensing equipment. As such, dispensing equipment must meet both high-pressure standards and chemical compatibility requirements. Improper or inappropriate use of dispensing equipment may result in severe injury or death. Application inconsistent with the labelling 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.

2. Equipment Specification And Use

a) General

The equipment used to dispense ECO₂FUME[®] Fumigant Gas provides a means of containing the gas during the fumigation and controlling the release of the product into the desired space. While some dispensing equipment have been developed and used to date, they cannot be expected to cover all possible fumigation scenarios. The development of suitable dispensing equipment is an ongoing process, based on the needs of the users and available technology.

The design of dispensing equipment must account for a number of technical issues, including pressure rating, material compatibility, temperature limitations and operator safety. For this reason, only appropriate

equipment must be used in the dispensing of ECO₂FUME[®] Fumigant Gas. Only persons trained in the proper use of ECO₂FUME[®] Fumigant Gas and the dispensing equipment shall be permitted to use ECO₂FUME[®] Fumigant Gas for fumigation.

The instruction materials provided with the dispensing equipment must be consulted for their proper use and maintenance.

b) 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 must not be used with ECO₂FUME[®] Fumigant Gas.

c) Approved Dispensing Methods

The approved dispensing methods for ECO₂FUME[®] Fumigant Gas include placing the cylinder outside the fumigation area. Pressure reducing regulators should be used for slow release, and selected piping components should be used for quick release. The slow release of ECO₂FUME[®] Fumigant Gas is generally used for fumigating bulk storage facilities such as silos or bins, or for small fumigation chambers or spaces and for fumigation of stacked materials under tarpaulins. The quick release method is used for space fumigation, or where the commodity to be treated is warehoused. The selection of the dispensing method will depend on the size of the fumigation, the time required and facility limitations.

d) Regulated Dispensing Equipment

Regulated dispensing equipment has been developed for use with ECO₂FUME[®] Fumigant Gas. The Regulated dispensers are designed to reduce the high cylinder pressure to a low pressure (less than 700 kPa (100 psig)) and provide the heat necessary to vapourize the fumigant. Once reduced to this lower pressure, the fumigant may be distributed to the desired dispensing points using inexpensive and easy to use materials, such as plastic tubing. Flow indicators are used with regulated dispensers to measure and set the dispensing rate. ECO₂FUME[®] Fumigant Gas regulator assemblies, equipped with basic features, are available through authorized ECO₂FUME[®] Fumigant Gas distributors. Multiple regulators may be used together to achieve higher fumigant flows than available through a single regulator and custom equipment can be developed for specific types of applications.

e) Quick Release Dispensing Equipment

For cases where the fumigation space is very large, such as a mill, warehouse or large fumigation chamber, and the use of a number of cylinders is anticipated, a quick means of dispensing ECO₂FUME[®] Fumigant Gas is available. Specially selected components can be used to direct the cylinder discharge into the fumigation space, without the need to enter the space itself during the fumigation. A single cylinder can be discharged using this method in as little as 15 minutes. Unlike the regulated dispensing methods, the dispensing rate is not adjustable and generally, entire cylinders are emptied using this process. If partial cylinder contents are needed, the ECO₂FUME[®] Fumigant Gas cylinder can be placed on a weight scale and the amount of fumigant released can be measured.

f) Calculating the Amount of ECO₂FUME[®] Fumigant Gas Required

The amount of ECO₂FUME[®] Fumigant Gas 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 ECO₂FUME[®] Fumigant Gas is used to establish a pesticidal atmosphere in the fumigation space, and through active monitoring of the phosphine concentrations, additional ECO₂FUME[®] Fumigant Gas 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 dispensing ECO₂FUME[®] Fumigant Gas, it is sometimes easier to speak in terms of the amount of phosphine that is required rather than the amount of ECO₂FUME[®] Fumigant Gas.

One gram of phosphine (PH₃) will produce a concentration of 0.71 parts per million (ppm) in a volume of 1000 cubic meters (m³) at 20°C (25 ppm in 1000 cubic feet (ft³) at 68°F). This is the fundamental conversion used when calculating the amount of ECO₂FUME[®] Fumigant Gas needed to dose a space.

$$\begin{aligned} 1 \text{ gram PH}_3/1000 \text{ m}^3 &= 0.71 \text{ ppm (25 ppm PH}_3/1000 \text{ ft}^3) \\ 1 \text{ kg ECO}_2\text{FUME}^{\text{®}} \text{ Fumigant Gas} &= 20 \text{ grams PH}_3 \\ (1 \text{ lb ECO}_2\text{FUME}^{\text{®}} \text{ Fumigant Gas} &= 9.07 \text{ grams PH}_3) \end{aligned}$$

To calculate the total amount of ECO₂FUME[®] Fumigant Gas required to fumigate a known volume :

$$\begin{aligned} \text{Kg ECO}_2\text{FUME}^{\text{®}} \text{ Fumigant Gas} &= (\text{Target ppm} \times \text{Volume m}^3)/14,200 \\ (\text{lb ECO}_2\text{FUME}^{\text{®}} \text{ Fumigant Gas} &= (\text{Target ppm} \times \text{Volume ft}^3)/226,800) \end{aligned}$$

“Target” is the desired phosphine concentration in parts per million (ppm)

“Volume” is the total volume of the space to be fumigated in cubic meters (m³) (or ft³)

Therefore:

Fumigation at 200 ppm requires 14.1 kg ECO₂FUME[®] Fumigant Gas per 1000 m³ (0.88 lb/1000ft³)

Fumigation at 500 ppm requires 35.2 kg ECO₂FUME[®] Fumigant Gas per 1000 m³ (2.2 lb/1000ft³)

One cylinder of ECO₂FUME[®] Fumigant Gas, 31 kg (68.34 lb), will generate 440 ppm phosphine in a fumigation volume of 1,000 m³ (35,315 ft³).

To calculate the amount of phosphine or ECO₂FUME[®] Fumigant Gas to be added to a space to reestablish the Target concentration:

$$\begin{aligned} \text{Kg ECO}_2\text{FUME}^{\text{®}} \text{ Fumigant Gas} &= ((\text{Target ppm} - \text{Actual ppm}) \times \text{Volume m}^3)/14,200 \\ (\text{lb ECO}_2\text{FUME}^{\text{®}} \text{ Fumigant Gas} &= ((\text{Target ppm} - \text{Actual ppm}) \times \text{Volume ft}^3)/226,800) \end{aligned}$$

“Target” is the desired phosphine concentration in parts per million (ppm)

“Volume” is the total volume of the space to be fumigated in cubic meters (m³)

“Actual” is the measured phosphine concentration in parts per million (ppm)

As a general rule, 200 ppm of PH₃ in ECO₂FUME[®] Fumigant Gas will release 7,700 ppm of carbon dioxide in the fumigation space.

When adding ECO₂FUME[®] Fumigant Gas to a space, the phosphine concentration must 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 ECO₂FUME[®] Fumigant Gas has been added, the addition of ECO₂FUME[®] Fumigant Gas must be stopped and the calculations must be checked. It is possible that a localized higher concentration has been detected and the ECO₂FUME[®] Fumigant Gas requires more time to evenly disperse.

When a partial cylinder of ECO₂FUME[®] Fumigant Gas is required, the cylinder can be placed on a scale and the amount of fumigant released can be measured. The scale can also be used to check how much ECO₂FUME[®] Fumigant Gas 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.

g) Troubleshooting

This section is provided to assist in addressing problems that may be encountered while using ECO₂FUME[®] Fumigant Gas cylinders. In the event of potential leaking structures, refer to Section F. SEALING. When troubleshooting leaking cylinders, SCBA is required when levels of phosphine are unknown, or known to exceed the short-term exposure limit (STEL; 1 ppm for 15 minutes 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 ECO₂FUME[®] Fumigant Gas distributor.

- (1) Condensation is forming on the outside of the cylinder.

This is normal. As the fumigant is removed from the cylinder, the liquefied gas mixture 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.

- (2) Ice has formed on the bottom of the cylinder.

This is normal. When the liquid fumigant level in the cylinder falls below the dip tube, gas only can be withdrawn, and the liquid that remains in the cylinder must vapourize in order to be released. If the dispensing 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.

- (3) There is a leak at the cylinder valve. REFER TO SECTION XIV. SPILL AND LEAK PROCEDURES.

- (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

dispensing equipment to vent the remaining fumigant in the line. 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. Attach a tag to the cylinder conspicuously indicating “Bad Valve Outlet” and return it.

(ii) If the cylinder is not attached to the dispensing 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.

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

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

(4) Gas is not dispensing

Check to see if the cylinder is empty. First connect a 6,895 kPa (1000 psig) pressure gauge to the cylinder outlet using a CGA 350 fitting. Open the cylinder valve and check the pressure gauge. If pressure is measured, the cylinder is not empty and a problem with the dispensing equipment is possible. Consult the dispensing equipment instructions for troubleshooting assistance. If no pressure is measured, 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.

3. APPLICATION TO BULK COMMODITIES

a) Storage

ECO₂FUME[®] Fumigant Gas 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.

b) Procedure for Fumigating Bulk Commodities

1. Determine the target phosphine concentration desired and the duration of the fumigation based on area fumigated, the insect pest(s) involved and the prevailing temperature.
2. Calculate the empty volume space to be treated.
3. Calculate how much fumigant will be required and the means by which it will be dispensed.
4. Determine where the fumigant will be dispensed into the space, and plan for and install required equipment.
5. Gas monitoring must 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 must be run in each

- fumigated structure. In the event of multi-floored structures or compartmentalized buildings, monitoring must 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.
6. Isolate and seal all connections to other storage and spaces that are not intended for fumigation.
 7. 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.
 8. Lock all entrances to the space.
 9. 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.
 10. Verify that all required safety equipment is available and in good working order.
 11. Notify all personnel in nearby buildings at the facility that fumigant release is about to commence.
 12. Connect the ECO₂FUME[®] Fumigant Gas cylinders to the dispensing equipment.
 13. Dispense the initial dose of fumigant.
 14. 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 of ECO₂FUME[®] Fumigant Gas the fumigation area must be monitored hourly for phosphine concentrations until stabilized. If concentration is falling rapidly, the applicator must 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 ECO₂FUME[®] Fumigant Gas added as required to ensure the desired phosphine concentrations are maintained during the fumigation period.
 15. Dispense additional fumigant as required to maintain the desired phosphine concentrations.
 16. When no further fumigant is required, close all cylinder valves. Depressurize the dispensing equipment and disconnect all ECO₂FUME[®] Fumigant Gas cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
 17. 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 ECO₂FUME[®] 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. ECO₂FUME[®] Fumigant Gas should 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.

4. APPLICATION TO SPACE FUMIGATIONS

a) Spaces

ECO₂FUME[®] Fumigant Gas can be used to fumigate any type of space where listed commodities are stored or processed, except barges. These include, but are not limited to mills, warehouses, processing facilities, packaging plants, empty greenhouses and other 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.

b) Procedure for Fumigating Spaces

1. 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.
2. Calculate the empty volume of the space to be treated.
3. Calculate how much fumigant will be required and the means by which it will be dispensed. Since space fumigations generally involve large volumes, fast dispensing methods are the best way to quickly achieve and maintain the desired phosphine concentrations.
4. 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. Securing the dispensing lines is important, for fast dispensing, to minimize the chance of unwanted movement of the lines during discharge. Direct the discharge toward the center of the space being treated and away from equipment if possible.
5. 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.
6. Determine where the fumigant concentrations will be measured and plan for and install required gas sampling lines.
7. Identify one access door and lock all others. Lock all ground level and other accessible windows if possible.
8. 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.
9. Remove from the space, or protect sensitive equipment, material and food.
10. 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.
11. Close, lock, seal and placard the access door.
12. Verify that all required safety equipment is available and in good working order.

13. Notify all personnel that fumigant release is about to commence.
14. Connect the ECO₂FUME[®] Fumigant Gas cylinders to the dispensing 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.
17. Dispense additional fumigant as required to maintain the desired phosphine concentrations.
18. When no further fumigant is required close all cylinder valves. Depressurize the dispensing equipment and disconnect all ECO₂FUME[®] Fumigant Gas cylinders. 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). 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 (see Section V.E-Personal Protective Equipment (PPE) – Respirators.)
20. Remove all dispensing and gas monitoring lines.
21. 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.

5. APPLICATION TO TARPAULIN FUMIGATIONS

a) General

ECO₂FUME[®] Fumigant Gas 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. This product is highly toxic to fish, birds and other forms of wildlife. Do not fumigate stacked materials under tarpaulins in the proximity of wildlife.

b) Procedure for Tarpaulin Fumigations

1. 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.
2. 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.
3. Calculate how much fumigant will be required, based on the volume calculation, and the means by which it will be dispensed. A regulated dispenser may be required, since high-speed discharge from fast dispensing can damage the tarp and undo any sealing that was done. The approved dispensing equipment includes a pressure regulator to reduce the cylinder pressure to less than 690 kPa (100 psig). From this pressure ECO₂FUME[®] Fumigant Gas flows through flow indicators, and the discharge side of the flow indicators is maintained near atmospheric pressure. The use of flow restricting nozzles is another option to control the rate of ECO₂FUME[®] Fumigant Gas dispensing to prevent damage to tape and seals.

4. Determine where the fumigant will be dispensed into the space, and plan for and install required components. Dispensing points must not be located in or attached to commodity packages or within containers.
5. Determine where the fumigant concentrations will be measured and plan for and install required gas sampling lines. Sampling points must not be located near dispensing points to avoid incorrect readings.
6. Cover the material with plastic sheeting using tape, glue or clamps to join individual sheets. If the material rests on soil or flooring of wood or other porous material, it must be repositioned onto poly prior to covering for fumigation. 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 or 6 mil is preferred and is more suitable for outdoor use. Ensure that tarp penetrations for dispensing and monitoring are well sealed.
7. Placard the tarped material.
8. Verify that all required safety equipment is available and in good working order.
9. 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 must be vacated.
10. Connect the ECO₂FUME[®] Fumigant Gas cylinders to the dispensing equipment.
11. Dispense the initial dose of fumigant.
12. 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.
13. Periodically monitor phosphine concentrations around the perimeter of the sealed tarpaulin. If concentrations exceed the TLV of 0.3 ppm, immediately locate and seal the source of the leak, or terminate fumigation until corrected.
14. Dispense additional fumigant as required to maintain the desired phosphine concentrations.
15. When no further fumigant is required, close all cylinder valves. Depressurize the dispensing equipment and disconnect all ECO₂FUME[®] Fumigant Gas cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
16. 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). Ensure the immediate area surrounding the tarpaulin-covered material is free of any birds and wildlife prior to commencing aeration.

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.

6. APPLICATION TO CONTAINERS AND TRAILERS

a) General

Railcars and containers, trucks, vans and other transport vehicles shipped piggyback by rail may be fumigated in-transit. However, it is not legal to move trucks, trailers, containers, vans, etc. over public roads or highways until they have been aerated and the warning placards removed. See appropriate sections of this manual for recommendations on placarding, commodity aeration and training of persons authorized to remove placarding. Containers, trucks, and other transport vehicles loaded with bulk commodities, to which ECO₂FUME[®] Fumigant Gas may be added are treated in essentially the same way as any other storage facility.

This product is highly toxic to fish, birds and other forms of wildlife. Do not fumigate containers, trucks, and other transport vehicles in the proximity of wildlife.

ECO₂FUME[®] Fumigant Gas dispensing lines shall not be placed in or attached to commodity packages containing processed food.

b) Procedure for Container and Trailer Fumigation

1. 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 fumigant will be required, and the dispensing time needed. A regulated dispenser on flow restricting nozzles is the recommended means of dispensing the fumigant.
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 ECO₂FUME[®] 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. Dispense the predetermined quantity of ECO₂FUME[®] Fumigant Gas into the container or trailer.
11. Disconnect dispensing lines from dispenser.
12. Remove all gas dispensing lines entering the space and seal the penetrations used.

Proper handling of treated railcars, containers and other transport vehicles shipped piggyback by rail, at their destination is the responsibility of the consignee. The consignee must be familiar with the properties of phosphine fumigants, worker exposure limits and symptoms and first aid treatment for phosphine poisoning and must know how to make gas concentration measurements.

Transfer without aeration:

Railcars, containers and other transport vehicles shipped piggyback by rail, containing commodities under fumigation may be transferred to a storage area without prior aeration. The consignee must:

1. Ensure that worker exposure levels are not exceeded, and
2. Ensure that the storage area into which the unaerated railcar, container or transport vehicle shipped piggyback is transferred is placarded if it contains more than 0.3 ppm phosphine.

Transfer with aeration:

The consignee must:

1. Aerate the railcar, containers or other transport vehicles shipped piggyback by rail, containing commodities under fumigation and verify that it contains no more than 0.3 ppm phosphine.
2. Remove the fumigation warning placard after aeration is completed.
3. Ensure that worker safety limits have not been exceeded.
4. Transfer the fumigated commodity from the railcar, or containers and other transport vehicles shipped piggyback.

7. APPLICATION TO SHIPS

a) General

Important – shipboard, in-transit ship or shiphold fumigation is governed by Transport Canada Ship Safety Regulations. Refer to and comply with those Regulations and Ship Safety Bulletins prior to fumigation. In Canada, fumigations must be carried out under the direction of a “Fumigator-in-Charge” as indicated in these regulations. No person shall fumigate in-transit or permit in-transit fumigation in a Canadian flagship. The decision to fumigate in-transit on non-Canadian flag vessels is at the discretion of the master (See Ship Safety Bulletin 13/93).

1. ECO₂FUME[®] Fumigant Gas is classified 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, provincially 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 ECO₂FUME[®] Fumigant Gas Application Manual that contains complete instructions for the safe use of this pesticide.
2. In addition to the ship fumigation procedures outlined in the following paragraphs (b, c, d, and e), 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.

b) Pre-Voyage Fumigation Procedures

1. Before fumigation is commenced, a notification of intention to fumigate must be given to the nearest Transport Canada Ship Safety office (generally no less than 24 hours in advance). Similarly, a notice must be given for vessels in-transit of Canadian waters and stopping at a Canadian Port. 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 may not be allowed to reoccupy the vessel until it has been properly aerated (to 0.3 ppm or below) 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 respiratory protection equipment* and detection equipment, and that a person qualified in the use of this equipment must accompany the vessel and 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 respiratory 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 levels up to 15 ppm. 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.

3. 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.
4. Placard all entrances to the treated spaces with fumigation warning signs as described in Section VI – Placarding of Fumigated Areas of this manual. A watchman must be posted at the gangway to keep unnecessary persons from boarding.
5. If the fumigation is not completed and the vessel aerated before the manned vessel leaves port, the Fumigator-in-Charge shall ensure that there be on board the vessel during the voyage: 1) at least four NIOSH/MSHA approved self-contained breathing apparatus (SCBA)** and four additional air bottles or combination supplied-air respirators; 2) two gas detection devices (when these devices require re-arming after use, the ship shall be equipped with 10% more spare tubes than are required to conduct the required testing for the duration of the voyage); 3) a person qualified in their operation. If the fumigated area of the vessel has to be re-entered before complete aeration, approved respiratory protection must be worn.
**the total number of SCBA on board a vessel need not exceed 6, including those already on board for fire fighting, etc. and required by other regulations.
6. 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 vapour detection equipment tests spaces adjacent to spaces containing fumigated cargo and all regularly occupied spaces for fumigant leakage. For fumigation in transit, the vessel must remain alongside for a minimum of 24 hours or the Fumigator-in-Charge must sail with the ship and remain on board for a minimum of 24 hours once fumigation has commenced. 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. At the end of the 24 hour period, final gas readings should be made and a clearance certificate issued.

7. 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.

c) 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.

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

In-transit fumigation of transport units on ships is also governed by Transport Canada Ship Safety Regulations. Refer to and comply with these regulations prior to fumigation. No fumigation of containers is to be commenced while the unit is on board a ship. The vessel Master must be notified and correct procedures regarding shipping documents, placarding and transport and stowage of containers under fumigation must be observed.

e) Precautions and Procedures During Voyages

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.

Do not enter fumigated areas except in an emergency. If necessary to enter a fumigated area, appropriate personal respiratory protection equipment must be used. Never enter fumigated areas alone. At least two persons wearing the required breathing apparatus should enter, and at least one other person, wearing personal respiratory 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 grain 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 or below 0.3 ppm.

V. PERSONAL PROTECTIVE EQUIPMENT (PPE)

A. GLOVES

It is recommended that leather work gloves or leather faced cotton gloves be used when connecting to or disconnecting ECO₂FUME[®] Fumigant Gas cylinders from the dispensing equipment.

B. 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.

C. SAFETY SHOES

It is recommended that steel-toed safety shoes be worn by anyone handling compressed gas cylinders.

D. HAND TRUCKS

Hand trucks are the recommended means of moving individual ECO₂FUME[®] Fumigant Gas 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 an ECO₂FUME[®] Fumigant Gas cylinder without valve cap and cylinder cap in place.

E. RESPIRATORS

1. When Respiratory Protection Must Be Worn

NIOSH/MSHA approved respiratory protection 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. The respiratory protection must fit properly, any obstruction to a proper fit should be removed (e.g., beard, long sideburns).

2. Permissible Gas Concentration Ranges For Respiratory Protection Devices

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 must be used at levels up to 15 ppm. Above this level or in situations where the phosphine concentration is unknown, a NIOSH/MSHA approved self-contained breathing apparatus (SCBA) must be worn and operated in positive pressure mode. Full-face canister respirators shall not be used in phosphine concentrations above 15 ppm phosphine because of the presence of carbon dioxide. Although respiratory protection is not required for CO₂ exposure up to 5,000 ppm, a canister respirator will not provide protection from CO₂ at any concentration.

3. Requirements For Availability Of Respiratory Protection

Respiratory protection must be available at the site of application in case it is needed when applying ECO₂FUME[®]. An adequate number of self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode must be available at the site of application. Other types of respiratory protective equipment may be used as appropriate. See the following Table.

NIOSH –RECOMMENDED RESPIRATORY PROTECTION FOR WORKERS EXPOSED TO PHOSPHINE GAS:

<u>CONDITION</u> (Phosphine gas, ppm)	<u>MINIMUM RESPIRATORY PROTECTION**</u>
0.3 - 3	• Supplied-air respirator
7.5 or less	• Supplied-air respirator operated in a continuous-flow mode
15 or less	• Self-contained breathing apparatus with full facepiece or supplied-air respirator with a full facepiece, or air-purifying full-facepiece respirator (gas mask) with a chin-style front- or back-mounted canister
50 or less	• Supplied-air respirator equipped with a full facepiece and operated in pressure-demand mode or SCBA with a full-facepiece and operated in a pressure-demand mode

**Only NIOSH/MSHA-approved or NIOSH-approved (effective July 10, 1995) respiratory equipment must be used. Respirators with higher assigned protection factors (APFs) may be substituted for those with lower APFs [NIOSH, 1987a].

VI. PLACARDING OF FUMIGATED AREAS

The applicator must placard or post all entrances to the fumigated area with signs at least 35 cm long and 25 cm wide in English and French bearing:

1. The signal word "**DANGER**" in letters at least 7 cm high and the **SKULL** and **CROSSBONES** symbol in red.
2. The statement, "Area and/or commodity under fumigation, **DO NOT ENTER**."
3. The statement, "This sign may only be removed after the fumigated area/commodity is completely aerated (contains 0.3 ppm or less of phosphine and 5,000 ppm or less of carbon dioxide). Transport of incompletely aerated commodities to a new site is permissible by rail or ship only, and the new storage site must be placarded if its concentration in phosphine is above 0.3 ppm or its concentration in carbon dioxide is above 5,000 ppm. Trucks, vans, trailers and similar transport vehicles cannot be moved over public roads or highways until they are aerated and the warning placards removed. If workers must handle incompletely aerated commodity, or re-enter incompletely aerated areas, or are indoors (e.g., an enclosed elevator head) they are to wear appropriate respiratory protection.
4. The date and time fumigation begins and date and time which aeration can begin.
5. Name of fumigant used.
6. Name, address, and telephone number of the applicator.
7. All entrances to a fumigated area must be placarded. Placards should be placed in advance of the fumigation in order to keep unauthorized persons away. Do not remove a placard until the treated commodity is aerated down to 0.3 ppm or less of phosphine and 5,000 ppm or less of carbon dioxide. To determine whether aeration is complete, each fumigated site or vehicle must be monitored and shown to contain 0.3 ppm or less phosphine gas and 5,000 ppm or less of carbon dioxide in the air space around and, when feasible, in the mass of the commodity. For railcar hopper cars, placarding must be placed securely on both sides of the car near the ladders and next to or on the top hatch into which the fumigant is added.
8. Placards can only be removed by workers under the direct supervision of a certified applicator when the structure/container/vehicle is no longer under fumigation and aeration is complete. It is

recommended that the person responsible for removing the placards be familiar with the physical, chemical and toxicological properties of phosphine and carbon dioxide. They should also be knowledgeable in how to take gas readings, exposure limits, symptoms and first aid treatment for phosphine and carbon dioxide poisoning.

VII. GAS DETECTION EQUIPMENT

There are a number of devices on the market for the measurement of phosphine gas as well as carbon dioxide levels for industrial hygiene purposes. Glass detection tubes used in conjunction with the appropriate hand-operated air sampling pumps are a widely used method. These devices are portable, simple to use, do not require extensive training and are relatively rapid, inexpensive and accurate. Electronic devices are also available for both low level and high phosphine and carbon dioxide gas readings. The newer low-level electronic units as well as the low-level detector tubes can detect 0.01 ppm of phosphine and are suitable for industrial hygiene monitoring. Such devices should be used in full compliance with manufacturers' recommendations. Information on hydrogen phosphide (phosphine, PH₃) detector tubes may be obtained from your distributor.

VIII. AERATION OF FUMIGATED COMMODITIES

A. 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, and 0.01 ppm in 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. If this pest control product is to be used on a commodity that may be exported to the U.S. and you require information on acceptable residue levels in the U.S., contact 1-866-375-4648 or www.cropro.org.

B. NON-FOOD COMMODITIES

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

C. 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.

IX. APPLICATOR AND WORKER EXPOSURE

A. PHOSPHINE EXPOSURE LIMITS

Exposure to phosphine must not exceed the 8-hour TWA of 0.3 ppm or the 15 minute Time-Weighted Short-Term Exposure Limit (STEL) of 1.0 ppm. All persons in the treated site and in adjacent indoor areas are covered by this exposure standard. Worker or applicator exposure must not exceed 0.3 ppm maximum

concentration over an 8-hour averaging period. Such exposures might occur because of leakage into enclosed areas from fumigation sites or during transfer of unaerated commodity. The short-term exposure limit (STEL) is 1.0 ppm phosphine for 15 minutes. Periodic gas measurements must be made in the worker's breathing zone using phosphine detector tubes or another suitable detector, unless they are protected by a NIOSH/MSHA approved supplied air respirator operated in a positive pressure mode.

B. CARBON DIOXIDE EXPOSURE LIMITS

Exposure to carbon dioxide must not exceed the 8-hour TWA of 5,000 ppm or the STEL of 30,000 ppm for applicators and workers during application. Exposure to carbon dioxide must not exceed the TLV of 5,000 ppm for any persons not associated with the application during the fumigation. All persons in the treated site and in adjacent indoor areas are covered by this exposure standard. After application is completed worker or applicator exposure must not exceed 5,000 ppm maximum concentration. Such exposures might occur because of leakage into enclosed areas from fumigation sites, during transfer of unaerated commodity. An SCBA is required for any carbon dioxide concentrations exceeding the TLV or TWA.

C. APPLICATION OF FUMIGANT

Because it is not dependent on environmental conditions such as temperature and humidity, ECO₂FUME[®] Fumigant Gas release is instantaneous. This instantaneous release can expose the fumigator to immediate high levels of fumigant. If the fumigator's exposure exceeds the 8- hour TWA of 0.3 ppm of phosphine or the TLV of 5,000 ppm (0.5% by volume) of carbon dioxide, approved respiratory protection such as an SCBA must be worn. Gas concentration measurements for safety purposes must be made using suitable low-level detection equipment. See the "Industrial Hygiene Monitoring" section below. The STEL for phosphine is 1.0 ppm for 15 minutes. The STEL for carbon dioxide is 30,000 ppm.

D. LEAKAGE FROM FUMIGATED SITES

Phosphine and carbon dioxide are highly mobile and given enough time may penetrate seemingly gas tight materials such as concrete and cinder block. Therefore, adjacent, enclosed areas likely to be occupied must be monitored to ensure that significant leakage has not occurred. Sealing of the fumigated site and/or air now in the occupied areas must be sufficient to meet exposure standards. Proper sealing of the fumigated area and/or proper ventilation of the occupied areas should be used to reduce exposure.

E. AERATION AND REENTRY

If the area is to be entered after fumigation, it must be aerated until the level of phosphine gas is 0.3 ppm or below and the level of carbon dioxide is 5,000 ppm (or 0.5% by volume) or below. The area or site must be monitored to ensure that liberation of gas from the treated commodity does not result in the development of unacceptable levels of phosphine and carbon dioxide. Do not allow reentry into treated areas by any person before this time unless protected by an approved respirator. A NIOSH/MSHA approved self-contained breathing apparatus with a positive pressure mode must be worn during testing of the phosphine level and during initiation of aeration if re-entry of the fumigated structure is necessary. Adhere to Provincial ambient air quality criteria standards and monitor downwind gas levels.

F. HANDLING UNAERATED COMMODITIES

Transfer and processing of a treated commodity prior to complete aeration is permissible. In the process, people must not be exposed to phosphine and/or carbon dioxide in excess of the permitted exposure limits. Transfer of incompletely aerated commodity via bulk handling equipment such as augers, drag conveyors and conveyor belts to a new site is permissible; however, the new storage must be placarded if it contains more than 0.3 ppm phosphine or 5,000 ppm of carbon dioxide. Workers who handle incompletely aerated listed commodity must be informed and appropriate measures must be taken (i.e., ventilation or respiratory protection) to prevent exposures from exceeding the exposure limits for phosphine and carbon dioxide. This section does not pertain to transferring fumigated containers or vehicles over public roads. The transfer of fumigated containers or truck trailers over public roads is prohibited.

G. INDUSTRIAL HYGIENE MONITORING

At each site and operation, monitor airborne phosphine and carbon dioxide concentrations in all indoor areas to which fumigators and other workers have had access during fumigation and aeration. Perform such monitoring in workers' breathing zones. This monitoring is performed to determine when and where respiratory protection is required. This monitoring is mandatory although, after gas concentrations have been adequately characterized for various locations, subsequent monitoring is not routinely required. However, spot-check those areas to determine whether conditions have significantly changed or if an unexpected garlic-like odour is present. Record all monitoring data in an operation log or manual. There are a number of devices on the market for the measurement of hydrogen phosphide gas levels for industrial hygiene purposes. One of these is the hydrogen phosphide detector tube used in conjunction with the appropriate hand-operated air sampling pump. These devices are reliable, portable, simple to use, do not require extensive training and are relatively rapid, inexpensive and accurate. Low level detector tubes are available which can detect 0.1 ppm and are suitable for industrial hygiene monitoring. Information on hydrogen phosphide (phosphine, PH_3) detector tubes may be obtained from your distributor.

H. ENGINEERING CONTROLS AND WORK PRACTICES

If initial monitoring shows that workers are exposed to concentrations in excess of the permitted exposure limits, then engineering controls (such as forced air ventilation) and/or appropriate work practices should be used (such as using personal exposure monitors) where possible to reduce exposure to below permitted limits. In any case, PPE must be worn if phosphine and/or carbon dioxide exposure limits are exceeded.

X. SAFE HANDLING OF COMPRESSED GASES IN CONTAINERS

The following are excerpts from the Compressed Gas Association (CGA) Pamphlet P-1 "Safe Handling of Compressed Gases in Containers". These are provided to assist the user with the more important aspects of cylinder handling. It is recommended that the user be familiar with all aspects of this pamphlet.

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, paint, deface, obstruct, remove or repair any part of the cylinder, including the pressure relief device, and the container valve or the valve protection device. Maintenance of the container and its valve or relief device (if required) shall be performed only by trained personnel under the direction of the container owner or an authorized representative.

3. The prescribed stamped markings on the container shall be made and kept in a legible condition. The user shall not add, 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. High temperatures may result in excessive cylinder pressure. Never apply a flame or heat directly to any part of a compressed gas container or allow it to come in contact with an electrically energized system. High temperatures may also damage the physical integrity of the container. If ice or snow accumulates on a container, thaw at room temperature, or with water at a temperature not exceeding 125°F (51.7°C).
6. Leaking or defective containers shall not be offered for shipment. Consult the gas supplier for advice under these circumstances.
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. Where valve outlet caps and /or plugs are provided by the gas supplier, the user shall keep the device on the valve outlet at all times, except when containers are secured and connected to dispensing equipment. Gas-tight valve outlet caps and plugs serve the purpose of containing any residual product and in accordance with the provisions of 49 CFR 173.40 and CSA B340, are mandatory for poison gas containers. The gas-tight valve outlet cap or plug must be checked and tightened securely before return shipment to the gas supplier.
9. The cylinder valve shall be kept closed at all times (charged or empty) except when the cylinder is in use. Do not use tools such as wrenches and hammers in attempting to open or close valves. An exception is when torque wrenches designed for use with container valve hand wheels are acceptable. Contact the gas supplier if the valve is difficult to operate.
10. Users of compressed gas containers shall ensure that they are not rolled in the horizontal position or dragged. A suitable hand truck, forklift truck, cylinder pallet system or similar material-handling device should be used with the container properly secured to the device. Never lift containers by using the container cap or 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. The transfer of compressed gases from one cylinder to another should only be performed by the gas supplier or by personnel who are trained and qualified with the proper transfill equipment and written operating procedures, and who are familiar with the precautions necessary to avoid the hazards of the product being transfilled and with the procedures necessary to comply with all government standards and regulations. Detailed written operating instructions including equipment inspection and maintenance procedures should be provided by the supplier or the transfill equipment and rigorously followed.
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. This can be confirmed by the use of a compatible leak test solution or an appropriate leak detection instrument. 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. The transportation of compressed gas cylinders in unsuitable vehicles or in closed-bodied vehicles can present serious safety hazards and should be discouraged. Refer to CGA PS-7, *CGA Position Statement on the Safe Transportation of Cylinders in Vehicles*, for additional guidance. Shipping compartments should be adequately ventilated.
17. An emergency response plan shall be in place wherever compressed gas containers and products are used, handled, stored or disposed of, according to 29 CFR 1910.120. Only trained personnel shall respond to an emergency situation involving a compressed gas container or product. Personnel shall be promptly evacuated from the immediate area in danger and kept up wind at sufficient distance to avoid any inhalation or contact with potentially hazardous products until safe reentry can be ensured.
18. In Canada, CANUTEC, the information center for Transportation Canada (TC), supplies a 24-hour response system for transportation emergencies. Canadian regulations require that when shipping certain gases the shipper file an emergency response plan with TC. In addition, CANUTEC will activate COMPGEAP Canada when necessary. CANUTEC's phone number for general information is 613-992-4624 and for emergency response is 613-996-6666.
19. Before using a gas, read the label and material safety data sheet for information about the material. Exposure to toxic gases shall be kept as low as possible but in no case should concentrations exceed the exposure levels established by the Occupational Safety and Health Administration Canada.

XI. STORAGE OF CYLINDERS

A. GENERAL

The first consideration when planning a storage area for ECO₂FUME[®] Fumigant Gas 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 ECO₂FUME[®] Fumigant Gas. 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 prohibited. 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 ECO₂FUME[®] Fumigant Gas cylinders be stored outdoors in a dedicated and properly designed and labelled storage area.

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.

E. TEMPERATURE LIMITATIONS

ECO₂FUME[®] Fumigant Gas cylinders should never be stored where the temperature will exceed 51.7 °C (125 °F) Low temperatures will not affect ECO₂FUME[®] Fumigant Gas.

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. LABELLING OF STORAGE

The labelling of the ECO₂FUME[®] Fumigant Gas 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 Storage must be clearly marked with the following signs:

1. Danger, Poison (with skull and crossed bones)
2. Authorized Personnel Only
3. 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 ECO₂FUME[®] Fumigant Gas:

<u>Category</u>	<u>Degree of Hazard</u>
Health	4 (Severe Hazard)
Flammability	0 (No Hazard)**
Reactivity	2 (Moderate)

**although phosphine gas is highly flammable, ECO₂FUME[®] Fumigant Gas contains 97% carbon dioxide by weight which makes it non-flammable.

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.

XII. TRANSPORT

A. GENERAL

ECO₂FUME[®] Fumigant Gas is classified as a poison gas by Transport Canada and it shall only be transported in accordance with Transport Canada regulations. All persons involved in the transport of or the preparation of cylinders for transport should be trained in and familiar with the regulations.

B. TRANSPORT DESIGNATIONS

The following transport designations apply ECO₂FUME[®] Fumigant Gas:

Proper Shipping Name:	Liquefied gas, toxic N.O.S.. (contains phosphine Inhalation Hazard, Zone A)
Hazard Class:	2.3
Identification Number:	UN 3162
Shipping Label:	Poison Gas

C. TRANSPORT REQUIREMENTS

1. Package Preparation

ECO₂FUME[®] Fumigant Gas 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.

2. Cylinder Contents

Used ECO₂FUME[®] Fumigant Gas 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 ECO₂FUME[®] Fumigant Gas cylinders.

3. Documents

Proper documentation is required by law, for the transport of any hazardous material. The documentation accompanying the shipment of ECO₂FUME[®] Fumigant Gas (whether full, partially full, or empty) must include the labelling, 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.

4. Vehicle Loading

ECO₂FUME[®] Fumigant Gas cylinders shall only be loaded into unoccupied spaces of vehicles. All cylinders shall be secured from movement during transport.

5. Vehicle Markings

Vehicles transporting ECO₂FUME[®] Fumigant Gas shall be placarded in accordance Transport Canada regulations for pressurized gases. Consideration should be made for other hazardous materials that are concurrently being transported. Proper placarding should take into account all hazardous materials on board.

6. Use of Common Carriers

Shipment of ECO₂FUME[®] Fumigant Gas cylinders by common carrier is permitted, provided the carrier meets certain criteria. Contact an authorized ECO₂FUME[®] Fumigant Gas distributor for an approved list of common carriers.

7. 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.

XIII. DISPOSAL

Once used, ECO₂FUME[®] Fumigant Gas 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. Disposal of the cylinder contents (mixture of phosphine and carbon dioxide) is prohibited. If the cylinder is partially full do not release the remaining gases; just send the cylinder to authorized distributor.

XIV. SPILL AND LEAK PROCEDURES

A. GENERAL

All releases can produce high levels of toxic phosphine gas, and therefore, attending personnel must wear a 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 must be worn.

B. WHAT TO DO

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.

C. WHO TO CALL

CYTEC operates a 24-hour Emergency Response and Incident Management System (ERIM). For emergencies involving spill, leak, fire, exposure or accident call Canadian Transport Emergency Centre (CANUTEC) 613/996-6666 or CHEMTREC: 1-800/424-9300. Outside the US or Canada call 703/527-3887.

D. EMERGENCY RESPONDERS

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.