

68387-7

08/28/2000

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U. S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460-000

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Alan Katz
Katz Associates
16090 Simon Kenton Road
Haymarket, VA 20169-2109

AUG 28 2000

Subject: EPA Reg. No. 68387-7
ECO₂FUME® Fumigant Gas
Amendment to Add Food Uses to Label
Submission Dated August 21, 2000

Dear Alan:

The bridging residue data that you submitted for adding the food and feed uses to the label are sufficient, with the exception of dates, nuts, dried fruits and oil seeds, where some confirmatory data are required.

The labeling (label and application manual), submitted in connection with registration under the Federal Insecticide, Fungicide, and Rodenticide Act, is acceptable, provided that:

- a. within 3 months of this approval, you submit a protocol to generate additional residue data on dates, nuts (walnut and pecans), dried fruits (raisins and prunes) and oil seeds (cotton seeds and peanuts),
- b. within 18 months of this approval, you submit the above requested confirmatory residue data,
- c. replace the second sentence "For emergencies involving CHEMTREC: 1-800-424-9300" under WHO TO CALL (page 3 of label and page 40 of Application Manual) with "For emergencies involving spill, call CHEMTREC: 1-800-424-9300. For emergencies involving leak, fire or exposure, call 911 or local Fire and Rescue or Cytec's Emergency Phone No. 1-800-424-9300."
- d. make sure that you follow the minimum type size requirements in the final printed label, and

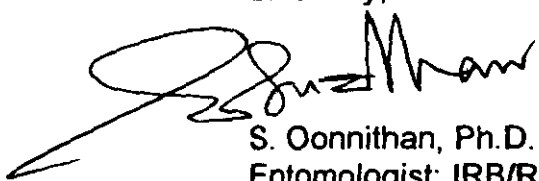
EPA Reg. No.: 68387-7 contd ...

- e. existing stocks of previously approved labels may be used for 18 months.

Submit two (2) copies of the final printed labeling and Applicator's Manual before you release the product for shipment. If this condition is not complied with, the registration will be subject to cancellation in accordance with FIFRA sec 6(e). Your release for shipment of the product bearing the amended labeling constitutes acceptance of this condition.

A stamped copy of the label and application manual are enclosed for your records. Should you have any questions, do not hesitate to contact me at 703-605-0368.

Sincerely,



S. Oonnithan, Ph.D.
Entomologist; IRB/RD (7505C)
Office of Pesticide Programs

Enclosures:

1. Stamped label
2. Stamped Application Manual
3. Copy of Minimum Type Sizes for Final Printed Labels page

RESTRICTED USE PESTICIDE

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

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

ECO₂FUME[®] Fumigant Gas

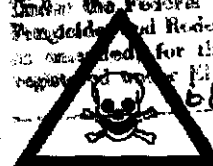
A phosphine-containing fumigant for use in controlling pests in listed raw agricultural commodities, processed foods, stored tobacco, animal feeds, and nonfood products. Not for use in ships or barges. See the Application Manual for a list of commodities and pests controlled.

	By Weight
ACTIVE INGREDIENTS: Phosphine Gas (PH ₃).....	2%*
Carbon Dioxide (CO ₂)	98%
TOTAL	100%
* 2.6% by volume	

ACCEPTED with COMMENTS
EPA Letter Dated:
AUG 28 2000
Under the Federal Insecticide, Fungicide and Rodenticide Act, this pesticide is registered for the purpose of...
68387-7



**KEEP OUT OF REACH OF CHILDREN
DANGER - POISON - PELIGRO**



PELIGRO AL USUARIO: Si usted no lee ingles, no use este productor hasta que la etiqueta se le haya sido explicado ampliamente
(TO THE USER: If you cannot read English, do not use this product until the label has been fully explained to you.)

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.

If Inhaled	<ul style="list-style-type: none"> • Move person to fresh air • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • 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. • 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 Industries Inc. West Paterson, NJ 07424 USA

Emergency Phone: 1-800/424-9300 or 703/527-3887

EPA Registration No. 68387-7

EPA Establishment No. 68387-CAN-1

Net Contents: 68.3 lbs.

THIS PRODUCT IS ACCOMPANIED BY AN APPROVED LABEL AND AN APPLICATION MANUAL. READ 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 LABEL OR APPLICATION MANUAL. IF THE PRODUCT LABEL OR APPLICATION MANUAL IS LOST, CONTACT CYTEC INDUSTRIES INC. TO OBTAIN A REPLACEMENT COPY.

PRECAUTIONARY STATEMENTS HAZARDS TO HUMANS AND DOMESTIC ANIMALS DANGER/PELIGRO – POISON

May be fatal if inhaled. The liquid may cause burns. Avoid contact with skin and eyes and avoid breathing vapor. Keep animals, children and unauthorized persons away from area under treatment, until area is shown to be free from phosphine gas, as indicated by a gas-measuring device. Working in an area with undetermined concentrations requires a self-contained breathing apparatus (SCBA) with full face-piece operated in a pressure-demand mode. Do not get in eyes, in nose, on skin or on clothing. Do not eat, drink or smoke while handling ECO₂FUME[®]. Phosphine gas may deaden the sense of smell. Do not depend solely on the odor to detect ECO₂FUME[®]. Observe proper application, aeration, reentry and dosing procedures specified elsewhere in the application manual to prevent overexposure.

NOTE TO PHYSICIAN – THIS IS PHOSPHINE

ECO₂FUME[®] 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 color), unconsciousness and death.

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

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

1. Exposure of skin to rapidly evaporating liquid 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 appear), the following is suggested:
Complete rest 1-2 days during which the patient must be kept quiet and warm. If the patient suffers from vomiting or increased blood sugar, appropriate solutions should be administered. Treatment with oxygen is recommended, as is the administration of cardiac and circulatory stimulants.
4. In cases of severe poisoning (intensive care unit is recommended):

Where pulmonary edema is observed, steroid therapy should be considered and close medical supervision is recommended. Blood transfusions may be necessary. In case of manifest pulmonary edema, venesection should be performed under vein pressure control. Heart glycosides (I.V.) can be used in case of hemoconcentration. Venesection may result in shock. In the case of progressive edema of the lungs, immediately intubate and remove edema fluid and administer oxygen over-pressure respiration, as well as any measures required for shock treatment. In case of kidney failure, extracorporeal hemodialysis is necessary. There is no specific antidote known for this poisoning.

ENVIRONMENTAL HAZARDS

Phosphine gas is highly toxic to fish and wildlife. Exposure to non-target organisms should be avoided.

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.**

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

Never open cylinder in confined space without a self-contained breathing apparatus (SCBA) with full face-piece and operated in a pressure-demand mode. Never enter a space under fumigation with ECO₂FUME[®] without first checking the gas concentration levels and wearing the appropriate breathing apparatus. These precautions will also reduce the applicator's exposure to gas. 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.

DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling. ECO₂FUME® is a Restricted Use Pesticide due to the acute inhalation toxicity of phosphine, PH₃ gas. For retail sale to and use only by certified applicators for those uses covered by the applicator's certification or persons trained in accordance with the application manual working under the direct supervision and in the physical presence of the certified applicator. Physical presence means on-site or on the premises.

ECO₂FUME® 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 Application Manual. Refer to the Application Manual for more detailed precautions, recommendations and directions for use.

STORAGE INSTRUCTIONS

INDOOR STORAGE

The storage of poison gases in occupied spaces is not recommended. Indoor storage in a separate building with no other occupancy is suitable. The building should be adequately ventilated and equipped with a continuous phosphine monitoring and alarm system that is activated at the TLV of 0.3 ppm. In some jurisdictions, the indoor storage of toxic gases is prohibited.

OUTDOOR STORAGE

It is recommended that both full and used ECO₂FUME® cylinders be stored outdoors in a dedicated and properly designed and labeled storage area. The following are recommended for outdoor storage:

- A firm and level surface, preferably reinforced concrete, well drained.
- A secured and locked area.
- Cylinders should never be stored where the temperature will exceed 125 °F (51.7 °C).
- A means of securing all cylinders.
- Away from building ventilation intakes.

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.

DISPOSAL INSTRUCTIONS

Once used, ECO₂FUME® 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 cylinder.

SPILL AND LEAK PROCEDURES

GENERAL

All releases can produce high levels of gas, and therefore, attending personnel must wear a self-contained breathing apparatus (SCBA) or its equivalent when the concentration of phosphine gas is unknown. If the concentration is known, other NIOSH/ MSHA approved respiratory protection must be worn.

WHAT TO DO

In the event of an accidental release, evacuate the area immediately. A response into the leak area should only be attempted by trained emergency responders. 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.

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 CHEMTREC: 1-800/424-9300. Outside the US or Canada call 703/527-3887.

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. Refer to the Application manual for more detailed recommendations for handling, storage, spill and leak procedures.

WARRANTY

Seller warrants that the product conforms to its chemical description and when used according to label directions under normal conditions of use, it is reasonably fit for the purpose stated on the label. Seller makes no other warranty, either expressed or implied, and buyer assumes all risk should the product be used contrary to label instructions.

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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. Not for use in ships or barges. Refer to the Application Manual for a list of commodities and pests controlled.

ACTIVE INGREDIENTS:	Phosphine Gas (PH ₃).....	By Weight	2%*
	Carbon Dioxide (CO ₂)		98%
	TOTAL		100%

* 2.6% by volume



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DANGER - POISON - PELIGRO**



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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.

If Inhaled	<ul style="list-style-type: none"> • Move person to fresh air • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • 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. • 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.

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Emergency Phone: 1-800/424-9300 or 703/527-3887
EPA Registration No. 68387-7
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Net Contents: 68.3 lbs.

[Rev 8/19/99]

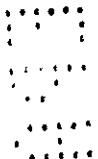
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AN APPROVED LABEL AND AN APPLICATION MANUAL ACCOMPANY THIS PRODUCT. READ THE ENTIRE LABEL AND APPLICATION MANUAL BEFORE USE. ALL PARTS OF THE LABEL AND APPLICATION MANUAL ARE EQUALLY IMPORTANT FOR SAFE AND EFFECTIVE USE OF THIS PRODUCT. CALL CYTEC 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.

WARRANTY

Seller warrants that the product conforms to its chemical description and when used according to label directions under normal conditions of use, it is reasonably fit for the purpose stated on the label. Seller makes no other warranty, either expressed or implied, and buyer assumes all risk should the product be used contrary to label instructions.



APPLICATION MANUAL
FOR
ECO₂FUME[®] Fumigant Gas

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I. INTRODUCTION

A. PRODUCT DESCRIPTION

ECO₂FUME[®] 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[®] cylinders contain carbon dioxide as liquefied gas under pressure. Pressurized carbon dioxide serves as a propellant for delivering the product. A poisonous gas, carbon dioxide retards flammability and may contribute to the effectiveness of the product as a fumigant.

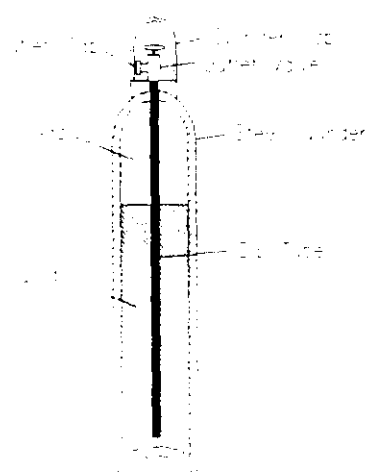
Phosphine and carbon dioxide are both gases that, under sufficient pressure, can exist in a liquid state. It is this "liquefied gas" that is stored in the cylinder. The product is withdrawn from the cylinder as a liquid, but dispensed as a gas. In expanding from a liquid to a gas, it increases in volume 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[®] is packaged in a steel compressed gas cylinder, designed, manufactured, maintained and filled in compliance with regulations established by the United States



Representative Package

Department of Transportation (DOT). 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 vaporizes to fill the remaining space in the cylinder. Through this vaporization, the cylinder pressure is maintained.

The valve outlet fitting is a CGA350, which was established by the Compressed Gas Association (CGA). The valve outlet is protected by a threaded gas-tight outlet cap, which must be secured whenever the cylinder is not in use. Attach only CYTEC provided (or approved) dispensing equipment to the cylinder valve outlet to dispense ECO₂FUME[®] 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[®] is a poisonous gas, DOT regulations prohibit the use of such a device.

Each cylinder is supplied with a cylinder cap, which is designed to protect the outlet valve. This cap must be secured whenever a cylinder is not in use. It is unlawful to transport an ECO₂FUME[®] cylinder without the valve outlet cap and the cylinder cap securely in place.

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

2. Dispensing Equipment

A typical ECO₂FUME[®] dispensing unit (see diagram on next page) uses a heating vaporizer to provide the energy required to vaporize the liquid fumigant. This regulator is limited to a dispensing rate of approximately 24 pounds of ECO₂FUME[®] per hour. The equipment is designed for a service pressure up to 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 and the temperature setting may be adjusted. Exiting the heater ECO₂FUME[®] gas flows through an actuated valve that can be used for emergency shutdown purposes. ECO₂FUME[®] gas then flows through a gas regulator that drops the pressure down to 30 psig. A diaphragm valve is used to control the gas flow at any desired value up to 100 liters/minute as indicated by the flow rotameter. The heater provides 1000 watts of power that can vaporize a maximum of 100 ppm. Lower rotameter ranges are possible. ECO₂FUME[®] regulator assemblies, equipped with basic features, are available through authorized ECO₂FUME[®] 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.

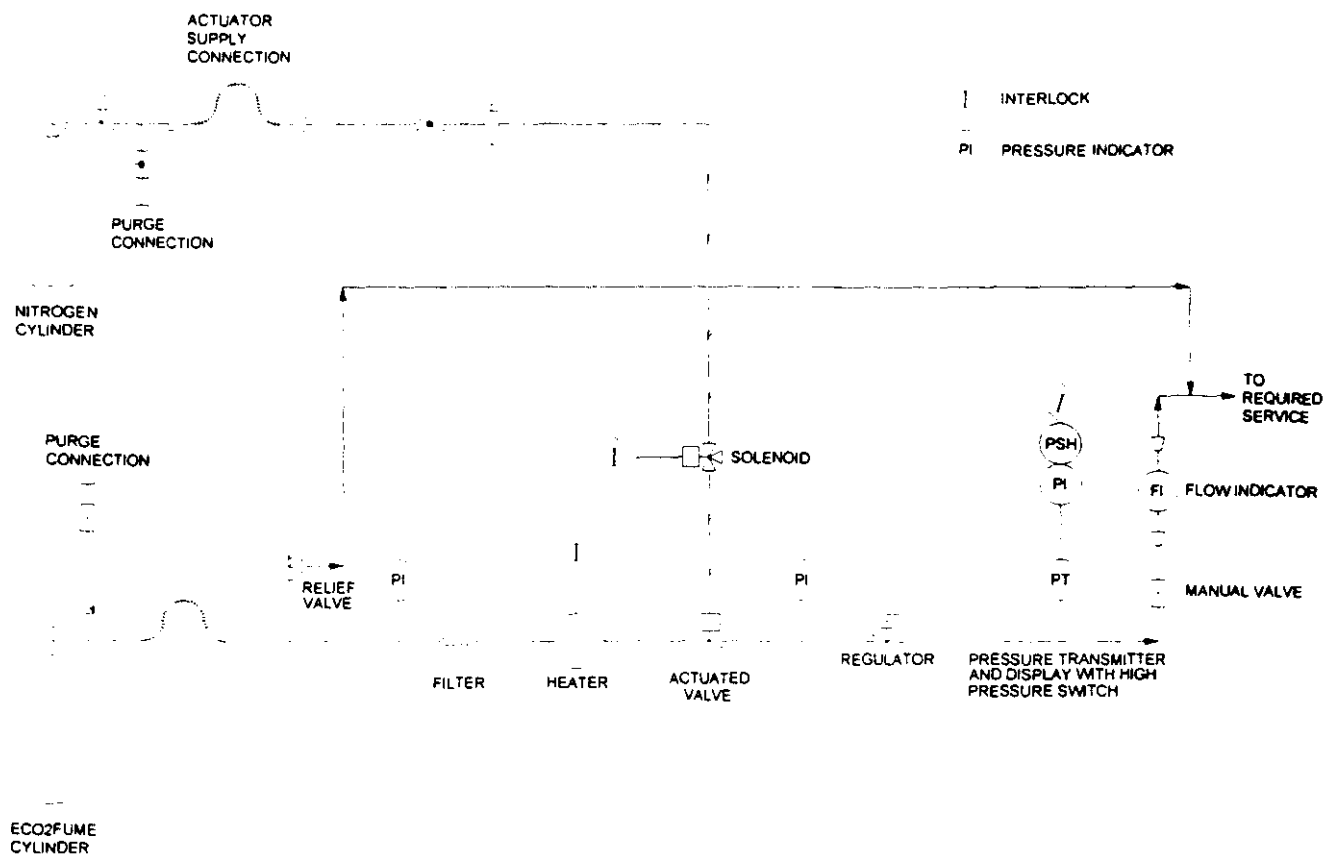


Diagram of a Representative Type of ECO₂FUME[®] Dispensing Equipment

C. PHOSPHINE AND CARBON DIOXIDE

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

Carbon dioxide is colorless, 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 used. Sometimes phosphine may have an odor due to the presence of impurities in the product; however, this odor cannot always be relied upon as an adequate indicator of phosphine exposure.

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

D. ENVIRONMENTAL FATE

ECO₂FUME[®] 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 vapor to produce traces of H₃PO₄ (phosphoric acid). Phosphine is only moderately soluble in water, 26 cc in 100 cc of water at 17° C, in which it gradually decomposes into phosphorus, hydrogen, and the lower hydrides of phosphorus.

II. SAFETY REQUIREMENTS

ECO₂FUME[®] is a restricted use product for retail sale and use only by certified applicators and people under their direct supervision.

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. Never allow untrained personnel to handle ECO₂FUME[®].
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[®] 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 during application or a maximum concentration of 0.3 ppm after application is completed. This includes reentry into a structure.
8. Worker exposure to carbon dioxide must not exceed the 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 also discussed in Section V.
- 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.

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® 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 XV. 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. Carbon dioxide should be used to pressurize and leak check equipment with soap solution prior to use in the field.

If any leak is encountered while using ECO₂FUME® 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[®] cylinders and dispensing equipment can achieve pressures of over 1000 pounds per square inch. Because of this high pressure, care must be taken to avoid unintentional releases of the product.

1. GAS DISCHARGE

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

2. TEMPERATURE

The rapid discharge of ECO₂FUME[®] 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 if touched by unprotected skin. While this chilling is typically evidenced by the formation of ice on the equipment and cylinders, the cold hazard may exist without the formation of ice.

3. RESIDUAL PRESSURE

The chilling of cylinders is the result of the liquefied gas 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[®] dispensing equipment at the conclusion of fumigation, all residual gas in the equipment should be vented to atmospheric pressure. The cylinder valve should be closed and the remaining product within the supply line discharged through the dispensing equipment. Cylinders should not be disconnected before ensuring that the line is fully vented.

4. LIQUID EXPANSION

Liquefied gases expand rapidly when they are warmed. Because of this characteristic, liquid ECO₂FUME[®] 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[®] is a restricted use product for the retail sale and use only by certified applicators and people under their direct supervision.

A. HAZARDS TO HUMANS AND DOMESTIC ANIMALS

Keep Out of Reach of Children

DANGER-POISON

May be fatal if inhaled. The liquid may cause burns. Avoid contact with skin and eyes and avoid breathing vapor. Use in well ventilated areas. Keep animals, children and unauthorized persons away from area under treatment until area is shown to be free from phosphine gas, as indicated by a gas-measuring device. Where the concentration of phosphine is unknown, a self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode must be used.

Do not get in eyes, in nose, on skin or on clothing. Do not eat, drink or smoke while handling ECO₂FUME[®]. Phosphine gas may deaden the sense of smell. Do not depend solely on the odor to detect ECO₂FUME[®]. Observe proper application, aeration, reentry and dosing procedures specified elsewhere in the labeling to prevent overexposure.

EXPOSURE TO CONCENTRATIONS ABOVE PERMISSIBLE LEVELS MAY CAUSE POISONING.

B. STATEMENT OF PRACTICAL TREATMENT

IF INHALED: Remove to fresh air, lay down and rest, if not breathing apply resuscitation. Keep warm. Transport to hospital or doctor. Take this label to doctor or hospital.

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

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

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

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

ECO₂FUME[®] 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 color), unconsciousness and death.

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

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

1. Exposure of skin to rapidly evaporating liquid 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 is highly toxic to fish and wildlife. Exposure to non-target organisms should be avoided.

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.**

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

Never open cylinder in a confined space without an SCBA with full facepiece operated in pressure-demand mode. Never enter a space under fumigation with ECO₂FUME[®] 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 a violation of federal law to use this product in a manner inconsistent with its labeling.** ECO₂FUME[®] is a Restricted Use Pesticide due to the acute inhalation toxicity of phosphine, PH₃ gas. For retail sale to and use only by certified applicators for those uses covered by the applicator's certification or persons trained in accordance with

this product manual working under the direct supervision and in the physical presence of certified applicators. Physical presence means on-site or on the premises.

2. ECO₂FUME® 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® Application Manual.
3. At least two Certified Applicators must be present during reentry into a fumigated or partially aerated site. One applicator should serve as an observer while the other enters the facility. The second applicator should not enter the facility and should seek help in the event of an emergency.
4. 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. 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 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. For additional information consult the manufacturer manuals and training information about safe and effective use of ECO₂FUME®.
5. Do not apply ECO₂FUME® in vacuum chambers.
6. Protect or remove copper, silver, gold and their alloys from corrosive exposure to phosphine.

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 favorable.

C. USE PATTERN

1. INSECT PESTS

ECO₂FUME® will control the following pests:

- | | |
|-------------------|-----------------------|
| Almond Moth | Angoumois Grain Moth |
| Bean Weevil | Cadelle |
| Carpet Beetle | Cereal Leaf Beetle |
| Cigarette Beetle | Confused Flour Beetle |
| Dermestid Beetle | Dried Fruit Beetle |
| Dried Fruit Moth | European Grain Moth |
| Flat Grain Beetle | Fruit Fly |

- Granary Weevil
- Hairy Fungus Beetle
- Khapra Beetle
- Lesser Grain Borer
- Mediterranean Flour Moth
- Pink Bollworm
- Red Flour Beetle
- Rusty Grain Beetle
- Spider Beetle
- Warehouse Beetle
- Africanized and honeybee infested with tracheal mites
- Greater Wax Moth
- Hessian Fly
- Indian Meal Moth
- Maize Weevil
- Pea Weevil
- Raisin Moth
- Rice Weevil
- Saw-toothed Grain Beetle
- Tobacco Moth
- Yellow Meal Worm

2. COMMODITIES

The following food commodities can be fumigated with ECO₂FUME®:

a. Raw Agricultural Commodities

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

b. Processed Foods

The listed processed foods may be fumigated with ECO₂FUME®.

Processed candy and sugar

Cereal flours and bakery mixes

Cereal foods (including cookies, crackers, macaroni, noodles, pasta, pretzels, snack foods and spaghetti)

Processed cereals (including milled fractions and packaged cereals)

Cheese and cheese by-products

Chocolate and chocolate products (such as assorted chocolate, chocolate liquor, cocoa, cocoa powder, dark chocolate coating and milk chocolate)

Processed coffee

Corn grits

Cured, dried and processed meat products and dried fish

Dates

Dried eggs and egg yolk solids

Dried milk, dried powdered milk, nondairy creamers, and nonfat dried milk

Dried or dehydrated fruits (such as apples, dates, figs, peaches, pears, prunes, raisins and sultanas)

Dried and dehydrated vegetables (such as beans, carrots, lentils, peas, potato flour, potato products and spinach)

Figs

Malt

Peanuts

Processed herbs, spices, seasonings and condiments

Processed nuts (almonds, apricot kernels, Brazil nuts, cashews, filberts, peanuts, pecans, pistachio nuts, walnuts and other processed nuts)

Processed oats (including oatmeal)

Rice (brewers rice grits, enriched and polished, wild rice)

Soybean flour and milled fractions

Processed tea

Yeast (including primary yeast)

Wild rice

c. Animal Feed and Feed Ingredients

d. Nonfood Commodities Including Tobacco

The listed nonfood items may be fumigated with ECO₂FUME®:

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 ECO₂FUME®**

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

E. EXPOSURE GUIDELINES

The above table may be used as a guide in determining the minimum length of the exposure at the indicated temperatures. These are the temperatures found within the immediate surroundings of the target pest (cold walls, center of grain mass, etc.). For example, this means that 200 parts per million of phosphine from ECO₂FUME® is

necessary for 2-3 days at 60-68° F at the location of the pest insect. This does not mean the ambient temperature the fumigator is experiencing but the localized concentration and temperature next to the pest insects.

Some insect species and life stages are harder to kill than others. It is important that you know and understand your target pest(s). For example, 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 serricornis*).

Consequently, exposure periods recommended in the table are minimum periods and may not be adequate to control all stages of stored product pests under all conditions. This is particularly true at lower temperatures (below 60 degrees F) due to the lower activity and respiration levels of insects.

Fumigators 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 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 labeling and Application Manual is a violation of Federal law. Buyer assumes all risk should the product be used contrary to label or Application Manual instructions.

2. EQUIPMENT SPECIFICATION AND USE

a) General

The equipment used to dispense ECO₂FUME[®] 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 has 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 should be used in the dispensing of ECO₂FUME[®]. Only persons trained in the proper use of ECO₂FUME[®] and the dispensing equipment shall be permitted to use ECO₂FUME[®] for fumigation.

The instruction materials provided with the dispensing equipment should 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 should not be used with ECO₂FUME[®].

c) Approved Dispensing Methods

The approved dispensing methods for ECO₂FUME® 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® 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

Two gas regulators have been developed for use with ECO₂FUME®. Each of the regulators are designed to reduce the high cylinder pressure to a low pressure (less than 30 psig) and provide the heat necessary to vaporize 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.

(1) Ambient Heat Regulator

The slower of the two regulators relies on ambient heat to vaporize the fumigant and is limited to a dispensing rate of about 1/2 pound of ECO₂FUME® per hour. This regulator requires no external power source.

(2) Heater Regulator

The heater regulator uses a built in heating vaporizer to provide the energy required to expand the fumigant at a much higher rate than the ambient heat regulator. This regulator is limited to a dispensing rate of about 6 pounds of ECO₂FUME® per hour, and requires power.

(3) Regulator Assemblies

ECO₂FUME® regulator assemblies, equipped with basic features, are available through authorized ECO₂FUME® 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® 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 20 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® cylinder can be placed on a weight scale

and the amount of fumigant released can be measured. The quick release method must not be used for fumigation of stacked materials under tarpaulins.

f) Calculating the Amount of ECO₂FUME[®] Required

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

One gram of phosphine (PH₃) will produce a concentration of 25 parts per million (ppm) in a volume of 1000 cubic feet (CF). This is the fundamental conversion used when calculating the amount of ECO₂FUME[®] needed to dose a space.

<p>1 gram PH₃ = 25 ppm PH₃/1000 CF 1 pound ECO₂FUME[®] = 9.07 grams PH₃</p>

To calculate the total amount of phosphine or ECO₂FUME[®] required to dose a space:

<p>grams of PH₃ = (Target x Volume) / 25,000 or pounds of ECO₂FUME[®] = (Target x Volume) / 226,800 "Target" is the desired phosphine concentration in parts per million (ppm). "Volume" is the empty volume of the space to be fumigated in cubic feet (CF).</p>
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To calculate the amount of phosphine or ECO₂FUME[®] to be added to a space to reestablish the Target concentration:

<p>grams of PH₃ = (Target - Actual) x Volume / 25,000 or pounds of ECO₂FUME[®] = (Target - Actual) x Volume / 226,800 "Target" is the desired phosphine concentration in parts per million (ppm). "Volume" is the empty volume of the space to be fumigated in cubic feet (CF). "Actual" is the measured phosphine concentration in parts per million (ppm).</p>
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As a general rule, 200 ppm of PH₃ in ECO₂FUME® will release 7,700 ppm of carbon dioxide in the fumigation space.

When adding ECO₂FUME® to a space, the phosphine concentration should be actively monitored. This can be accomplished from outside the space by use of plastic sample tubing run through an opening and securely attached to a point inside the space. If the desired concentration is achieved before the calculated amount of ECO₂FUME® has been added, the addition of ECO₂FUME® should be stopped and the calculations should be checked. It is possible that a localized higher concentration has been detected and the ECO₂FUME® requires more time to evenly disperse.

When a partial cylinder of ECO₂FUME® 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® 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® 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® 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 vaporize 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 Spill and Leak Procedures.

4) Gas is not dispensing.

Check to see if the cylinder is empty. First connect a 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[®] 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.

- 30/4
5. Gas monitoring should be performed from outside the fumigated structure. Polyethylene tubing is used for remote monitoring. This tubing can be run from each area of the fumigation to an outside location where gas samples can be taken safely. At least one monitoring line should be run in each fumigated structure. In the event of multi-floored structures or compartmentalized buildings, monitoring should be performed in all major areas of the fumigated structure. Fans can be used to help distribute gas into smaller areas and the outer reaches of these structures.
 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[®] 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[®] the fumigation area should be monitored hourly for phosphine concentrations until stabilized. If concentration is falling rapidly, the applicator should investigate the structure for possible leak points. Seal any leak points found. In a well-sealed structure, the phosphine concentration should stabilize quickly and monitoring frequency can be reduced to daily measurements. The sampling frequency should be adjusted and additional ECO₂FUME[®] 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[®] 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[®] 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[®] 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[®] can be used to fumigate any type of space where listed commodities are stored or processed, except ships or barges. These include, but are not limited to empty mills, warehouses, processing facilities, packaging plants and other empty structures. The most important aspects of a successful fumigation, as with any fumigant, are the degree to which the space is sealed and the assurance that the minimum fumigant concentrations are maintained for the required time.

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 (if used) 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[®] 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[®] 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.
- 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[®] 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.

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 is 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 approximately 30 psig. From this pressure ECO₂FUME[®] flows through flow indicators, and the discharge side of the flow indicators is maintained near atmospheric pressure.
- 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 or within containers.
- 5. Determine where the fumigant concentrations will be measured and plan for and install required gas sampling lines. Sampling points should not be located near dispensing points to avoid incorrect readings.

6. Cover the material with plastic sheeting using tape, glue or clamps to join individual sheets. If the flooring on which the material is placed is wood or other porous material, it should be covered first with plastic sheeting. Seal the plastic covering to the floor using tape, glue, sand or water "snakes", shoveling sand or soil onto the ends of the plastic, or by other suitable means. Reinforce by tape or other means, any sharp corners or edges to reduce the risk of tearing the plastic. Plastic sheeting should be a minimum of 2-mil thickness for indoor applications however, 4 mil is preferred and is more suitable for outdoor use. Ensure that tarp penetrations for dispensing and monitoring are well sealed.
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 should be vacated.
10. Connect the ECO₂FUME[®] 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. Dispense additional fumigant as required to maintain the desired phosphine concentrations.
14. When no further fumigant is required, close all cylinder valves. Depressurize the dispensing equipment and disconnect all ECO₂FUME[®] cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
15. When the fumigation is complete, remove the tarp and aerate as appropriate using precautions to prevent exposure to workers (see VIII. AERATION OF FUMIGATED COMMODITIES and IX. E. AERATION AND REENTRY).

Additional Considerations:

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

6. APPLICATION TO CONTAINERS AND TRAILERS

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a) General

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

Containers, trucks, and other transport vehicles loaded with bulk non-food commodities, to which ECO₂FUME® may be added are treated in essentially the same way as any other storage facility.

ECO₂FUME® 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 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® 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® 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.

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[®] 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[®] 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[®] 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.

2. PERMISSIBLE GAS CONCENTRATION RANGES FOR RESPIRATORY PROTECTION DEVICES

A NIOSH/MSHA approved, full-face gas mask phosphine canister combination may be used at levels up to 15 ppm. 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>	<u>MINIMUM RESPIRATORY PROTECTION</u>
(Phosphine gas, ppm)	
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

VI. PLACARDING OF FUMIGATED AREAS

The applicator must placard or post all entrances to the fumigated area with signs in English and Spanish bearing:

1. The signal word "**DANGER/PELIGRO**" and the **SKULL and CROSSBONES** symbol in red.
2. The statement, "Area and/or commodity under fumigation, **DO NOT ENTER/NO ENTRE**".
3. The statement "This sign may only be removed after the commodity is completely aerated (contains 0.3 ppm or less phosphine gas and 5,000 ppm or less carbon dioxide). If incompletely aerated commodity is transferred to a new site, the new site must also be placarded and workers must not be exposed to more than 0.3 ppm phosphine or 5,000 ppm carbon dioxide."
4. The date and time fumigation begins and fumigation is completed.
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. 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.

VIII. AERATION OF FUMIGATED COMMODITIES

A. FOODS AND FEEDS

Tolerances for phosphine residues have been established at 0.1 ppm for animal feeds, 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 release of the fumigated food or feed item. As an alternative to this aeration period each container of the treated commodity may be analyzed for residues using accepted analytical methods.

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 for applicators and workers during application. 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 10 minutes.

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[®]'s 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 and 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 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.

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. After gas concentrations have been adequately characterized for various locations, spot-check those areas to determine whether conditions have significantly changed or if an unexpected garlic-like odor is present. Record all monitoring data in an operation log or manual.

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, obstruct, remove or repair any part of the cylinder package. Only trained personnel under direction of the container owner or authorized representative shall perform maintenance of the container and its valve.
3. The prescribed stamped marking on the container shall be made and kept in a legible condition. The user shall not remove or alter any of these markings.
4. The labels applied by the gas manufacturer to identify the container contents shall not be defaced or removed by the user.

5. Compressed gas containers shall not be exposed to temperature extremes.
6. Leaking or defective containers shall not be offered for shipment.
7. Any damage that might impair the safety of the container shall be called to the attention of the gas supplier before returning the container.
8. The user shall keep the supplied cap and gas tight outlet cap on the cylinder at all times, except when cylinders are secured and connected to dispensing equipment. Both of these caps must be in place prior to shipment. The outlet cap shall be tightened.
9. The cylinder valve shall be kept closed at all times (charged or empty) except when the cylinder is in use. Wrenches, hammers or other tools shall not be used in attempting to open or close a valve.
10. Cylinders shall not be rolled in the horizontal position or dragged. A suitable hand truck should be used for individual cylinders and as appropriate, a forklift truck for use with palletized cylinders. Cylinders shall never be lifted by the cap, valve or by use of magnets.
11. Care should be used when handling cylinders to guard against dropping or permitting them to violently strike against each other and other surfaces.
12. Compressed gases shall not be transferred from one cylinder to another except by the gas manufacturer using qualified, trained personnel with the appropriate equipment and operating procedures.
13. Cylinder valve connections that do not fit shall not be forced.
14. Gas tight connections including piping, regulators and other apparatus shall be kept gas tight to prevent leakage. DO NOT tighten connections or leaking fittings or attempt other repairs while the system is under pressure.
15. Prior to disconnecting a cylinder from dispensing equipment, the cylinder valve shall be closed and the dispensing equipment relieved of pressure.
16. Transportation of compressed gas cylinders in automobiles or closed-bodied vehicles can present serious safety hazards and should not be done. Shipping compartments should be adequately ventilated.
17. An emergency response plan shall be implemented whenever compressed gas containers are used, handled or stored.
18. 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.

XI. STORAGE OF CYLINDERS

A. GENERAL

The first consideration when planning a storage area for ECO₂FUME[®] 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[®]. All site personnel should be trained in the plan and it should be practiced periodically.

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

C. INDOOR STORAGE

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

D. OUTDOOR STORAGE

It is recommended that both full and used ECO₂FUME[®] cylinders be stored outdoors in a dedicated and properly designed and labeled 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[®] cylinders should never be stored where the temperature will exceed 125 °F (51.7 °C). Low temperatures will not affect ECO₂FUME[®].

F. SECURING CYLINDERS

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

G. LABELING OF STORAGE

The labeling of the ECO₂FUME[®] cylinder storage area should take into account the needs of a variety of organizations. These should include, but not be limited to: corporate policy, insurance carrier, Occupational Safety and Health Administration (OSHA), Right to Know and local emergency response professionals. As a minimum, it is suggested that the storage be clearly marked with the following signs:

1. Danger, Poison (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[®]:

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

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

B. TRANSPORT DESIGNATIONS

The following transport designations apply to ECO₂FUME® :

Proper Shipping Name:	Liquefied gas, toxic n.o.s. (Phosphine, Carbon Dioxide)
Hazard Class:	2.3
Identification Number:	UN 3162
Shipping Label:	Poison Gas
Additional Description:	Poison Inhalation Hazard, Zone A

C. TRANSPORT REQUIREMENTS

1. Package Preparation

ECO₂FUME® 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® 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® cylinders.

3. Documents

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

4. Vehicle Loading

ECO₂FUME® 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® shall be placarded in accordance with table I of 172.504 of 49 CFR. Consideration should be made for other hazardous materials that are concurrently being transported. Proper placarding should take into account all hazardous materials on board.

6. Use of Common Carriers

Shipment of ECO₂FUME® cylinders by common carrier is permitted, provided the carrier meets certain criteria. Contact an authorized ECO₂FUME® 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® 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 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.