ECO$_2$FUME®

FUMIGANT GAS

Product Stewardship

Applicator Training Manual

CYTEC INDUSTRIES INC.

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1. INTRODUCTION

A. Product Stewardship of $ECO_2FUME^{â}$

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

B. What is Product Stewardship?

Product Stewardship is the responsible and ethical management of the health, safety and environmental aspects of a product such as $ECO_2FUME^{®}$ from its inception through production to its ultimate use and disposition. As Product stewards, we improve the health and safety of people and the environment. T he cornerstone of Product Stewardship is working with customers. We must sufficiently understand their process and provide them with accurate, reliable, and up-to-date information to foster effective health, safety and environmental handling of $ECO_2FUME^{®}$.

Product Stewardship is part of the Responsible Care initiative of the Chemical Manufacturers' Association, of which Cytec is a member. Product Stewardship extends our concerns about the health, safety and environmental impact on each and every stage of $ECO_2FUME^{®}$'s life cycle.

1. How Does Product Stewardship Work?

Being Product Stewards involves teamwork to continuously review all $ECO_2FUME^{®}$ processes and applications for ways to improve them and reduce waste. All of us make sure that fellow employees, suppliers, contractors, and customers around the world are part of the process. This training is in support of those activities.

Cytec personnel work with customers to help them use the Company's products efficiently.

2. What is Product Stewardship's Benefits?

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

3. What's My Part in Product Stewardship?

Always think about how you can improve health, safety and the environment. That applies to all of us. In one way or another, each of us participates in product responsibility. We have to develop a constant focus on that responsibility, and use it on a daily basis. The best way to do this is to learn more about $ECO_2FUME^{®}$ and its proper use at each stage of its life cycle, from cradle to grave.

And, we must always be thinking about how to improve upon each aspect of $ECO_2FUME^{®}$'s life cycle: customer need, product research and development, shipment, customer use and ultimate disposal or recycle.

The $ECO_2FUME^{®}$ Product Stewardship Training Manual for use with $ECO_2FUME^{®}$ Fumigant Gas has been prepared as part of a continuing Product Stewardship Program for $ECO_2FUME^{®}$ Fumigant Gas provided by Cytec.

Each fumigator using $ECO_2FUME^{®}$ is responsible for complying with all federal, state, and local regulations or codes regulating the use of this product. Although the Product Stewardship Program covers regulatory issues, these regulations can change and it is the ultimate responsibility of the end user to keep current on any regulatory changes.

It is a violation of federal law to use this product in a manner inconsistent with its labeling. Cytec and its distributors reserve the right to withhold future sales of $ECO_2FUME^{®}$ to any persons who fail to follow the guidelines of the product label or who go outside of the guidelines given in the Product Stewardship Training.

C. What is Phosphine?

Phosphine (PH_3) or hydrogen phosphide has typically been known as the gas released from fumigants known as metal phosphides. Aluminum phosphide and magnesium phosphide are the metal phosphides which generate phosphine gas when exposed to water molecules in the atmosphere. The chemical reaction when aluminum phosphide (AlP) is acted upon by atmospheric moisture is:

$$AlP + 3H_20 \rightarrow Al(OH)_3 + PH_3$$

Cytec manufactures phosphine directly from elemental phosphorus. There is no waste byproduct from this process. The phosphine is then liquified and blended with carbon dioxide in high pressure cylinders for shipment.

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

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

1. The molecules that gain quick access to the nervous system may act on it to paralyze the insects. (Kashi, 1981)
2. The paralysis of the spiracular muscles prevent active respiration to continue.
3. The enzyme cytochrome oxidase is attacked by phosphine to cause toxic action in the insect. (Kashi and Chefurka, 1976)
4. The cellular membrane can act as a sieve and prevent the PH_3 molecule from entering the cell. (Bell, 1975)

D. What is Carbon Dioxide?

Carbon Dioxide (CO_2) is a colorless gas having a faint, sharp odor and a sour taste. It is a minor component of the Earth's atmosphere (about 3 volumes in 10,000), formed in combustion of carbon-containing materials, in fermentation, and in respiration of animals and employed by plants in the photosynthesis of carbohydrates.

CO_2 was recognized as a gas different from others early in the 17th century by a Belgian chemist, Jan Baptist van Helmont, who observed it as a product of both fermentation and combustion. It liquefies upon compression to 75 kilograms per square centimeter (1,071 pounds per square inch) at 31°C (87.4°F). If the liquid is allowed to expand to atmospheric pressure, it cools and partially freezes to a snow-like solid called Dry Ice.

Besides its uses as a fumigant, CO_2 is used as a refrigerant, in fire extinguishers, for inflating life rafts and life jackets, blasting coal, foaming rubber and plastics, promoting the growth of plants in greenhouses, immobilizing animals before slaughter, and in carbonated beverages.

An increased interest in the insecticidal potential of CO_2 has been generated because of the need to reduce pesticide residues in food materials, while still controlling pests effectively and economically. CO_2 also has synergistic properties when used as a fumigant. Effectiveness of a fumigant may be increased six-fold or more in some cases when CO_2 is used as a synergist. (Bond, 1978)

E. History of Phosphine

Fluck (1973) mentions that the discovery of phosphine was by Gengembre and Kirwan in the late 1700s. It was further investigated by Guy-Lussac and Thenard in 1811. Not until the 1930's, however, was the behavior of this chemical systematically studied. A German chemical company patented phosphine in 1952 and the first uses in the United States occurred in 1958 on grain in Kansas. The milling industry began using it in 1962 in Indiana.

F. History of ECO$_2$FUME™

Since 1988, ECO$_2$FUME® has been used to protect stored products. ECO$_2$FUME® fumigant gas is a non-flammable pre-mixed cylinderized mixture of phosphine and carbon dioxide, which provides highly effective fumigation in sealed storage facilities. This breakthrough fumigation management system is available to professional applicators that seek an environmentally friendly alternative that is easy to use with improved worker safety.

CYTEC INDUSTRIES INC.

ECO$_2$FUME® fumigant gas is a product of CYTEC INDUSTRIES INC. A global leader in innovative stored product protection, Cytec Industries Inc. continues to provide its customers with the latest in phosphine technology, service and solutions. Cytec is the largest producer of phosphine in the world.

G. Advantages of ECO$_2$FUME™

Advantages: ECO$_2$FUME®'s unique make-up of phosphine and CO_2 in a cylinder offers numerous advantages to the solid metal phosphide fumigants. Some of these advantages are:

1. Nonflammable

$ECO_2FUME^{®}$ Fumigant Gas is a gaseous mixture of 2% phosphine (by weight) in carbon dioxide. Carbon dioxide is an excellent carrier for phosphine and diluting phosphine to this concentration ensures $ECO_2FUME^{®}$ is nonflammable in all proportions with air.

2. Synergistic Reaction

Research has shown a synergistic effect when CO_2 is used in combination with phosphine. Although these studies were conducted with higher levels of CO_2, they suggest there may be a synergistic effect at the CO_2 concentrations achieved when using $ECO_2FUME^{®}$. Because of this possible synergistic effect, CO_2 is a registered active ingredient in $ECO_2FUME^{®}$. The CO_2 has the tendency to increase respiration and open insect's breathing spiracles which results in the insect and rodent pests taking in lethal doses of phosphine in an accelerated manner. This leads to using less phosphine to achieve desired results. Also, the time frame of the fumigation may be somewhat shortened because of the synergistic reaction.

3. Gas Levels Remain Constant

Through monitoring lines and detection equipment, a constant gas level of phosphine can be maintained throughout a fumigation. When using solid metal phosphides, a typical graphed curve of phosphine levels would start very low and reach a peak about 20 hours after the fumigant was introduced into a structure. The curve would then slowly come down to lower levels before the time of aeration 72+ hours later. With $ECO_2FUME^{®}$, a constant lethal dose over the period of the fumigation can be held by monitoring and injecting additional gas as needed to maintain lethal levels. With this method, a fumigator will not experience the initial "spike" of fumigant in the first 20 hours, which often leads to corrosion problems. Also, if the initial dose of phosphine was too low, it can be corrected well into the fumigation without sacrificing the effectiveness. With metal phosphides and their disposal problems, one would not want to add gas 1 – 2 days into a fumigation, because there would be a considerable amount of unreacted fumigant to dispose of upon aeration.

4. A Better Controlled Atmosphere Can Lead to Less Corrosion

Corrosion of metals (copper and copper alloys) from exposure to phosphine occurs significantly when the levels of phosphine are over 200 ppm. $ECO_2FUME^{®}$'s phosphine levels should never reach levels over 500 ppm due to the applicator's ability to precisely control gas levels with cylinders. By not experiencing the initial "spike" of phosphine like the metal phosphide products produce, $ECO_2FUME^{®}$ should considerably reduce metal corrosion during a phosphine fumigation.

5. Decreases in Amounts of Phosphine Used

With the ability to precisely control phosphine gas levels along with the benefit of the synergistic reaction of phosphine and carbon dioxide, the total amount of phosphine released should be less when using $ECO_2FUME^{®}$ compared to metal phosphides.

6. No Messy Disposal Problems

Metal phosphide fumigants are notorious for messy and sometimes dangerous disposal of spent or partially spent fumigant. The solid aluminum and magnesium phosphide products leave a gray,

powdery ash after releasing the phosphine. This ash must be stirred in a water and detergent solution to be deactivated. The spent dust can easily get blown around and end up in places where it shouldn't be. Also, if some of the material has not broken down completely, the wet disposal dust can spontaneously combust. Since $ECO_2FUME^{®}$ releases pure phosphine with carbon dioxide, there is no material disposal except for returning the cylinders.

2. PRODUCTION INFORMATION

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, the active ingredient, makes up 2 percent (by weight) of the product. The carbon dioxide is used as a propellant and a flame inhibitor, making the product non-flammable in all proportions with air. $ECO_2FUME^{®}$ is a poisonous liquefied gas under pressure.

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.

The rate at which phosphine is dispensed using $ECO_2FUME^{®}$ is not dependant on temperature or humidity, but on the dispensing equipment used. Unlike metal phosphide fumigants, the 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.

An approved label (EPA Reg. No. 68387-7) and an Application Manual accompany $ECO_2FUME^{®}$ product. Refer to the Application Manual for Detailed precautions, recommendations and directions for use.

B. Product Packaging

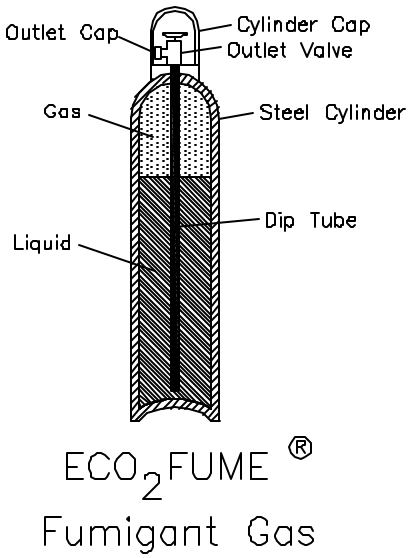
$ECO_2FUME^{®}$ is packaged in a steel compressed gas cylinder, designed, manufactured, maintained and filled in compliance with regulations established by the United States Department of Transportation (DOT). The product flows to the dispensing equipment through the cylinder outlet valve, which is equipped with a "dip tube". This tube extends to the bottom of the cylinder to facilitate the withdrawal of the liquefied gas mixture. 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.

Most compressed gas cylinder valves are equipped with a safety device that releases the cylinder contents due to fire exposure or over-pressurization. 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 should be secured whenever a cylinder is not in use. It is unlawful to transport an $ECO_2FUME^{®}$ cylinder without the valve outlet plug 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. The cylinder may be used if it is past the five-year test period, but it cannot be refilled until re-tested.



Representative Package

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

WARNING: $ECO_2FUME^{®}$ cylinders are painted yellow with a dark green shoulder and cap. If you receive a cylinder of a different color or without an $ECO_2FUME^{®}$ label do not use the cylinder. Contact your distributor or Cytec with the cylinder serial number.

Cytec produces three other grades of phosphine: CYPURE, CYTOP 1, and VAPORPH3OS. All of these other grades are pure phosphine and are pyrophoric. These grades of phosphine will spontaneously ignite in air. Discharge of these products will cause a fire and explosive hazard. CYPURE cylinders are painted blue. CYTOP 1 and VAPORPH3OS cylinders are painted entirely yellow, i.e., no green shoulder or cap.

If you find cylinders painted this way or should you find a cylinder labeled CYPURE, CYTOP 1, OR VAPORPH3OS do not use the cylinder. Tag the cylinder **"DO NOT USE"** and contact your supplier or Cytec with the cylinder serial number.

3. SAFETY REQUIREMENTS AND HAZARD INFORMATION

RESTRICTED USE PESTICIDE

DUE TO ACUTE INHALATION TOXICITY OF
HIGHLY TOXIC PHOSPHINE (HYDROGEN PHOSPHIDE, PH_3) GAS

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

A. General

1. Carefully read the label and Application Manual and follow instructions explicitly.
2. Never work alone when applying fumigant.
3. Never allow untrained personnel to handle $ECO_2FUME^{®}$.
4. A NIOSH approved self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode must be worn in confined spaces and in fumigation structures. At least one or more employees equipped with a SCBA and trained to provide effective rescue must remain outside when employees are inside confined spaces and fumigation structures. Visual, voice or signal line communication must be maintained between these employees. This is commonly referred to as the "Buddy System". Respiratory protection devices must be used according to local regulations, including training, fit testing and medical clearance for respirator use.
5. Post $ECO_2FUME^{®}$ warning placards on fumigated areas, including all entrances/ exits. See Section VI of the Application Manual for specific wording that must appear on these placards. Ensure that no personnel are inside any of the structures to be fumigated prior to initiating fumigation.
6. Notify appropriate company employees and provide relevant safety information to local officials annually for use in the event of an emergency.
7. Worker exposure to phosphine must not exceed the 8-hour TWA of 0.3 ppm during application or a maximum concentration of 0.3 ppm after application is completed. This includes reentry into a structure.
8. Worker exposure to carbon dioxide must not exceed the TWA of 5,000 ppm (0.5 % by volume) during application or a maximum concentration of 5000 ppm after application is completed. This includes reentry into a structure.
9. Exposure screening of employees should be conducted to detect impaired pulmonary function. Any employees developing the above condition should be referred for medical attention.
10. Protect or remove materials containing metals such as copper, silver, gold and their alloys and salts from corrosive exposure to phosphine.
11. Do not connect cylinders to dispensing equipment until all warning placards have been posted and the space to be fumigated is clear and secured.
12. Wear protective clothing and respiratory protection as described in Section V of the Application Manual.

13. Fence-line concentrations of phosphine must never be allowed to exceed the TWA of 0.3 ppm. Large leaks must be repaired to minimize loss of fumigant and reduce risk of exposure to bystanders and/or occupants of nearby buildings.

*** $ECO_2FUME^{®}$ does not have an expiration date. Contact CYTEC Industries Inc. for any questions ***

B. Health Hazards

$ECO_2FUME^{®}$ is a gaseous mixture of phosphine and carbon dioxide. Phosphine makes up 2 percent (by weight) of the mixture. The current U.S. OSHA Permissible Exposure Limit (PEL) for phosphine is 0.3 ppm as an eight-hour time weighted average. The American Conference of Governmental Industrial Hygienists (ACGIH) has established a Short Term Exposure Limit (STEL) for phosphine of 1 ppm as a 15-minute time weighted average exposure. The current U.S. OSHA Permissible Exposure Limit (PEL) for carbon dioxide is 5000 ppm as an eight-hour time weighted average. In order to standardize the references to phosphine's exposure limit of 0.3 ppm and carbon dioxide's exposure limit of 5000 ppm, we will use the term Time Weighted Average (TWA).

1. Phosphine

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

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

2. Carbon Dioxide

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

C. Physical Property Hazards

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

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

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

D. Poison Gas Hazards

Because $ECO_2FUME^{®}$ is comprised of poisonous gases, care must be taken to avoid direct exposure. Although the dispensing equipment is designed to contain the gas, small leaks can occur. A phosphine detector must be used at the beginning of each application to check the integrity of the equipment and any leaks must be corrected immediately. Carbon dioxide should be used to pressurize and leak-check equipment with soap solution prior to use in the field.

If any leak is encountered while using $ECO_2FUME^{®}$, clear the immediate area of all personnel.

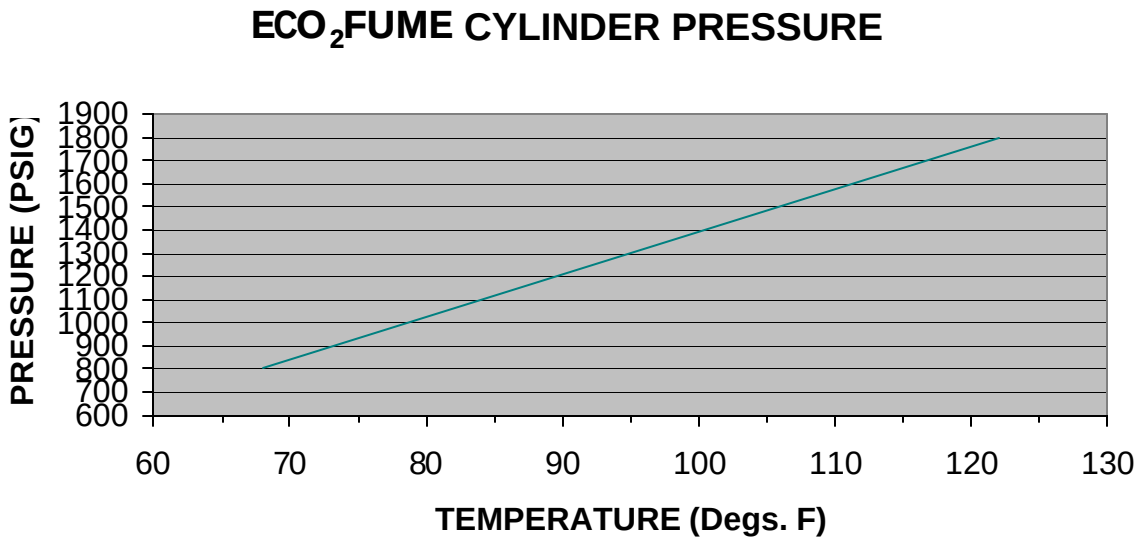
Only persons who are wearing a self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode or its equivalent are permitted in the area to address the leak. The "buddy system" described under Safety Requirements - General should be employed. Once the leak has been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

E. Liquified Gas Hazards

$ECO_2FUME^{®}$ cylinders and dispensing equipment can achieve pressures of over 1000 pounds per square inch. (See graph below of $ECO_2FUME^{®}$ cylinder pressure versus temperature). Because of this high pressure, care must be taken to avoid unintentional releases of the product. The fumigant gas is withdrawn from the cylinder as a liquid and dry ice plugs can be formed when liquid carbon dioxide is decreased below its triple point pressure of 60.4 psig. The dry ice can be compacted into a plug that can trap gas. The pressure behind or within a plug may increase as the dry ice sublimes until the plug is forcibly ejected or the hose or pipe ruptures. A dry ice plug may be ejected with enough force to cause serious injury to personnel.

Liquid carbon dioxide that is forced to occupy a fixed volume (i.e., between two closed valves) will increase in pressure as it warms and expands. A fixed volume of liquid carbon dioxide at 290 psig and

0°F (-17.8 C) when warmed 10°F (12.2°C) will cause the pressure to increase to 2000 psig. As the temperature continues to increase, the pressure of the trapped liquid could exceed that which the piping and hoses can withstand. This may cause rupture of the hose or piping with possible injury and property damage. To prevent trapped liquid from becoming a hazard, all liquid carbon dioxide piping must be equipped with pressure relief devices located in all parts of the system in which liquid can be trapped (between valves, check valves, etc.) These pressure relief devices shall be set to discharge within the design pressure of the part of the system they protect.



1. Gas Discharge

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

2. Temperature

The rapid discharge of ECO2FUME® through fast dispensing equipment will result in a chilling effect on parts of the equipment and cylinders. This thermodynamic effect can create temperatures low enough to cause frostbite to unprotected skin, if touched. While this chilling is typically evidenced by the formation of ice on the equipment and cylinders, the presence of ice is not necessary for the cold hazard to exist.

The low temperature effect of dry ice, -109.3°F (-78.5°C) on the materials in the system is another hazard. At dry ice temperatures many materials used in hose and piping systems may become brittle and fail if highly stressed. Materials used in the construction of ECO2FUME® dispensing equipment are compatible with liquid carbon dioxide and the temperature and pressure conditions encountered.

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 when the

product is dispensed very quickly and the liquid product level falls below the bottom of the dip tube in the cylinder. 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 ECO2FUME® 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 should not be disconnected before ensuring that the line is fully vented and purged.

It is best to purge the dispensing equipment of the small amount of ECO2FUME® left in the equipment after depressurizing. Otherwise, this residual phosphine will slowly oxidize with air and form hydrides that will eventually cause the equipment to plug or malfunction. Purging the equipment with Nitrogen or Carbon Dioxide will ensure extended, trouble-free operation.

4. Liquid Expansion

Liquefied gases expand rapidly when they are warmed. Because of this characteristic, liquid ECO2FUME® should never be trapped between two shutoff valves, without adequate safety relief devices in place. Only approved application equipment should be used because of this hazard.

F. First Aid Measures

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

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

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

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

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

ECO2FUME® is a gaseous mixture of phosphine and carbon dioxide. Mild exposure by inhalation causes malaise (indefinite feeling of sickness), ringing of ears, fatigue, nausea and pressure in chest, which are relieved by removal to fresh air. Moderate poisoning causes weakness, vomiting, epigastric pain (pain just above the stomach), chest pain, diarrhea and dyspnea (difficulty in breathing). Symptoms of severe poisoning may occur within a few hours or up to several days, resulting in pulmonary edema (fluid in lungs) and may lead to dizziness, cyanosis (blue or purple skin color), unconsciousness and death.

In sufficient quantity phosphine affects the liver, kidneys, lungs, nervous system, and circulatory system. Inhalation can cause lung edema (fluid in lungs) and hyperemia (excess of blood in a body

part), small perivascular brain hemorrhages and brain edema (fluid in brain). Ingestion can cause lung and brain symptoms, but damage to the viscera (body cavity organs) is more common. Poisoning may result in (1) pulmonary edema, elevated MB-creatine phosphokinase fraction of cardiac enzymes, cardiac dysrhythmia, (2) liver elevated serum GOT, LDH and alkaline phosphatase reduced prothrombin, hemorrhage and jaundice (yellow skin color)) and (3 hematuria (blood in urine) and anuria (abnormal or lack of urination). Pathology is characteristic of hypoxia (oxygen deficiency in body tissue). Frequent exposure over a period of days or weeks may cause poisoning. Treatment is symptomatic.

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

1. Exposure of skin to rapidly evaporating liquid may cause cryogenic "burn." Treat the "burn" in a similar manner as a thermal burn.
2. In case of freezing or cryogenic "burns" to eyes by rapidly evaporating liquid, RINSE EYES WITH COOL WATER. Do not rinse eyes with hot or even tepid water.
3. In its milder to moderate forms (symptoms of poisoning may take up to 24 hours to appear), the following is suggested:
   - Complete rest 1-2 days during which the patient must be kept quiet and warm. If the patient suffers from vomiting or increased blood sugar, appropriate solutions should be administered. Treatment with oxygen is recommended, as is the administration of cardiac and circulatory stimulants.
4. In cases of severe poisoning (intensive care unit recommended):

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

G. Personal Protective Equipment

1. Gloves: It is recommended that leather work gloves or leather-faced cotton gloves be used when connecting to or disconnecting $ECO_2FUME^{®}$ cylinders from the dispensing equipment.
2. Safety Glasses: When working with pressurized equipment, safety glasses should be worn. Eye protection must be worn to prevent freezing or cryo genic "burns" to the eyes by rapidly evaporating liquid.
3. Safety Shoes: It is recommended that steel-toed safety shoes be worn by anyone handling compressed gas cylinders.

NOTE: Hand trucks are the recommended means of moving individual $ECO_2FUME^{®}$ cylinders about the fumigation site. The hand truck should be designed specifically for compressed gas cylinders and equipped with a suitable chain or strap to ensure the cylinder remains in place. Never move an $ECO_2FUME^{®}$ cylinder without valve cap and cylinder cap in place.

Respiratory Protection:

Respiratory protection should be available at the site when applying ECO2FUME®. An adequate number of NIOSH approved self-contained breathing apparatus (SCBA) with full facepiece and operated in pressure-demand mode should be available. SCBA must be worn during exposure to concentrations in excess of permitted limits or when concentrations are unknown. Respiratory protection (SCBA) must be worn during trouble shooting for leaks if the concentration of phosphine is unknown or known to exceed the STELs for phosphine and/or carbon dioxide. Respiratory protection must be used according to local regulations, including regular training of workers in the proper use of respiratory protection equipment, medical clearance for respirator use, fit testing, inspection, maintenance, cleaning and storage of respiratory protection equipment.

4. SAFE STORAGE, HANDLING AND TRANSPORT OF CYLINDERS

A. General

The first consideration when planning a storage area for ECO2FUME® cylinders is the needs of the local authorities. It is important that emergency response professionals are aware of all hazardous materials stored in their jurisdiction. They should be provided with an MSDS and detailed information on the quantities of product stored and the nature and location of the storage area.

B. Emergency Response Plan

A clearly defined emergency response plan should be developed for the site. This plan should define procedures and outline responsibilities in addressing emergency situations involving ECO2FUME®. All site personnel should be trained in the plan and it should be practiced periodically.

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

C. Indoor Storage

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

D. Outdoor Storage

It is recommended that both full and used ECO2FUME® cylinders be stored outdoors in a dedicated and properly designed and labeled storage area. Outdoor storage is defined as a fenced area where all sides consist of fence material or where not more than one exterior wall obstructs the flow of air with the other three sides unobstructed and open to the atmosphere.

The following are recommended for outdoor storage:

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

E. Temperature Limitations

ECO$_2$FUME® cylinders should never be stored where the temperature will exceed 125°F (51.7°C). Low temperatures will not affect ECO$_2$FUME®.

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$_2$FUME® cylinder storage area should take into account the needs of a variety of organizations. These should include, but not be limited to: corporate policy, insurance carrier, Occupational Safety and Health Administration (OSHA), Right to Know and local emergency response professionals. As a minimum, it is suggested that the storage be clearly marked with the following signs:

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

The National Fire Protection Association (NFPA) developed NFPA Hazard Identification Symbols. This standardized symbol system is designed to provide, at a glance, information regarding the health, fire, and reactivity hazards associated with hazardous materials. The following are the hazard categories and degree of hazard for ECO$_2$FUME®.

Category	Degree of Hazard
Health	2 (Hazardous to Health)
Flammability	0 (Will Not Burn)
Reactivity	2 (Normally Unstable)

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

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

H. Transportation

1. General

ECO2FUME® is classified as a poison gas by the United States Department of Transportation (DOT) and it shall only be transported in accordance with DOT regulations. All persons involved in the transport of or the preparation of cylinders for transport should be trained in and familiar with the specifications of 49 CFR (Code of Federal Regulations).

Since ECO2FUME® still contains a "Hazard Zone A" compound, DOT regulations allow Cytec to continue to use cylinders without relief devices.

2. Transport Designations

The following transport designations apply to ECO2FUME®:

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

3. Transport Requirements

a) Package Preparation

ECO2FUME® cylinders shall not be transported unless:

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

b) Cylinder Contents

Used ECO2FUME® cylinders can still contain residual gas, and shall be offered for transport and transported as if they are full. Check with your distributor if you have questions about shipping ECO2FUME® cylinders.

c) Documents

Proper documentation is required by law, for the transport of any hazardous material. The documents must clearly identify the quantity and nature of all hazardous materials being transported or offered for

transport by a second party. All persons generating such documents should be trained in their preparation.

d) Vehicle Loading

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

e) Vehicle Placarding

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

f) Use of Common Carriers

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

g) Driver Qualifications

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

5. DOSAGE AND EXPOSURE TIMES

A. Approved Target Pests

ECO2FUME® will control the following pests:

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

B. Commodities

The following food commodities can be fumigated with ECO2FUME®:

1. Raw Agricultural Commodities

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

2. Processed Foods

The listed processed foods may be fumigated with ECO$_2$FUME®.

- Processed candy and sugar
- Cereal flours and bakery mixes
- Cereal foods (including cookies, crackers, macaroni, noodles, pasta, pretzels, snack foods and spaghetti)
- Processed cereals (including milled fractions and packaged cereals)
- Cheese and cheese by-products
- Chocolate and chocolate products (such as assorted chocolate, chocolate liquor, cocoa, cocoa powder, dark chocolate coating and milk chocolate)
- Processed coffee
- Corn grits
- Cured, dried and processed meat products and dried fish
- Dates
- Dried eggs and egg yolk solids
- Dried milk, dried powdered milk, nondairy creamers, and nonfat dried milk
- Dried or dehydrated fruits (such as apples, dates, figs, peaches, pears, prunes, raisins and sultanas)
- Dried and dehydrated vegetables (such as beans, carrots, lentils, peas, potato flour, potato products and spinach)
- Figs
- Malt
- Peanuts
- Processed herbs, spices, seasonings and condiments

- Processed nuts (almonds, apricot kernels, Brazil nuts, cashews, filberts, peanuts, pecans, pistachio nuts, walnuts and other processed nuts)
- Processed oats (including oatmeal)
- Rice (brewers rice grits, enriched and polished, wild rice)
- Soybean flour and milled fractions
- Processed tea
- Yeast (including primary yeast)
- Wild rice

3. Animal Feed and Feed Ingredients

All animal feed and feed ingredients.

4. Nonfood Commodities Including Tobacco

The listed nonfood items may be fumigated with $ECO_2FUME^{®}$:

- Animal hide
- Processed or unprocessed cotton, wool and other natural fibers or cloth
- Clothing, feathers, furs, human hair, rubberized hair, vulcanized hair, mohair
- Leather products
- Tobacco
- Wood, cut trees, wood chips and wood and bamboo products
- Paper and paper products
- Non-food flour
- Dunnage
- Non-food starch
- Dried plants and flowers
- Seeds (grass seed, ornamental herbaceous plant seed, and vegetable seed)
- Straw or hay
- Psyllium seed and psyllium seed husks*

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

C. Dosage Guide

1. Recommended Dosages for $ECO_2FUME^{Ò}$

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

The above table may be used as a guide in determining the minimum length of the exposure at the indicated temperatures. These are the temperatures found within the immediate surroundings of the target pest (cold walls, center of grain mass, etc.). For example, this means that 200 parts per million of phosphine from $ECO_2FUME^{®}$ is necessary for 2-3 days at 60-68º F at the location of the pest insect. This does not mean the ambient temperature the fumigator is experiencing but the localized concentration and temperature next to the pest insects.

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

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

Consequently, exposure periods recommended in the table are minimum periods and may not be adequate to control all stages of stored product pests under all conditions. This is particularly true at lower temperatures (below 60 degrees F) due to the lower activity and respiration levels of insects. The key to a successful fumigation remains with correct dosage, adequate exposure periods, proper application procedures and well-sealed enclosures.

2. Calculating the amount of $ECO_2FUME^{Ò}$ required

The amount of $ECO_2FUME^{®}$ required to perform a fumigation will depend on the tightness of the space to be treated, and the tendency for the space to lose fumigant through the duration of the fumigation. An initial dose of $ECO_2FUME^{®}$ is used to establish a pesticidal atmosphere in the fumigation space, and through active monitoring of the phosphine concentrations, additional $ECO_2FUME^{®}$ is added as required to maintain the target concentration for the prescribed time period.

The initial dose of fumigant is based on the total volume of the space to be fumigated and the target phosphine concentration desired. When dispensing $ECO_2FUME^{®}$, it is sometimes easier to speak in terms of the amount of phosphine that is required rather than the amount of $ECO_2FUME^{®}$.

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 $ECO_2FUME^{®}$ needed to dose a space.

1 gram PH_3 =	25 ppm PH_3/1000 ft^3
1 pound $ECO_2FUME^{®}$ =	9.07 grams PH_3

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

Grams of PH_3 =	(Target x Volume) / 25,000
or	
pounds of ECO$_2$FUME® =	(Target x Volume) / 226,800
"Target" is the desired phosphine concentration in parts per million (ppm).	
"Volume" is the empty volume of the space to be fumigated in cubic feet (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 - Actual) x Volume / 25,000
or	
pounds of ECO$_2$FUME® =	(Target – Actual) x Volume / 226,800
"Target" is the desired phosphine concentration in parts per million (ppm).	
"Volume" is the empty volume of the space to be fumigated in cubic feet (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.

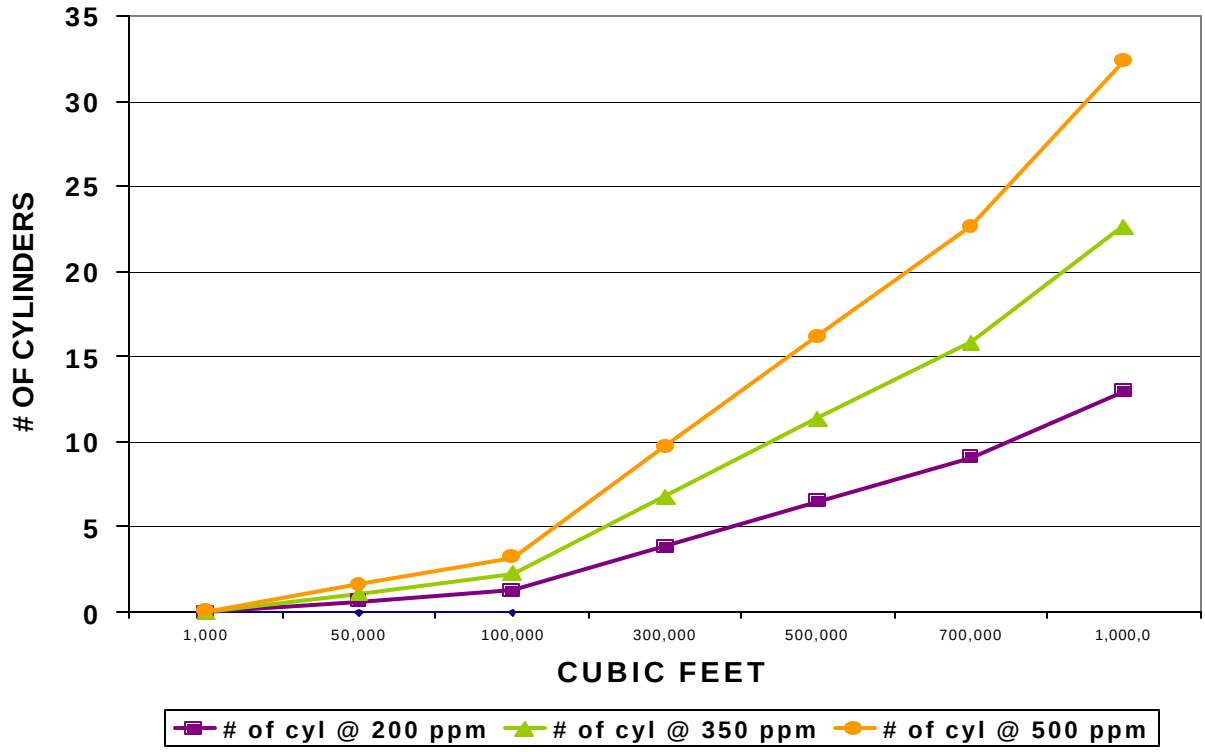
When adding ECO$_2$FUME® to a space, the phosphine concentration should be actively monitored. This can be accomplished from outside the space by use of plastic sample tubing run through an opening and securely attached to a point inside the space. If the desired concentration is achieved before the calculated amount of ECO$_2$FUME® has been added, the addition of ECO$_2$FUME® should be stopped and the calculations should 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, the cylinder can be placed on a scale and the amount of fumigant released can be measured. The scale can also be used to check how much 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.

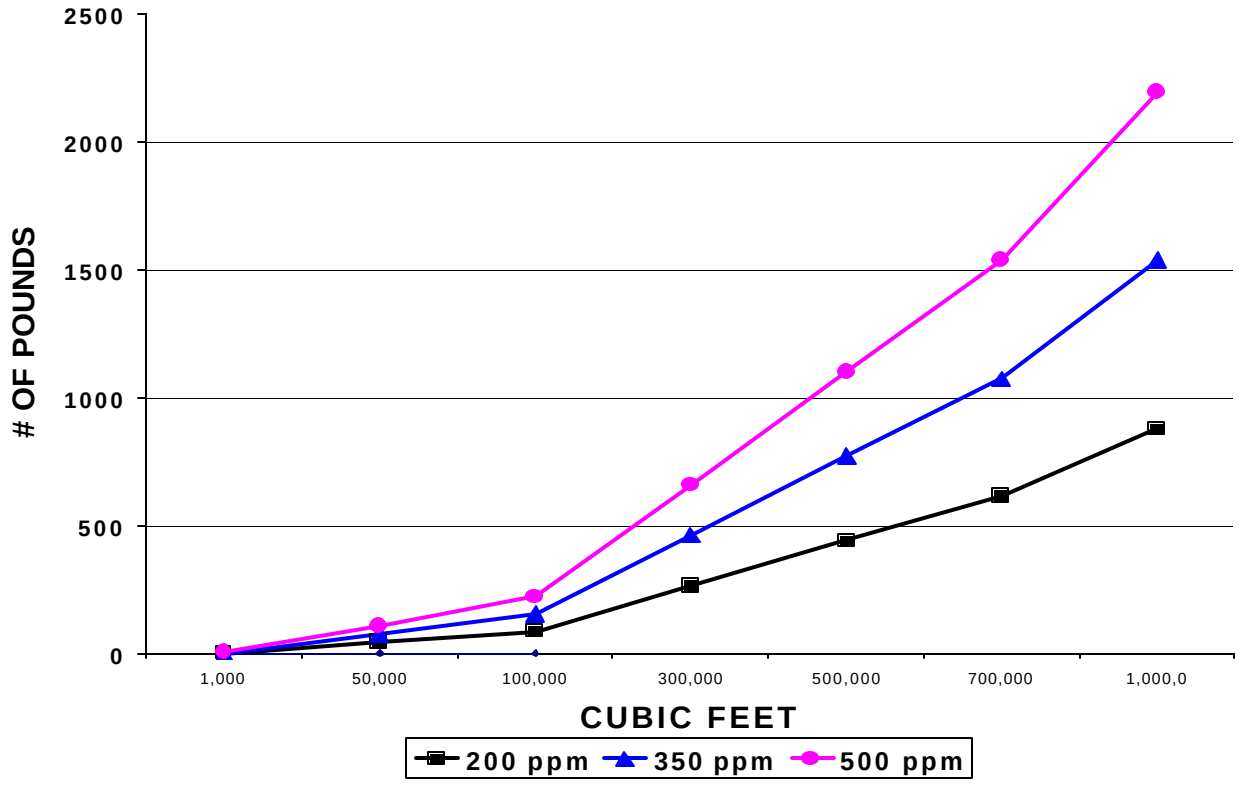
USAGE CHART

POUNDS of $ECO_2FUME^{Ò}$ and # of CYLINDERS REQUIRED														
Volume Cubic Feet	200 ppm		250 ppm		300 ppm		350 ppm		400 ppm		450 ppm		500 ppm	
	lb gas	# of Cyl	lb gas	# of Cyl	lb gas	# of Cyl	lb gas	# of Cyl	lb gas	# of Cyl	lb gas	# of Cyl	lb gas	# of Cyl
1,000	0.9	0.01	1.1	0.02	1.3	0.02	1.6	0.02	1.8	0.03	2.0	0.03	2.2	0.03
2,000	1.8	0.03	2.2	0.03	2.7	0.04	3.1	0.05	3.6	0.05	4.0	0.06	4.5	0.06
3,000	2.7	0.04	3.3	0.05	4.0	0.06	4.7	0.07	5.4	0.08	6.0	0.09	6.7	0.10
4,000	3.6	0.05	4.5	0.06	5.4	0.08	6.3	0.09	7.1	0.10	8.0	0.12	8.9	0.13
5,000	4.5	0.06	5.6	0.08	6.7	0.10	7.8	0.11	8.9	0.13	10.0	0.15	11.2	0.16
6,000	5.4	0.08	6.7	0.10	8.0	0.12	9.4	0.14	10.7	0.15	12.1	0.18	13.4	0.19
7,000	6.3	0.09	7.8	0.11	9.4	0.14	10.9	0.16	12.5	0.18	14.1	0.20	15.6	0.23
8,000	7.1	0.10	8.9	0.13	10.7	0.15	12.5	0.18	14.3	0.21	16.1	0.23	17.9	0.26
9,000	8.0	0.12	10.0	0.15	12.1	0.18	14.1	0.20	16.1	0.23	18.1	0.26	20.1	0.29
10,000	8.9	0.13	11.2	0.16	13.4	0.19	15.6	0.23	17.9	0.26	20.1	0.29	22.3	0.32
20,000	17.9	0.26	22.3	0.32	26.8	0.39	31.3	0.45	35.7	0.52	40.2	0.58	44.7	0.65
30,000	26.8	0.39	33.5	0.49	40.2	0.58	46.9	0.68	53.6	0.78	60.3	0.87	67.0	0.97
40,000	35.7	0.52	44.7	0.65	53.6	0.78	62.5	0.90	71.4	1.0	80.4	1.2	89.3	1.3
50,000	44.7	0.65	55.8	0.81	67.0	1.0	78.1	1.1	89.3	1.3	100.5	1.5	111.6	1.6
60,000	53.6	0.78	67.0	1.0	80.4	1.2	93.8	1.4	107.2	1.6	120.6	1.7	134.0	1.9
70,000	62.5	0.90	78.1	1.1	93.8	1.4	109.4	1.6	125.0	1.8	140.7	2.0	156.3	2.3
80,000	71.4	1.0	89.3	1.3	107.2	1.6	125.0	1.8	142.9	2.1	160.7	2.3	178.6	2.6
90,000	80.4	1.2	100.5	1.5	120.6	1.7	140.7	2.0	160.7	2.3	180.8	2.6	200.9	2.9
100,000	89.3	1.3	111.6	1.6	134.0	1.9	156.3	2.3	178.6	2.6	200.9	2.9	223.3	3.2
200,000	178.6	2.6	223.3	3.2	267.9	3.9	312.6	4.5	357.2	5.2	401.9	5.8	446.5	6.5
300,000	267.9	3.9	334.9	4.8	401.9	5.8	468.8	6.8	535.8	7.8	602.8	8.7	669.8	9.7
400,000	357.2	5.2	446.5	6.5	535.8	7.8	625.1	9.1	714.4	10.3	803.7	11.6	893.0	12.9
500,000	446.5	6.5	558.1	8.1	669.8	9.7	781.4	11.3	893.0	12.9	1004.7	14.5	1116.3	16.2
600,000	535.8	7.8	669.8	9.7	803.7	11.6	937.7	13.6	1071.6	15.5	1205.6	17.5	1339.6	19.4
700,000	625.1	9.1	781.4	11.3	937.7	13.6	1094.0	15.8	1250.3	18.1	1406.5	20.4	1562.8	22.6
800,000	714.4	10.3	893.0	12.9	1071.6	15.5	1250.3	18.1	1428.9	20.7	1607.5	23.3	1786.1	25.9
900,000	803.7	11.6	1004.7	14.5	1205.6	17.5	1406.5	20.4	1607.5	23.3	1808.4	26.2	2009.3	29.1
1,000,000	893.0	12.9	1116.3	16.2	1339.6	19.4	1562.8	22.6	1786.1	25.9	2009.3	29.1	2232.6	32.3

$ECO_2FUME^{Ò}$ Requirements (# of Cyl)



$ECO_2FUME^{Ò}$ Requirements (# of lb)



6. FUMIGATION MANAGEMENT PLAN

A. Purpose

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

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

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

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

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

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

B. Materials Sensitive to Phosphine

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

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

This list does not identify all equipment and materials sensitive to Phosphine. Please inventory all supplies, equipment, and materials and cross check the above materials. If you have any questions regarding the sensitivity of equipment and materials to Phosphine, please feel free to contact Cytec Canada Inc. at 905-374-5828 or an approved distributor.

C. Guidance For Preparation of a Fumigation Management Plan

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

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

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

D. A Checklist For a Fumigation Management Plan

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

A. <u>Preliminary Planning and Preparation</u>

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

2. Determine the type of fumigation, for example:
   a. Space: tarp, mill, warehouse, food plant
   b. Vehicle: railcar, truck, van, container
   c. Commodity: raw agricultural or processed foods
   d. Grain: vertical silo, farm storage, flat storage
   e. Vessels: ship or barge. In addition to the Applicator's Manual, read the US Coast Guard Regulations 46CFR 147A

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

B. <u>Personnel</u>

1. Confirm in writing that all personnel in and around the area to be fumigated have been notified prior to application of the fumigant. Consider using a checklist each one initials indicating they have been notified.

2. Instruct all fumigation personnel about the hazards that may be encountered; and about the selection of personal protection devices, including detection equipment
3. Confirm that all personnel are aware of and know how to proceed in case of an emergency situation
4. Instruct all personnel on how to report any accident and/or incidents related to fumigant exposure. Provide a telephone number for emergency response reporting
5. Instruct all personnel to report to proper authorities any theft of fumigant and/or equipment related to fumigation
6. Establish a meeting area for all personnel in case of emergency

C. Monitoring

1. Safety
   a. Monitoring must be conducted in areas to prevent excessive exposure and to determine where exposure may occur. Document where monitoring will occur.
   b. Keep a log or manual of monitoring records for each fumigation site. This log must at a minimum contain the timing, number of readings taken and level of concentrations found in each location.
   c. When monitoring log records, document there is no phosphine present above the safe levels; subsequent monitoring is not routinely required. However, spot checks should be made occasionally, especially if conditions significantly change
   d. Monitoring must be conducted during aeration and corrective action take if gas levels exceed the allowed levels in an area where bystanders and/or nearby residents may be exposed.

2. Efficacy
   a. Gas readings should be taken from within the fumigated structure to insure proper gas concentrations. If the phosphine levels have fallen below the targeted level the fumigators should dispense additional $ECO_2FUME^{®}$ to maintain the desired levels.
   b. Document readings

D. Notification

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

E. Sealing Procedures

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

F. Application Procedures and Fumigation Period

1. Plan carefully and apply $ECO_2FUME^{®}$ in accordance with the label requirements

2. When entering into the area under fumigation, always work with two or more people under the direct supervision of a certified applicator wearing appropriate respirators
3. Apply fumigant from the outside where appropriate
4. Provide watchmen when a fumigation site cannot otherwise be made secure from entry by unauthorized persons
5. When entering structures always follow OSHA rules for confined spaces
6. Document that the receiver of in-transit fumigation has been notified and is trained to receive commodity under fumigation

G. Post-Application Operations

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

Sample Fumigation Notice

NOTICE OF FUMIGATION

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

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

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

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

FUMIGATION DATES: _____ TO_____

7. SEALING OF FUMIGATION SPACE

Good sealing is necessary for an effective fumigation. Block off any and all areas allowing the fumigant to escape. These areas could include, but are not limited to: windows, doors, vents, chimneys and structural flaws. Sealing techniques can vary, but most often include polyethylene sheeting, adhesive tapes and adhesive sprays. Expandable foam or caulking material can work well on structural flaws. Proper sealing will insure sufficient gas levels within the fumigated area and will decrease the chance of unwanted exposure outside of the fumigated area.

A. Tapes

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

B. Polyethylene Sheeting

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

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

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

The fumigator should make certain that there are no conduits, openings, pipes, etc., which lead from the building. Since it is often difficult to determine if two or more structures are connected

to one sewer or electrical conduit line, any sewer drains or conduit lines leading out of the structure should be sealed with tape or water filled balloons.

C. Other Materials

Expandable foam or other building materials can be used to permanently seal off structural flaws or openings. Rather than individually sealing openings to a structure, an alternate method is to cover the structure with large vinyl laminated nylon tarpaulins. Although these tarps are heavy and can be difficult to work with, they are reusable and more manageable in the wind. Tarps are usually laid out and adjoining edges are rolled together and clamped. Sand snakes (Tubes filled with sand or water) are used to affect a seal to the ground.

CAUTION: The dispensing of ECO_2FUME can cause a pressure increase in a tightly sealed fumigation space. A perfectly sealed space will see an increase of 8 inches water pressure when applying ECO_2FUME at 500 ppm phosphine concentration. This pressure increase can cause failure of the seal material and bonding areas. It is advisable to have a vent area in one or more of the openings to the space to allow air to escape as ECO_2FUME is applied. This space can be sealed after the target concentration has been achieved.

8. DISPENSING $ECO_2FUME^{Ò}$ FUMIGANT GAS

A. General Statement

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

B. Equipment Specification and Use

1. 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 desired space. While some dispensing equipment has been developed and used to date, it cannot be expected to cover all possible fumigation scenarios. The development of suitable dispensing equipment is an ongoing process, based on the needs of the users and available technology.

The design of dispensing equipment must account for a number of technical issues, including pressure rating, material compatibility, temperature limitations and operator safety. For this reason, only appropriate equipment should be used in the dispensing of $ECO_2FUME^{®}$. 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 should be consulted for their proper use and maintenance.

2. Unapproved Dispensing Methods

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

3. Approved Dispensing Methods

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

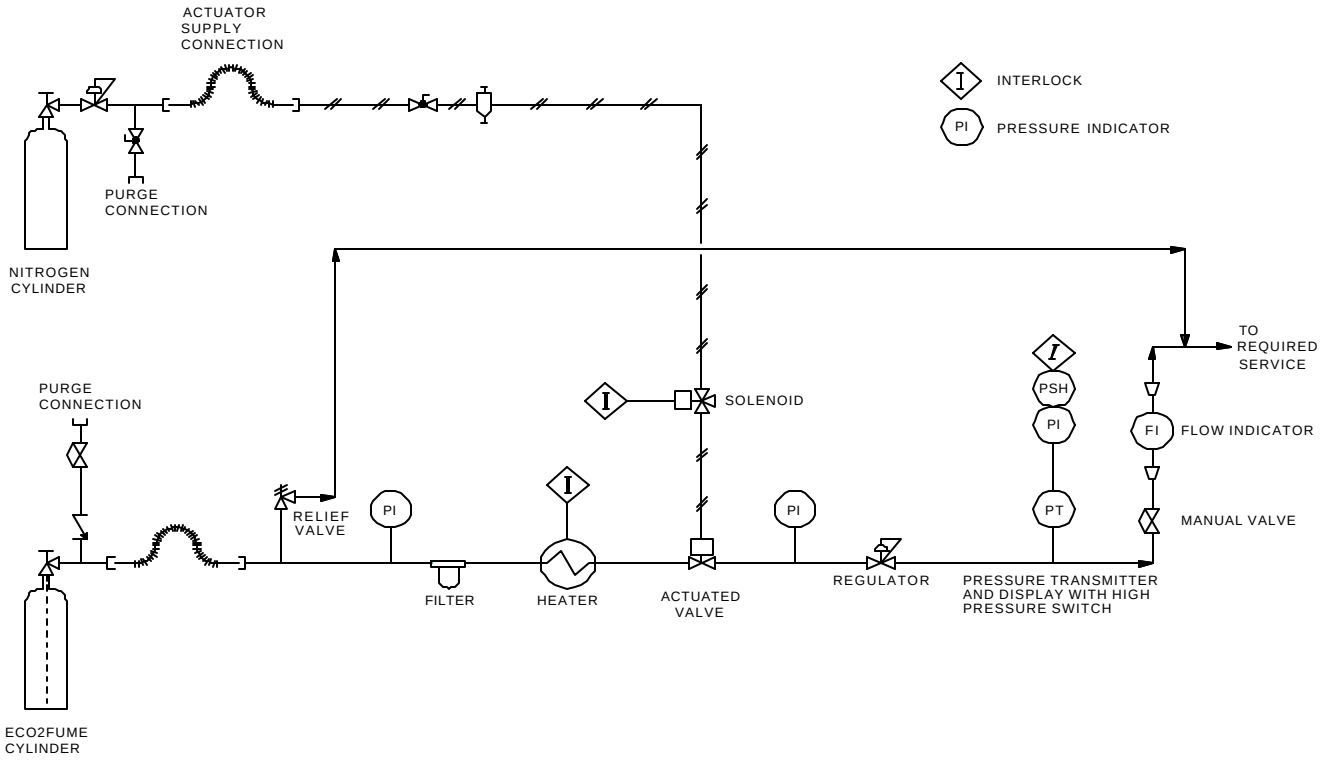
A heated regulated dispenser has been developed for use with $ECO_2FUME^{®}$. It is designed to reduce the high cylinder pressure to a low pressure (less than 30 psig) and provide the heat necessary to vaporize the fumigant. Once reduced to this lower pressure, the fumigant may be distributed to the desired dispensing points using inexpensive and easy to use materials, such as plastic tubing. Flow indicators are used with regulated dispensers to measure and set the dispensing rate.

a) Heated Regulated Dispenser

The heated regulator uses an external heating vaporizer to provide the energy required to vaporize the liquid fumigant at a much higher rate than the ambient heat regulator. This regulator is limited to a dispensing rate of about 24 pounds of $ECO_2FUME^{®}$ per hour. (Approximately 130 lpm or 4.5 scfm) The equipment is designed for a service pressure up to 3000 psig. Refer to diagram of a typical dispensing unit below. From the cylinder the liquid mixture flows **down a flexible** hose or pigtail through a filter and into a heater. The heater is thermostatically controlled and the temperature setting may be adjusted. Exiting the heater $ECO_2FUME^{®}$ gas flows through an actuated valve that can be used for emergency shutdown purposes.

$ECO_2FUME^{®}$ gas then flows through a gas regulator that drops the pressure down to 30 psig. A diaphragm valve is used to control the gas flow at any desired value up to 100 liters/minute (lpm)as indicated by the flow rotameter. The heater provides 1000 watts of power that can vaporize a maximum of 100 lpm. Lower rotameter ranges are possible. $ECO_2FUME^{®}$ 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. A detailed operating instruction manual will be

provided with each dispensing unit. Review the manual before operation of the dispensing unit.



4. Cylinder Valve Connection

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

5. Leak Testing

It is the responsibility of the end user to verify the leak integrity of all connections and fittings before opening the cylinder valve. A soap solution such as "snoop" must be used to check the integrity of the cylinder connection and all other fittings in the dispensing equipment. Using a cylinder of CO_2, nitrogen, helium or other inert gas, the appropriate regulator and a flexible connection, the dispensing equipment may be pressurized to several hundred psig. Apply the soap solution to all possible leak points and observe any formation of bubbles that would indicate a leak. Repair all leaks before opening the cylinder valve. If phosphine is detected in

the area after the cylinder valve is opened, close the cylinder valve and leak test the system again. Repair all leaks before proceeding.

6. Quick Release Dispensing Equipment

For cases where the fumigation space is very large, such as a mill, warehouse or large fumigation chamber, and the use of a number of cylinders is anticipated, a quick means of dispensing $ECO_2FUME^{®}$ 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 completely 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 $ECO_2FUME^{®}$ cylinder can be placed on a weight scale and the amount of fumigant released can be measured. The quick release method must not be used for fumigation of stacked materials under tarpaulins. The quick dispensing method will be used for most applications. Three techniques of quick dispensing are presented in this section, with the major difference being the tubing size.

1) Use of high pressure ¼ inch tubing connected directly to the cylinder valve and the tubing routed into the fumigation space. When the cylinder valve is opened the majority of the liquid will be dispensed in 4 to 5 minutes. The last few pounds below the cylinder internal dip pipe will require several additional minutes to vaporize and be dispensed.
   NOTE: When the cylinder is empty of liquid approximately 22 lbs. of gas will remain in the cylinder. Cylinders may be manifolded to make the dispensing easier.
   NOTE: Always leak test the dispensing piping and cylinder connection before opening the cylinder valve.

2) When a slower dispensing rate is desired the use of smaller tubing is recommended. **NOTE:** The fumigator must not throttle the cylinder valve to slow the dispensing rate. Doing this will cause a high pressure drop through the valve. The pressure drop will result in cooling, and dry ice formation. This solid dry ice formation will plug the dispensing pipe and possibly the cylinder valve. Attaching a short section of 1/8 inch tubing to the end of the ¼ inch tubing will slow the dispensing rate to approximately 5 lb./min. Use of a scale is recommended to ensure the proper amount of product is dispensed.

3) If a dispensing rate of less than 5 lb./min is required, then a small section of 1/16 inch tubing (0.04 inch ID) can be attached to the end of the ¼ inch tubing to slow the dispensing rate to approximately 1.6 lb./min. Use of a scale is recommended to ensure the proper amount of product is dispensed. The 1/16 inch tubing is also available in smaller internal diameters I.D. for reduced dispensing rates. See table below.

   NOTE: When 1/8 inch tubing or 1/16 inch tubing is used a filter is recommended to prevent pluggage of the smaller tubing.

DISPENSING LIQUID DISCHARGE RATES	
Tubing Size	**Approximate Rate**
3/8 inch tubing	35 lb/min
1/4 inch tubing	15 lb/min
1/8 inch tubing	5 lb/min
1/16 inch (0.04 I.D.)	1.6 lb/min
1/16 inch (0.03 I.D.)	1.1 lb/min
1/16 inch (0.02 I.D.)	0.4 lb/min

7. Troubleshooting

This section is provided to assist in addressing problems that may be encountered while using $ECO_2FUME^{®}$ cylinders. When troubleshooting leaking cylinders, SCBA is required when levels of phosphine are unknown, or known to exceed the short-term exposure limits (STEL; 1 ppm for phosphine). Troubleshooting assistance for a particular piece of dispensing equipment is addressed in the respective equipment manual. Questions for problems other than those listed below, should be directed to the authorized $ECO_2FUME^{®}$ distributor.

a) 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.

b) 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.

c) There is a leak at the cylinder valve

REFER TO SECTION 12 EMERGENCY RESPONSE.

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

i) If the cylinder <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 should be moved to a well-ventilated area, away from personnel. Refer to Spill and Leak Procedures.

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

Assistance is required. Refer to Spill and Leak Procedures.

d) 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. Replace the cylinder cap, attach a tag to the cylinder indicating "bad valve" and return it to your distributor.

C. Application to Bulk Commodities

1. Storage

ECO$_2$FUME® can be used to fumigate any type of storage used to hold listed bulk commodities. These include, but are not limited to bins, tanks, flat storage, and bunkers. The most important aspects of a successful fumigation, as with any fumigant, are the degree to which the space is sealed and the assurance that the minimum fumigant concentrations are maintained for the required time.

2. Procedure for Fumigating Bulk Commodities

1. Determine the target phosphine concentration desired and the duration of the fumigation.
2. Calculate the empty volume space to be treated.
3. Calculate how much fumigant will be required and the means by which it will be dispensed.
4. Determine where the fumigant will be dispensed into the space, and plan for and install required equipment.
5. Determine where the fumigant concentrations will be measured and plan for and install required phosphine gas sampling lines.
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 warning 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 that fumigant release is about to commence.
12. Connect the ECO2FUME® cylinders to the dispensing equipment.
13. Dispense the initial dose of fumigant.
14. Periodically monitor the phosphine concentrations within the space, using suitable gas detection equipment, to ensure that the minimum concentrations are being maintained.
15. Dispense additional fumigant as required to maintain the desired phosphine concentrations.
16. When no further fumigant is required, close all cylinder valves. Depressurize the dispensing equipment and disconnect all ECO2FUME® cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
17. When the fumigation is complete, unseal the space and aerate (see 10 AERATION OF FUMIGATED COMMODITIES AND SPACES). Barricade and placard all open entries into the space to prevent entry by unauthorized personnel. Use suitable gas detection equipment to check both the carbon dioxide and phosphine concentrations before allowing entry into the space. Use appropriate breathing apparatus and entry procedures to avoid undue worker exposure.

Additional Considerations:

1. Dispensing and monitoring lines should be implemented with loading, unloading and other operations in mind. If frequent fumigations are expected, permanently mounted lines should be secured within the space. If temporary lines are to be used, they should be installed so they can easily be removed at the end of the fumigation.
2. The use of additional tarpaulins or plastic sheeting atop the commodity should be considered, if there is a substantial open space above the stored product. This will help minimize the loss of phosphine from the commodity and the total amount of fumigant required.
3. Recirculation is an excellent means of distributing ECO2FUME® throughout the space being treated. The use of existing aeration blowers is not suggested since their capacity is often so high that it assists in the loss of the fumigant. Small commercial blowers can be used to recirculate the atmosphere within the space being treated. ECO2FUME® should be dispensed into the discharge of recirculation blowers. The blowers should not be run continuously, but long enough to ensure good fumigant distribution and each time fumigant is added.
4. For large storage facilities, multiple dispensing points should be considered to assist in the distribution of the fumigant.

D. Application to Space Fumigations

1. Spaces

ECO2FUME® can be used to fumigate any type of space where listed commodities are stored or processed, except ships or barges. These include, but are not limited to empty mills, warehouses, processing facilities, packaging plants and other empty structures. The most important aspects of a successful fumigation, as with any fumigant, are the degree to which the space is sealed and the assurance that the minimum fumigant concentrations are maintained for the required time.

2. Procedure for Fumigating Spaces

1. Determine the target phosphine concentration desired and the duration of the fumigation. This should be based on the target pests and the temperature of the space.
2. Calculate the empty volume of the space to be treated.
3. Calculate how much fumigant will be required and the means by which it will be dispensed. Since space fumigations generally involve large volumes, fast dispensing methods are the best way to quickly achieve and maintain the desired phosphine concentrations.
4. Determine where the fumigant will be dispensed into the space, and plan for and install required components. Dispensing points should not be located in or attached to commodity packages. Securing the dispensing lines is important, for fast dispensing, to minimize the chance of unwanted movement of the lines during discharge. Direct the discharge toward the center of the space being treated and away from equipment if possible.
5. Determine the number and location of circulating fans. Low speed fans should be placed on the floor and angled upwards. A means of turning the fans off from outside the treated space is suggested.
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 warning placards on and lock all points of access. The only exception to this is silo complexes connected by tunnels. Separate ventilation and monitoring must be in place to protect workers in adjacent areas.
11. Close, lock, seal and placard the access door.
12. Verify that all required safety equipment is available and in good working order.
13. Notify all personnel that fumigant release is about to commence.
14. Connect the ECO2FUME® cylinders to the dispensing equipment.
15. Dispense the initial dose of fumigant.
16. Periodically monitor the phosphine concentrations within the space, using suitable gas detection equipment, to ensure that the minimum concentrations are being maintained.
17. Dispense additional fumigant as required to maintain the desired phosphine concentrations.
18. When no further fumigant is required close all cylinder valves. Depressurize the dispensing equipment and disconnect all ECO2FUME® cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
19. When the fumigation is complete, unseal the space and aerate (see 10 AERATION OF FUMIGATED COMMODITIES AND SPACES). Barricade and placard all open entries into the space to prevent entry by unauthorized personnel. Use suitable gas detection equipment to check both the carbon dioxide and phosphine concentrations before allowing entry into the space. Use appropriate breathing apparatus and entry procedures to avoid undue worker exposure.

20. Remove all dispensing and gas monitoring lines.
21. Workers should be aware that some residual gas may be entrapped within the fumigated commodity container (i.e., bagged product such as SUPERSACKS). Adequate monitoring and aeration must be performed to reduce any residual phosphine levels to below 0.3 ppm.

E. Application to Tarpaulin Fumigations

1. General

ECO$_2$FUME® can be used to fumigate stacked materials by covering the material with a tarpaulin made from plastic sheeting. This allows the fumigant to be contained to the treated material only. The most important aspects of a successful fumigation, as with any fumigant, are the degree to which the space is sealed and the assurance that the minimum fumigant concentrations are maintained for the required time.

2. Procedure for Tarpaulin Fumigations

1. Determine the target phosphine concentration desired and the duration of the fumigation. This should be based on the target pests and the temperature of the material being treated.
2. Since the volume of tarped materials can vary widely, it is important to make a good estimate of the volume enclosed by the tarp. Calculate the volume taken up by the material itself (palletized stacks for example) or any containers used to hold it. After tarping is complete, revise the volume estimate based on the additional space contained within the tarp.
3. Calculate how much fumigant will be required, based on the volume calculation, and the means by which it will be dispensed. A regulated dispenser is required, since high-speed discharge from fast dispensing can damage the tarp and undo any sealing that was done. The approved dispensing equipment includes a pressure regulator to reduce the cylinder pressure to approximately 30 psig. From this pressure ECO$_2$FUME® flows through flow indicators, and the discharge side of the flow indicators is maintained near atmospheric pressure.
4. Determine where the fumigant will be dispensed into the space, and plan for and install required components. Dispensing points should not be located in or attached to commodity packages or within containers.
5. Determine where the fumigant concentrations will be measured and plan for and install required gas sampling lines. Sampling points should not be located near dispensing points to avoid incorrect readings.
6. Cover the material with plastic sheeting using tape, glue or clamps to join individual sheets. If the flooring on which the material is placed is wood or other porous material, it should be covered first with plastic sheeting. Seal the plastic covering to the floor using tape, glue, sand or water "snakes", shoveling sand or soil onto the ends of the plastic, or by other suitable means. Reinforce by tape or other means, any sharp corners or edges to reduce the risk of tearing the plastic. Plastic sheeting should be a minimum of 2-mil thickness for indoor applications however, 4-mil is preferred and is more suitable for outdoor use. Ensure that tarp penetrations for dispensing and monitoring are well sealed.
7. Placard the tarped material.
8. Verify that all required safety equipment is available and in good working order.

9. Notify all personnel that fumigant release is about to commence. For the case of indoor tarp fumigations, the area surrounding the material being treated should be monitored for phosphine and carbon dioxide concentrations to ensure that workers are not unduly exposed. It is required that all personnel not trained or involved in execution of the fumigation be restricted from entering the area, until the work is complete. Workers under a continuous roof, connected buildings or those working near an adjacent outside wall should be vacated.
10. Connect the ECO2FUME® cylinders to the dispensing equipment.
11. Dispense the initial dose of fumigant.
12. Periodically monitor the phosphine concentrations within the space, using suitable gas detection equipment, to ensure that the minimum concentrations are being maintained for the required time.
13. Dispense additional fumigant as required to maintain the desired phosphine concentrations.
14. When no further fumigant is required, close all cylinder valves. Depressurize the dispensing equipment and disconnect all ECO2FUME® cylinders. Ensure that the valve discharge cap is securely installed and replace the cylinder cap.
15. When the fumigation is complete, remove the tarp and aerate as appropriate using precautions to prevent exposure to workers (see 10 AERATION OF FUMIGATED COMMODITIES AND SPACES).

Additional Considerations:

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

F. Application to Containers and Trailers

1. General

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

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

2. Procedure for Container and Trailer Fumigation

1. Determine the target phosphine concentration and exposure time desired. This should be based on the target pests and the commodity temperature.
2. Determine the empty volume of the trailer or container.
3. Calculate how much fumigant will be required, and the dispensing time needed. A regulated dispenser is the recommended means of dispensing the fumigant.
4. Inspect all sidewalls, roof, floor, and doors for cracks, holes or defects. Seal all openings with tape or caulk. Particular attention should be paid to any drain holes in the floor.

5. Install the ECO2FUME® gas dispensing line and secure it to the door, wall or floor with tape.
6. Close the door and seal with tape, caulk or polyethylene sheeting to prevent gas loss.
7. Affix warning placards to all sides of the container or trailer.
8. Verify that all required safety equipment is available and in good working condition.
9. Notify all personnel that fumigant release is about to commence.
10. Dispense the predetermined quantity of ECO2FUME® into the container or trailer.
11. Disconnect dispensing lines from dispenser. Remove all gas dispensing lines entering the space and seal the penetrations

9. PHOSPINE/CARBON DIOXIDE MONITORING

A. Detection Equipment

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

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

1. Hand Pump Monitors

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

1) PHOSPHINE DETECTOR TUBES:
MEASURING RANGE- 0.1 to 4.0 ppm
STROKES- 10 (hand pump)
COLOUR CHANGE- white to grayish-violet
ACCURACY- +/- 15-20%
TIME WEIGHTED AVERAGE (TWA) - 0.3 ppm

2) CARBON DIOXIDE DETECTOR TUBES:
MEASURING RANGE- 1% to 20%
STROKES- 1 (hand pump)
COLOUR CHANGE- white to bluish-violet
ACCURACY-+/- 5 to 10%
TIME WEIGHTED AVERAGE (TWA) - 5000 ppm

2. Electronic Monitors

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

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

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

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

1) <u>NATIONAL</u> DRAGER INC PAC III- ELECTRONIC PERSONAL GAS DETECTOR (phosphine)
DESIGN-continuously monitor one gas in ambient air
ALARM- audio and visual
RANGE- 0 to 20 ppm
ALARM SET POINT- 0.1 ppm (this can be set higher/lower manually)

2) PORTASENS (ANALYTICAL TECHNOLOGY INC.)
Portable gas detector for measuring phosphine concentration in ambient air.
RANGE-0 to 1000 ppm
ALARM SET POINT- 5 ppm

3) INDUSTRIAL SCIENTIFIC

Multi-gas monitor- continuous detection of oxygen and combustible gas.
Can be outfitted with two additional gas detector sensors (H_2S & CO,CL,NO_2,SO_2)
Internal pump can draw sample from as far as 100 feet.

3. Monitoring Hoses and Air Sampling Pumps

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

B. Phosphine exposure limits

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

C. Carbon Dioxide exposure limits

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

D. Indoor monitoring

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

Initial monitoring of the interior of the fumigation area, if entered, regardless of remote sample readings, should be done wearing an SCBA due to the possibility of areas of high PH_3 and CO_2 concentrations.

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

E. Perimeter monitoring

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

Perimeter readings should be performed as follows:

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

10. AERATION OF FUMIGATED COMMODITIES AND SPACES

A. Commodities

Aerate all commodities to 0.3 ppm of phosphine. Continue to monitor densely packed commodities carefully, even after initial gas levels have dropped to acceptable levels. When stored in an unventilated area, densely packed commodities which have been recently fumigated and considered aerated, can bleed out enough fumigant to exceed the threshold limit values for the fumigant. Forced aeration with the use of portable or permanent fans will greatly decrease the amount of time necessary to aerate a commodity to acceptable gas levels. Be extremely cautious and aware of where the fumigant is being directed. Make sure gas concentrations are below the threshold limit values at the property lines. Closely monitor any inhabited structures adjacent to the fumigated area.

B. Tobacco

Tobacco must be aerated to 0.3 ppm. When plastic liners are used, longer aeration periods will probably be required to aerate the commodity down to 0.3 ppm. Hogsheads may require between 3 days to several weeks to completely aerate. Continue to monitor densely packed commodities carefully, even after initial gas levels have dropped to acceptable levels. When stored in an unventilated area, densely packed commodities which have been recently fumigated and considered aerated, can bleed out enough fumigant to exceed the threshold limit values for the fumigant. Forced aeration with the use of portable or permanent fans will greatly decrease the amount of time necessary to aerate a commodity to acceptable gas levels. Be extremely cautious and aware of where the fumigant is being directed. Make sure gas concentrations are below the threshold limit values at the property lines. Closely monitor any inhabited structures adjacent to the fumigated area.

C. Residue Analysis

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

11. CYLINDER RETURN AND TRACKING

Once used, ECO$_2$FUME® cylinders are to be returned only to an authorized distributor or their designated point of return. This applies to all cylinders, regardless of the quantity of material remaining in the package.

The production facility tracks all ECO$_2$FUME® cylinders by the cylinder serial number. Our computer system records the serial numbers of the cylinders as they are filled and shipped from the plant. The same serial numbers are recorded as cylinders are returned to the plant. The computer system will automatically issue a demurrage invoice for any of the quantity of cylinders that have not been returned for a period longer that one-month's time. It is recommended that the end user track the use of cylinders by the same serial number. This will help resolve any billing inquiries and serve as a record of how many and exactly which cylinders

were used for a fumigation job. The serial numbers can be found stamped into the shoulder of the cylinders.

12. EMERGENCY RESPONSE

A. Spill and Leak Procedures

All releases can produce high levels of both phosphine and carbon dioxide gas, thus requiring the need for self contained breathing apparatus (SCBA) and protective outerwear. SCBA must be worn in conjunction with a full face piece and operated in pressure demand mode if the levels of phosphine and carbon dioxide exceed 0.3 ppm and 5000 ppm respectively or either level is unknown.

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

Cytec Industries Inc. operates a 24-hour EMERGENCY RESPONSE and INCIDENT MANAGEMENT system (ERIM). For emergencies involving spill, leak, fire, exposure or accident call:

In U.S.A.	CHEMTREC	1-800-424-9300
In CANADA	CYTEC	(905) 356-8310
	CANUTEC	(613) 996-6666

B. Emergency Responders

In the event of a leak, evacuate immediate area and isolate leak area 700 feet in all directions. Sample downwind of leak for phosphine and carbon dioxide; the isolation area may need to be lengthened if levels exceed TWAs.

If possible, the best response may be to vent cylinder to atmosphere keeping the isolation area clear at all times and monitoring the phosphine and carbon dioxide levels at the isolation perimeter to ensure the safety of adjacent personnel. If venting is not possible, the use of a cylinder over-pack may be necessary.

All emergency responses, at the very minimum should be made wearing flame retardant coveralls, leather faced gloves and self contained breathing apparatus (SCBA) with full face piece and operated in pressure demand mode. Any person entering a confined space, a space under fumigation or responding to a leak must have a safety watcher present.

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

1) Be aware of the possible behavioral effects of hazard exposures to entrants.
2) Continuously maintain count of entrants as well as visual contact at all times.
3) Remain outside the fumigation area at all times during entry operations.
4) Perform no other duties that will interfere with the monitoring of the entrants.

5) Summon rescue/emergency assistance immediately if the entrants need assistance to escape the fumigation area.
6) Safety watcher **must not enter** the fumigation area to perform rescue until he is relieved from his post by another watcher. Unprotected. rescuers account for over 60% of confined space fatalities. Do not attempt to remove anyone exposed to high concentrations of phosphine or carbon dioxide without using the proper rescue equipment or you may also become a casualty. Obtain assistance and use the established emergency procedures.

THE BEST WAY TO HANDLE AN EMERGENCY IS
TO PREVENT IT FROM HAPPENING TO BEGIN WITH!

Three rules to **LIVE** by

#1 PROPER PROCEDURES –DON'T TAKE SHORTCUTS

#2 KNOWLEDGE OF HAZARDS – THINK ABOUT ALL THE HAZARDS

#3 PROTECTIVE EQUIPMENT – USE IT

APPENDIX I Contact List

CYTEC INDUSTRIES INC. CONTACTS

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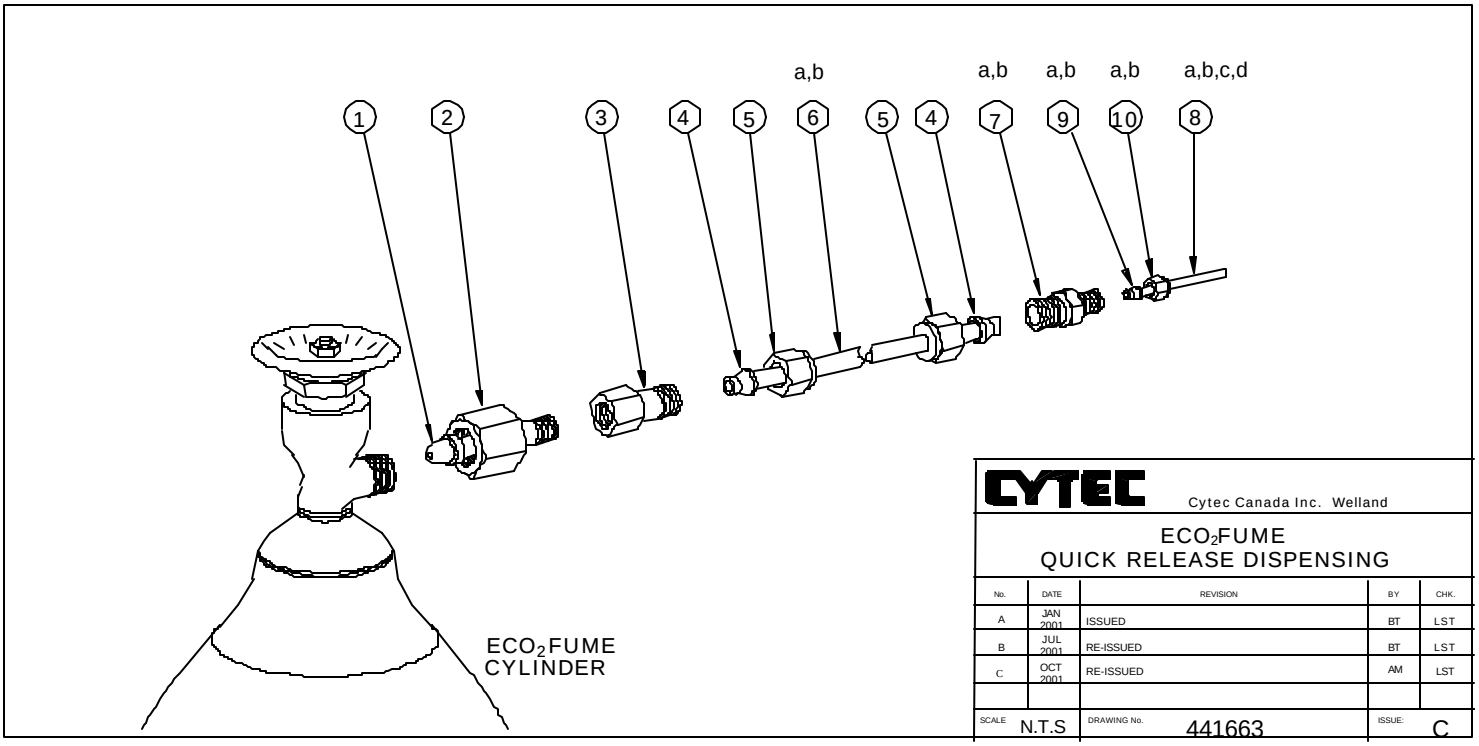
Patricia Vernon Manager, Product Regulatory Compliance, North America Toxicology and Product Regulatory Compliance Department	**CYTEC INDUSTRIES INC.** Five Garrett Mountain Plaza West Patterson, NJ 07424 USA	Bus: (973) 357-3375 Fax: (973) 357-3057 E-Mail: patti.vernon@cytec.com Website: www.cytec.com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

DISTRIBUTORS

Ed Hosoda Vice President	**Cardinal Professional Products** 10 N. East Street, Suite 207 Woodland, CA 95776-5922 USA	Bus: 1-800-548-2223 Direct: (530) 666-1020 Fax: (530) 666-3170 E-Mail: EHosoda@pacbell.net Website: www.cardinalproproducts.com
John Mueller President	**Fumigation Service and Supply Inc.** 16950 Westfield Park Road Westfield, IN 46074 USA	Bus: 1-800-992-1991 Direct: (317) 896-9300 Fax: (317) 867-5757 E-Mail: insectltd@aol.com Website: www.insectslimited.com
A. Chris Mueller VP of Marketing and Business Development	**Industrial Fumigant Company** 19745 W. 159th Street P.O.Box 1200 Olathe, KS 66051-1200 USA	Bus: 913-782-7600 Fax: 913-782-6299 E-Mail: indfumco@toto.net Website: www.indfumco.com
Vince Geiger Industry Manager	**Univar** **740 Alverna Dr.** **Indianapolis, IN 46260**	Bus: 317-257-2889 Fax: 317-255-4536 E-Mail: vince.geiger@univarusa.com Website: www.univarusa.com.com

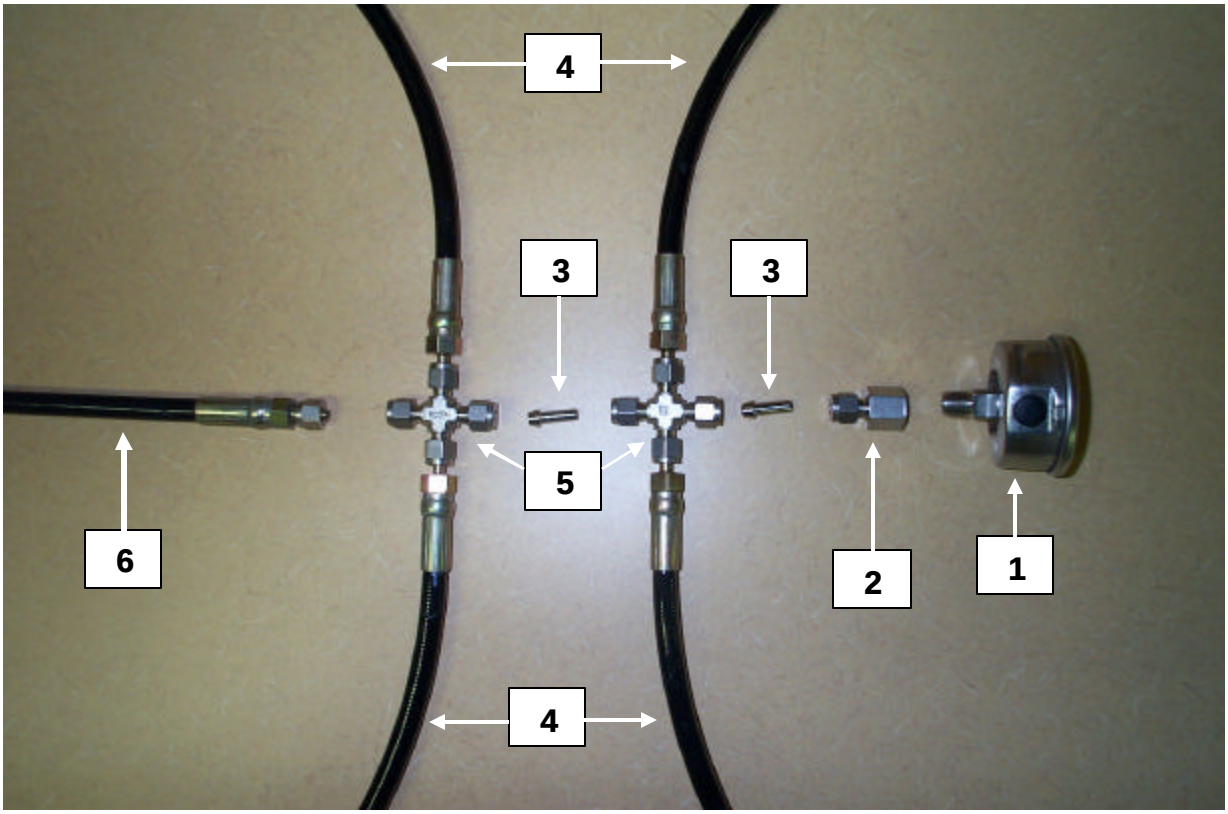
APPENDIX II Quick Release Dispensing Equipment Parts List

Item	DESCRIPTION	MANUFACTURER	PART NUMBER
1	CGA 350 X 1/4" male NPT	Parker	56-350-4M2-48
2	CGA 350 nut	Parker	55-350-3
3	female connector, 1/4" female NPT x 1/4" tube fitting	Swagelok	SS-400-7-4
4	1/4" tube ferrule(s)	Swagelok	SS-400-SET
5	1/4" tube nut	Swagelok	SS-402-1
6a	1/4" O.D. tubing, SS, required length (maximum 200 feet)	Swagelok	SS-t4-s-035
6b	Parflex 1/4" hydraulic hose with nylon core, WP 2750 psi with 1/4" crimped steel tube 55 series fittings, in required length	Parker	520N-TUTU-4-4-4C
7a	tubing reducer, 1/4" X 1/16", drilled for 1/16" O.D. tube	Swagelok	SS-400-6-1ZV
7b	tubing reducer 1/4" X 1/8", drilled for 1/8" O.D. tube	Swagelok	SS-400-6-2BT or ZV
8a	1/16" tubing, stainless steel, 0.02 I.D., 4" (10 cm)	Valco Instruments	T10C20D
8b	1/16" tubing, stainless steel, 0.03 I.D. 4" (10 cm)	Valco Instruments	T10C30D
8c	1/16" tubing, stainless steel, 0.04 I.D. 4" (10 cm)	Valco Instruments	T10C40D
8d	1/8" O.D. tubing, stainless steel	Swagelok	SS-T2-S-028
9a	1/16" tube ferrule(s)	Swagelok	SS-100-SET
9b	1/8" tube ferrule(s)	Swagelok	SS-200-SET
10a	1/16" tube nut	Swagelok	SS-102-1
10b	1/8" tube nut	Swagelok	SS-202-1



APPENDIX III Parts for Assembling Manifold (1/4" x 1/4" Dispensing Line)

Item	Qty	Description	Manufacturer Supplier	Manufacturer Supplier Part #
1	1	2.32.53 2.5" 1/4 CBM 0/3000 pressure gauge	WIKA	7310528
		generic description: 0-3000 psi, 1/4" NPT center mount pressure gauge		
2	1	Female connector, 1/4" female NPT x 1/4" tube fitting	Swagelok	SS-400-7-4
3	3	1/4" port connector	Swagelok	SS-401-PC
4	4	Parflex 1/.4" hydraulic hose with nylon core, WP 2750 psi with 1/4" crimped steel tube 55 series fittings, 3 foot length	Parker	540N-TUTU-4-4-4-36
		generic description: 1/4" SAE 100R7 flex hose with 1/4" crimped steel tube 55 series fittings, 3 foot length		
5	2	1/4" union cross	Swagelok	SS-400-4
6	1	Parflex 1/.4" hydraulic hose with nylon core, WP 2750 psi with 1/4" crimped steel tube 55 series fittings, 25 foot length	Parker	540N-TUTU-4-4-4-300
		generic description: 1/4" SAE 100R7 flex hose with 1/4" crimped steel tube 55 series fittings, 25 foot length		
7	4	CGA 350 nut - 303SS	Parker	55-350-3
8	4	CGA 350 nipple - 316SS 2-1/4" long	Parker	56-350-4M2-36
9	1	1/4" union	Swagelok	SS-400-6
10	4	Female elbow, 1/4" x 1/4" NPT	Swagelok	SS-400-8-4
Parker: www.parker.com		Swagelok: www.swagelok.com		WIKA: www.wika.com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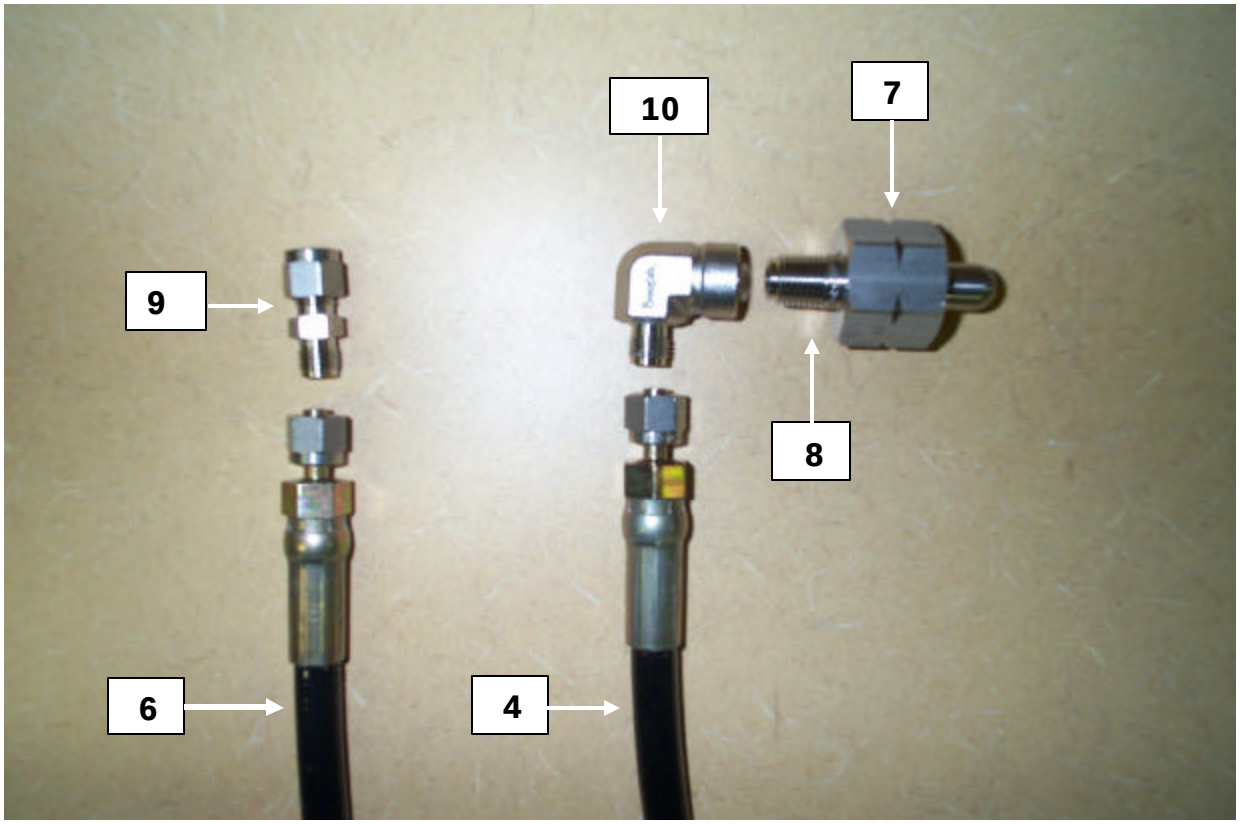
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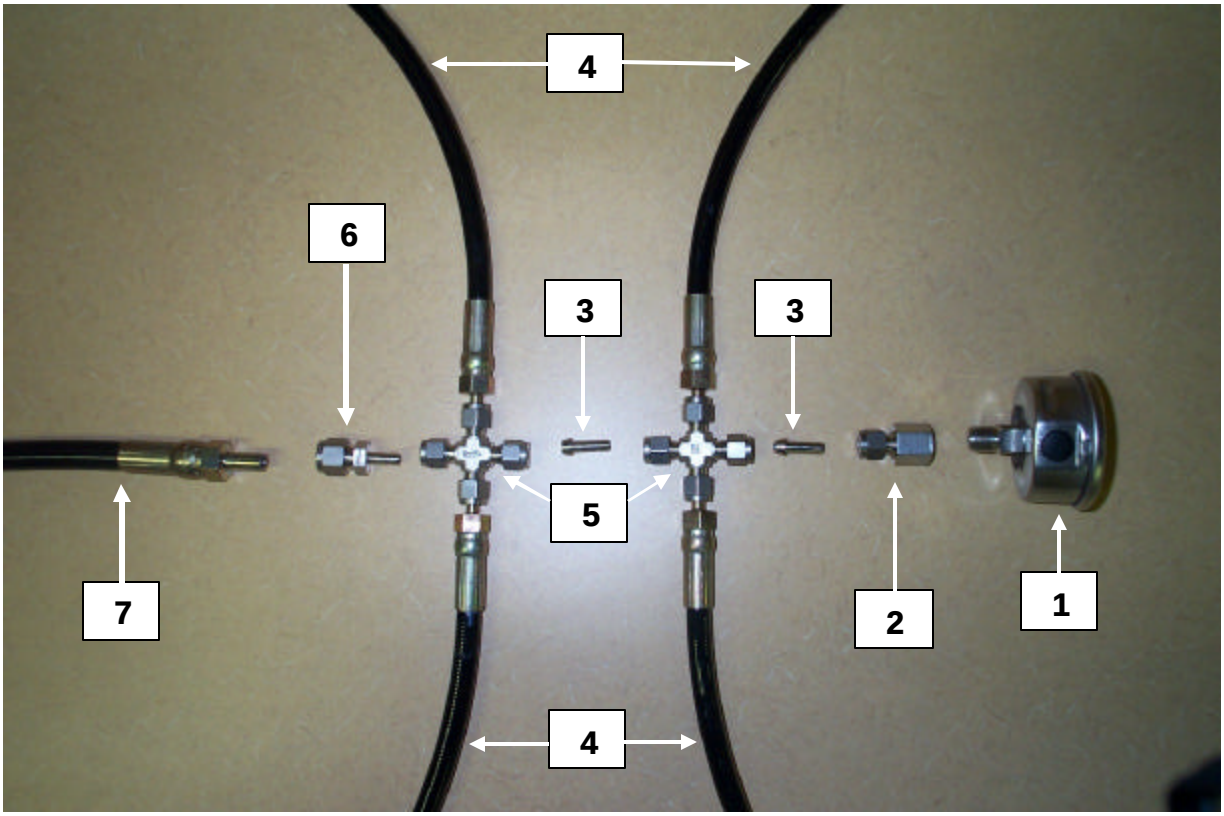
APPENDIX IV Parts for Assembling Manifold (1/4" x 3/8" Dispensing Line)

Item	Qty	Description	Manufacturer Supplier	Manufacturer Supplier Part #
1	1	2.32.53 2.5" 1/4 CBM 0/3000 pressure gauge	WIKA	7310528
		generic description: 0-3000 psi, 1/4" NPT center mount pressure gauge		
2	1	Female connector, 1/4" female NPT x 1/4" tube fitting	Swagelok	SS-400-7-4
3	3	1/4" port connector	Swagelok	SS-401-PC
4	4	Parflex 1/.4" hydraulic hose with nylon core, WP 2750 psi with 1/4" crimped steel tube 55 series fittings, 3 foot length	Parker	540N-TUTU-4-4-4-36
		generic description: 1/4" SAE 100R7 flex hose with 1/4" crimped steel tube 55 series fittings, 3 foot length		
5	2	1/4" union cross	Swagelok	SS-400-4
6	1	3/8"T to 1/4"T reducing union	Swagelok	SS-600-R-4
7	1	Parflex 3/8" hydraulic hose with nylon core, WP 2250 psi with 3/8" crimped steel tube 55 series fittings, 25 foot length	Parker	540N-TUTU-6-6-6-300
		generic description: 3/8" SAE 100R7 flex hose with 3/8" crimped steel tube 55 series fittings, 25 foot length		
8	4	CGA 350 nut - 303SS	Parker	55-350-3
9	4	CGA 350 nipple - 316SS 2-1/4" long	Parker	56-350-4M2-36
10	1	3/8" union	Swagelok	SS-400-6
11	4	Female elbow, 1/4" x 1/4" NPT	Swagelok	SS-400-8-4
Parker: www.parker.com		Swagelok: www.swagelok.com		WIKA: www.wika.com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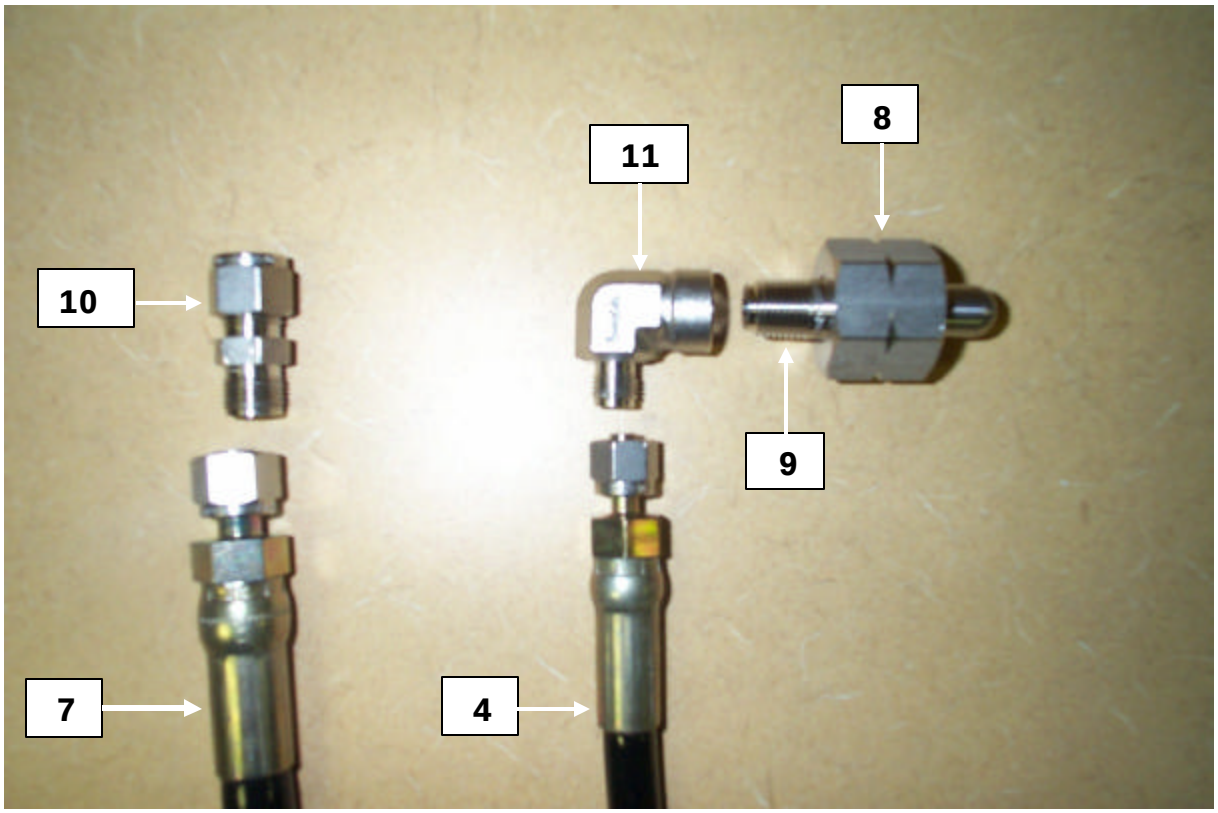
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APPENDIX V CGA SAFE HANDLING

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

APPENDIX VI U.S. STATE REGISTRATIONS

Alabama	Kansas	Nevada	South Carolina
Arizona	Kentucky	New Hampshire	South Dakota
Arkansas	Louisiana	New Jersey	Tennessee
California	Maine	New Mexico	Texas
Colorado	Maryland	New York	Utah
Connecticut	Massachusetts	North Carolina	Virginia
Delaware	Michigan	North Dakota	Vermont
Florida	Minnesota	Ohio	Washington D.C.
Idaho	Mississippi	Oklahoma	Washington
Illinois	Missouri	Oregon	West Virginia
Indiana	Montana	Pennsylvania	Wisconsin
Iowa	Nebraska	Rhode Island	Wyoming
Georgia			