# RESTRICTED USE PESTICIDE

DUE TO HIGH ACUTE INHALATION TOXICITY OF PHOSPHINE GAS

For retail sale to Dealers and Certified Applicators only.

For use by Certified Applicators or persons under their direct supervision, and only for those uses covered by the Certified Applicator's certification. Refer to the directions in this applicator manual for requirements of the physical presence of a Certified Applicator.

THE COMPLETE LABEL FOR THIS PRODUCT CONSISTS OF THE CONTAINER LABEL AND APPLICATOR'S MANUAL WHICH MUST ACCOMPANY THE PRODUCT. READ AND UNDERSTAND THE ENTIRE CONTAINER LABEL AND APPLICATOR'S MANUAL.

A FUMIGATION MANAGEMENT PLAN MUST BE WRITTEN FOR ALL FUMIGATIONS PRIOR TO ACTUAL TREATMENT.

CONSULT WITH YOUR STATE LEAD PESTICIDE REGULATORY AGENCY TO DETERMINE REGULATORY STATUS, REQUIREMENTS, AND RESTRICTIONS FOR FUMIGATION USE IN THAT STATE. CALL CYTEC INDUSTRIES INC. (905/374-5899) IF YOU HAVE ANY QUESTIONS OR DO NOT UNDERSTAND ANY PART OF THE LABEL.

**APPLICATION MANUAL**

FOR

# ECO$_2$FUME® Fumigant Gas

A phosphine-containing fumigant for use in controlling pests in enclosed empty spaces or enclosed spaces (including temperature-controlled spaces such as cold storage chambers, transport containers and other suitable fumigation spaces) containing listed raw agricultural commodities, processed foods, stored tobacco, animal feeds, and nonfood products. Not for use in barges. Refer to the Application Manual for a list of commodities and pests controlled.

| | By Weight |
|---|---|
| ACTIVE INGREDIENTS: Phosphine Gas ($PH_3$)…… | 2%* |
| OTHER INGREDIENTS: …… | 98% |
| TOTAL | 100% |

* 2.6% by volume

**KEEP OUT OF REACH OF CHILDREN**

## DANGER - POISON – PELIGRO

**PELIGRO AL USUARIO:** Si usted no lee ingles, no use este producto 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.)

CYTEC Industries Inc. Woodland Park, NJ 07424 USA
Emergency Phone (CHEMTREC): 1-800/424-9300 or 703/527-3887
EPA Registration No. 68387 -7
EPA Establishment No. 68387-CAN-1
Net Contents: 68.3 lbs (31 kg)

**THE USE OF THIS PRODUCT IS STRICTLY PROHIBITED ON SINGLE AND MULTI-FAMILY RESIDENTIAL PROPERTIES AND NURSING HOMES, SCHOOLS, DAYCARE FACILITIES AND HOSPITALS.**

## 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** | • Move person to fresh air<br>• If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| **If on Skin** | • May cause frostbite to unprotected skin upon contact with dispensing equipment while gas is discharged rapidly.<br>• Take off contaminated clothing and allow clothes to aerate in ventilated room prior to laundering.<br>• Call a poison control center or doctor for treatment advice. |
| **If in Eyes** | • Hold eye open and rinse slowly and gently with cool water for 15-20 minutes in case of freezing or cryogenic "burns." Do not rinse eyes with hot or even tepid water.<br>• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing.<br>• Call a poison control center or doctor for treatment advice.<br>• Never introduce oil or ointment into eyes without medical advice. |

**HOT LINE NUMBER**

Have the Application Manual with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-424-9300 or 703-527-3887 for emergency medical treatment information. See side panel of the label for additional precautionary statements.

## 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. To the extent consistent with applicable law, the seller makes no other warranty, either expressed or implied, and buyer assumes all risk if the product is used contrary to label instructions.**

[12/1/2015, 10/26/2015]

**APPLICATION MANUAL**

FOR

# $ECO_2FUME^{®}$ Fumigant Gas

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# I. PRECAUTIONARY STATEMENTS

$ECO_2FUME^®$ 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

Fatal if inhaled. The liquid may cause burns. 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 NIOSH approved self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode must be used. See respirator requirements in Section V. E.

Do not get in eyes, in nose, on skin or on clothing. Do not breathe vapor. Do not eat, drink or smoke while handling $ECO_2FUME^®$. Phosphine gas may deaden the sense of smell. Do not depend solely on the odor to detect $ECO_2FUME^®$. Observe proper application, aeration and reentry procedures specified in the Application Manual (IX. APPLICATOR AND WORKER EXPOSURE) to prevent overexposure.

EXPOSURE TO CONCENTRATIONS ABOVE PERMISSIBLE LEVELS MAY CAUSE POISONING OR DEATH.

## B. NOTE TO PHYSICIAN

$ECO_2FUME^®$ 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). 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 must 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 must be considered and close medical supervision is recommended. Blood transfusions may be necessary.
   b. In case of manifest pulmonary edema, venesection must 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.

## C. ENVIRONMENTAL HAZARDS

Phosphine gas is highly toxic to fish and wildlife. Non-target organisms exposed to phosphine gas will be killed.

## D. PHYSICAL AND CHEMICAL HAZARDS

Never allow the buildup of phosphine to exceed explosive concentrations. 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. For this reason, the ratio of phosphine and carbon dioxide in ECO$_2$FUME® was specifically chosen to ensure the mixture is nonflammable in all proportions with air.

Contents under pressure. Do not use or store near heat or open flame. Do not puncture or incinerate container. Exposure to temperatures above 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 ECO$_2$FUME® 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 must 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., must not be exposed.

# II. INTRODUCTION

# A. PRODUCT DESCRIPTION

$ECO_2FUME^®$ 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. $ECO_2FUME^®$ cylinders contain carbon dioxide as liquefied gas under pressure. Pressurized carbon dioxide serves as a propellant for delivering the product and may contribute to the effectiveness of the product as a fumigant by helping to quickly disperse phosphine into the space to be fumigated. A poisonous gas, carbon dioxide retards flammability.

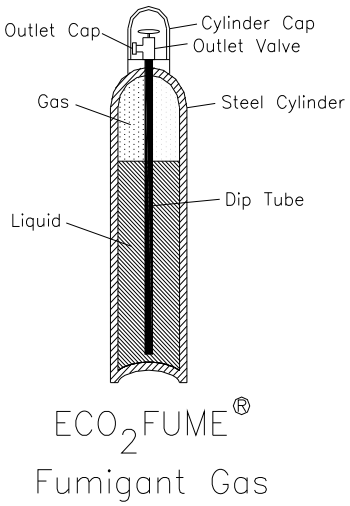
Phosphine and carbon dioxide are both gases that, under sufficient pressure, can exist in a liquid state. It is this "liquefied gas" that is stored in the cylinder. The product is withdrawn from the cylinder as a liquid, but dispensed as a gas. In expanding from a liquid to a gas, it increases in volume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

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

# B. PRODUCT PACKAGING

## 1. Packaging

$ECO_2FUME^®$ is packaged in a steel compressed gas cylinder, designed, manufactured, maintained and filled in compliance with regulations established by the United States Department of Transportation (DOT). The product flows to the 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.




Representative Package

Overall Height: 60 inches
Diameter: 9 1/4 inches
Material: Steel
Empty Weight: 138 pounds
Product Weight: 68.34 pounds
1.34 pounds phosphine
67 pounds carbon dioxide

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 $ECO_2FUME^®$ 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 $ECO_2FUME^{®}$ 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 $ECO_2FUME^{®}$ cylinder without the valve outlet cap and the cylinder cap securely in place.

$ECO_2FUME^{®}$ 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**

The equipment used to dispense $ECO_2FUME^{®}$ provides a means of containing the gas during the fumigation and controlling the release of the product into the space to be fumigated. 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 must be used in the dispensing of $ECO_2FUME^{®}$. Only persons trained in the proper use of $ECO_2FUME^{®}$ and the dispensing equipment shall be permitted to use $ECO_2FUME^{®}$ for fumigation. The instruction materials provided with the dispensing equipment must be consulted for their proper use and maintenance. Refer to Section H. Application Procedures of this manual for information on approved dispensing options or contact CYTEC Industries Inc. Customer Service Department, Phone No. (905) 374-5899, Fax No. (905) 374-5888

## 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.

** $ECO_2FUME^{®}$ *does not have an expiration date. Contact* CYTEC Industries Inc. Customer Service Department, Phone No. (905) 374-5899, Fax No. (905) 374-5888 *for any questions* **

## D. ENVIRONMENTAL FATE

$ECO_2FUME^{®}$ is a volatile gaseous mixture. The environmental fate is affected by the gas 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 $H_3PO_4$ (phosphoric acid). Phosphine is only moderately soluble in water, 26 cc in 100 cc of water at 17º C, in which it gradually decomposes into phosphorus, hydrogen, and the lower hydrides of phosphorus.

# III. SAFETY REQUIREMENTS

$ECO_2FUME^{®}$ *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 container label and Application Manual and follow instructions explicitly.
2. Never work alone when applying fumigant from within the storage structure or when aerating commodities after the fumigation is over.
3. Never allow untrained personnel to handle $ECO_2FUME^{®}$.
4. The use of respiratory protection may be required as described in Section V. E. of this manual.
5. Post $ECO_2FUME^{®}$ 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 or near to 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 must be assessed for impaired pulmonary function prior to initial use and at least annually thereafter. Any employees found to have impaired pulmonary function must 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.

14. Special instructions are provided in Section IV.H.8 to establish buffer zones during fumigation and aeration of cold storage fumigations to ensure worker and bystander safety during rapid aeration of chambers containing fresh commodities.

## 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 ECO$_2$FUME® is comprised of poisonous gases, care must be taken to avoid exposure to levels above 0.3 ppm phosphine. Appropriate procedures must be followed to detect and repair leaks in dispensing equipment and structures. These are discussed below. Also, see section XIV of this manual, "SPILL AND LEAK PROCEDURES."

### 1. Dispensing Equipment

Although the dispensing equipment is designed to contain the gas, small leaks can occur. A phosphine detector must be used at the beginning of each application to check the integrity of the equipment and any leaks must be corrected immediately. Nitrogen or carbon dioxide must be used to pressurize and leak check equipment with soap solution prior to use in the field.

**If any leak is encountered while using ECO$_2$FUME® clear the immediate area of all personnel.**

Where the concentration of phosphine is unknown, only persons who are wearing a NIOSH approved, 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 Short Term Exposure Limit (STEL) of 1 ppm for 15 minutes, are unprotected personnel permitted to enter.

If a cylinder leak is detected, refer to section IV.H. 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 must 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 prevent 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 (for details see IV. A. 2. and 3. under Directions for Use and IX. E. under Aeration and Reentry) including wearing a NIOSH approved respirator (refer to PPE section V.E.) operated in pressure-demand mode.

## D. COMPRESSED GAS HAZARDS

ECO$_2$FUME® 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 ECO$_2$FUME® 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 must always be closed before disconnecting the dispensing equipment.

Prior to the dismantling of ECO$_2$FUME® dispensing equipment at the conclusion of fumigation, all residual gas in the equipment must be vented to atmospheric pressure. The cylinder valve must be closed and the remaining product within the supply line discharged through the dispensing equipment. Cylinders must not be disconnected before ensuring that the line is fully vented.

### 4. Liquid Expansion

Liquefied gases expand rapidly when they are warmed. Because of this characteristic, liquid ECO$_2$FUME® must 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 may be used because of this hazard.

# 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. $ECO_2FUME^{®}$ is a Restricted Use Pesticide due to the acute inhalation toxicity of phosphine, $PH_3$ gas. For retail sale to dealers and certified applicators only. For use by certified applicators or persons under their direct supervision, and only for those uses covered by the Certified Applicator's certification. Refer to the directions in this applicator manual for requirements of the physical presence of a Certified Applicator. Before using, read and follow the label precautions, restrictions and directions on the label, which includes the container label and the $ECO_2FUME^{®}$ application manual. Additional copies of this manual are available from CYTEC Industries Inc., Phone No. (905)374-5899; Fax No. (905) 374-5888.

2. Requirements for Certified Applicator to be present and responsible for all workers:
   a. A Certified Applicator must be physically present, responsible for, and maintain visual and/or voice contact with all fumigation workers during the application of the fumigant. Once the application is complete and the structure has been made secure the certified applicator does not need to be physically present at the site.
   b. A Certified Applicator must be physically present, responsible for and maintain visual and/or voice contact with all fumigation workers during the initial opening of the fumigation structure for aeration. Once the aeration process is secured and monitoring has established that aeration can be completed safely the certified applicator does not need to be physically present and trained person(s) can complete the process and remove the placards.
   c. Persons with documented training in the handling of Phosphine products must be responsible for receiving, aerating and removal of placards from vehicles, transport containers and trailers which have been fumigated in-transit.

3. Requirements for Reentry Following Fumigation:
   If the structure is to be entered after fumigation, it must be aerated until the level of phosphine gas is 0.3 ppm or below. The structure or site must be monitored to ensure that liberation of gas from the treated commodity does not result in the development of unacceptable levels (i.e., over industrial hygiene levels of phosphine). Do not allow reentry into treated structures by any person before the level of phosphine reaches 0.3 ppm or below unless protected by an approved respirator (refer to PPE section V.E.).

4. Preparation and Notification Requirements for Fumigation Sites:
   Prior to applying this product, the storage structure must be inspected to determine if it can be made sufficiently gas tight. The storage structure must be sealed so as to maintain a suitable gas concentration over the time period required for control of insects. Personal exposure monitoring must 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 $ECO_2FUME^{®}$. Contact CYTEC Industries Inc., Phone No. (905) 374-5899, Fax No. (905) 374-5888

5. 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. Improperly sealed structures may allow pests (especially rodents and other vertebrates) to escape to non-fumigated areas. In addition, some insects are less susceptible to phosphine than others. To maximize control, extreme care must be observed in sealing, higher dosages up to the maximum labeled dosage 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. PESTS

$ECO_2FUME^{®}$ Fumigant Gas will control the following pests:

*a. Insects, specifically:*

| | |
|---|---|
| Almond Moth | Angoumois Grain Moth |
| Light Brown Apple Moth | Asian Citrus Psyllid |
| Bean Weevil | Brown Marmorated Stink Bug |
| Cadelle | California Red Scale |
| Carob Moth | Carpet Beetle** |
| Cereal Leaf Beetle | Cigarette Beetle |
| Codling Moth | Confused Flour Beetle |
| Dermestid Beetle | Dried Fruit Beetle |
| Dried Fruit Moth | Eulia |
| European Grain Moth | European Grapevine Moth |
| Flat Grain Beetle | Fruit Flies (e.g., Mediterranean, Oriental, Melon, Caribbean, |
| Fuller Rose Beetle | Spotted wing, Western Cherry) |
| Fruit Tree Weevil | Granary Weevil |
| Grape Mealybug | Greater Wax Moth |
| Hairy Fungus Beetle | Hessian Fly |
| Khapra Beetle | Indian Meal Moth |
| Leaf Miner | Lesser Grain Borer |
| Maize Weevil | Mealybugs |
| Mediterranean Flour Moth | Mites (e.g., California citrus, False Chilean, Pacific, Spider) |
| Navel Orange Worm | Pea Weevil |
| Pink Bollworm | Raisin Moth |
| Red Flour Beetle | Rice Weevil |
| Rusty Grain Beetle | Saw-toothed Grain Beetle |
| Spider Beetles | Thrips |
| Tobacco Moth | Warehouse Beetle** |
| Yellow Meal Worm | Bees |

**Non-residential use sites such as warehouses, bulk storages, flour/feed mills, processing plants.

*b. Rodents and other vertebrate* pests. Not for use in burrows

c. *Wood pests (specifically the pine wood nematode and other wood-infesting nematodes and beetles).* Non-residential use only. For use on wood, cut trees, wood chips and wood and bamboo products stored in bins, flat storage bunkers, mills, warehouses, stacked under tarpaulin and in containers or ship holds

## 2. COMMODITIES

The following commodities can be fumigated with $ECO_2FUME^{®}$:

*a. Raw Agricultural Commodities*

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

*b. Processed Foods*

Processed foods that may be fumigated with $ECO_2FUME^{®}$.

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 citrus, 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
Other processed foods, including commodities kept refrigerated or in cold storage.

*c. Animal Feed and Feed Ingredients*

*d. Nonfood Commodities Including Tobacco*

Nonfood items that may be fumigated with $ECO_2FUME^{®}$:

Animal hide
Processed or unprocessed cotton, wool and other natural fibers or cloth, including clothing
Clothing, feathers, furs, human hair, rubberized hair, vulcanized hair, mohair
Leather products
Tobacco
Wood, cut trees, wood chips and wood and bamboo products
Tires (for mosquito control)
Paper and paper products
Non-food flour (used in non-food coatings, sizings, etc.)
Dunnage
Non-food starch (used in non-food coatings, sizings, etc.)
Fresh or dried plants and flowers
Bulbs, tubers, corms and rhizomes (non-food use, flowers/ornamentals)
Seeds (grass seed, ornamental herbaceous plant seed, and vegetable seed)
Straw or hay
Psyllium seed and psyllium seed husks**
Other nonfood commodities, including commodities kept refrigerated or in cold storage.

**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

1. AMBIENT TEMPERATURE FUMIGATIONS

ALLOWABLE PHOSPHINE DOSAGES FOR $ECO_2FUME^{®}$[1,2,3,4] FOR COMMODITIES LISTED IN IV.C.2.a.*ii* and IV.C.2.b, c and d.)

| | $PH_3$ Concentration Maintained (ppm)/ Rate of $ECO_2FUME^{®}$ (lb) per 1,000 $ft^3$ of Area | | |
|---|---|---|---|
| Temperature | Minimum | Maximum | Minimum Duration |
| Below 32°F (0°C) | Do not fumigate | | |
| 32-39° F (0-4° C) | 200 ppm/0.88 lb | 3,625 ppm/16.0 lb | 6 days |
| 40-53° F (5-12° C) | 200 ppm/0.88 lb | 3,625 ppm/16.0 lb | 4 days[4] |
| 54-59° F (12-15° C) | 200 ppm/0.88 lb | 3,625 ppm/16.0 lb | 3 days |
| 60-79° F (16-25° C) | 200 ppm/0.88 lb | 3,625 ppm/16.0 lb | 2 days |
| 80° F & Above (≥26° C) | 500 ppm/2.20 lb | 3,625 ppm/16.0 lb | 24-36 hours |

****Restriction: After introduction and stabilization, the maximum concentration of phosphine maintained during fumigation must not exceed 2,500 ppm for fresh commodities, or 3,625 ppm for all other commodities.**

[1] For other calculations, refer to Section IV.H.2.f

[2]For spot treatment applications see Section IV.H.8.

[3]When fumigating wood or wood products, the fumigation rate may need to be adjusted depending upon the moisture content of the wood or wood product. For best results, fumigate with a dose of 750 – 1,000 ppm phosphine for 10 days. Higher concentrations (within the dosage range) are recommended to counter the solubility of phosphine in water or moisture present in the wood or wood product. If fumigating for quarantine purposes, check with the receiving country concerning accepted fumigation methods for the specific product being fumigated.

[4]$ECO_2FUME$ Fumigant Gas can be used on cocoa beans to control all stages of those moth species (including Indian Meal Moth) that commonly infest cocoa beans in a 24-hour exposure time with 500-1000 ppm phosphine at a temperature of 40°F or higher.

Rodents and other vertebrate pests in storages may be controlled with short-term fumigations within 1 to 4 hours with low levels of phosphine (200 ppm) after achieving distribution of phosphine throughout the structure. *Not for use in burrows.*

Although it is permissible to use the maximum allowable dosage of 3,625 ppm for food/feed and non-food commodities (excluding fresh commodities), the following table lists a range of dosages that can be used as a guideline for various types of fumigations.

| **Commodity** | **Phosphine** |
|---|---|
| Food/Feed Commodities in bulk storage | 500 – 3,625 ppm |
| Packaged Commodities | 500 – 2,250 ppm |
| Stored Tobacco | 200 – 1,250 ppm |

| | |
|---|---|
| Non-food products | 500 – 2,250 ppm |
| Nuts, dates or dried fruit in bulk or storage boxes | 250 – 1,000 ppm |
| Space fumigations | 200– 1,500 ppm |

Use higher rates (not to exceed the maximum dosage rate of 3,625 ppm) under conditions of severe infestation, lower temperature and other application variables.

2. FUMIGATION UNDER COLD STORAGE

ALLOWABLE PHOSPHINE DOSAGE FOR $ECO_2FUME^{®}$ FOR FRESH COMMODITIES LISTED IN SECTION IV.C.2.a.*i* AND PROCESSED FOODS AND NONFOOD COMMODITIES KEPT REFRIGERATED OR IN COLD STORAGE

| Temperature | $PH_3$ Concentration Maintained/1,000 $ft^3$ of Area | Rate of $ECO_2FUME^{®}$/1000 $ft^3$ | Duration |
|---|---|---|---|
| 28°F – 43°F (-2°C – 6°C) | 1,000 – 2,500 ppm[1] | 4.41 – 11.03 lb | 24 – 72 hours |
| >43°F (> 6°C) | 750 – 2,500 ppm[1] | 3.33 – 11.03 lb | 24 – 48 hours |

1 For control of False Chilean mites in cold storage, fumigate with >300 ppm at 28°F to 43°F (-2 to 6°C) for > 9 days.

Specific directions for cold storage fumigations are provided in Section IV.H.9.

## E. DOSAGE INFORMATION

Do not exceed the maximum allowable rate. Use the "Allowable Dosages" tables to determine 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.). The applicator must measure the temperature in the space or the stored commodity next to the pest insect and use the dosage tables (Section III.D.1 for ambient fumigations and Section III.D.2 for cold storage fumigations) to determine the minimum duration of exposure needed. For example, if the commodity temperature for a cold storage fumigation of fresh commodities is greater than 43°F (>6°C) then a dose of 750 – 2,500 ppm must be maintained for 24-48 hours.

Some insect species and life stages are harder to kill than others. It is important that target pests are known and understood. For example, eggs of certain pests or overwintering dormant larva may be more difficult to kill than an active larva or other life stages of the same species. For ambient fumigations, use of the maximum duration is recommended when possible. A dosage of up to 3,625 ppm phosphine can be used when necessary (excluding on fresh commodities) to prevent or control tolerant or resistant insect strains and reduce future potential for resistance. Insects, in general, are more difficult to control at lower temperatures because of factors such as slower respiration and slower diffusion of the fumigant into the space and commodity.

Short treatment times are effective at high temperatures (80°F and above). At these higher temperatures a treatment time of one day is sufficient to kill most storage pests, however, two days may be needed to destroy 100% of the eggs of some storage pests (e.g., *Amyelois transitella, tribolium* spp., and *Trogoderma variabile*). Knowing the pest and life stage to control is critical to determining the dose and treatment time needed.

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.), and Cigarette beetle (*Lasioderma serricorne*).

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

For both ambient and cold storage fumigations, fumigators also must be aware that different types of packaging will influence the penetration rate of the gas. Selection of appropriate exposure times must 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, and any other air moving systems that could negatively affect the fumigation. Thoroughly inspect the fumigation chamber/structure 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 ensure sufficient gas levels within the fumigated structure and will decrease the chance of unwanted exposure outside of the fumigated structure.

As with all fumigations, perimeter monitoring for leaks and potential exposures is required. If phosphine above 0.3 ppm is found in an area where exposure to workers or bystanders may occur, 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 a NIOSH approved respirator (refer to PPE section V.E.) 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.

Phosphine gas is 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 examined to ensure that significant leakage has not occurred. Sealing of the fumigated site and/or airflow in the occupied areas must be sufficient to bring down the phosphine concentration to a safe level of 0.3 ppm or below.

DO NOT FUMIGATE A STRUCTURE THAT CANNOT BE SEALED SUFFICIENTLY GAS TIGHT.

## G. REQUIRED WRITTEN FUMIGATION MANAGEMENT PLANS

The certified applicator is responsible for working with the owners and/or responsible employees of the structure and/or area to be fumigated to develop and follow a written Fumigation Management Plan (FMP). State, county and local authorities may also have specific requirements. The FMP must be written PRIOR TO EVERY

TREATMENT. The FMP is intended to ensure a safe and effective fumigation. The FMP must address characterization of the site, and include appropriate monitoring and notification requirements, consistent with, but not limited to, the following:

1. The use of this product is strictly prohibited on single and multi-family residential properties, nursing homes, schools, daycare facilities and hospitals.
2. Inspect the structure and/or area to determine its suitability for fumigation.
3. When sealing is required, consult previous records for any changes to the structure, seal leaks, and monitor any occupied adjacent buildings to ensure safety.
4. Prior to each fumigation, review any existing FMP, MSDS, Applicators Manual and other relevant safety procedures with company officials and appropriate employees.
5. Consult company officials in the development of procedures and appropriate safety measures for nearby workers that will be in and around the area during application and aeration.
6. Consult with company officials to develop an appropriate monitoring plan that will confirm that nearby workers and bystanders are not exposed to levels above the allowed limits during application, fumigation and aeration. This plan must also demonstrate that nearby residents will not be exposed to concentrations above the allowable limits.
7. Consult with company officials to develop procedures for local authorities to notify nearby residents in the event of an emergency.
8. Confirm the placement of placards to secure entrance or access into any area under fumigation.
9. Confirm the required safety equipment is in place and the necessary manpower is available to complete a safe and effective fumigation.
10. Written notification must be provided to the receiver of a vehicle that is fumigated in transit.

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

In addition to the plan, the applicator must read the entire label, which includes the container label and the Application Manual, follow their directions carefully, and abide by all restrictions. If the applicator has any questions about the development of a FMP contact CYTEC Industries Inc., Customer Service Department, Phone No. (905) 374-5899, Fax No. (905) 374-5888 for further assistance.

The FMP and related documentation, including monitoring records, must be on-site and available for review during the fumigation and must be maintained for a minimum of 2 years.

**1. Steps for Preparation of a Fumigation Management Plan**

Purpose

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

This guidance is intended to help you organize any fumigation that you might perform PRIOR TO ACTUAL TREATMENT. It is meant to be somewhat prescriptive, yet flexible enough to allow the experience and expertise

of the fumigator to make changes based on circumstances that may exist in the field. By following a step-by-step procedure, yet allowing for flexibility, a safe and effective fumigation can be performed.

Before any fumigation begins, carefully read and review the entire label, which includes the container label and the Application Manual. This information must also be given to the appropriate company officials (supervisors, foreman, safety officer, etc.) in charge of the structure and/or area. Preparation is the key to any successful fumigation. If you do not find specific instructions for the type of fumigation that you are to perform listed in this Guidance Document you must construct a similar set of procedures using this document as your guide or contact Cytec Industries Inc. for assistance. Finally, before any fumigation begins you must be familiar with and comply with all applicable federal, state and local regulations. The success of the fumigation is not only dependent on your ability to do your job but also upon carefully following all rules, regulations, and procedures required by governmental agencies.

## 2. A Checklist Guide for a Fumigation Management Plan

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

A. PRELIMINARY PLANNING AND PREPARATION

1. Determine the purpose of the fumigation.
   a. Elimination of insect infestation
   b. Elimination of rodent/vertebrate pests
   c. Plant pest quarantine.

2. Determine the type of fumigation, for example:
   a. Space; tarp, mill, warehouse, food plant, spot treatment, packaging facility, temperature-controlled storage structures suitable for fumigation.
   b. Transport Vehicle; railcars, trucks, vans, containers, refrigerated containers for railcars or trucks
   c. Commodity; raw agricultural commodities, processed foods, perishable processed foods or nonfoods
   d. Type of Storage; vertical silo, farm storage, flat storage, cold temperature storage spaces
   e. Vessels or ships (not for use on barges), refrigerated containers. In addition to the Application Manual, read the US Coast Guard Regulations 46CFR 147A.

3. Fully acquaint yourself with the structure and commodity to be fumigated, including:
   a. The general structure layout, construction (materials, design, age, maintenance, of the structure, fire or combustibility hazards, connecting structures and escape routes, above and below ground, and other unique hazards or structure characteristics. Prepare, with the owner/operator/person in charge. Draw or have a drawing or sketch of structure to be fumigated, delineating features, hazards, and other structural issues.
   b. The number and identification of persons who routinely enter the area to be fumigated (i.e., Employees, visitors, customers, etc.).
   c. The specific commodity to be fumigated, its mode of storage, and its condition.
   d. The previous treatment history of the commodity, if available.
   e. Accessibility of utility service connections.
   f. Nearest telephone or other means of communication, and mark the location of these items on the drawing/sketch.
   g. Emergency shut-off stations for electricity water and gas. Mark the location of these items on the drawing/sketch.
   h. Current emergency telephone numbers of local health, fire, police, hospital and physician responders.
   i. Name and phone number (both day and night) of appropriate company officials.

j. Check, mark and prepare the points of fumigation application.
k. Review the entire label, which includes both the container label and Application Manual.
l. Exposure time considerations.
    1. Product to be used.
    2. Minimum fumigation period, as defined and described by the label use directions.
    3. Down time required to be available.
    4. Aeration requirements (follow special requirements for aeration following cold storage fumigation).
    5. Measure and recorded commodity temperature.
m. Determination of dosage.
    1. Cubic footage or other appropriate space/location calculations.
    2. Structure sealing capability and methods.
    3. Maximum allowable dosage rates.
    4. Temperature, humidity and wind.
    5. Commodity/space volume.
    6. Past history of fumigation of structure
    7. Exposure time.
    8. Commodity Type
    9. Pest and life stage

B. PERSONNEL

1. Confirm in writing that all personnel in and around the structure to be fumigated have been notified prior to application of the fumigant. Consider using a checklist that each employee initials indicating they have been notified.
2. Instruct all fumigation personnel to read the Application Manual. Fumigation personnel must be trained in the proper method of application, the hazards that may be encountered, and the selection of personal protection devices, including detection equipment. Confirm that all applicators have been trained in the use of $ECO_2FUME^{®}$ Fumigant Gas and have received the required refresher training every two years.
3. Confirm that all personnel are aware of and know how to proceed in case of an emergency situation.
4. Instruct all personnel on how to report any accident and/or incidents related to fumigant exposure. Provide a telephone number for emergency response reporting.
5. Instruct all personnel to report to proper authorities any theft of fumigant and/or equipment related to fumigation.
6. Establish a meeting area for all personnel in case of emergency.

C. MONITORING

1. Perimeter Safety
    a. Monitoring of phosphine concentrations must be conducted in enclosed areas to prevent excessive exposure and to determine where exposure may occur. Document where monitoring will occur.
    b. Keep a log or manual of monitoring records for each fumigation site. This log must at a minimum contain the timing, number of readings taken and level of concentrations found in each location.
    c. When monitoring for leaks, document even if there is no phosphine present above the safe levels. In such cases, subsequent leak monitoring is not routinely required. However spot checks must be made, especially if conditions significantly change.
    d. Monitoring must be conducted during aeration and corrective action taken if gas levels exceed the allowed levels in an area where bystanders and/or nearby residents may be exposed.
    e. Buffer zones are required during cold storage fumigations unless the fumigation chamber/structure has been leak tested and found to be gas tight (see Section F. below, “APPLICATION PROCEDURES & FUMIGATION PERIOD”). Buffer zones must be established during aeration of chambers fumigated under cold storage conditions (see Section G. below, “POST-APPLICATION OPERATIONS , and Section VIII. A. Special instructions for Aeration after Cold Storage Fumigations for buffer zone requirements). Entry into buffer zone areas requires periodic monitoring and the use of SCBA respirators as set forth in Section V. E. RESPIRATORS and the USDA Treatment Manual.

2. Efficacy
    a. Gas readings must be taken from within the fumigated structure to ensure proper gas concentrations. This can be safely achieved outside the structure through the use of sample lines.
    b. All phosphine readings must be documented.

D. NOTIFICATION

1. Confirm that all appropriate local authorities (fire departments, police departments, etc.) have been notified as per label instructions, local ordinances if applicable, or instructions of the client.
2. Prepare written procedure ("Emergency Response Plan") which contains explicit instructions, names, and telephone numbers so as to be able to notify local authorities if phosphine levels are exceeded in an area that could be dangerous to bystanders and/or domestic animals.
3. Confirm that the receivers of vehicles and containers under in-transit fumigation have been notified and that trained workers will be available on site (IV. H. 6. c. under DIRECTIONS FOR USE).

E. SEALING PROCEDURES

1. Sealing must be adequate to control pests. Care must be taken to ensure that sealing materials will remain intact until the fumigation is complete.
2. If the structure has been fumigated before, review the previous FMP for previous sealing information.
3. Make sure that construction/remodeling has not changed the building in a manner that will affect the fumigation.
4. Warning placards must be placed on every possible entrance to the fumigation site.

F. APPLICATION PROCEDURES & FUMIGATION PERIOD

1. Plan carefully and apply all fumigants in accordance with the label requirements.
2. When entering into the area under fumigation always work with two or more people under the direct supervision of a certified applicator wearing appropriate respirators (refer to PPE section V.E.).
3. Apply fumigant from outside the fumigation space.
4. Provide watchmen when a fumigation site cannot otherwise be made secure from entry by unauthorized persons.
5. When entering structures always follow OSHA rules for confined spaces.
6. Document that the receiver of vehicles fumigated in transit has been notified and is trained to receive commodity under fumigation.
7. Turn off any electric lights in the fumigated area of the structure, as well as all non-essential electrical motors.
8. For cold storage fumigations, a 30 foot buffer zone must be established from the outside edge of the structure being fumigated unless the structure has been pressure tested and found to be gas tight per USDA testing protocols (see the USDA Treatment Manual, available from the Animal and Plant Health Inspection Service (APHIS) web site (http://www.aphis.usda.gov )).

G. POST-APPLICATION OPERATIONS

For Ambient Fumigations:

1. Provide watchmen when you cannot secure the fumigation site from entry by unauthorized persons during the aeration process.
2. Ventilate and aerate in accordance with structural limitations.
3. Turn on ventilating or aerating fans where appropriate.
4. Use a suitable gas detector before reentry into a fumigated structure to determine fumigant concentration.
5. Keep written records of monitoring to document completion of aeration.
6. Consider temperature when aerating.
7. Ensure aeration is complete before moving a treated vehicle onto public roads.
8. Remove warning placards when aeration is complete.

9. Inform business/client that employees/other persons may return to work or otherwise be allowed to reenter the aerated structure.

For Cold Storage Fumigations:

1. Provide watchmen when you cannot secure the fumigation site from entry by unauthorized persons during the aeration process.
2. Ventilate and aerate in accordance with structural limitations.
3. Turn on ventilating or aerating fans where appropriate.
   To ensure bystander safety during rapid aeration of chambers containing fresh commodities fumigated under cold storage conditions, the following buffer zones must be maintained:

   The required buffer zones vary based upon the volumes treated.
   - 200 foot buffer for all aeration methods and fumigations ≤ 100,000 $ft^3$
   - 350 foot buffer for all aeration methods and fumigations ≤ 500,000 $ft^3$
   - 500 foot buffer for all aeration methods and fumigations > 500,000 $ft^3$

   During the first 10 minutes of aeration, no one is permitted within the buffer zone surrounding the exhaust duct outlet. If the exhaust duct is not used for aeration, the buffer zone distances must be measured from the perimeter of the fumigated structure. In either scenario, no one is permitted within the buffer zone until the structure has aerated for 10 minutes and monitoring indicates that the level of phosphine gas is 0.3 ppm or below. For personal safety, gas levels should occasionally be monitored at greater distances, especially downwind to ensure this buffer zone is adequate.

   Everyone within the aeration buffer zone must be made aware that a release of fumigant gas is about to take place. If personnel involved with the fumigation choose to remain in the area, they must wear the minimum respiratory protection specified in Section V. E. Anyone not involved with the fumigation must evacuate and remain beyond the buffer zone. If people cannot be restricted from the buffer zone during regular work hours, aeration must be done during another time of the day. When securing the duct outlet area, consider the direction of the wind and face the duct outlet toward an open area, and away from people. Always point the duct outlet upward to aid in dispersing the exhausted gas.

4. Use a suitable gas detector before reentry into a fumigated structure to determine fumigant concentration.
5. Keep written records of monitoring to document completion of aeration.
6. Consider temperature when aerating.
7. Ensure aeration is complete before moving a treated vehicle onto public roads.
8. Remove warning placards when aeration is complete.
9. Inform business/client that employees/other persons may return to work or otherwise be allowed to reenter the aerated structure.

# H. APPLICATION PROCEDURES

## 1. General Statement

A Fumigation Management Plan (FMP) (see Section IV. G above) must be written PRIOR to all applications. A FMP must be prepared for all structures and containers to cover application, exposure period and aeration before fumigation is started in order to prevent human and animal exposure to phosphine and to help assure adequate control of insect pests.

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 if the product is used contrary to label or Application Manual instructions.

## 2. Equipment Specification and Use

a. General

The equipment used to dispense $ECO_2FUME^{®}$ provides a means of containing the gas during the fumigation and controlling the release of the product into the space to be fumigated. 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 must be used in the dispensing of $ECO_2FUME^{®}$. Only persons trained in the proper use of $ECO_2FUME^{®}$ and the dispensing equipment shall be permitted to use $ECO_2FUME^{®}$ for fumigation. The instruction materials provided with the dispensing equipment must be consulted for their proper use and maintenance.

b. Unapproved Dispensing Methods

It has been common practice, with other cylinderized fumigants, to place the cylinder in the space to be fumigated and the cylinder outlet valve opened to allow the fumigant to release. This is not an approved dispensing method and must not be used with $ECO_2FUME^{®}$.

c. Approved Dispensing Methods

The approved dispensing methods for $ECO_2FUME^{®}$ include placing the cylinder outside the fumigation area. Pressure reducing regulators or flow restricting nozzles must be used for slow release, and selected piping components must be used for quick release. The slow release of $ECO_2FUME^{®}$ is generally used for fumigating bulk storage facilities such as silos or bins, for small fumigation structures and for fumigation of stacked materials under tarpaulins. The quick release method is used for space fumigation, or where the commodity to be treated is warehoused. The selection of the dispensing method will depend on the size of the fumigation, the time required and facility limitations.

d. Regulated Dispensing Equipment

Regulated dispensing equipment has been developed for use in very small volume applications with $ECO_2FUME^{®}$. The regulated dispensers are designed to reduce the high cylinder pressure to a low pressure (less than 100 psig exit the pressure regulator) and provide the heat necessary to vaporize the fumigant. This pressure is further reduced to near ambient exit the flow control valve. Once reduced to this lower pressure, the fumigant may be distributed to the 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.

$ECO_2FUME^{®}$ regulator assemblies, equipped with basic features, are available through authorized $ECO_2FUME^{®}$ 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, large tarpaulin or large fumigation chamber, and the use of a number of cylinders is anticipated, a quick means of dispensing ECO$_2$FUME® 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 ECO$_2$FUME® 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 small sized fumigation of stacked materials under tarpaulins. The use of regulated dispensing equipment or flow restricting nozzles to control the rate of ECO$_2$FUME® dispensing is recommended for small tarpaulin fumigations (see IV.G.5.3 Applications to Tarpaulin Fumigations).

f. Calculating the Amount of ECO$_2$FUME® Required

The amount of ECO$_2$FUME® required to perform a fumigation will depend on (i) type of space to be fumigated and its sealability, (ii) type of commodity, (iii) type of insect pest, its life stage and resistance level, (iv) temperature at the infestation site, (v) duration of fumigation, (vi) use of any re-circulation or temperature control devices and (vii) whether or not it is stationary or in-transit fumigation.. An initial dose of ECO$_2$FUME® is used to establish a pesticidal atmosphere in the fumigation space, and through active monitoring of the phosphine concentrations, additional ECO$_2$FUME® 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. When dispensing ECO$_2$FUME® it is sometimes easier to speak in terms of the amount of phosphine that is required rather than the amount of ECO$_2$FUME®. The maximum concentration of ECO$_2$FUME® used per fumigation must not exceed 3,625 ppm of Phosphine for ambient temperature fumigations, or 2,500 ppm for cold storage fumigations.

**One gram of phosphine ($PH_3$) will produce a concentration of 25 parts per million (ppm) in a volume of 1000 cubic feet ($ft^3$). This is the fundamental conversion used when calculating the amount of ECO$_2$FUME® needed to dose a space.**

To calculate the total amount of phosphine or ECO$_2$FUME® required to dose a space:

| |
|---|
| 1 gram $PH_3$ = 25 ppm $PH_3$/1000 $ft^3$ |
| 1 pound ECO$_2$FUME® = 9.07 grams $PH_3$ |

| |
|---|
| grams of $PH_3$ = (Target Concentration x Volume) / 25,000 |
| or |
| pounds of ECO2FUME® = (Target Concentration x Volume) / 226,800 |

"Target" is the phosphine concentration to be achieved in parts per million (ppm).

"Volume" is the empty volume of the space to be fumigated in cubic feet ($ft^3$).

To calculate the amount of phosphine or ECO$_2$FUME® to be added to a space to reestablish the Target concentration:

grams of $PH_3$ = (Target Concentration – Actual) x Volume / 25,000

or

pounds of ECO$_2$FUME® = (Target Concentration– Actual) x Volume / 226,800

"Target" is the phosphine concentration to be achieved in parts per million (ppm).

"Volume" is the empty volume of the space to be fumigated in cubic feet ($ft^3$).

"Actual" is the measured phosphine concentration in parts per million (ppm).

As a general rule, 200 ppm of $PH_3$ in ECO$_2$FUME® will release 7,700 ppm of carbon dioxide in the fumigation space.

When adding ECO$_2$FUME® to a space, the phosphine concentration must be monitored. For example 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 target concentration is achieved before the calculated amount of ECO$_2$FUME® has been added, the addition of ECO$_2$FUME® must be stopped and the calculations must be checked. It is possible that a localized higher concentration has been detected and the ECO$_2$FUME® requires more time to evenly disperse.

When a partial cylinder of ECO$_2$FUME® is required, a scale can also be used to check how much ECO$_2$FUME® 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. The scale must have a maximum capacity for at least 200 lb (90.7 kg) to accommodate the cylinder weight. It must also have an accuracy of ±10% of the phosphine dosage.

g. Troubleshooting

This section is provided to assist in addressing problems that may be encountered while using ECO$_2$FUME® 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 must be directed to the authorized ECO$_2$FUME® 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 <u>is</u> 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 <u>is not</u> 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 must 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

$ECO_2FUME^{®}$ 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. Develop and follow an appropriate Fumigation Management Plan (Refer to Section IV. G. Fumigation Management Plans).

c. Procedure for Fumigating Bulk Commodities

1. Calculate the empty volume space to be treated.
2. Determine the target phosphine concentration and the duration of the fumigation based on area fumigated (space volume), the insect pest(s) involved and the commodity temperature.
3. Calculate how much fumigant will be required and the means by which it will be dispensed.
4. Determine where the fumigant will be dispensed into the space, and plan for and install required equipment.
5. Gas monitoring must be performed from outside the fumigated structure. Polyethylene tubing is used for remote monitoring. This tubing can be run from each area of the fumigation to an outside location where gas samples can be taken safely. At least one monitoring line must be run in each fumigated structure. In the event of multi-floored structures or compartmentalized buildings, monitoring must be performed in all major areas of the fumigated structure. Fans can be used to help distribute gas into smaller areas and the outer reaches of these structures.
6. Isolate and seal all connections to other storage and spaces that are not intended for fumigation.
7. Seal all openings including cracks, windows, doors, vents, eaves, hatches, loading and unloading connections and ventilation fans. Seal all penetrations used for fumigant dispensing and monitoring. Use proper safety equipment and entry procedures if confined space entry is required.
8. Lock all entrances to the space.
9. Ensure that all personnel, animals, and damageable goods are clear of the space to be treated and post fumigation placards on all points of access and any unloading penetrations.
10. Verify that all required safety equipment is available and in good working order.
11. Notify all personnel in nearby buildings at the facility that fumigant release is about to commence.
12. Connect the $ECO_2FUME^{®}$ 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. Additional $ECO_2FUME^{®}$ can be added as required to ensure that the target phosphine concentrations are maintained during the fumigation period.
15. During and immediately after dispensing of $ECO_2FUME^{®}$, perimeter monitoring for phosphine concentrations must be conducted to identify possible leak points. Seal any leak points found.
16. Dispense additional fumigant as required to maintain the target phosphine concentrations. When no further fumigant is required, close all cylinder valves. Depressurize the dispensing equipment and disconnect all $ECO_2FUME^{®}$ cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
17. Before leaving the fumigation site, re-check barricades and placards at all entrances/exits into the fumigation space and/or area under fumigation to prevent entry by unauthorized people and animals during fumigation.
18. When the fumigation is complete, unseal the space and aerate (see VIII. AERATION OF FUMIGATED COMMODITIES and IX. E. AERATION AND REENTRY). 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 must be installed with loading, unloading and other operations in mind. If frequent fumigations are expected, permanently mounted lines must be secured within the space. If temporary lines are to be used, they must 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 must 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 $ECO_2FUME^{®}$ 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. Dispense $ECO_2FUME^{®}$ into the discharge of recirculation blowers. Do not run blowers continuously, but long enough to ensure good fumigant distribution and each time fumigant is added.
4. For large storage facilities, multiple dispensing points must be considered to assist in the distribution of the fumigant.

## 4. APPLICATION TO SPACE FUMIGATIONS

a. Spaces

$ECO_2FUME^{®}$ can be used to fumigate any type of space where listed commodities are stored or processed, except barges. These include, but are not limited to mills, warehouses, processing facilities, packaging plants and other structures. The most important aspects of a successful fumigation, as with any fumigant, are the degree to which the space is sealed and the assurance that the minimum fumigant concentrations are maintained for the required time.

b. Develop and follow an appropriate Fumigation Management Plan (Refer to Section IV. G.).

c. Procedure for Fumigating Spaces

1. Calculate the empty volume of the space to be treated.
2. Determine the target phosphine concentration and the duration of the fumigation. This must be based on the target pests and the temperature of the space.
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 target phosphine concentrations.
4. Determine where the fumigant will be dispensed into the space, and plan for and install required components. Dispensing points must not be located in or attached to commodity packages. 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. If required, determine the number and location of circulating fans. Low speed fans must be placed on the floor and angled upwards. A means of turning the fans off from outside the treated space ,must 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 $ECO_2FUME^{®}$ 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 target phosphine concentrations.
18. When no further fumigant is required close all cylinder valves. Depressurize the dispensing equipment and disconnect all $ECO_2FUME^{®}$ cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
19. Before leaving the fumigation site, recheck barricades and placards at all entries into the fumigation space and/or fumigated area to prevent entry by unauthorized personnel during fumigation
20. When the fumigation is complete, unseal the space and aerate (see VIII. AERATION OF FUMIGATED COMMODITIES and IX. E. AERATION AND REENTRY). Use suitable gas detection equipment to check both the carbon dioxide and phosphine concentrations before allowing entry into the space. Use appropriate breathing apparatus (refer to PPE section V.E.) and entry procedures to avoid undue worker exposure.
21. Remove all dispensing and gas monitoring lines.
22. Workers must be made 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

$ECO_2FUME^{®}$ 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. Develop and follow an appropriate Fumigation Management Plan (Refer to Section IV. G).

c. Procedure for Tarpaulin Fumigations

1. 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 empty space contained within the tarp.
2. Determine the target phosphine concentration and the duration of the fumigation. This must be based on the target pests and the temperature of the material being treated.
3. Calculate how much fumigant will be required, based on the volume calculation, and the means by which it will be dispensed. A means of controlling the dispensing flow rate is required for small sized tarpaulin fumigations since high-speed discharge from fast dispensing can damage the tarp and undo any sealing that was done. A regulated dispenser is one option to achieve control of dispensing flow rates. The approved dispensing equipment includes a pressure regulator to reduce the cylinder pressure to less than 100 psig exit the pressure regulator. From this pressure $ECO_2FUME^{®}$ flows through a flow control further reducing the exit pressure to near ambient. The use of flow restricting nozzles is another option to control the rate of $ECO_2FUME^{®}$ dispensing to prevent damage to tape and seals.
4. Determine where the fumigant will be dispensed into the space, and plan for and install required components. Dispensing points must not be located in or attached to commodity packages or within containers.
5. Determine where the fumigant concentrations will be measured and plan for and install required gas sampling lines. Sampling points must not be located near dispensing points to avoid inaccurate 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 must 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 must be a minimum of 2-mil thickness for indoor applications however, 4 or 6 mil is preferred and is more suitable for outdoor use. Ensure that tarp penetrations for dispensing and monitoring are well sealed.
7. Placard the tarped material.
8. Verify that all required safety equipment is available and in good working order.
9. Connect the $ECO_2FUME^{®}$ cylinders to the dispensing equipment.
10. Dispense the initial dose of fumigant.
11. 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.

12. Phosphine gas is 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 and phosphine concentrations are at a safe level of 0.3 ppm or below.
13. Dispense additional fumigant as required to maintain the target phosphine concentrations.
14. When no further fumigant is required, close all cylinder valves. Depressurize the dispensing equipment and disconnect all $ECO_2FUME^{®}$ cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
15. Before leaving the fumigation site, recheck barricades and placards at all entries into the fumigation space and/or fumigated area to prevent entry by unauthorized personnel during fumigation.
16. When the fumigation is complete, remove the tarp and aerate as appropriate using precautions to prevent exposure to workers (see VIII. AERATION OF FUMIGATED COMMODITIES and IX. E. AERATION AND REENTRY).

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 TRANSPORT CONTAINERS AND TRAILERS

a. General

Railcars and containers, trucks, vans and other transport vehicles shipped piggyback by rail may be fumigated in-transit, however, aeration en-route is prohibited. It is not legal to move trucks, trailers, containers, vans, etc. over public roads or highways until they have been aerated and the warning placards removed. Notify the consignee if the commodity is to be shipped under fumigation. If the consignee is unfamiliar with proper handling of fumigated rail cars and containers fumigated in-transit, they must be provided with this information. See Sections VI and VIII of this manual for recommendations on placarding, commodity aeration, and training of persons authorized to remove placarding.

Containers, trucks, and other transport vehicles loaded with bulk commodities, to which $ECO_2FUME^{®}$ may be added are treated in essentially the same way as any other storage facility.

$ECO_2FUME^{®}$ gas dispensing lines shall not be placed in or attached to commodity packages containing processed food.

b. Procedure for Stationary Container and Trailer Fumigation

1. Develop and follow an appropriate Fumigation Management Plan (Refer to Section IV. G).
2. Determine the empty volume of the trailer or container.
3. Determine the target phosphine concentration and exposure time. This must be based on the target pests, commodity temperature, and commodity stored in the container.

4. Calculate how much fumigant will be required, and the dispensing time needed. A regulated dispenser or flow restricting nozzles are the recommended means of dispensing the fumigant.
5. Inspect all sidewalls, roof, floor, and doors for cracks, holes or defects. Seal all openings with tape or caulk. Particular attention must be paid to any drain holes in the floor.
6. Install the $ECO_2FUME^{®}$ gas dispensing line and secure it to the door, wall or floor with tape.
7. Close the door and seal with tape, caulk or polyethylene sheeting to prevent gas loss.
8. Affix fumigation placards to all sides and at all openings of the container or trailer.
9. Verify that all required safety equipment is available and in good working condition before fumigation begins.
10. Notify all personnel that fumigant release is about to commence. When trailers attached to tractors and trucks are fumigated, drivers must not be allowed to enter the vehicle until fumigation has ended and the truck is aerated.
11. Dispense the predetermined quantity of $ECO_2FUME^{®}$ into the container or trailer.
12. Before leaving the fumigation site, recheck barricades and placards at all doors into the fumigation space and/or fumigated area to prevent entry by unauthorized personnel while fumigation is in progress
13. When the fumigation is complete, aerate as appropriate using precautions to prevent exposure to workers (See Section VIII. Aeration of Fumigated Commodities and Section IX.E. Aeration and Reentry. Adequate monitoring and aeration must be performed to reduce any residual Phosphine levels to below 0.3 ppm.

c. Procedure for In-Transit Container and Trailer Fumigation

Develop and follow an appropriate Fumigation Management Plan (Refer to Section IV. G).

A certified applicator or trained person under his direct supervision must be responsible for adding fumigant and sealing and placarding the container or trailer for transport. The shipper and/or the fumigator must provide written notification to the receiver of the railcar, railroad boxcars, shipping containers and other vehicles which have been fumigated in-transit. A certified applicator or trained person under his direct supervision is responsible for ensuring that a copy of the label and Application Manual precedes or accompanies all transportation containers or vehicles, which are fumigated in-transit. If the Applicator's manual is sent with the transport vehicle it must be placed securely on the outside of the vehicle.

Proper handling at their destination is the responsibility of the consignee. Upon receipt of the railcar, railroad boxcars, shipping containers and other vehicles fumigated in-transit, a certified applicator and/or persons with documented authorized training must supervise the aeration process and removal of the placards.

TRAINING REQUIREMENTS FOR RECEIPT OF VEHICLES OR SHIPPING CONTAINERS FUMIGATED IN-TRANSIT

The trained person(s) must be trained by a Certified Applicator following the EPA accepted product application manual or by other training which is accepted by local or state authorities. The worker training must take place before the in-transit (fumigated) containers arrive and the training must include related instructional materials in addition to the Application Manual. When training has been completed and the employee demonstrates safety knowledge proficiency, the training date must be logged and maintained in

the employee's safety training record for a minimum of three years. Refresher training must be done on an annual basis.

This training must cover the following items, each of which may be found in this manual. Additional training in the use of fumigant pesticides may be required by the local or state authorities.

1. How to aerate the vehicle or shipping container and verify that it contains no more than 0.3 ppm phosphine

   OR

2. How to transfer the commodity under fumigation to another storage area without prior aeration and ensure that safety limits for workers and people in neighboring areas are not being exceeded during transfer and to placard the new storage area until aeration.

3. How to determine when respiratory protection must be worn (refer to PPE section V.E..

4. How to protect workers and nearby persons from exposure to levels above the 8-hour time weighted average (TWA) of 0.3 ppm or the 15 minute TWA short- term exposure limit (STEL) of 1.0 ppm phosphine.

5. Proper removal of placards from the vehicle or shipping container

## 7. APPLICATION TO SHIPS (not for use on barges)

a. General

1. Develop and follow an appropriate Fumigation Management Plan (Refer to Section IV. G.).

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

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

3. In addition to the ship fumigation procedures outlined in the following paragraphs (b, c, d, and e), applicators must follow the general procedures for fumigating bulk commodities (see IV. H. 3. c.), spaces (see IV. H. 4. c), or containers (see IV.H. 6. b), as appropriate. Gas circulation assistance may be needed to ensure complete penetration with $ECO_2FUME^{®}$ Fumigant Gas for bulk commodity fumigations. Suggestions are provided under "Additional Considerations" in Section IV.H. 3. c. of "Application to Bulk Commodities."

b. Pre-Voyage Fumigation Procedures for In-Transit Fumigation

1. Prior to fumigating a vessel for in-transit cargo fumigation, the master of the vessel, or his representative, and the fumigator must determine if the vessel is suitably designed and configured to allow for safe occupancy by the ship's crew throughout the duration of the fumigation. If it is determined that the design and configuration of the vessel does not allow for safe occupancy by the ship's crew throughout the duration of the fumigation, then the vessel will not be fumigated unless all crew members are removed from the vessel. The crew members must not be allowed to reoccupy the vessel until it has been properly aerated to 0.3 ppm or less and a determination has been made by the master of the vessel and the fumigator that the vessel is safe for occupancy.

2. The person responsible for the fumigation must notify the master of the vessel or his representative of the requirements relating to personal protection equipment* and detection equipment, and that a person qualified in the use of all this equipment must accompany the vessel with cargo under fumigation. Emergency procedures, cargo ventilation, periodic monitoring and inspections, and first aid measures must be discussed with the master of the vessel or his representative.

   *Personal protection equipment means a NIOSH-approved air purifying full face gas-mask with a chin style mounted canister approved for phosphine, OR a NIOSH approved supplied-air respirator (refer to PPE section V.E.) with a full facepiece for phosphine levels up to 15 ppm. A self-contained breathing apparatus (SCBA) must be worn and operated in a positive pressure mode when phosphine levels are above 15 ppm or at unknown concentrations.

3. Seal all openings to the cargo hold or tank and lock or otherwise secure all openings, manways, etc., that might be used to enter the hold. The overspace pressure relief system of each tank aboard tankers must be sealed by closing the appropriate valves and sealing the openings into the overspace with gas-tight materials.

4. Placard all entrances to the treated spaces with fumigation warning signs.

5. If the fumigation is not completed and the vessel aerated before the manned vessel leaves port, the person in charge of the vessel shall ensure that at least two units of personal protection equipment and one gas or vapor detection device, and a person qualified in their operation be on board the vessel during the voyage. $ECO_2FUME^{®}$ cylinders must be disconnected and removed from the vessel before it leaves port.

6. During the fumigation or until a manned vessel leaves port or the cargo is aerated, the person in charge of the fumigation shall ensure that a qualified person using gas or vapor detection equipment tests spaces adjacent to spaces containing fumigated cargo and all regularly occupied spaces for fumigant leakage. If leakage of the fumigant is detected, the person in charge of the fumigation shall take action to correct the leakage or shall inform the master of the vessel, or his representative, of the leakage so that corrective action can be taken.

7. The person in charge of the fumigation shall review with the master, or his representative, the precautions and procedures to be followed during the voyage.

c. Application Procedures for Bulk Dry Cargo Vessels and Tankers

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

1. If the fumigation is not completed and the vessel aerated before the manned vessel leaves port, the person in charge of the vessel shall ensure that at least two units of personal protection equipment and one gas or vapor detection device, and a person qualified in their operation be on board the vessel during the voyage.

   **$ECO_2FUME^{®}$ cylinders must be disconnected and removed from the vessel before it leaves port**.

2. During the fumigation or until a manned vessel leaves port or the cargo is aerated, the person in charge of the fumigation shall ensure that a qualified person using gas or vapor detection equipment tests spaces adjacent to spaces containing fumigated cargo and all regularly occupied spaces for fumigant leakage. If leakage of the fumigant is detected, the person in charge of the fumigation shall take action to correct the leakage or shall inform the master of the vessel, or his representative, of the leakage so that corrective action can be taken.

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

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

1. If the fumigation is not completed and the vessel aerated before the manned vessel leaves port, the person in charge of the vessel shall ensure that at least two units of personal protection equipment and one gas or vapor detection device, and a person qualified in their operation be on board the vessel during the voyage. **$ECO_2FUME^{®}$ cylinders must be disconnected and removed from the vessel before it leaves port**.

2. During the fumigation or until a manned vessel leaves port or the cargo is aerated, the person in charge of the fumigation shall ensure that a qualified person using gas or vapor detection equipment tests spaces adjacent to spaces containing fumigated cargo and all regularly occupied spaces for fumigant leakage. If leakage of the fumigant is detected, the person in charge of the fumigation shall take action to correct the leakage or shall inform the master of the vessel, or his representative, of the leakage so that corrective action can be taken.

   Application procedures for fumigation of raw commodities or processed foods in transport units (containers) are described in Section IV. H. 6. of this manual.

e. Precautions and Procedures During Voyage

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

2. Do not enter fumigated areas except in an emergency. If necessary to enter a fumigated area, appropriate personal protection equipment must be used. Never enter fumigated areas alone. At

least one other person, who is also wearing personal protection equipment, must be available to assist in case of an emergency.

f. Precautions and Procedures During Discharge

If necessary to enter holds prior to discharge, test spaces directly above cargo surface for fumigant concentration using appropriate gas detection and personal safety equipment. Do not allow entry to fumigated areas without personal safety equipment, unless fumigant concentrations are 0.3 ppm or less, as indicated by a suitable detector.

## 8. SPOT FUMIGATION APPLICATION

a. General

$ECO_2$FUME® Fumigant Gas is recommended for spot fumigation treatment of bins, silos, holding tanks, elevator boots and heads, filters, conveyers, spouting and purifiers, food processing equipment (e.g., sifters, rollers, dusters and other related equipment); and other related equipment found in mills, food and feed processing plants, breweries and similar industries.

Traditionally spot fumigation has been defined as a method of achieving short-term control of insect infestations resulting from the presence of food and food particles that remain within the processing equipment. This practice is meant to control only the adult and larval stages of the insects. It is therefore recommended that spot fumigation be repeated as necessary to control insect re-infestation from the emergence of egg and pupae stages that may not have been completely eliminated by the first treatment.
Spot treatment with $ECO_2$FUME® Fumigant Gas can be conducted as a supplement to general fumigation. The frequency of treatments is recommended on a monthly basis at a minimum.

b. Develop and Follow an appropriate Fumigation Management Plan (Refer to Section IV.G.)

c. Efficacy

As with all fumigants, the most important aspects of any successful fumigation is the degree to which the space is sealed and the assurance that the minimum fumigant concentrations is maintained for the required time. Given the wide variation in potential infestation scenarios and the difficulty in achieving a well-sealed area in certain situations it is important to note that spot fumigation alone may not completely control the infestation in all cases. Consideration must be given to an integrated pest management solution which may include the use of fogging chemicals and routine hygiene in conjunction with $ECO_2$FUME® Fumigant Gas.

Monitoring of the phosphine gas concentrations within and around the fumigated space must be conducted to ensure that the sealing has been adequate. This effort will assist in determining the ability of the fumigation space to hold gas, identifying any leak points that can then be repaired and allow for necessary steps to ensure no one is exposed to unacceptable levels of phosphine. Monitoring of the phosphine concentrations within the fumigation space will also ensure that lethal concentrations are maintained for the minimum exposure time. As a rule of thumb to obtain satisfactory results minimum phosphine concentrations of 50-100 ppm should be observed after 10 hours of the initial addition of $ECO_2$FUME®Fumigant Gas.

The minimum exposure time for treatment in spot fumigation using $ECO_2$FUME® Fumigant Gas is 24 hours. Efficacy studies have shown that effective control of adults and larva can be achieved within this time frame with $ECO_2$FUME® Fumigant Gas. The complete control of the egg and pupae stages is more difficult in spot fumigation applications in 24 hrs due to the difficulty in achieving a gas tight seal in all situations. It is

recommended that retrievable insect bioassays be added inside the fumigation space as a measure of assessing the success of each treatment. As spot fumigation is meant as a short–term control measure the frequency of repetitive treatments recommended is one month or less until the problem is brought under control.

d. Dosage and Exposure Time

The minimum dosage requirement for spot fumigation with $ECO_2FUME®$ Fumigant Gas is 250 ppm. Refer to the Application Procedure section of this manual for instructions on calculating of the amount of $ECO_2FUME®$ Fumigant Gas required. Under colder temperature conditions or when certain pieces of equipment including purifiers and sifters cannot be readily sealed a maximum dosage of 2,500 ppm may be used. The recommended dosage and exposure times are summarized in the following table.

| Temperature | $PH_3$ Dosage (ppm); lb $ECO_2FUME®$/ 1000 $ft^3$ | Minimum Duration | Comments |
|---|---|---|---|
| Below 32°F (0°C) | Do not fumigate. | Do not Fumigate | Do not fumigate. |
| 32-59°F (0-15°C) | 500-2,500 ppm; 2.2-11.03 lb/1000 $ft^3$ | 24 hours | |
| 60°F & above (16°C & above) | 250-2,500 ppm; 1.1-11.03 lb/1000 $ft^3$ | 24 hours | Choose dosage based upon target insect, level of infestation, ability to achieve gas tight seal. |

e. General Procedure for Spot Fumigation

The following procedure is intended to provide general guidelines only for the use of $ECO_2FUME®$ Fumigant Gas in spot fumigation. It is required that the use of $ECO_2FUME®$ Fumigant Gas for spot fumigation be conducted in compliance with all other instructions found in this manual including sections regarding Health and Safety; Directions for Use; Monitoring; Aeration; Handling, Storage and Transportation of $ECO_2FUME®$ Fumigant Gas cylinders; and the Fumigation Management Plan.

1. Examine the equipment and area to be fumigated thoroughly in order to determine if the equipment can be sealed sufficiently to hold gas.
2. Develop a comprehensive plan before conducting a spot fumigation. This plan must include a thorough understanding of the equipment to be fumigated including all related products and air flow patterns. Review equipment schematics and or diagrams when available.
3. Assess the condition of the equipment for potential sources of leakage and determine the best sealing practice(s). The fumigator must also have a sound understanding of the facility design and the areas surrounding the site of fumigation.
4. Establish and follow all aspects of the Fumigation Management plan to prevent exposure to any workers and bystanders during the fumigation.
5. Establish a security plan to prevent entrance by unauthorized personnel into the placarded fumigation area until after aeration.
6. Phosphine gas can be corrosive to copper, copper alloys and precious metals including gold and silver. Ensure that any sensitive equipment or components of the equipment to be fumigated that may contain these items are removed or protected prior to fumigation.
7. Determine the target phosphine concentration for the fumigation. Refer to the Section C Recommended Dosage and Exposure Time guide for spot fumigation in Section (IV.H.8.c). Additional

information for calculating the amount of ECO2FUME® Fumigant Gas required is found in Section IV.H.2.d.

8. Calculate the volume within the space to be treated. Since the volume of spot treatment area can vary widely, it is important to make a good estimate of the enclosed volume. If a tarp is involved first calculate the volume taken up by the equipment itself. After tarping is complete, revise the volume estimate based on the additional space contained within the tarp.
9. Calculate how much fumigant will be required, based on the volume calculation, and the means by which it will be dispensed. A regulated dispenser may be required, since high-speed discharge from fast dispensing may damage small tarped areas and undo any sealing that was done. The approved dispensing equipment includes a pressure regulator to reduce the cylinder pressure to less than 100 psig. From this pressure ECO2FUME® Fumigant Gas flows through flow indicators, and the discharge side of the flow indicators is maintained near atmospheric pressure. The use of flow restricting nozzles is another option to control the rate of ECO2FUME® Fumigant Gas dispensing to prevent damage to tarps and seals.
10. Determine where the fumigant will be dispensed into the space, and plan for and install required components.
11. Determine where the fumigant concentrations will be measured and plan for and install required gas sampling lines. Sampling points must not be located near dispensing points to avoid inaccurate readings.
12. All equipment to which ECO2FUME® Fumigant Gas will be applied must be sealed. Seal all openings using tape, glue, tarping etc. When tarps are used seal the plastic covering to the floor using tape, glue, sand or water "snakes" or by other suitable means. Reinforce by tape or other means, any sharp corners or edges to reduce the risk of tearing the plastic sheeting. Plastic sheeting must be a minimum of 2-mil thickness for indoor applications however, 4 or 6 mi1 is preferred and is more suitable for outdoor use. Ensure that any penetrations made in the tarp for dispensing and monitoring purposes are well sealed.
13. Placard the sealed equipment or tarped area as well as all entrances or access points to the area under fumigation with $ECO_2$FUME® Fumigant Gas warning placards. Phosphine gas is highly mobile and given enough time may penetrate seemingly gas-tight materials such as concrete and cinder block and may escape from sealed or partially sealed equipment. This is generally of no consequence if the tank or bin is out-of-doors. However, leakage into rooms housing treated machinery, equipment, transfer lines, etc. may result in phosphine gas levels above 0.3 ppm Doors leading to work areas that contain treated equipment must be placarded and entry prior to aeration prohibited, unless approved respiratory protection (refer to PPE section V.E.) is worn or gas levels less than 0.3 ppm have been measured. Adjacent, enclosed areas likely to be occupied must be examined to ensure that significant leakage has not occurred. Sealing of the fumigated site and/or airflow in the occupied areas must be sufficient to meet exposure standards.
14. Verify that all required safety equipment is available and in good working order.
15. Notify all personnel that fumigant release is about to commence. The area surrounding the equipment being treated must be monitored for phosphine concentrations to ensure that workers are not 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. The licensed fumigator must evaluate if workers under a continuous roof, connected buildings or those working near an adjacent outside wall must be vacated to prevent exposure.
16. Connect the ECO2FUME® Fumigant Gas cylinders to the dispensing equipment.
17. Dispense the initial dose of fumigant.

18. Immediately after application close all doors and windows so as to reduce drafts and air currents in the building during the exposure period.
19. 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.
20. Dispense additional fumigant as required to maintain the target phosphine concentrations.
21. When no further fumigant is required, close all cylinder valves. When using the regulated dispenser depressurize the equipment and disconnect all $ECO_2FUME^{®}$ Fumigant Gas cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
22. When the fumigation is complete, remove any tarps or sealed openings and aerate as appropriate using precautions to prevent exposure to workers (see VIII. AERATION OF FUMIGATED COMMODITIES and IX. E. AERATION AND REENTRY). The use of aeration fans, dust collectors or the opening of windows may help in the aeration process.
23. Determine that the gas concentration is 0.3 ppm or below before removal of warning placards or allowing entry of any personnel without the appropriate respiratory protection (refer to PPE section V.E.) into the fumigation area.

## 9. APPLICATIONS TO PERISHABLE COMMODITIES IN COLD STORAGE

### a. General

$ECO_2FUME^{®}$ can be used to fumigate fresh commodities under cold storage conditions.

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. Develop and follow an appropriate Fumigation Management Plan (Refer to Section IV. G.)

The Fumigation Management Plan must be written PRIOR to fumigation. Following the instructions provided in Section IV.G of this manual will ensure that the applicator has become acquainted with the structure and commodity to be fumigated, has notified personnel and potential bystanders in and around the structure to be fumigated, and has established the monitoring necessary to ensure perimeter safety during fumigation and aeration.

The main difference between fumigation of fresh commodities in cold storage and other raw or processed commodities is the reduced amount of time for fumigation and aeration that is necessary to preserve the quality of the fresh commodities. Typical fumigation sites for fresh commodities include cooling chambers, controlled atmosphere chambers or reefer containers specially adapted for fumigations. Other sites may be used provided that they are gas-tight and meet the quality assurance needs of the commodity to be fumigated. The chamber design typically will reflect what is needed to maintain the quality of the particular fresh commodity that is being fumigated. For example, fumigation and aeration must be completed as rapidly as feasible when highly perishable commodities are treated. To accomplish this, it may be necessary to release the gas near the fans of the cooling system in order to distribute the phosphine in the chamber rapidly and safely. For aeration, extraction fans are available with the capacity to perform 20-30 air changes or more in the chamber per hour. Under these conditions it is possible to ventilate a chamber from over 1,000 ppm to less than 0.3 ppm in about 90 minutes.

Another potential difference between fumigation under cold storage conditions and ambient temperatures is that temperature differences could occur during the fumigation process that result in pressure increases or vacuum formation. When this is the case, a pressure monitoring device (e.g., U-manomenter) can be installed on the chamber to monitor the pressure during the fumigation process, and/or a pressure relief system such as flappers or water traps can be installed.

For advice concerning cold storage fumigations and the development of a Fumigation Management Plan, contact CYTEC Industries Inc., Customer Service Department, Phone No. (905) 374-5899, Fax No. (905) 374-5888 for further assistance.

**c. Cold storage buffer zone requirements for fumigation and aeration**.
For cold storage fumigations, a 30 foot buffer zone must be established from the outside edge of the structure being fumigated unless the structure has been pressure tested and found to be gas tight per USDA testing protocols (see the USDA Treatment Manual, available from the Animal and Plant Health Inspection Service (APHIS) web site (http://www.aphis.usda.gov )).

During aeration, follow the special instructions for aeration after cold storage fumigations found in Section VIII. A. To ensure bystander safety during rapid aeration of chambers containing fresh commodities fumigated under cold storage conditions, the following buffer zones must be maintained:

The required buffer zones vary based upon the volumes treated.
- 200 foot buffer for all aeration methods and fumigations ≤ 100,000 $ft^3$
- 350 foot buffer for all aeration methods and fumigations ≤ 500,000 $ft^3$
- 500 foot buffer for all aeration methods and fumigations > 500,000 $ft^3$

During the first 10 minutes of aeration, no one is permitted within the buffer zone surrounding the exhaust duct outlet. If the exhaust duct is not used for aeration, the buffer zone distances must be measured from the perimeter of the fumigated structure. In either scenario, no one is permitted within the buffer zone until the structure has aerated for 10 minutes and monitoring indicates that the level of phosphine gas is 0.3 ppm or below. For personal safety, gas levels should occasionally be monitored at greater distances, especially downwind to ensure this buffer zone is adequate.

Everyone within the aeration buffer zone must be made aware that a release of fumigant gas is about to take place. If personnel involved with the fumigation choose to remain in the area, they must wear the minimum respiratory protection specified in Section V. E. Anyone not involved with the fumigation must evacuate and remain beyond the buffer zone. If people cannot be restricted from the buffer zone during regular work hours, aeration must be done during another time of the day. When securing the duct outlet area, consider the direction of the wind and face the duct outlet toward an open area, and away from people. Always point the duct outlet upward to aid in dispersing the exhausted gas.

Entry into buffer zone areas requires periodic monitoring and the use of SCBA respirators as set forth in Section V. E. RESPIRATORS and the USDA Treatment Manual.

**d. For complete control of most pests**, treat at a concentration of 750-2,500 ppm phosphine for 24-72 hours at approximately 28°F to 43°F (-2°C to 6°C) during the fumigation. When the commodity temperature is >43°F (>6°C) treat at a concentration of 750 – 2,500 ppm phosphine for 24-48 hours. If survivors are found, follow with continued cold treatment for up to 10 days at 32°F (0°C).

**e. Procedure for fumigating cold storage chambers, including fumigation chambers, warehouses, transport containers for railcars, trucks and ships, and other suitable structures:**

1. Calculate the empty volume of the space to be treated.

2. Calculate how much $ECO_2FUME^{®}$ will be required.

3. Determine where the fumigant will be dispensed into the space, and plan for and install required components.

4. Determine where fumigation concentrations will be measured (if used) and plan for and install required gas sampling lines.

5. Identify one access door and lock all others. Lock all ground level and other accessible windows if possible.

6. Except for the access door, seal all openings including cracks, windows, doors, vents, eaves, ventilation fan 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 to be fumigated.

7. Remove from the space, or protect sensitive equipment.

8. 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. Comply with the buffer zone requirements set forth in Section IV.H. 9. c. (above).

9. Close, lock, seal and placard the access door. Prevent gas loss by sealing with tape, caulk or polyethylene sheeting or by using specially designed permanent door seal and closure systems. Affix fumigation placards to all sides and at all openings of the fumigated space.

10. Verify that all required safety equipment is available and in good working order.

11. Notify all personnel that fumigant release is about to commence.

12. Connect the $ECO_2FUME^{®}$ cylinders to the dispensing equipment. Follow directions provided by the manufacturer of the equipment.

13. Dispense the initial dose of $ECO_2FUME^{®}$. Because it is not dependent on environmental conditions such as temperature and humidity, $ECO_2FUME^{®}$ release is instantaneous. Low level phosphine monitoring for personal exposure should begin at the time gas is released from the dispensing equipment. If leakage causes the fumigator's exposure to exceed the 8-hour TWA of 0.3 ppm of phosphine, approved respiratory protection such as SCBA must be worn. Gas concentration measurements for safety purposes must be made using suitable low-level detection equipment. See Section IX. G. "Industrial Hygiene Monitoring" for more information. The STEL is 1.0 ppm phosphine for 15 minutes. Conduct permitted monitoring during the release of fumigant to ensure phosphine levels do not exceed exposure limits around the fumigation structure where workers and bystanders have access.

14. Periodically monitor the phosphine concentrations within the space, using suitable gas detection equipment, to ensure that minimum concentrations are being maintained.

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 $ECO_2FUME^{®}$ cylinders in accordance with equipment operating instructions. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.

17. Before leaving the fumigation site, recheck barricades and placards at all entries into the fumigation space to prevent entry by unauthorized personnel during fumigation.

18. When the fumigation is complete, unseal the space and aerate as appropriate using precautions to prevent exposure to workers. Comply with the buffer zone requirements set forth in Section IV. H. 9. c (above), Section VIII. AERATION OF FUMIGATED COMMODITIES with attention to the SPECIAL INSTRUCTIONS FOR AERATION AFTER COLD STORAGE FUMIGATIONS, and IX.E. AERATION AND REENTRY).

Phosphine concentrations must be monitored continuously during aeration to ensure no worker exposure occurs.

19. Remove all dispensing and gas monitoring lines.

20. Workers should be aware that some residual gas may be entrapped within the fumigated commodity container (i.e., bagged and/or boxed commodities). Adequate monitoring and aeration must be performed to reduce any residual phosphine levels to below 0.3 ppm.

# V. PERSONAL PROTECTIVE EQUIPMENT (PPE)

## A. GLOVES

Wear leather work gloves or leather faced cotton gloves when connecting to or disconnecting $ECO_2FUME^{®}$ cylinders from the dispensing equipment.

## B. SAFETY GLASSES

When working with pressurized equipment, safety glasses must 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 $ECO_2FUME^{®}$ cylinders about the fumigation site. The hand truck must 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 $ECO_2FUME^{®}$ cylinder without valve cap and cylinder cap in place.

## E. RESPIRATORS

1. When respiratory protection must be worn

NIOSH approved self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode must be worn when phosphine concentrations are unknown.

2. Permissible gas concentration ranges for respiratory protection devices

A NIOSH approved, full-face gas mask phosphine canister 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 $CO_2$ exposure up to 5,000 ppm, a canister respirator will not provide protection from $CO_2$ 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 fumigating with $ECO_2FUME^{®}$ Fumigant Gas. At least two self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode must be available at the site of application. See the following table for the required minimum respiratory protection needed for different phosphine concentrations.

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

| **CONDITION** | **MINIMUM RESPIRATORY PROTECTION** |
|---|---|
| (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. |

## F. NOTIFICATION REQUIREMENTS

1. Authorities and on-site workers:

On an annual basis, prior to a fumigation, or more frequently if required by the Fumigation Management Plan, provide and review with local emergency planning committee officials (as defined by Emergency Planning and Community Right-to-Know Act (EPCRA) section 301(c), the MSDS, Applicator's Manual, and other relevant safety information, if available, for use in the event of an emergency.

2. Incidents involving these products:

Registrants must be informed of any incident involving the use of this product. Please call Dan Liebowitz at Cytec Industries Inc. (1-973-357-3460) so the registrant can report all incidents as per requirements of OSHA CFR 29.

3. Theft of products:

Report all thefts of product immediately to proper local officials.

# 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, "Structure 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 and nearby personnel must not be exposed to more than 0.3 ppm phosphine or 5,000 ppm carbon dioxide."
4. The date and time fumigation began and expected completion date.
5. Trade Name and EPA Registration Number of fumigant used.
6. Name, address, and telephone number of the applicator.
7. All entrances to a fumigated structure must be placarded. Placards must 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. A Certified Applicator or person under his direct supervision must put placards in place after determining how many are required at the container or fumigation site and where they must be placed. An exception is when a trained worker receives raw agricultural commodities under in-transit fumigation and the commodity is transferred to another container before the contents are aerated. In this case, placarding is the responsibility of the trained worker.
9. Persons with documented training in the handling of phosphine products must be responsible for receiving, aerating and removal of placards from vehicles, which have been fumigated in transit. Refer to Section IV. H. 6. c for training requirements. The person responsible for removing the placards is required to be familiar with the physical, chemical and toxicological properties of phosphine and carbon dioxide. They must 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 must 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, grains, nuts and dates; 0.01 ppm for processed foods; and 0.01 ppm in fresh fruits and vegetables. To guarantee compliance with these tolerances, it is necessary to aerate commodities for a minimum of 48 hours prior to offering them to the end consumer. A shorter aeration period may be permitted if the airborne phosphine was found to be less than 0.3 ppm. Commodities may be analyzed before release to consumers to ensure that phosphine levels do not exceed tolerances. Fresh commodities fumigated under cold storage conditions must be aerated to 0.3 ppm very rapidly (one to two hours) in order to preserve quality – see special instructions below.

**SPECIAL INSTRUCTIONS FOR AERATION AFTER COLD STORAGE FUMIGATIONS:**

Cold storage chambers must be aerated rapidly in order to preserve the quality of the stored commodity. In order to aerate while keeping the commodity cold, use large fans and/or exhaust systems capable of replacing the air in the chamber with fresh air in about one to two hours. The aerated chamber must be tested and found to have airborne phosphine concentrations less than the TLV of 0.3 ppm before aeration is considered complete. Phosphine concentrations must be monitored continuously during aeration to ensure no worker exposure occurs. When aeration is complete, turn off the aeration fans, seal the door(s) and bring the temperature back down to the required cold storage temperature. If survivors are found following treatment, treated fruit must be kept in cold storage for up to 10 days following treatment.

To ensure bystander safety during rapid aeration of chambers containing fresh commodities fumigated under cold storage conditions, the following buffer zones must be maintained:

The required buffer zones vary based upon the volumes treated.

- 200 foot buffer for all aeration methods and fumigations $\leq$ 100,000 $ft^3$
- 350 foot buffer for all aeration methods and fumigations $\leq$ 500,000 $ft^3$
- 500 foot buffer for all aeration methods and fumigations > 500,000 $ft^3$

During the first 10 minutes of aeration, no one is permitted within the buffer zone surrounding the exhaust duct outlet. If the exhaust duct is not used for aeration, the buffer zone distances must be measured from from the perimeter of the fumigated structure. In either scenario, no one is permitted within the buffer zone until the structure has aerated for 10 minutes and monitoring indicates that the level of phosphine gas is 0.3 ppm or below. For personal safety, gas levels should occasionally be monitored at greater distances, especially downwind to ensure this buffer zone is adequate.

Everyone within the aeration buffer zone must be made aware that a release of fumigant gas is about to take place. If personnel involved with the fumigation choose to remain in the area, they must wear the minimum respiratory protection specified in Section V. E. Anyone not involved with the fumigation must evacuate and remain beyond the buffer zone. If people cannot be restricted from the buffer zone during regular work hours, aeration must be done during another time of the day. When securing the duct outlet area, consider the direction of the wind and face the duct outlet toward an open area, and away from people. Always point the duct outlet upward to aid in dispersing the exhausted gas.

## 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. Such exposures might occur because of leakage into enclosed areas from fumigation sites or during transfer of unaerated commodity. The short-term exposure limit (STEL) is 1.0 ppm phosphine for 15 minutes.

## 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, release of $ECO_2FUME^{®}$ is instantaneous. This instantaneous release can expose the fumigator to immediate high levels of fumigant. If the fumigator's exposure exceeds the 8- hour TWA of 0.3 ppm of phosphine or the TLV of 5,000 ppm (0.5% by volume) of carbon dioxide, approved respiratory protection such as an SCBA must be worn (refer to PPE section V.E). 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. Proper sealing of the fumigated structure must be done to reduce exposure.

## E. AERATION AND REENTRY

If the structure 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 structure 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 structures by any person before this time unless protected by an approved respirator (refer to PPE section V.E.).

## F. HANDLING UNAERATED COMMODITIES

With the exception of fresh commodities fumigated in cold storage, transfer 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 (refer to PPE section V.E.)) 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.

Fresh commodities fumigated in cold storage must be completely aerated before being handled or moved.

## 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 (refer to PPE section V.E.). 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 must 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. The user must read all of the following information contained in the pamphlet.

1. The user is responsible for the safe use of the container and its contents and for returning the container to the gas manufacturer or distributor in the same safe condition as it was received.
2. The user shall not modify, tamper with, paint, deface, obstruct, remove or repair any part of the cylinder, including the pressure relief device, and the container valve or the valve protection device. Maintenance of the container and its valve or relief device (if required) shall be performed only by trained personnel under the direction of the container owner or an authorized representative.

3. The prescribed stamped markings on the container shall be made and kept in a legible condition. The user shall not add, remove or alter any of these markings.

4. The labels applied by the gas manufacturer to identify the container contents shall not be defaced or removed by the user.

5. Compressed gas containers shall not be exposed to temperature extremes. High temperatures may result in excessive cylinder pressure. Never apply a flame or heat directly to any part of a compressed gas container or allow it to come in contact with an electrically energized system. High temperatures may also damage the physical integrity of the container. If ice or snow accumulates on a container, thaw at room temperature, or with water at a temperature not exceeding 125$^{o}$F (51.7$^{o}$C).

6. Leaking or defective containers shall not be offered for shipment. Consult the gas supplier for advice under these circumstances.

7. Any damage that might impair the safety of the container shall be called to the attention of the gas supplier before returning the container.

8. Where valve outlet caps and /or plugs are provided by the gas supplier, the user shall keep the device on the valve outlet at all times, except when containers are secured and connected to dispensing equipment. Gas-tight valve outlet caps and plugs serve the purpose of containing any residual product and in accordance with the provisions of 49 CFR 173.40 and CSA B340, are mandatory for poison gas containers. The gas-tight valve outlet cap or plug must be checked and tightened securely before return shipment to the gas supplier.

9. The cylinder valve shall be kept closed at all times (charged or empty) except when the cylinder is in use. Do not use tools such as wrenches and hammers in attempting to open or close valves. An exception is when torque wrenches designed for use with container valve hand wheels are acceptable. Contact the gas supplier if the valve is difficult to operate.

10. Users of compressed gas containers shall ensure that they are not rolled in the horizontal position or dragged. A suitable hand truck, forklift truck, cylinder pallet system or similar material-handling device should be used with the container properly secured to the device. Never lift containers by using the container cap or magnets.

11. Caution should be used when handling cylinders to guard against dropping or permitting them to violently strike against each other and other surfaces.

12. The transfer of compressed gases from one cylinder to another should only be performed by the gas supplier or by personnel who are trained and qualified with the proper transfill equipment and written operating procedures, and who are familiar with the precautions necessary to avoid the hazards of the product being transfilled and with the procedures necessary to comply with all government standards and regulations. Detailed written operating instructions including equipment inspection and maintenance procedures should be provided by the supplier or the transfill equipment and rigorously followed.

13. Cylinder valve connections that do not fit shall not be forced.

14. Gas tight connections including piping, regulators and other apparatus shall be kept gas tight to prevent leakage. This can be confirmed by the use of a compatible leak test solution or an appropriate leak detection instrument. DO NOT tighten connections or leaking fittings or attempt other repairs while the system is under pressure.

15. Prior to disconnecting a cylinder from dispensing equipment, the cylinder valve shall be closed and the dispensing equipment relieved of pressure.

16. The transportation of compressed gas cylinders in unsuitable vehicles or in closed-bodied vehicles can present serious safety hazards and should be discouraged. Refer to CGA PS-7, CGA Position Statement on

the Safe Transportation of Cylinders in Vehicles, for additional guidance. Shipping compartments should be adequately ventilated.

17. An emergency response plan shall be in place wherever compressed gas containers and products are used, handled, stored or disposed of, according to 29 CFR 1910.120. Only trained personnel shall respond to an emergency situation involving a compressed gas container or product. Personnel shall be promptly evacuated from the immediate area in danger and kept up wind at sufficient distance to avoid any inhalation or contact with potentially hazardous products until safe reentry can be ensured.

18. 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 $ECO_2FUME^{®}$ 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 must 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 must be developed for the site. This plan must define procedures and outline responsibilities in addressing emergency situations involving $ECO_2FUME^{®}$. All site personnel must be trained in the plan and it must be practiced periodically.

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

## C. INDOOR STORAGE

The storage of poison gases in occupied spaces is prohibited. However, indoor storage in a separate building with no other occupancy is suitable. It is recommended that the building be made 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. Alternatively, an approved low range phosphine monitor can be used to ensure that phosphine levels are below the TLV of 0.3 ppm before entry into the storage. In some jurisdictions, the indoor storage of toxic gases is prohibited.

## D. OUTDOOR STORAGE

It is recommended that both full and used $ECO_2FUME^{®}$ 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

$ECO_2FUME^{®}$ cylinders must never be stored where the temperature will exceed 125°F (51.7°C). Low temperatures will not affect $ECO_2FUME^{®}$

## 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 $ECO_2FUME^{®}$ cylinder storage area must take into account the needs of a variety of organizations. These must include, but not be limited to: corporate policy, insurance carrier, Occupational Safety and Health Administration (OSHA), Right to Know and local emergency response professionals. Storage must be clearly marked with the following signs:

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

The National Fire Protection Association (NFPA) developed NFPA Hazard Identification Symbols. This standardized symbol system is designed to provide, at a glance, information regarding the health, fire, and reactivity hazards associated with hazardous materials. The following are the hazard categories and degree of hazard for $ECO_2FUME^{®}$.

| Category | Degree of Hazard |
|---|---|
| Health | 2 (Moderate) |
| 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 must be consulted for guidance on the selection and placement of such signs.

# XII. TRANSPORT

## A. GENERAL

$ECO_2FUME^®$ 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 must be trained in and familiar with the specifications of 49 CFR (Code of Federal Regulations).

## B. TRANSPORT DESIGNATIONS

The following transport designations apply to $ECO_2FUME^®$:

| | |
|---|---|
| Proper Shipping Name: | Liquefied gas, toxic, n.o.s.<br>(contains phosphine)<br>(Inhalation Hazard Zone D) |
| Hazard Class: | 2.3 |
| Identification Number: | UN 3162 |
| Shipping Label: | Poison Gas |

## C. TRANSPORT REQUIREMENTS

### 1. Package Preparation

$ECO_2FUME^®$ cylinders shall not be transported unless:

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

### 2. Cylinder Contents

Used $ECO_2FUME^®$ 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 $ECO_2FUME^®$ cylinders.

### 3. Documents

Proper documentation is required by law, for the transport of any hazardous material. The documentation accompanying the shipment of $ECO_2FUME^®$ (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 must be trained in their preparation.

### 4. Vehicle Loading

$ECO_2FUME^®$ cylinders shall only be loaded into unoccupied spaces of vehicles. All cylinders shall be secured from movement during transport.

### 5. Vehicle Markings

Vehicles transporting $ECO_2FUME^®$ shall be placarded in accordance with table I of 172.504 of 49 CFR. Consideration must be made for other hazardous materials that are concurrently being transported. Proper placarding must take into account all hazardous materials on board.

### 6. Use of Common Carriers

Shipment of $ECO_2FUME^®$ cylinders by common carrier is permitted, provided the carrier meets certain criteria. Contact an authorized $ECO_2FUME^®$ distributor or CYTEC Industries Inc. Customer Service Department, Phone No. (905) 374-5899, Fax No. (905) 374-5888.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

Container handling: Refillable container. Refill this container with a phosphine/carbon dioxide mixture only. Do not reuse this container for any other purpose.

Once used, $ECO_2FUME^®$ 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 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 approved respiratory protection must be worn (refer to PPE section V.E).

In case of fire, keep cylinder cool by spraying with water; combat fire from a sheltered position. Never direct water jet on liquid.

## B. WHAT TO DO

In the event of an accidental release, evacuate the area immediately and call for expert assistance. All releases can produce high levels of gas. Stop leak if possible if it can be done without risk. Isolate area until gas has dispersed. Where exposure level is not known, wear approved, positive pressure, self-contained respirator. Where exposure level is known, wear approved respirator suitable for level of exposure (refer to PPE section V.E). High concentrations of carbon dioxide in the air cause a deficiency of oxygen with the risk of unconsciousness or death. Check oxygen before entering area.

## 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 **(Use Guide 123 from the Emergency Response Guidebook for First Responders)**

All emergency responses must 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 PPE section V.E.).