

Fumigation

The Use of Poisonous and Lethal Fumigants

Volume V
(2004 - 2005 Version)



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Nevada Department of Agriculture Test Taking Rules

- 1) All Pest Control Examinations are Monitored; and Video and Audio Taped.....
- 2) Anyone who cheats on an examination will be excluded from taking another pest control examination for a minimum of 6 months (NAC 555.340.7).....
- 3) No cell phones or pagers can be used at anytime during an examination.....
- 4) No unapproved study materials, notes or other aids are to be in your possession during an examination....
- 5) Tests must be paid for prior to examination....
- 6) PLEASE bring a sharp pencil, eraser and calculator...

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Preface and Acknowledgments

This manual was prepared as a general study guide for urban-structural pest control operators to prepare for the written fumigation examination. The enclosed sections provide an understanding of current fumigation practices in the pest control industry. This manual will apply primarily to three commonly used fumigants (Methyl Bromide fumigants, Sulfuryl Fluoride fumigants, and Phosphide gas fumigants) for the treatment of pests where other non-fumigant pesticides do not reach. The information contained herein is basic and practical and is not intended to serve as a complete guide to fumigation. Every manufacturer of fumigants publishes their own fumigation guide or manual which, along with the label of the fumigant, will assist the fumigator in successfully completing the job. This information is not intended to replace or supplement standard industry practices, any pesticide label information, fumigation guides or manuals, or any other directions required by law. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used.

The use of sample pesticide labels implies no endorsement by the State of Nevada Department of Agriculture.

Contributors to this study guide include the Nevada Department of Agriculture, Utah Department of Food and Agriculture and Utah State University Extension Service. This study guide is based on a similar one published by the Colorado Department of Agriculture. Materials were prepared by the Colorado State University Extension Service and Extension Service personnel of California, Kansas, Nebraska, Illinois, Oregon, Pennsylvania, Wyoming and Georgia, as well as, materials prepared in the previous version by Metro Pest Management Consultants, Inc., which were utilized freely and with appreciation.

Nevada State Department of Agriculture

Poison Control Centers

Nevada has two Poison Control Centers with toll-free phone numbers that anyone can call at any hour for information regarding proper treatment of pesticide poisoning.

Rocky Mountain Poison Control Center
1-800-446-6179

U.S. Poison Control
1-800-222-1222

Nevada has two local Poison Control Centers that anyone can call at any hour for information regarding proper treatment of pesticide poisoning.

Poison Control
Humana-Sunrise Hospital
3186 S. Maryland Pkwy
Las Vegas, Nevada 89109
702-732-4989

Washoe Poison Center
Washoe Medical Center
77 Pringle Way
Reno, Nevada 89502
775-982-4129

It Is **Your Responsibility** to Periodically Check the Phone Numbers Listed above to Insure Correctness!

Introduction

A fumigant is a chemical which, at a required temperature and pressure, can exist as a vapor or gas that, when released, penetrates objects or enclosed areas in concentrations that are lethal to pest organisms. This definition excludes aerosols, which are particles suspended in the air, often referred to as smokes, fogs or mists. It's important to make this distinction since it emphasizes one of the most important and useful properties of fumigants: as gases, they diffuse as separate molecules. This allows them to penetrate into the material being fumigated and to diffuse away afterward.

Some insecticides, when sprayed on leaves or other surfaces as contact or stomach poisons, sometimes give off a gas. This gas may account for part of the toxic action of these applications. This is called the fumigation effect. This study guide will not deal with this effect; the guide is limited to fumigants that are dispensed so that the poison is present as a gas soon after application and reaches the pest as a gas.

Fumigation techniques have great adaptability in pest control. They can be used to control wood-destroying insects in structures and furniture where liquid or dust formulations are ineffective or where these materials may cause damage. Under some conditions, fumigants can be applied to control burrowing rodents that can't be reached with other types of rodenticides. Most commonly, fumigants are used in Nevada to control insects and diseases for interstate and federal quarantine compliance, weed and disease control in soils, commodity fumigations for insects in fresh and stored food products such as grains, fruits, vegetables, nuts and dried fruit, and ground burrowing rodent control. Limited fumigations take place to control infestations of wood destroying insects in structures. Fumigation may take place in a variety of locations: at a customer's home or storage facility, or it can occur in a common carrier, such as a truck or railway car.

Controlled atmosphere storage of certain food products is a unique form of fumigation. In a controlled atmosphere, most of the air in an enclosed storage area is replaced with a gas such as carbon dioxide.

Before performing a fumigation, the applicator needs to understand clearly the hazards and problems associated with the use of fumigants. Most fumigants are highly toxic to all forms of life, including humans, animals, plants, and even microbes. Fumigation is a highly specialized operation that requires equipment, techniques, and skills not generally used for applying other types of pesticides. Applying a fumigant may be time consuming and expensive, usually requiring more labor than other pest control methods.

Structural fumigation can be very disruptive, since it requires that tenants and other occupants leave the building. Because of the special hazards and conditions of fumigation, strict legal restrictions exist concerning its use.

As label instructions and industry practices may change, this study guide is not intended to be the final authority on fumigation nor is it intended to replace label requirements or any specific local or state laws. Some specific state laws dealing with fumigations can be found in NAC 555.510. It is the responsibility of the fumigator to periodically obtain current fumigation guides for the particular fumigant being used. These manuals are periodically revised to reflect additional modifications of the label, as well as knowledge obtained through research and experience.

Why Fumigate?

Fumigants are tools available to the pest control industry, as are liquid residuals, dusts, baits, aerosols, etc. Non-fumigants do not reach structurally destructive insects living deep in wood, or quarantinable pests in commodities. Localized treatments may often control small or localized infestations, but as the complexity of the infestation increases, the ability to get the chemical to the pest becomes impossible unless a fumigation is performed.

In addition, visual inspection usually will not reveal the entire infestation, and exact distribution of the population in homes and/or other buildings is usually difficult to determine. In commodities, fumigations are required as a condition to get a specific commodity into another state or country. In structures, damage and insect activity may be on the inside of walls, under insulation and in other areas that are inaccessible and go undetected by even the most experienced inspectors.

Cockroaches and other domicile pests can reach levels in structures where conventional pest control methods are not effective or fast enough. Harborage become established in “protected” areas that are difficult, or even impossible, to effectively treat. Resistance has been known to develop in cases where continual pressure from repeated applications of residuals and knockdown agents has existed and control is seemingly unattainable.

During fumigation of these pests, most fumigants effectively penetrate the structure, contents or commodity under fumigation to completely eliminate the existing pest population. The physical nature of fumigants is to occupy all the air spaces within the structure, chamber, or commodity under fumigation. Being a gas, the fumigant penetrates all spaces, including pores in wooden members or structures, and reaches other inaccessible areas where liquids and aerosols cannot, and does so without the necessity of locating every site of possible infestation or pest harborage.

Fumigants have no residual activity, but when needed, fumigation is more effective and efficient than any other means of control in structures and commodities and may be the only way to control pests in stored commodities, dried fruits and nuts in warehouses, food plants, and bulk grain facilities.

Determining the Need for Fumigation

Several criteria should be considered in determining the need and suitability of fumigation for pest control. These include:

1. Characteristics and habits of the pest
2. Life stages of the pest
3. Characteristics of the treatment area
4. Hazards located in the treatment area
5. Available pest management alternative
6. Established pesticide residue tolerances
7. Quarantine compliance

Quarantine compliance

Commodity or article quarantines have been established by either a foreign country, a region within the U.S., a state, or even a region within a state, whereby restricted articles are permitted movement from a regulated to a non-regulated area. Commodity or article treatment performs an important role in a variety of functions. First and foremost, it performs a vital service in the prevention of pest entry. By means of approved treatments, including fumigation, agricultural commodities as well as non-agricultural commodities originating from quarantine pest-infested areas are disinfected, thus allowing entry into non-infested areas.

Another important function of quarantine treatment is the sanitizing of articles infested with pests of worldwide distribution. Many grain and stored product pests fall into this category. By conducting both quarantine and general sanitary treatments, article deterioration is prevented, thus preserving the marketing integrity that will preserve existing sales and enhance commerce. Note: containers containing the articles should also be treated, these include bins, boxes, holds, etc, and in some cases the mode of conveyance.

There are a number of approved methods for treatment of quarantined articles. These methods generally fall into two categories:

- ❖ Those methods requiring the use of pesticides, and
- ❖ Those employing physical methods or the use of chemicals not classified as pesticides.

For the purpose of this section, the fumigator needs to know where to find quarantine requirements for a particular article so the appropriate quarantine treatment can be performed. In some cases fumigation may be the only approved treatment for the article. As discussed later in this manual, specific rates and hold times may be required for quarantine compliance. The following references will provide information on quarantine compliance.



California Plant Quarantine Manual (PQM) - This manual summarizes current federal, state and county regulations and restrictions that apply to plant material entering California and its counties: <http://pi.cdffa.ca.gov/pqm/manual/htm/pqdown.htm> OR AT California Department of Food and Agriculture
Pest Exclusion Branch
Plant Health and Pest Prevention Services Division
1220 N Street Sacramento, CA 95814
(916) 654-0466



Federal Treatment Manual - Operational guide for selecting and conducting quarantine treatments. The procedures and treatment schedules in this manual are administratively authorized for use by APHIS to prevent the movement of agricultural pests into or within the United States. Listed treatments include chemical treatments such as fumigation with methyl bromide, and non-chemical treatments with heat, cold, or irradiation: http://www.aphis.usda.gov/ppq/manuals/pdf_files/Treatment_Chapters.htm OR AT

USDA Manuals Unit
69 Thomas Johnson Dr., Suite 100,
Frederick, Maryland 21702
240-629-1929



Federal & State Quarantine Summaries - The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine Program (USDA APHIS PPQ) and the plant health agencies in each of the 50 states, regulate the shipment of nursery and greenhouse stock in an effort to minimize the spread of harmful insects, diseases, and other pests. The *Federal & State Quarantine Summaries* is designed as a reference tool for nursery stock growers, brokers, purchasers, and others involved in the buying, selling, and interstate transport of nursery and greenhouse plants. It outlines the basic quarantine and other plant health requirements of APHIS, all 50 states, and Puerto Rico. The information presented here is designed as an aid to help users avoid costly delays, rejections of plant material shipments, and introduction of harmful pests into new areas.

The Federal summaries feature the major quarantines that regulate nursery plants and related items. Descriptions include the areas regulated, commodities regulated, a summary of restrictions that apply, and regional APHIS contact information.

Each State summary lists the relevant plant health agency and contact information; definition of nursery stock; general shipping requirements; and quarantines or other specific certification requirements that apply for shipment into that state: <http://www.aphis.usda.gov/npb/F&SQS/sqs.html> or contact

Nevada Department of Agriculture
350 Capitol Hill Ave
Reno, Nevada 89502
702-688-1180



The State of California Commodity Treatment Manual (1991 edition) - This manual summarizes all currently available treatments for commodities entering California. No web version was available at the time of publication. However, according to CDFA a web version is being planned. Check <http://pi.cdfa.ca.gov/pqm/manual/htm/pqdown.htm> periodically or contact CDFA for a manual:

California Department of Food and Agriculture
Pest Exclusion Branch
Plant Health and Pest Prevention Services Division
1220 N Street Sacramento, CA 95814
(916) 654-1440

How Fumigants Work

Fumigants kill by interfering with the respiratory function of the target pest. Molecules of some fumigants (for instance, carbon dioxide or inert gases) replace oxygen molecules in the air, so the pest control action involves smothering (asphyxiation) due to lack of oxygen. Other fumigants enter tissues and disrupt enzymes used in the respiration of animal or plant cells.

The killing action of a fumigant is influenced by its concentration in the atmosphere, the length of time it stays in the atmosphere, and the temperature and humidity of the area at the time of fumigation. Fumigants are designed to enter cracks, crevices and other areas where target pests may occur. They must be applied in enclosed areas. Fumigation has no residual effect, and re-infestation may occur after the fumigant has diffused from the area.

Advantages of Fumigation

Fumigation has several advantages over other methods of pest control:

- Fumigants are usually quick acting and can result in total eradication of the pest.
- Because fumigants are gases, they diffuse through all parts of the structure or commodity being treated and can reach pests that cannot be reached with conventional pest control materials or techniques.
- For certain commodities, fumigation is the only practical way to control pests.

Disadvantages of Fumigation

There are several reasons why fumigation sometimes may not be the best means of pest control:

- The control achieved through fumigation is temporary -- there's no residual action from fumigants. Where untreated populations of the pest remain, re-infestation of the treated site can take place quickly.
- Fumigants are toxic and often highly hazardous to the applicator, requiring special precautions during application.
- Fumigants must be retained in the gas form for a period of time to be effective, often calling for extra supervision.
- Fumigation must never be done by just one person, which requires added labor.
- Some commodities or pieces of equipment may be damaged by certain fumigants and must be removed or otherwise protected.
- Fumigant activity may be greatly affected by temperature and humidity.

How to Choose a Fumigant

If the need for fumigation has been proven, the right fumigant must be chosen. To decide on an effective fumigant, it's important for the applicator to know the habits of the pest, the characteristics of the fumigation site, and environmental conditions that may influence the fumigation process. He or she also needs to understand the chemical and physical characteristics of the fumigant.

When choosing a fumigant, consider such factors as these:

- Toxicity to the target pest
- Volatility and ability to penetrate
- Corrosive effect, flammability, and potential for explosion
- Warning properties and detection methods
- Effect on seed germination and finished product quality
- Residue tolerances
- Availability
- Ease of application
- Cost

Chemical and Physical Characteristics

Important physical and chemical characteristics of a fumigant include volatility, molecular weight, boiling point, vapor pressure, specific gravity, diffusion potential, water solubility, latent heat of vaporization, flammability, and chemical reactivity. **Read the product information** supplied by the manufacturer to be sure that the material you select is appropriate to the commodity, treatment site, and pest control needs. The label must list the commodity (nuts, vegetables, fresh fruits, grains, etc.) and target sites (soil, structures, rodent burrows, tractor trailer, ship holds, mil vans, etc).

Volatility

Volatility is the tendency of a chemical to evaporate and become a gas or vapor. Volatility increases as temperature rises. Some "gaseous-type" fumigants, such as methyl bromide, are normally a gas at room temperature. Other fumigants exist as a liquid or solid (paradichlorobenzene, naphthalene) at room temperature. Also, many of the "solid-type" fumigants, such as aluminum and magnesium phosphide, are not fumigants themselves but react with moisture to form a fumigant gas (phosphine or hydrogen phosphide).

Molecular weight

Molecular weight is a measure of the weight of the atoms that form the fumigant molecule. More complex molecules have greater molecular weight because they have more atoms. Larger molecules are often less suitable as fumigants since they are less volatile.

Boiling point

The boiling point of the chemical is the temperature at which the liquid stage boils under specific atmospheric conditions to become a gas. Some materials used as fumigants, such as methyl bromide, have low boiling points so they are gases at normal temperatures and atmospheric pressure. These types of fumigants are usually stored as liquids under high pressure. Other fumigants have a high boiling point and are described as liquid or solid type fumigants depending on the way they are shipped and handled. These high boiling point fumigants are slow to evaporate (liquids) and solids are easier to handle making them safer to use.

The boiling point of a fumigant may influence the type of application equipment required. For example, fumigants with low boiling points usually require heaters to warm the gas as it is being released. This is because these materials may freeze on release into the atmosphere since much heat is lost as fumigants turn from a liquid to a gas.

Vapor pressure

The vapor pressure of the fumigant affects the atmospheric concentration of the gas in the air. When a volatile liquid or solid is confined in an area, equilibrium gradually takes place between molecules in the gas and liquid phases. Once the gas molecules reach a saturation point, further volatilization won't increase the number of molecules in the vapor phase. Although volatilization may appear to stop, what actually happens is that every molecule evaporating from the liquid is replaced by a gas molecule condensing back to the liquid form. Since vapor pressure determines the concentration that can be maintained during fumigation, materials of high vapor pressure will be more concentrated and therefore have better fumigant qualities.

Specific gravity

The specific gravity of a chemical compound is a measure of its weight in a given volume. With fumigants, it's important to know if the gas is lighter or heavier than air. Most commonly used fumigants are heavier than air. A heavy gas in a confined area will tend to concentrate in low areas and mix slowly with the air.

These fumigants usually require mechanical mixing with a fan to distribute the molecules evenly through the fumigated area; the use of multiple gas inlets; and/or circulation by means of ducts and pipes. These methods employed singly or in suitable combination will distribute the gas evenly from the very beginning of the treatment. However, once the fumigant is thoroughly mixed with the air, settling takes place very slowly. As a result, the problem of stratification -- or layering -- of heavier than air fumigants doesn't have much practical meaning for the exposure periods usually required in fumigation work.

All gases become lighter as they become warmer. This is because warm molecules take up more space, so fewer molecules can be contained in a given space at the same pressure.

Diffusion potential

Graham's *Law of Diffusion of Gases* states that the velocity of diffusion of a gas is inversely proportional to the square root of its density. Also the densities of gases are proportional to their molecular weights.

Diffusion potential is a measure of how fast gas molecules disperse through the atmosphere. After a while, the molecules become evenly distributed. The speed with which molecules disperse is affected by the molecular weight of the gas. Gases that are heavier

(ethylene dibromide) diffuse more slowly, and it may be important to disperse these types of gases with fans or blowers.

Water solubility

The water solubility of a fumigant becomes an important consideration if items in a fumigated area contain even small amounts of water. The water will tie up water-soluble fumigant molecules, reducing the fumigant concentration in the atmosphere. Toxic molecules also may be incorporated into the water of fumigated materials and may remain as undesirable residues. Suitable fumigants for most applications are those that are insoluble or only slightly soluble in water.

Latent heat of vaporization

Latent heat of vaporization (the extra heat required to change the liquid to a gas) must be considered when using fumigants that have boiling points below room temperature. Unless sustained by warming from an outside source, the temperature of an evaporating liquid constantly drops. This is shown by the cooling effect of evaporating water on the skin. The number of calories lost in the formation of one gram of vapor is called the latent heat of vaporization of the liquid. Some fumigants have higher latent heats than others.

The factor of latent heat has important practical significance. High pressure fumigants, such as methyl bromide, volatilize and lose heat rapidly on release. Unless the lost heat is restored, the temperature of the fumigant may fall below its boiling point, causing the gas to no longer evolve. Also, as the liquid changing to gas is led through metal pipes and tubes or rubber tubing, the drop in temperature may freeze the fumigant in the lines, preventing further passage.

In many applications, it's wise to apply heat to the fumigant as it passes from the container into the fumigation space. Fumigants that are liquids at normal temperatures and are volatilized from evaporating pans or vaporizing nozzles also lose heat. These applications may require a source of heat, such as a hot plate, so that full concentrations will take place rapidly.

Flammability

Flammability of a fumigant is another physical characteristic that is very important in its safe use. Fumigants that are flammable gases are usually combined with a non-flammable gas (such as carbon dioxide) to reduce the danger of fire or explosion.

Chemical reactivity

Chemical reactivity of some fumigants with other chemicals in the environment may limit some fumigant uses. For example, methyl bromide combines with sulfur-containing compounds (such as rubber, leather and other animal products) and gives off a strong, foul odor that is hard to eliminate. Phosphine gas reacts with copper (used in electrical wiring, motors and plumbing) to cause serious corrosion. High temperatures around an open flame may cause some fumigants to form corrosive acids. Certain fumigants may make photographic film and paper unusable because of chemical reaction.

Types and Nature of Fumigants

Many of the active ingredients in fumigants used in earlier years have either been canceled entirely or had their uses restricted. All space fumigation products and several soil fumigant products (especially those containing chloropicrin and/or methyl bromide) are now Restricted- Use pesticides.

Some active ingredients that are still EPA registered and registered in Nevada for legal use include:

1. Methyl bromide (Meth-O-Gas® 100)
2. Chloropicrin (Chlor-O-Pic®)
3. Aluminum phosphide (Fumitoxin®)
4. Magnesium phosphide (Magtoxin®)
5. Sulfuryl fluoride (Vikane®)
6. Carbon dioxide



Methyl Bromide

Methyl bromide has been used as a fumigant since the 1930's. It readily penetrates many materials and is in wide use for structural space fumigation. Methyl bromide is also used in agriculture as a soil fumigant to control fungi, weeds, nematodes and insects. Methyl bromide is one of the only fumigants registered that can be used on shipments of commodities that must meet strict agricultural quarantine regulations of most countries, including the U.S. Methyl bromide is sold as a liquid under pressure. Upon release, it vaporizes to form a gas that is about 3.3 times heavier than air.



In the past, methyl bromide's major uses were in agriculture as a soil fumigant and in structures for termites and other structural pests. However, with the phase-out of methyl bromide uses in the U.S., the use of methyl bromide has shifted to quarantine treatments. Methyl bromide is effective against a variety of pests, including "hitchhikers" and can be easily and economically applied to both small and large shipments. U.S. regulations require that a wide array of important food and non-food commodities be fumigated with methyl bromide as a condition of entry into the U.S. This is also true of a number of commodities being exported from the U.S. to other foreign countries, and interstate shipments of items from domestic quarantine locations to non-quarantine locations.

Methyl bromide is a colorless, odorless and tasteless gas, but it's highly toxic as a respiratory poison and can cause serious eye and skin damage. It's usually formulated with a small amount of chloropicrin as a warning agent. Early symptoms of overexposure are dizziness, headaches, nausea and vomiting, weakness, and collapse. Fluids in the lungs and heart irregularities may develop two to 48 hours after exposure. These effects can result in death.

Methyl bromide is retained, at least for a short time, in body tissues. Repeated small over exposures can cause symptoms such as blurred vision, staggering walk, and mental imbalances, with probable recovery after a period of no exposure. If trapped inside tight clothing next to the

skin, methyl bromide can cause severe skin burns. Monthly blood bromide tests are suggested for those using or exposed to methyl bromide. Chronic effects are often irreversible.

Methyl bromide reacts chemically with sulfur products and should not be used to fumigate materials such as fur, leather, rubber, wool, and feathers.

Chloropicrin

Chloropicrin fumigants include products marketed under the names Chlor-O-Pic®, Lavacide® 100 and Quasar®. These products contain nearly 100 percent chloropicrin and are marketed as liquids. Chloropicrin volatilizes to form a dense gas that is about 5.7 times heavier than air.

Chloropicrin is highly toxic to insects, vertebrates, and many soil microbes, such as fungi. It is also injurious to plants even when used as a warning agent in other fumigants. It's highly irritating to eyes and is a powerful "tear gas." Concentrations as low as 1.0 part per million (ppm) cause intense eye irritation, and prolonged exposures cause severe lung injury. Chloropicrin can cause severe injury upon skin contact. Uses of chloropicrin on foodstuffs is prohibited due to adsorption potentials. Right now, chloropicrin is mainly being used as a warning agent for methyl bromide or Sulfuryl fluoride fumigations.



Aluminum Phosphide



Aluminum phosphide fumigants include products marketed under the trade names Detia®, Fumitoxin®, Gastoxin®, Phostek® and Phostoxin®. These products contain aluminum phosphide in combination with inert ingredients such as ammonium carbamate and urea. The formulated material is a solid molded into pellets or tablets. The active ingredient, aluminum phosphide, reacts with atmospheric water to produce hydrogen phosphide gas. This gas is also known as phosphine. Phosphine is a colorless gas with an odor that smells different to different people. The odor is often described as similar to garlic, commercial carbide, or decaying fish. It is highly toxic to insects although requiring 72 or more hours of treatment time. Preadult stages of some insects are resistant to short exposures to phosphine gas but are controlled by a 10 day or more fumigation period.

Phosphine is only slightly heavier than air, about 1.2 times as heavy. Fumigators can't rely on the gas moving through a solid storage such as a grain bin, so they need to set up one or more fans to mix the fumigant with the air.

Aluminum phosphide is commonly used to protect stored commodities from damage by insects and for the control of burrowing pests. These fumigants, when applied in a manner as prescribed by their label, does not contaminate the marketed commodity. Aluminum phosphide gas is highly toxic to all forms of animal life, including insects, burrowing rodents, humans, and other forms of animal life. The lowest threshold working limit is 0.3 ppm (0.0003% air). Early symptoms of poisoning can be severe, but these symptoms are reversible if exposure stops. Initial symptoms of overexposure include "tightness" in the chest, faintness, dizziness, nausea, vomiting and diarrhea. Severe poisoning leads to coma and death. Phosphine (hydrogen

phosphide) gas isn't absorbed through the skin and is not stored in body tissues. Aluminum phosphide may explode on contact with water.

In addition to its toxic properties, Hydrogen-phosphide (phosphine) gas is reactive and very corrosive to metals, especially copper, silver, gold, and platinum and may ignite spontaneously in air at concentrations above its lower flammable limit of 1.8% (v/v).

Aluminum phosphide fumigants also contain ammonium carbamate which liberates ammonia and carbon dioxide. These gasses are essentially nonflammable and act as inerting agents to reduce fire hazards. The ammonia gas also serves as a warning agent.

A standard among all aluminum phosphide fumigants is that they are all prepared in two spherical shapes. The **rounded tablets** weigh approximately 3 grams and release 1 gram of hydrogen phosphide gas. They are 16mm in diameter and are bulk packaged in re-sealable aluminum flasks containing 100 or 500 tablets each. The **pellets** weigh approximately 0.6 grams and release 0.2 grams of hydrogen phosphide gas. They are about 10mm in diameter and are also packaged in re-sealable flasks containing about 1660 or 2490 pellets.

Upon exposure to air the aluminum phosphide pellets or tablets begin to react with atmospheric moisture to produce small quantities of hydrogen phosphide gas. This reaction starts slowly, gradually accelerates and then tapers off again as the aluminum phosphide is spent. The pellets react somewhat faster than do the tablets. The rate of decomposition of the tablets and pellets will vary depending upon moisture and temperature conditions, the higher the moisture and temperature the faster decomposition (i.e. 3 days versus 5 days for lower moisture and temperatures). After decomposition, a grey-white powder composed almost entirely of aluminum hydroxide and other approved inert ingredients will remain. According to the manufacture, this residual spent powder will cause no problems if the fumigant has been added directly to a commodity such as grain. However, the spent powder must be retrieved for disposal after a space fumigation. If the fumigation was conducted properly, the spent powder that remains normally contains a small amount of un-reacted aluminum phosphide and may be disposed of without hazard. Partially spent residual dusts from incompletely exposed aluminum phosphide will require special care. Read the product label and products Applicator's Manual for deactivation procedures and disposal requirements.

Aluminum phosphide tablets and pellets are supplied in gas-tight containers and their shelf life is unlimited as long as the packaging remains intact. Once opened for fumigation, the aluminum flasks of tablets or pellets may be tightly resealed and stored for future use. Storage and handling instructions are given in detail on the products label and in the products Applicator's Manual.

Magnesium Phosphide

Magnesium phosphide is similar to aluminum phosphide, releasing hydrogen phosphide gas in reaction with water. Release of the gas is faster than occurs with aluminum phosphide. Common magnesium phosphide products contain the solid magnesium phosphide material attached to a strip or blanket that can be put in place very quickly. Because this application method may not provide good distribution of the gas in a grain mass, it isn't usually used in grain storage fumigation. Magnesium phosphide fumigants can be used effectively for warehouse and processing plant fumigations.

Sulfuryl Fluoride

Sulfuryl fluoride is sold under the trade name Vikane®. Vikane® gas fumigant was specifically developed by Dow Chemical Company in 1950 to be used exclusively by professional fumigators to control wood destroying insects in structures. Vikane® is a colorless, odorless gas. It is sold in canisters as a liquid under pressure that volatilizes readily. It is non-corrosive and unreactive to most materials. Sulfuryl fluoride also can provide good penetration of wood products and fabrics, but it needs fans or blowers to mix well with air as it is 3.5 times heavier than air. Sulfuryl fluoride is non-flammable, but in the presence of an open flame, it forms a very corrosive gas. It's highly toxic to humans.

Vikane® gas fumigant is registered to control undesirable pests in the following infested sites: structures, fumigation chambers, construction materials and furnishings (including household effects, but not food stuffs or commodities) and vehicles (including rail cars and cargo containers). Aircraft and subsurface water vehicles are not labeled sites.

Due to its toxic and penetrating qualities, Vikane® gas fumigant is excellent for controlling a broad spectrum of pests in the above listed sites. These pests include insects, other arthropods and rodents. Pests for which Vikane® gas fumigant is commonly used include drywood termites, Formosan subterranean termites, wood-boring beetles, fabric and museum pests, cockroaches and rodents.



Carbon Dioxide

Carbon dioxide (CO₂) is a colorless, odorless and tasteless gas that is about 1.5 times heavier than air. It's non-combustible and is used as a fire extinguishing material. It's usually found in the air at concentrations of about 0.03 percent. However, carbon dioxide is poisonous at higher concentrations and is used for fumigating food products at about 60 percent concentration.

Using carbon dioxide is desirable because no toxic residues stay in treated materials. Also, CO₂ doesn't change the germination potential of treated grain and leaves no objectionable odor or flavors. However, fumigation with carbon dioxide requires fairly long exposure periods to be effective. Effectiveness is greatly reduced by low temperatures, so if temperatures are below 60 degrees F., fumigation periods may be too long to be practical (three to four weeks or more).

Other Fumigants

Carbon tetrachloride

Carbon tetrachloride (CT) may be used alone as a fumigant, but because of its low toxicity to insects, high dosages or greatly prolonged exposure periods are needed. It has, however, been used alone for grain fumigation, usually when there is a shortage of more toxic materials.

At recommended insecticidal concentrations, CT does not affect the germination of seeds. However it may be injurious to growing plants, nursery stock, fruit and vegetables.

Cumulative liver damage from repeated exposure to minimum vapor concentrations of CT and Chloroform has been reported.

Carbon disulfide

Carbon disulfide (CS₂) was one of the first fumigants employed on a large scale. Its use in France, in 1869, against the grape phylloxera is a landmark in the history of applied entomology. It was injected into the soil to control insects infesting the roots of the grapevine. For many years afterwards, CS₂ was widely used as a soil or space fumigant. Its tendency to burn or explode presents a hazard, and many explosions have been recorded during its use as a fumigant. Effects on humans are similar to that for CT plus effects on the central nervous system.

Carbon disulfide penetrates well and is still the only fumigant used in certain parts of the world. It is of practical value in tropical countries where the high temperatures favor volatilization. It is a colorless liquid with sweet, pleasing odor. This gas is heavier than air.

Carbon disulfide is commonly formulated in mixtures with nonflammable ingredients for fumigating grain.

Ethylene dibromide

The insecticidal properties of ethylene dibromide (EDB) were reported in 1925. It has become important as an insecticidal fumigant as a result of its specific value for the destruction of fruit flies (family Trypetidae) in fruit and as a fumigant for grain in the tropics. It has also been found useful throughout the world as an ingredient of a number of liquid type grain fumigants and "spot" fumigants.

Although EDB is a fumigant of considerable utility, it has a high boiling point and is adsorbed by many materials, into which it does not penetrate well. It is thus more limited in usefulness than some of the more volatile fumigants. It has, however, found extensive use in soil fumigation. It is also effective as an ingredient in very low proportions of dips to control fruit flies in fruit. In this use, the insecticidal effect is undoubtedly due to fumigant action.

Ethylene dichloride

Ethylene dichloride (EDC) is not as toxic to insects as other commonly used fumigants, but it is useful in the fumigation of grain and seeds. Because both the vapors and the liquid are flammable EDC can explode at concentrations above 6% in air. EDC is mixed with some nonflammable material, usually carbon tetrachloride (CT) in the proportion of three parts EDC to one part CT by volume. The mixture, applied according to label directions, has no adverse effect on the germination of seeds or the milling qualities of grain. Care must be taken to avoid excessive exposure. Although some plants and fruits appear to be tolerant to EDC, severe injury has been recorded with certain species. This fumigant, therefore, should not be used alone or in a mixture for fumigating nursery stock, living plants or vegetables without consulting its fumigation manual or guide. This fumigant is a heavy liquid with pleasant odor and sweet taste.

EDC has been used in emulsion with water against the peach tree borer when soil temperatures were too low for effective use of paradichlorobenzene. Some injury has been reported to peach trees.

Because EDC is soluble in fats and oils, it is not recommended for use on cereals or foods with a high oil content.

Acrylonitrile

Because of its flammability, acrylonitrile is never applied alone but always in admixture with nonflammable materials. Mixed with carbon tetrachloride it has been used as a local fumigant and for the fumigation of tobacco, and as a spot fumigant in milling and processing machinery. Mixed with chloroform or methylene chloride it has been employed with some success for fumigating buildings against dry wood termites. Although in comparison with methyl bromide these mixtures do not have a deleterious effect on household materials, such as sponge rubber, they do not aerate after fumigation as rapidly as methyl bromide or sulfuryl fluoride.

Mixtures of acrylonitrile with carbon tetrachloride are made in a ratio of 1 part acrylonitrile to 2 parts CT. Acrylonitrile has a mustard-like odor.

Dichloronitroethane

This fumigant (boiling point 124°C) was introduced some years ago and appeared useful for treating grain, other stored products and soil. It gives warning by odor and irritation of the eyes. It may be strongly corrosive to metals in moist atmospheres.

Ethylene Chlorobromide

Ethylene chlorobromide is effective against the oriental fruit fly, but it is not as toxic as the closely allied ethylene dibromide. It has a lower boiling point than EDB. The effect of this fumigant on fruit and plant material is similar to that of EDB. It has not come into general use, although it has been adequate in many fields of application for which EDB is also suited.

Methylene Chloride

Methylene chloride has been found useful as an ingredient of fumigant mixtures. It is nonflammable and has a boiling point of 40.2°C. In itself it is toxic to insects, but ranks low in toxicity in comparison with other commonly used materials.

Ethylene Oxide

As an insecticide, the principal use of ethylene oxide (ETO) has been for fumigation of bulk grain in recirculating systems and in the vacuum fumigation of packaged foods and tobacco. It has also proved to be effective both under vacuum and at atmospheric pressure for destroying several species of snails entering the United States in military cargoes from the Mediterranean area. In recent years, ETO has been used extensively for the cold sterilization of medical supplies and instruments, for preventing spoilage in foodstuffs and spices and also for controlling diseases in honeycombs and equipment from honeybee colonies.

ETO has an irritating, mustard-like odor, it is highly flammable thus it is necessary to mix it with non-flammable carriers, and it reacts strongly with living plant material and microorganisms.

Hydrogen cyanide (HCN)

Hydrogen cyanide was one of the first fumigants to be used extensively under modern conditions. Its use for treating trees under tents against scale insects was developed in California

in 1886. The use of HCN has been declining in recent years, but it is still important in certain fields of application.

HCN is one of the most toxic of insect fumigants and may be absorbed through unbroken skin in toxic amounts (absorption increased if skin is moist). The fact that it is very soluble in water has considerable bearing on its use in practice. Thus, it may produce injury on moist materials, such as fruit and vegetables because the solution of HCN in water is a dilute acid. Not only does this acid render these materials unpalatable and possibly hazardous for human consumption, but its action, by causing burning, wilting or discoloration, may make them unmarketable.

On the other hand, HCN has been widely used for fumigating dormant nursery stock that is sufficiently dry. It may be used for some living plants if they can be washed with water immediately after treatment to prevent burning by the acid.

HCN may be employed for fumigating many dry foodstuffs, grains and seeds. Although HCN is strongly absorbed by many materials, this action is usually reversible when they are dry, and, given time, all the fumigant vapors are desorbed. With many foodstuffs little, if any, chemical reaction occurs, and there is no detectable permanent residue.

Because of the high degree of absorption at atmospheric pressure, HCN does not penetrate well into some materials. It WAS largely because of this that vacuum fumigation was adopted.

Dichlorvos (DDVP)

Dichlorvos, sometimes called DDVP, is the common name of dimethyl 2,2 dichlorovinyl phosphate. Discussion of this material is pertinent to this manual, despite its high boiling point and low vapor pressure, because for certain usages it is discharged as a true gas to control insects in the open spaces of structures. It is also used as a contact insecticide.

Alternatives to Fumigation for Drywood Termite Control

All treatments listed below will kill drywood termites, but their effectiveness is limited when used beyond their intended scope.

COVERAGE AND TYPICAL TIME RANGE FOR DRYWOOD TERMITE TREATMENTS		
Treatment	Unit of Coverage	Time per Unit
Fumigation	entire structure	1-2 days
Heat	several rooms, attic, an apartment	4-12 hours
Cold	wall voids between studs	30 min
Electrocution	3-4 ft of board	2-30 min
Microwaves	1-4 ft of board	10-30 min
Drill-and-Inject	3-12 ft. of termite gallery	5-20 min
Borate Surface Spray	raw wood surfaces	10 min - 2 hours
Wood Replacement	removed wood member	highly variable

IMPORTANT ADVANTAGES AND DISADVANTAGES OF DRYWOOD TERMITE TREATMENTS		
Treatment	Advantages	Disadvantages
Fumigation	complete eradication of termites in entire structure	overnight evacuation and food protection required
Heat	eradication where heat is confined	all heat sensitive materials must be removed from area
Cold	eradication where cold can be confined, usually a wall void	holes drilled in wall for injection of liquid nitrogen
Electrocution	maneuverable device	no ability to measure lethal application
Microwaves	control without drilling	poor maneuverability for confined areas
Drill-and-Inject	long tract record, residual chemical delivered directly into termite gallery	drilling of infested wood required
Borate Surface Spray	large coverage possible, residual protection	only unfinished wood treatable, drilling of infested wood recommended
Wood Replacement	absolute removal of infestation	infestation may run into adjacent, more difficult to remove, wood members

Target Pest Considerations

Fumigants used in pest control tend to affect all forms of life. Almost any pest in an enclosed area can be destroyed when exposed to an adequate concentration of a fumigant. Fumigations are most often used to treat pests that infest harvested commodities such as bulk grain, greenhouse insects, etc. Inaccessible pests, such as wood boring beetles and drywood termites, are also targets for fumigation. Fumigation may sometimes be the best choice for controlling heavy infestations of insects such as cockroaches, especially when it's hard to gain access to all of the pest's hiding places. Fumigation is also useful to avoid toxic residues associated with application of other pesticide formulations to food, clothing, and similar materials.

Habits of the Pest

Pests that are reclusive or hard to locate can often be treated successfully with fumigation. However, it's important to understand the habits of the pest before choosing fumigation. For example, colonies of drywood termites, very uncommon in Nevada, nest in structural wood above ground and are good targets for fumigation. The far more common subterranean termites nest underground and are not killed by fumigation. Situations where large reservoirs of the pest will remain outside the treated area can allow quick re-infestation, wiping out the benefits of fumigation.

Life Stages of the Pest

An applicator should also consider how various life stages of the pest respond to fumigation. For instance, the post-embryonic stages of most arthropods, including insects are more susceptible to fumigants than the eggs. This susceptibility is dependent on the arthropod's intrinsic metabolism and respiration rates. A rule of thumb, the faster the locomotion of the arthropod, the more susceptible it will be to the fumigant. Insects may also be dormant during certain periods and not be susceptible, and for solitary (non-social) insects, a higher dosage of fumigant is required to kill egg stages. For insect egg stages surviving the first fumigation, a second fumigation may need to be conducted after the eggs hatch, but before the insects reach adulthood (i.e. dermestid beetles, and some cockroach species).

Unlike insects, rodents are warm-blooded animals and do not need high dosages of fumigants at cooler temperatures. For weed control (seeds), plant-parasitic nematodes, soil-borne disease causing organisms, and soil living insects, soil temperature and moisture are critical for a good fumigation.

Be sure to check the fumigant label to see what life stages of the target pests the manufacturer claims the product will control and if there are any minimum temperatures or minimum exposure times associated for the life stage to be controlled.

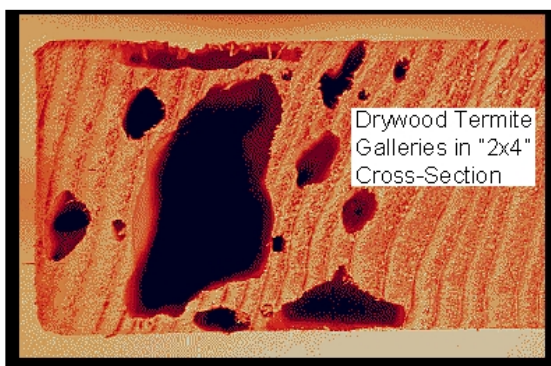
Facts about some Selected Pests Associated with Fumigations

Termites

Termites are social insects of the order *Isoptera*, meaning “equal wings”. They are sometimes popularly called “white ants”, although they are not closely related to ants, which belong to a different order of insects. Termites can easily be identified by the equal length of their front and hind wings and thickness of their waistline; ants have unequal wings and pinched waists.

The structure-infesting drywood and subterranean termites in the U.S. feed on cellulose, but these termites cannot make use of this material for nutrients without the help of microorganisms in their digestive tracts. Newly hatched termites feed on materials passed to them by the older termites, thus the necessary microorganisms are passed on to new generations. Newly hatched young cannot survive without nest mates to feed them.

The three important types of termites found in the U.S. – drywood, subterranean and dampwood – are most easily identified on the basis of their habits and where they live. The commonly found termites in Nevada are described in detail in the NDOA Structural Pest Control – Control of Wood Destroying Pests Vol. IV. Simplistically, **drywood termites** are a problem chiefly in warm, moist coastal regions, however, can be found in isolated structures within Nevada. They live inside of wood and do not



require contact with the soil. **Subterranean termites**, as their name implies, generally live underground, and, with rare exceptions, must maintain contact with the soil. The **dampwood termite** is a larger insect than either the drywood or the subterranean termite, but is of less economic importance than the other two. Dampwood termites typically infest posts, forest trash, dead trees and wooden structural members in soil or areas with sufficient exposure to water.

Wood Borers

Powderpost beetles (*Lyctus spp.*) are members of the family Lyctidae. Lycids are mainly found infesting the sapwood of hardwoods. They digest starches and sugars, but not cellulose. Their growth is relatively slow as they average only two generations a year. However, they can do extensive damage before their presence is known.

Death watch beetles (*Xestobium spp.*) are members of the family Anobiidae. They feed on hardwoods and softwoods and are usually associated with some fungal decay. Their total life cycle is from four to five years.

Old house borers belong to the family Cerambycidae, which is called “long horn beetles” (*Hylotrupes spp.*). They mainly infest sapwood of pine and spruce, but occasionally have been in hemlock, Douglas fir and other true firs. They are usually seen near the surface of

wood in the sapwood and generally don't infest the heartwood. These beetles have a wide geographic distribution. Development from egg to adult can require up to 10 years in temperate zones.

For more information on these pests see the NDOA Structural Pest Control – Control of Wood Destroying Pests Vol. IV.

Fabric Pests

Clothes moths are widely distributed, persistent pests in structures. They are noted for the damage caused to woolens and are normally controlled by localized treatments. When severe infestations occur, or localized control measures fail, fumigation may need to be utilized.

Carpet beetles are common pests of carpets, woolen garments, skins, furs and museum specimens, including bones. Their life cycle is usually complete in 12 months. This is one of the insect species that may require two fumigations in order to control all beetles.

For more information on these pests see the NDOA Industrial and Institutional Control of Insects and Vertebrates Vol. III.

Health-Related Pests

Cockroaches are highly successful life forms that have existed almost in their present forms for 100 million years or more. The living and feeding habits of mankind have made commensal living attractive to cockroaches. The **German cockroach** is considered by many in the pest control profession to be the number one domestic pest. All stages of the German cockroach can be controlled by fumigation because the female carries the ootheca during incubation and the embryos are dependent on the female for survival. In contrast, the female of the **brown-banded** and **Oriental cockroaches** deposit the ootheca shortly after it is formed. The embryos are not dependent on the female for survival. Therefore, the ootheca may not be affected by fumigants unless they are applied at high dosages.

Bed bugs are occasional parasites of humans. They are usually hidden in the seams and folds of mattresses. They can be controlled by fumigation.

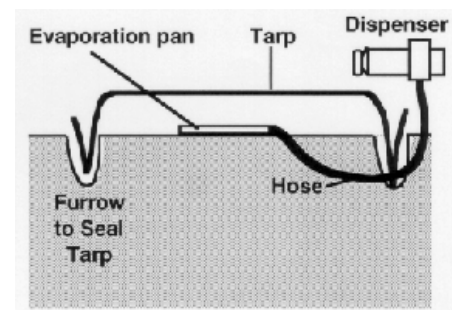
Rats and **Mice** (rodents in general) are always unwelcome guests in any structure. They are easily controlled with fumigants, however, the fumigator must use sufficient gas and expose the structure for the minimum exposure on the label for a successful fumigation.

For more information on these pests see the NDOA Industrial and Institutional Control of Insects and Vertebrates Vol. III.

Soil-Related Pests

Soil fumigation can yield vastly improved seedlings and crop performance. By decreasing weed competition, eliminating parasitic attack by nematodes and soil-borne disease causing organisms, fumigation cost is more than offset by increased production. Plant bed fumigation has been reported to be more effective and uniform than steam sterilization or burning.

The following pests may be controlled by selected soil fumigants when present in the soil at the time of treatment:



Plant-parasitic nematodes, including root-knot, root lesion (meadow), cyst, citrus, burrowing, false root-knot, lance, spiral, ring, sting, stubby root, dagger, awl, sheath and stunt (stylet).

Soil-borne disease causing organisms, including the fungi *Pythium*, *Rhizoctonia*, *Phytophthora*, *Pyrenochaeta*, *Sclerotinia* and *Fusarium* and the clubroot organism *Plasmodiophora*.

Weeds, including broadleaf weeds such as broomrape and lambsquarters and grasses such as bermudagrass, annual bluegrass, torpedograss and quackgrass. Most fumigants have little or no effect on hard seed weeds, such as mallow, dodder, morning glory, and certain leguminous weeds. Check the label of the fumigant for weed species controlled before attempting fumigation.

Insects, including wireworm, cutworm, grubs, rootworms, ants and garden symphylans.

Stored Commodities

Raw agricultural and processed commodities, animal feeds, and various commodity storage facilities where they are held, are subject to infestations of insects, rats, mice, and occasionally fungi and bacteria. Fumigants can quickly penetrate into even hidden insect harborage in storage areas and into the commodities they contain for complete kill. The fumigant then vents off rapidly so the entire fumigation and aeration procedure may be conducted over a relatively short period of time. Most fumigants labeled for these uses are non-flammable and present no danger from fire or explosion and leave no residue on the commodity being fumigated. A complete section in this manual has been dedicated to stored commodity fumigation.

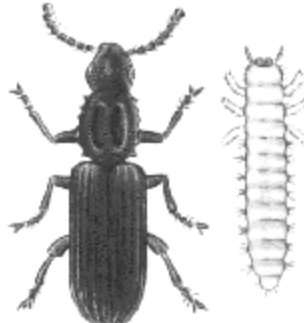


PRINCIPAL STORED GRAIN INSECTS

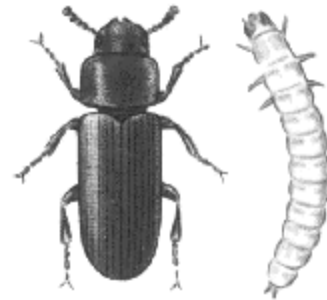
For safe and effective use of insecticides, always identify the problem correctly.



1. Granary weevil 



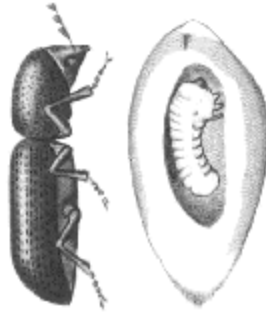
2. Saw-toothed grain beetle 



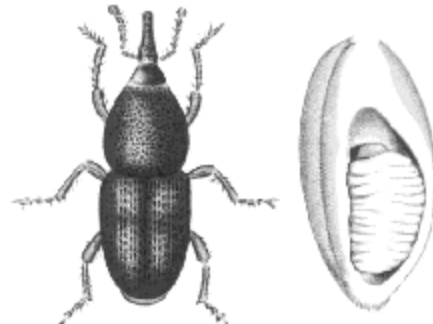
3. Red flour beetle 



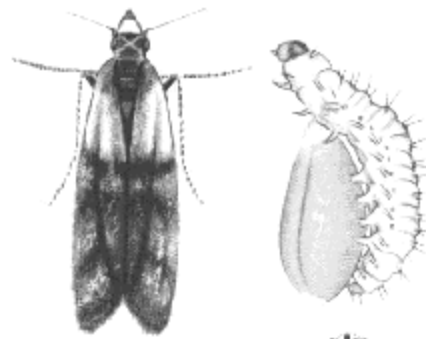
4. Larger cabinet beetle 



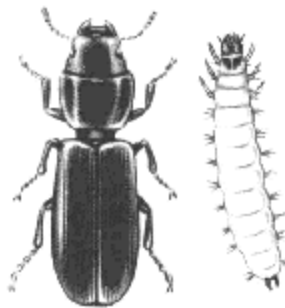
5. Lesser grain borer 



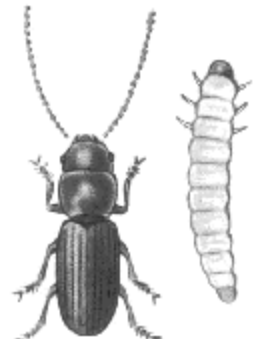
6. Rice weevil 



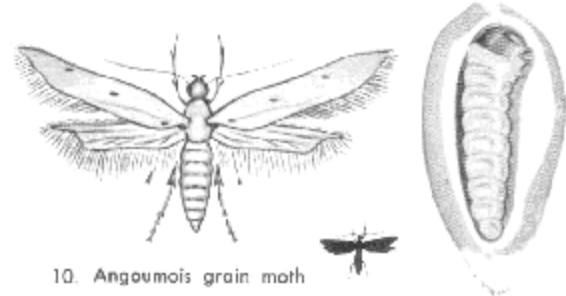
7. Indian-meal moth 



8. Cadelle 



9. Flat grain beetle 



10. Angoumois grain moth 

Some of these stored grain insects are also KITCHEN PESTS.

The saw-toothed grain beetle, red flour beetle, larger cabinet beetle, and Indian-meal moth develop in flour, cake mixes, corn meal, breakfast foods and similar products. The Angoumois grain moth infests popcorn.

Prepared by Extension Entomologists of the North Central States in cooperation with the Federal Extension Service, U. S. Department of Agriculture

Site Suitability Considerations

Fumigation may be used in several types of situations, including structures, bulk storage facilities, specially designed chambers, rail cars and trucks.

However, fumigants should only be used in enclosed areas because the molecules of the fumigant penetrate throughout the area and escape through openings. Fumigants can't be used in localized areas of a building unless it's possible to completely seal and control access to the treated area throughout the fumigation and aeration period. Fumigants should never be used in any areas that can not be fully secured to prevent entry or contact by people or animals.

The fumigation site also must have the proper environmental conditions to allow successful use of the fumigants. This includes correct temperature, humidity, and air circulation conditions required for effective pest control.

Sites should also be thoroughly surveyed to identify and protect items that may react with or be damaged by the fumigant. This may include such items as furnishings, floor coverings, foodstuffs, wall hangings, finishes, plumbing and electrical devices, and moisture sources.

Structural Fumigation

Fumigation may be used to control certain pests within existing buildings such as grain storage bins, warehouses, apartments, and homes. Since typical constructions are sufficiently airtight, these require sealing. In relatively airtight structures, taping may be sufficient. However, many buildings require tarping the entire structure.

Fumigants used in grain storage are very useful for control of stored product insects such as weevils and various "bran bugs." Structural fumigants for use in warehouses, apartments, and homes can help control pests such as drywood termites, powder post beetles, other wood boring beetles, and other domicile pests (i.e. rodents and cockroaches) that are hard to control with other methods.



Chamber Fumigation

Since environmental conditions can be carefully controlled and monitored, chamber fumigation is a superior method for fumigating many materials. Using a chamber will allow only small amounts of a commodity to be fumigated at a time because of the limited size of the chamber. However, the limited space can be an advantage, because the fumigant is confined, saving the time it





takes to fumigate and the amount of fumigant used. The ability to carefully control environmental conditions in a chamber also allows fumigation to be used to control pests on fragile commodities such as fresh fruits or vegetables without damage.

Chamber fumigation can also be used to disinfect fresh produce, packaged foods, bagged or baled agricultural products, museum specimens, furniture, high value garments, and similar items.

atmospheric or vacuum type. Vacuum chambers provide the quickest and most thorough fumigation and are best for finely divided items, such as flour. Applying a vacuum increases the penetration of a fumigant and shortens fumigation time. However, some materials may be damaged by vacuum and require special precautions. Atmospheric chambers are useful for fumigating materials that might be damaged in a vacuum chamber.

Chambers used for fumigation may be either the

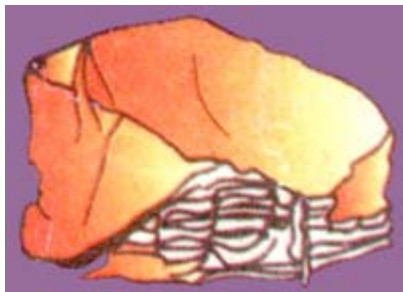


Tarpaulin Fumigation

Tarpaulin fumigation involves placing a gas tight material over the commodity or structure to be fumigated. The tarps must be specially made for fumigation, such as impregnated nylon or sheet polyethylene. (Waterproof canvas tarpaulins are not satisfactory.) Polyethylene tarps can be used in thickness from four to six mils. Use gas impervious adhesive tape to join various sections of polyethylene film.



The tarpaulin method provides thorough protection from insect damage at a practical cost. Done in place, it permits fumigation without the expense of moving huge stores of commodities. Tarpaulin fumigation can effectively and economically free materials such as bagged grain, dried fruit, stacked lumber, and other commodities from insects.



Tarpaulin fumigation may be done in the open, on loading docks, or in areas of buildings that allow safe aeration when the tarpaulin is removed. However, sites must also be checked for possible hazards in securing the fumigated area from humans and animals as well as for adequate sealing.

Rail Car and Truck Fumigation

Items shipped in rail cars or in large truck trailers are often fumigated after they are loaded into the vehicle. This prevents pests from being transported to other locations and protects shipped products from pest damage during transport. Most vehicles, depending on their condition and on the type of commodity being fumigated, require at a minimum taping of all doors, drains and vents, or in some cases even tarping to confine the fumigant to the vehicle of transport.



Pests controlled by rail car and truck fumigation include beetles and moths that infest flour, grains, nuts, dried fruits, and other agricultural products. These insects usually are brought into the vehicle on the commodity being shipped. Some insect pests may hide in empty vehicles, feeding on residues from previous cargoes. Unless controlled by fumigation or removed by thorough cleaning, these pests can infest future loads.

Fumigation of rail cars and truck trailers must comply with the regulations of state and local highway departments and departments of transportation as well as fumigant label instructions. In some cases, loaded rail cars can be fumigated in transit. However, regulations prohibit truck trailers from being moved until fumigation and aeration have been completed. When performing a truck or boxcar fumigation, the pesticide applicator must post warning signs on all entrances to warn of the hazards.

Because fumigated boxcars or trailers may contain residues of a fumigant after aeration, the vehicles need to be monitored with appropriate detection equipment once they reach their destination and before they are unloaded. The person opening and monitoring fumigated loads must wear respiratory protection and any other protective equipment required by the fumigant label.



Factors Affecting Fumigant Performance

For a fumigant to work effectively, the correct concentration of gas molecules must be present in the atmosphere surrounding the target pest. Molecule concentration may be affected by several factors. Some important ones are:

1. Sorptive quality of the treated commodity, either through absorbing (taking fumigant into the commodity) or adsorbing (fumigant condensing on the surface of the commodity).
2. Temperature and humidity during treatment.
3. Speed of diffusion of the fumigant through the commodity.
4. Reactions of the fumigant with other chemicals or articles in the treated area.
5. Amount of fumigant applied.
6. Susceptibility of the target pests.
7. In fumigation chambers, the pressure of the gas in the chamber.

Sorptive Qualities

Surfaces or items within the fumigated area may affect the concentration of fumigant molecules. For instance; cardboard boxes that contain produce or other food items will absorb some of the fumigant. Foam rubber used in upholstery or as carpet padding is also sorptive. Building insulation has large surface areas and therefore will sorb fumigant molecules.

Molecules can be either absorbed or adsorbed (See No. 1 in above list). When absorbed, fumigant molecules dissolve into another material, such as water, oil, or other liquid. Absorption may not always be reversible, therefore resulting in greater problems with chemical residues.

Adsorption

Adsorption is a molecular attraction between gas molecules and the surface of something in the environment. The rate of adsorption is influenced by temperature. Fumigants applied while temperatures are low will adsorb more rapidly than when applied under higher temperatures. Adsorbed molecules may be released (desorption) as the temperature rises and as the concentration of the gas molecules in the surrounding atmosphere decreases. Fans and blowers that force air through the commodity can further speed the reversal of fumigant adsorption.

Temperature

Temperature at the treatment site affects both the fumigant and the target pest. Low temperature increases the sorption rate of the fumigant so that the concentration of the fumigant is reduced, and desorption is slowed by cooler temperatures. Fumigants also volatilize and

diffuse more slowly at cooler temperatures.

Insects and other target pests may be less sensitive to effects of fumigants at lower temperatures. During cooler conditions, respiration of the target pests is slowed, making them less susceptible to poisons that affect respiration. Preferred fumigation temperatures usually range between 50 and 95 degrees F. Check the label of the fumigant being used for its optimum temperature and acceptable temperature range. Also remember that during the course of a fumigation application, the temperature of the treated area can decrease or increase due to fluctuations in outside temperatures and also due to the cooling action of the fumigant being released (latent heat of vaporization).

Humidity

The concentration of water vapor in the atmosphere -- humidity -- can affect the performance of fumigants that are water soluble, such as methyl bromide. The water soluble fumigants become unavailable when dissolved in water, reducing their concentration. Fumigants may not be able to penetrate wet areas, allowing insects in those areas to survive.

High humidity can also create moisture condensation in the fumigated area. Condensation can cause spotting of treated surfaces. In stored grains, condensation can cause wet spots that allow molds and storage heating to develop.

As the moisture content of a commodity increases, it becomes more difficult for a fumigant to penetrate it. This makes fumigants less effective on insects. This also increases the potential for residues exceeding legal tolerances. Adequate moisture is required for the generation of some fumigants.

Diffusion

For a fumigant to be effective, it must penetrate the entire treatment site quickly and must be in the proper concentration. Factors that slow the diffusion rate include heavier fumigant molecules, low diffusion potential, and cool temperatures. Diffusion may also be hampered by dust in the fumigated area, a common problem in fumigating grain storage structures. A fan or blower will increase diffusion.

Reaction with Other Chemicals

Materials in the treatment area, including food products being treated, may react chemically with a fumigant. Higher temperatures may further speed reaction processes. For instance, the flame from a pilot light or heat from a glowing electric heating element may cause fumigant molecules to react with other gas molecules in the air. Chemical reactions of this type are not reversible under normal conditions. If fumigant molecules react chemically, new chemical compounds will be formed. This may include corrosive acids, such as result from heating sulfuryl fluoride (Vikane®). Possible residues of newly formed chemicals may also stay in the fumigated area or on treated food products. For example, inorganic bromide compounds are found as residues on some food items that have been fumigated with methyl bromide.

In addition, chemical reaction of fumigants may lower the concentration of the fumigant

enough to reduce the effectiveness of the fumigation. Check the fumigant label and the products fumigation manual or guide for specific precautions, and inspect the fumigation site thoroughly to eliminate materials or conditions that may allow reactions to occur.

Concentration and Time

How well a fumigant works depend both on the amount that has been applied and how well the concentration of gas molecules is maintained after application. The amount of fumigant applied is usually expressed in weight per volume (for example, pounds per 1,000 cubic feet or grams per cubic meter). The concentration of a fumigant is the amount of gas present in a given volume (for example, ounces per 1,000 cubic feet or milligrams per liter). Concentration is influenced by sorptive qualities, temperature, chemical reactions, and how well the fumigated area is sealed.

When fumigating grains, the applicator needs to adjust the dosage for the intergranular space (the amount of space between individual grains). This factor varies with the type and condition of the grain. Refer to the product's fumigation manual or guide, as well as reading the fumigant label for dosage information about these sites.

It's also important to maintain the critical amount of gas in the area of the target pests for a certain period of time. Although most fumigants are fast acting, effective concentrations need to be maintained for several hours to days or weeks to allow control. For example, in order to kill cereal leaf beetles in alfalfa hay, a concentration (dosage) of methyl bromide is 3 pounds per 1,000 ft³ and must be maintained for a period of 24 hours; or in the case of Vikane®, to control Drywood termites in a house, taking into consideration a number of factors prior to fumigation, an applicator may determine that it will take 17 ounces of Vikane® per 1,000 ft³ and must have a 20 hour exposure period for adequate control.



Susceptibility of Target Organisms

Target organisms can react very differently to the effects of fumigants. This variation may be due to species differences. It can also be acquired, by development of populations that are genetically resistant to the treatment. Variation in susceptibility also is affected by the life stage of the pest. In addition, the way a fumigant is applied can sometimes influence pests' susceptibility. For instance, some insects can tolerate a higher concentration of fumigant if they are first exposed to a low concentration for a short time. To avoid this problem, bring the fumigant level to the lethal concentration quickly, and then maintain that level throughout the fumigation period.

Pressure

In an airtight chamber, the penetration rate of fumigants may be controlled by using positive or negative (vacuum) pressure. Too much pressure or vacuum may cause structural changes in the commodity being fumigated. Therefore, care must be taken to prevent damage to the commodities. To prevent undue expansion of tightly sealed packaged goods while a vacuum is being created, the pressure should be lowered slowly and/or the decompression process should be stopped for two to five minutes after each one inch fall of mercury in a pressure measuring device.

Safety Precautions and Protective Devices

Labels are always changing as U.S. EPA re-registers pesticides and evaluates or re-evaluates uses of those products. It is an applicator's responsibility to read and follow all label directions and to have available a current fumigation guide or fumigation manual in addition to the product label. The information below is not all inclusive to all products, but will provide a general understanding of fumigant safety. Read and follow the current label on the product you use, and follow the most current fumigation guide or manual associated with the product you choose!

Using Two Trained Applicators

Recent requirements by the EPA to registrants of fumigants has mandated changes in warning statements on labels which now require the presence of two trained applicators during hazardous stages of fumigant application (one must be licensed and certified in Nevada and must be physically present during all hazardous stages of fumigation, if the application is for hire). This strengthens long standing recommendations to always work in pairs. Two applicators are to work together during introduction of the gas, whenever the application or gas monitoring requires entry into the fumigation site, when working within the confined space where a fumigant is applied, and during the initial aeration procedure.

Aluminum phosphide and some methyl bromide labels will permit an applicator to work alone in limited situations. This includes situations where the fumigant is applied outdoors to a moving grain stream (aluminum phosphide) or in recirculation systems where methyl bromide concentrations don't exceed 5 ppm in the work area. Even so, the presence of two trained (one must be licensed, if for hire) or certified individuals is always a wise investment for safety in the event of accident or emergency.

Exposure Levels

Respiratory protection is required for certain phases of most fumigant applications and other times when the airborne concentration exceeds a set value. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends following established exposure limits known as **Threshold Limit Values** (TLVs). A TLV is the airborne concentration of a fumigant in parts per million that nearly all workers may be repeatedly exposed to on a daily basis without adverse effect. A TLV is usually established for each fumigant as a guide to prevent health hazards, but it should not be considered the distinction between safe and unsafe fumigant concentrations.

Two types of TLVs are recommended by the ACGIH as guidelines for protecting persons handling toxic vapors, including fumigants. These recommendations are not enforceable standards, although they contribute to better worker safety. The two recommended TLVs are:

1. TLV-TWA, the **threshold limit value-time-weight average**, is an airborne concentration, in parts per million, of a fumigant (or other toxic gas) that most workers can be exposed to during an eight hour workday or 40 hour workweek without developing health problems. Typically, the TLV-TWA value is the concentration referred to on fumigant labels that must not be exceeded without appropriate respiratory protection.

2. TLV-STEL, the **threshold limit value-short-term exposure level**, is the maximum allowable concentration of any fumigant that a person should be exposed to without respiratory protection. It's recommended that exposure to this concentration be for no longer than **15 minutes** at a time, with a minimum of 60 minutes between exposure periods. No more than four exposure periods should be allowed in one workday. The total exposure for any single day should not exceed the TIV-TWA level for an eight-hour work period.

If the fumigant doesn't specify a maximum exposure value, exposures must then be kept below the Permissible Exposure Limit (PEL). PELs are set forth in state or federal health and safety regulations. These limits usually represent the maximum concentration of an airborne chemical that can be present without being a health hazard to most people. Nevada OSHA can be contacted to find out what the current PEL is for the fumigant you choose. Remember these are occupational hazards and the Nevada Department of Agriculture nor does U.S. EPA establish the occupational requirements for working with fumigants.

Department of Business and Industry Occupational Safety & Health Enforcement Section		
<u>Carson City</u>	<u>Las Vegas</u>	<u>Reno</u>
400 West King St, Ste 200 555E. Carson City, Nevada 89703 775-687-5240	Washington Ave, Ste 4900 Las Vegas, Nevada 89101 702-486-5054	4600 Kietzke LN, Bldg F, Ste 153 Reno, Nevada 89502 775-688-1380

The TLV and PEL values should only be used as a guide, since these levels may not protect everyone under all types of conditions. For example, there may be a few workers who will be sensitive to effects of the chemical below the TLV or PEL. Heavy physical activity, which increases the breathing rate, increases chemical uptake of airborne chemicals. Also, the exposure levels are based solely on exposure through inhalation. Since some fumigants can be absorbed through the skin or accidentally ingested, this increases overall exposure levels.

Gas Detection Devices

Revised labels for fumigants require the use of sensitive gas monitoring devices during fumigant application and before warning placards can be removed from fumigated sites.

Devices that provide adequate sensitivity includes detector tubes and matching pumps manufactured by Auer, Draeger, Matheson-Kitagawa, MSA, and Sensidyne. Detector tubes are sealed glass tubes filled with a specific, reactive solid. Both ends of the tube are broken off just before use, and one end is attached to a calibrated pump. Available pumps use a





bellows, bulb, or piston type syringe to draw a precise volume of air through the detector tube. Discoloration of the solid material within the tube indicates fumigant concentration; gas concentrations can be read directly from the glass tube. Tubes and pumps manufactured by different companies may be very similar, but to get accurate readings, it's necessary to match detector tubes and pumps from the

same manufacturer. Don't mix separate brands of equipment.

"Low-range" detector tubes that accurately indicate low levels of fumigant concentrations are required for label specified monitoring practices that provide information for worker safety. "High-range" tubes may be useful for detecting fumigant leaks. These tubes are scaled for measuring much higher concentrations of fumigants, and they are especially useful for monitoring gas concentrations within storages during fumigation to determine if the necessary levels were reached. Other gas monitoring devices, such as halide leak detectors, and thermal conductivity meters (Fumiscope® or Gow-Mac®) may be used to detect leaks or determine internal concentrations of gas during fumigation. However, these devices don't provide label required levels of sensitivity necessary for determining safety (respiratory protection) needs and should not be used to "clear" the fumigation site. Halide leak detector lamps also should not be used around grain storage buildings since the flame may trigger an explosion of grain dust. Halide leak detector lamps are designed to be used with non-flammable halogenated hydrocarbon fumigants.



When measuring fumigant levels after fumigation, it's important to take readings from several locations. Often fumigants may become trapped in localized pockets. Different materials will also desorb at varying rates, a process called "off gassing". This can allow toxic levels of the fumigant to occur in scattered locations.



Detector tubes are specific for a single fumigant. Auer, Draeger, Matheson-Kitagawa, MSA and Sensidyne manufacture detectors that offer adequate sensitivity for label required monitoring of hydrogen phosphide (phosphine) and/or methyl bromide.

The only currently available detector that offers adequate sensitivity for label required detection of chloropicrin is produced by Matheson-Kitagawa and is specified on the chloropicrin label.

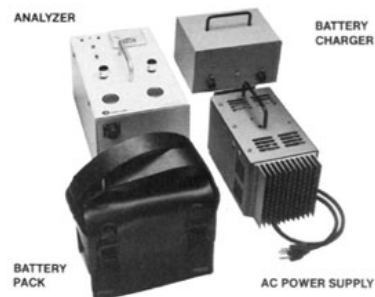
Tubes available for measuring CO₂ concentrations are available from several manufacturers. Several types of tubes may be needed, since applicators must be able to measure low (below one percent) CO₂ ,



levels to provide information on worker safety, and high concentrations (up to 60 percent, minimum) to determine the need for continued injection of the gas into the structure.

Warning agents, such as chloropicrin, are sometimes added to fumigant gases that otherwise have little odor. Sometimes warning agents may affect the accurate reading of fumigant levels, so be sure to use detecting equipment that can reliably measure fumigant concentrations in the presence of the warning agent. (Note: Commodity fumigators must not use chloropicrin as a warning agent since this material isn't permitted for use on most food items, and it would result in an illegal residue.)

The only currently available detectors for Vikane® (sulfuryl fluoride) that offer adequate sensitivity for label required detection are INTERSCAN Gas Analyzer, manufactured by Interscan Corp. and MIRAN Specific Vapor Analyzer, Manufactured by Thermo Environmental Instruments. One of these two gas analyzers must be used to “clear” a structure and confirm a concentration of Vikane® at 5 ppm or less, per label directions.



Protective Equipment

Various types of respiratory equipment are available, but their effective and safe use requires that the equipment is matched to the specific need. For example, chemical cartridge respirators, used in applying many types of pesticides, are not suitable for fumigation work. Depending on the gases and their concentration, various types of gas masks, self contained breathing apparatus, or air supplied systems are appropriate.

Canister and cartridge type **gas masks** employ a replaceable canister or cartridge that contains chemical components that absorb specific gases. Full face canister respirators (not half face cartridge respirators) should be used as protection where this meets label specifications.



The effective life of an individual canister varies according to fumigant concentration and the respiratory rate of the applicator. Maximum limits are stated on each canister. Under NIOSH/MSHA regulations, canisters are color coded according to fumigant absorbency. For example, canisters approved for protection from hydrogen phosphide are coded yellow with an orange stripe. Canisters effective for methyl bromide and chloropicrin are color coded black. Always double check the color code with written specifications that indicate the canister is effective for the fumigant.

As a canister empties, it becomes hot. Breathing hot air or encountering high resistance to breathing provides a warning that the canister is about to become ineffective for protection.

When this occurs, or when the applicator smells or tastes the fumigant or experiences poisoning symptoms, the applicator should **immediately** leave the fumigated area. An empty canister should be crushed before it's discarded so that no one will mistakenly use it in the future.

Canister respirators are inadequate for use in oxygen deficient (less than 19.5 percent) environments, such as that produced by CO₂ fumigation. Although canisters may absorb the toxic fumigant in this environment, they don't supply necessary oxygen. In these situations, a self contained breathing apparatus (SCBA) or a combination air supplied/SCBA is needed.

General Rules on Canister Use

1. Discard any canister that has been used for more than 30 minutes (total time) in a fumigant atmosphere.
2. Discard any canister whenever an odor of fumigant is detected as coming through. (The absorption material isn't working).
3. Discard any canister used for less than 30 minutes if it's more than one year old.
4. Discard canisters with expired expiration dates or that have been manufactured more than two years earlier (even if unused), unless the instruction sheet specifically says otherwise.
5. DON'T use a canister type gas mask to enter a recently fumigated or oxygen deficient area.

The **self contained breathing apparatus (SCBA)** commonly used for fumigation is the NIOSH or MSHA approved positive-pressure, self contained breathing apparatus or “air pack”. Air packs comprise a full face mask attached to a tank of air carried on the applicator's back. An air pack supplies up to 30 minutes of air supply and allows work in an oxygen deficient environment. This time period may be considerably shorter if overexertion increases the rate of breathing. A warning bell can be set to signal the depletion of the air supply.



In a fumigant laden storage, safe exits may require uninterrupted respiratory protection. For this reason, carrying an approved canister respirator when using an air pack is recommended for situations where oxygen concentrations remain adequate. The canister respirator will allow emergency escape if the SCBA expires or malfunctions.

Methyl bromide and chloropicrin label directions concerning respiratory protection include reference to **combination air-supplied/SCBA respirators**, such as manufactured by Ranger, Survivair, Scott or MSA. Air supplied respirators employ an outside air source pumped to the applicator through an air line. The major advantage of the air line system is that the air supply doesn't expire in a limited time. Disadvantages include the need to tow the air line throughout the storage. Air pump failure or a constriction of the air line can shut off the air supply. The air pump must also be located in a fumigant free area. In combination with a SCBA, an air supplied respirator does offer an unlimited work period with backup respiratory protection provided by the SCBA, if for any reason the outside air supply is cut off.



One final respiratory protection topic concerns the fit of a face mask. If a face mask doesn't seal tightly against the face, it cannot provide protection from a fumigant gas. An applicator must select a mask that fits his or her face; facial hair must be cleanly shaved to allow a tight fit. Fit can be tested by closing off the breathing tube and trying to breathe in or blow air out.

Air passage between the mask and the face indicates an unsatisfactory fit. The release of irritant gases near the edges of the mask can also indicate an improper fit. Detection of the irritant within the mask signals a poor seal between the mask and the face.

None of the respiratory protection equipment provides protection from skin absorption or skin injury by fumigants. When using fumigants that have potential to injure the skin or be absorbed by it, such as chloropicrin, be sure to wear additional protective clothing.

Respiratory Protection Requirements

Fumigant labels require the use of specified types of respiratory protection equipment during most fumigant applications. Labels specify maximum fumigant concentrations in which applicators can work without respiratory protection equipment. Gas concentrations greater than what a label specifies is safe, signals a need for exposed workers to use respiratory protection equipment. These levels include the following:

- Workers exposed to hydrogen phosphide (phosphine) at levels above 0.3 ppm must wear a canister type gas mask or self contained breathing apparatus (SCBA).
- Workers exposed to concentrations of hydrogen phosphide above 15 ppm, or where levels are not measured, must wear a SCBA.
- Workers exposed to chloropicrin concentrations above 0.1 ppm must wear a canister type respirator, a SCBA, or a combination-air supplied/SCBA respirator.
- Workers exposed to methyl bromide or sulfuryl fluoride at levels above 5 ppm must wear a SCBA or a combination-air supplied/SCBA respirator.
- Workers exposed to carbon dioxide concentrations exceeding 1.0 percent must wear a SCBA or combination-air supplied/SCBA respirator.

Symptoms of Exposure to Fumigants

Most reactions to fumigant poisoning differ from those of exposure to other pesticides. For instance, many fumigant reactions simulate drunkenness. Symptoms of fumigant exposure can include:

- Slowed body movements
- Slurred/slowed speech
- Dizziness
- Numbness of hands or feet
- Coughing
- Sneezing
- Dryness/irritation of nose and throat
- Breathing difficulty
- Nausea
- Abdominal pain

Remember OSHA Requires:

- Safe Work Place Practices
- Hazard Communication Program
- Material Safety Data Sheets (MSDS)
- Safety Training
- Identification of Chemicals
- Incident Reporting



Calculating Use Rates

The first step in deciding how much fumigant must be released to achieve the desired concentration is to measure the length, width and height of the area to be treated and figure its volume (volume measurements on fumigant labels are given in cubic feet). If the commodity, container or structure to be fumigated is to be tarped, the total volume inside the tarp must be determined, not just the volume of the structure or commodity. This must account for spaces caused by overhangs, eaves, and other irregular shapes.

The fumigants “fumigation guide” or “fumigation manual” and the products label are the applicator’s best sources of information on calculating the proper amount of fumigant to use for specific situations. Some manufactures provide fact sheets or handouts on how to measure buildings and calculate the correct dosages of their fumigant. **Always read and follow label instructions.**

Physical or environmental conditions may influence the amount of fumigant that must be applied to achieve the required dosage. Factors that must be considered include:

1. Temperature and temperature fluctuation during fumigation.
2. Sorption qualities of the commodity or items in the target site.
3. The type and condition of the sealing method.
4. Texture and moisture content of the soil beneath the fumigation site.
5. Wind velocity during the fumigation period.
6. The volume of the area being fumigated.

Some fumigant manufacturers, such as Dow AgroSciences, furnish or offer for sale calculators, charts, or slide rules to help figure dose adjustments for these factors. Examples of calculators used to calculate Vikane® dosages would be a Fumiguide electronic calculator or a manual Fumiguide B calculator.

Low temperatures may affect dispersal of the fumigant in a treated area. Also, insects are generally more resistant to a fumigant when the temperature is low because their metabolism slows. If a fumigation lasts over a lengthy period, there also may be important temperature fluctuations. Heating the fumigated area and increasing air circulation can overcome most low temperature related problems.

Sorption of fumigant molecules by commodities or surfaces in the treatment area reduces the concentration. With the exception of temperature, little can be done to change sorption qualities. Therefore, the applied dose of fumigant may need to be increased. Whenever fumigation takes place over soil, such as outdoor bulk commodity fumigation or structure fumigation, the texture of the soil and its moisture content will influence fumigant concentration. Soils made up of fine clay or loam have less space between particles. Coarser soils, such as silt or sand, are much more porous and hold more fumigant. Increasing soil moisture by wetting will lower fumigant loss.

The way a fumigation site is sealed influences how fast fumigant molecules escape. Poorly sealed seams or holes in the tarp allow a quicker drop in concentration. Wind may increase the amount of air exchange between the fumigation site and the external environment, speeding fumigant loss.

Sealing

In most cases, the only way to achieve a sufficiently high concentration of fumigant is to seal the treatment area with a gas proof barrier. The best possible seal should be at the lower sections of the fumigated space, since most fumigants are heavier than air. Leaks in the lower portion of the fumigated space will allow more fumigant to be lost than leaks in upper areas.

Sealing can be accomplished in several ways. One method is to cover the treatment site with four or six mil polyethylene sheeting or an impregnated gas proof tarpaulin. Some containers, such as storage bins and truck trailers, may be sufficiently airtight, and therefore, may only require taping around openings or vents. Seams or cracks can sometimes be sealed with a liquid that expands to form a solid foam after being applied. Sealants that come into contact with food must be approved food grade sealants. Fumigation chambers are built to be airtight so they usually need no additional sealing.

It may be necessary to wet the soil around the foundation when doing structural or outdoor fumigations. This will reduce the amount of fumigant that will pass into the soil and will help achieve a good seal. Concrete or asphalt surfaces provide a satisfactory seal.

In structural fumigations, look for potential problems associated with tarping, such as landscape plants. Plants can interfere with sealing, and they may be damaged by the fumigant. Fragile roofs or roof mounted structures can also be damaged in the sealing process unless special care is taken.

Structural fumigation may also require sealing of areas within the structure. Materials that may be damaged by the fumigation and that can't be removed should be sealed off to exclude the fumigant gas. Drains and other conduits for the fumigant may also need to be blocked. However, it should be recognized that these areas may also provide refuges and, if not exposed to the fumigant, allow some of the target pests to survive the treatment. Pay particular attention to flames (including all pilot lights) and electrical heaters. **The fumigator should contact your local gas company to determine what procedures should be followed in your area when it comes to shutting off gas service to a fumigation site.**

Seal seams and holes in the tarp with durable tape or clamps. Cover sharp edges of a vehicle, container, or structure with protective material, such as foam rubber, to keep them from tearing the tarp.

Moisture may condense inside the tarp or on surfaces or commodities being fumigated. Condensation is greatest during periods of high humidity or falling temperature. High humidity may be due to a recent rainfall or because of high humidity of the commodity. Condensation can cause several problems, such as interfering with the fumigant and damaging commodities by staining, spotting, and surface corrosion. If possible, dry out commodities or areas having high moisture before beginning a fumigation. Drying can be quickened by heating, exposing the materials to sunlight, increasing air circulation, or -- in closed buildings -- running air conditioners before and during tarping to remove moisture.



With tarpaulin fumigation, careful consideration must be given to the method of obtaining a ground seal. If concrete and asphalt surfaces are smooth, they are satisfactory. Wood surfaces are not suitable. With wood and most soil surfaces, it's necessary to place a section of the tarp material beneath the commodity as well as over it.

There are several methods of getting a good ground seal. Allow enough tarp material to skirt outward to at least 18 inches from the stack. Loose sand, sand snakes, or water snakes can then be used to hold the skirt to the ground surface.

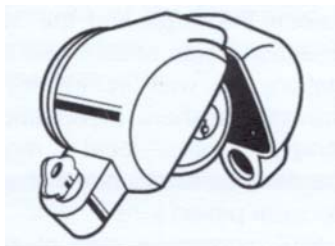
Posting and Security at a Fumigation Site

In addition to technical knowledge required for fumigation, the fumigator must at all times be guided by a good sense of safety and judgment. No two fumigations are exactly alike. Each job requires a fumigator/crew to establish a temporary fumigation chamber (unless using a chamber) in the field, often under adverse conditions. This must be in a manner that will effectively control the target pest(s) without causing undue risk to people and/or highly valuable property.

All fumigants are toxic gasses. The Nevada Department of Agriculture has specific regulations regarding security of fumigation sites. NAC 555.510 outlines the State's general fumigation requirements and specific site security requirements when conducting a structural type fumigation which may be in addition to label directions. The fumigator must conform to all label directions, as well as to all federal, state and local regulations – always remember state OSHA regulations when working on structures!

Some generalizations in common with most fumigants are as follows:

1. The fumigated site is required to be posted with specific warning signs on all usual entrances to the site during the exposure period and aeration period and must be in both English and Spanish.
2. During structural fumigations all normal entrances to the structure must be locked and in some cases a secondary locking device may be required on all exterior doors (read the label carefully for this requirement).

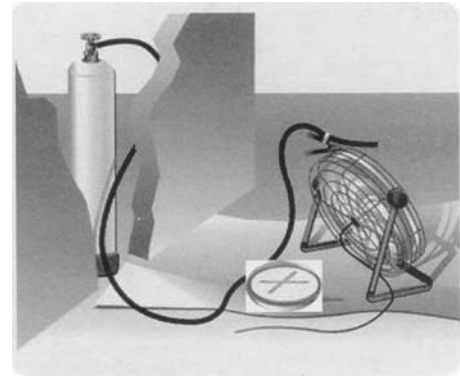


Applying the Fumigant

Before applying any fumigant, notify local fire and police authorities and other security personnel as to the location, chemicals to be used, proposed date and time of the fumigation, type of protective equipment required, and fire hazard rating. If necessary, provide authorities with pertinent safety literature on the materials to be employed. In addition to normal equipment needs, also arrange for standby equipment, replacement parts, and an alternate plan of action.

The proper introduction of a fumigant into an enclosed area is often referred to as "shooting" or "shooting the fumigant." This introduction is essential to the success, safety and economy of a fumigation. It is imperative that the fumigator understand the principals involved as well as the conditions that exist for introducing the fumigant on each job. Remember no two are alike.

Methods of application, or shooting, vary according to the type of fumigant used, what is being fumigated, and where the fumigation takes place. The way fumigants are applied in any situation, however, influences the degree of control of the target pests. Incorrect application or improper introduction of the fumigant can damage the area, damage the commodity, or injure people.



Gas Fumigants



Gas fumigants come packaged under pressure in large steel gas cylinders or small metal cans. When using fumigant from a large cylinder, suspend the cylinder from a scale and monitor its weight change over time to calculate the rate of application. The total weight of fumigant used will determine the dosage applied.

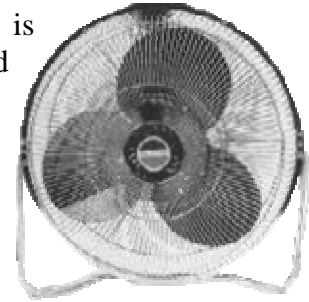
Gas is injected into the treatment area through one or more hoses or shooting tubes. Rate of application is influenced by the diameter and length of the shooting hose. Nozzles attached to the shooting hose further affect the fumigant release rate. Cylinder pressure also controls the rate of release, the pressure in the cylinder being influenced by the remaining gas and cylinder temperature. Obtain charts from the fumigant supplier to calculate the optimum release rate for the fumigant being used.

Releasing fumigant too fast may cause rapid cooling of the fumigation site and result in poor fumigant distribution. Rapid cooling will also promote condensation of water vapor. Releasing the fumigant too slowly may cause icing of the shooting tube and possibly restrict the flow of fumigant. As the ice melts, it may spot or stain. Slow release may also prevent the fumigant from reaching the effective concentration



quickly enough to control the target pests.

Fans or blowers should always be used when the fumigant is heavier than air. Continue the use of fans or blowers until the desired concentration of fumigant is achieved uniformly throughout the fumigated space. The desired concentration should be read using an appropriate Thermal Conductivity Gas Analyzer or T/C unit. Discontinue its use after this point to reduce potential leaking.



Pelleted Fumigants

Phosphine gases are mainly used in protecting bulk grains and needs to be evenly distributed to provide adequate fumigant levels. Pellets should be inserted deeply within the grain mass, at least five feet, and no more than 50 pellets or 20 tablets should be inserted per probe. Applicators should also wear cotton gloves so that perspiration doesn't contact the aluminum phosphide, releasing the phosphine gas. The applicator not making the probes should periodically monitor fumigant (hydrogen phosphide / phosphine) levels.

Since hydrogen phosphide gas doesn't provide adequate and uniform concentrations more than 30 feet below its application site, supplemental insertions may be needed in larger structures. These may sometimes be able to be inserted through the aeration or drying fan. Within grain storage facilities, it's best to tarp over the surface of the grain mass. If the grain isn't tarped, the fumigant rate must be increased to provide adequate concentration in the bin headspace as well as within the grain mass. Eaves and roof hatches must be tightly sealed if the grain surface isn't covered.

Phosphine gases are also labeled to control certain types of burrowing rodents and moles in outdoor settings. The pellets should be placed as follows, depending on the burrow system: **Closed burrows** (pocket gophers) – place 2 to 4 tablets or 10 to 20 pellets in the main underground runway 12 to 18 inches from a fresh mound. For **open burrow systems** the same rate applies, however all entrances to the burrow system must be plugged or sealed tight, except for one where the pellets or tablets are to be placed. That entrance will be plugged with crumpled paper and soil after the pellets or tablets are placed. The paper prevents soil from covering the pellets or tablets. At the time of publication, no endangered species considerations were placed on phosphine gas fumigants labels for any county within Nevada. However, Nevada does have a number of endangered and threatened species that utilize ground burrows. For a listing of these species in your county, contact the U.S. Fish and Wildlife Service at:

<http://www.fws.gov> or 1-800-344-9453

Liquid Fumigants

Liquid fumigants volatilize rapidly into a gas. The gas then penetrates through the commodity being treated. To assure even distribution, apply liquid sprays to commodities as they are being loaded into a storage container or storage building. Consult the fumigant label to determine protective clothing and equipment needs for these applications.

Carbon Dioxide

Use of carbon dioxide as a fumigant requires special application since the gas must displace much of the existing air to achieve the necessary concentration, usually 60 percent. This requires introducing large amounts of the gas and venting the structure to allow the normal atmosphere to be expelled. A top down purge involves allowing the CO₂ to be introduced at the top of the structure, displacing air as it settles downward. Bottom injections of carbon dioxide are sometimes used in storages with leaky roof or eave areas. Following the purge, complete sealing will result in the most successful fumigation. Additional injections of small amounts of CO₂ should be made when measurements indicate that concentrations have dropped below 50 to 60 percent.

Aerating

When fumigation is completed, the fumigant must be completely dissipated by aeration before allowing access to anyone or before vehicles can be moved. **It is an applicators responsibility to read and follow all label directions and to have available a current fumigation guide or fumigation manual in addition to the product label. The information below is not all inclusive to all products but will provide a general understanding of fumigant aeration procedures. Read and follow the current label on the product you use, and follow the most current fumigation guide or manual associated with the product you choose!**

Bulk Grain and Other Commodities

Wear label required respiratory equipment to aerate bulk items that have been covered with a tarpaulin. First, pull the tarp up from the sides for about 30 minutes, then remove the tarp completely. If this fumigation was made inside a building, open doors and windows and use fans to exhaust the fumigant. The air being exhausted from the building must be directed away from work areas, sensitive plants, and neighboring property. Make sure downwind areas in the vicinity are kept clear to prevent people or animals from contacting the fumigant as it disperses.

If entry into a building is required, check the fumigant level to determine the level at which it's safe to allow re-entry without protective equipment, if the level is unknown, respiratory equipment is required. Take measurements at several locations.

Continue to keep people away until monitoring equipment confirms that the fumigant level is below the harmful stage. Continue to aerate for several hours, and leave the building or commodity unsealed; this will prevent a fumigant buildup by desorption.

Vehicles

Roll back the tarp that covers boxcars or truck trailers, and open the doors and ventilators for 30 to 60 minutes; then remove the tarps. Measure the fumigant level before entering the fumigated area, and wear protective equipment until the fumigant has dispersed. To prevent injury, notify people who will open the vehicle at its destination that they must wear respiratory protection.

Instruct them not to unload the vehicle until fumigant levels have been monitored again and are determined to be in the safe range.

Buildings

Wear the label recommended respiratory protection when beginning the aeration of structures. Use fans to force the fumigant out of the structure. Fans should be installed during tarping and before the fumigant is applied. Connect electrical cords to a remote power source so the fans can be started without entering the fumigated area. Be sure the exhaust from the fans is directed away from work areas, sensitive plants, and neighboring work areas.

Begin by starting the fans, which will pull the tarps up against the sides of the structure. When the tarps have drawn up tight, slightly open a seam on the opposite side of the building from the fans. Wearing respirator equipment, enter the structure and close outside doors and most windows to prevent fumigant inside the building from getting into the space between the tarp and the building's exterior.

Next, remove the bottom seal, working in both directions away from the exhaust fans. Open all lower tarp seams before opening roof seams. Pull tarps up or peel them away from the sides of the building rather than dropping them to the ground. As soon as tarps are being removed, the exhaust fans can be shut off and all doors and windows opened.

After tarps have been removed, use an atmosphere monitoring device to determine when the fumigant has been dissipated well. Check for pockets of the fumigant in low areas and in corners, closets, crawl spaces, basements or other areas where there is poor air circulation. Areas where there are porous materials may have sorbed quantities of fumigant that will be more slowly dissipated. Longer aeration periods will be needed under these conditions. To hasten the desorption process, increase the temperature inside the structure and maintain good air circulation. Be sure to ventilate refrigerators and freezers as well as attics and crawl spaces.

Special Considerations for Fumigant and Container Disposal

Fumigants are hazardous materials; empty containers and any excess or unused fumigants must be handled appropriately. The correct method of handling fumigant containers differs among fumigant products. Empty canisters or tanks that were used to hold methyl bromide, Vikane® or CO₂ under pressure should be returned through the original shipper to the manufacturer for recycling, refurbishing and refilling. Some chloropicrin containers should be handled in the same manner, while others should be triple rinsed, punctured and disposed of in landfill. Consult your dealer, manufacturer and/or product label for instructions.

Unused phosphine gas pellets or tablets in opened flasks should not be disposed of. Once flasks are resealed, these tablets or pellets can be stored safely (as long as the label remains intact) for future use. Do not store flasks at sub-zero temperatures as doing so will increase the likelihood of ignition (flash) when they are opened.

If phosphine gas tablets or pellets are spilled or flasks are punctured, hydrogen phosphide gas is released. Persons cleaning up the spill or working in the contaminated area must wear an SCBA unless gas detection equipment is used. If gas concentrations are measured and if hydrogen phosphide concentrations range between 0.3 and 15.0 ppm, a canister respirator should be used. At higher concentrations, an SCBA is required. Cleanup personnel should wear cotton or neoprene gloves while handling spilled material. If a spill can be cleaned up immediately, spilled pellets or tablets should be used immediately or transferred to an empty flask with an intact label. If such a container isn't available, tablets or pellets can be placed in a sound, DRY metal container that should be sealed and labeled as aluminum phosphide (see NAC 555.445). Remember, a complete product label must be available for the product.

If spilled material has begun to react and decompose, or if it's contaminated by other substances so that it can't be safely stored, it should be gathered and placed into open top, perforated gallon cans and deactivated immediately according to the manufacturer's directions. Don't use water to clean up an aluminum phosphide spill. Water will react with tablets or pellets to rapidly release hydrogen phosphide gas, and the rapid production of gas can result in spontaneous ignition and explosion.

In general, to deactivate unreacted or partially reacted phosphine gas tablets or pellets, transport them by hand or in an open vehicle to a location in the open air away from occupied structures. Fill a drum two-thirds full of water, and add one-fourth cup of low sudsing detergent or surfactant for each gallon of water. Mix each flask of tablets or pellets with no less than one gallon of the water detergent mixture. Wear respiratory protection equipment, and slowly add the phosphine gas tablets or pellets to the drum while stirring. Stir occasionally thereafter for at least 36 hours. **DON'T COVER THE CONTAINER!** Covering the container will confine the hydrogen phosphide gas that is generated, and the resulting high concentrations may explode. This **wet method** of deactivation is preferred when five or more flasks of materials must be deactivated. The resulting slurry may be disposed of at an approved landfill.

An alternative to slurry deactivation is **dry deactivation** (for small quantities not exceeding five flasks). If allowed by the manufacturer, pellets or tablets can be spread out in an open, secure area away from occupied buildings and deactivated by atmospheric moisture.

Disposal of residual dust from reacted pellets or tablets is necessary following a space fumigation. Residual dust is grayish white, and it contains a small amount of unreacted aluminum phosphide. (Tablets or pellets that are only partially reacted remain slightly greenish in color and should be disposed of in the manners described above for spills.) Residual dust from up to five flasks can be disposed of by on site burial or by spreading over the land surface in a secure area away from inhabited buildings. This amount of dust may also be disposed of at a sanitary landfill or an approved pesticide incinerator. For larger amounts of residual dust a detergent slurry disposal method, described above, is recommended. See product labels for additional directions.

Residual dust from up to three flasks can be held in an open one gallon bucket pending disposal. Larger amounts of dust should be held in a porous cloth bag during any storage or transport before disposal. Don't put the residual dust from more than eight flasks of tablets or ten flasks of pellets in any one bag before disposal. Greater amounts may generate enough gas to risk explosion. Don't pile bags. Don't confine, dispose of, or store residual dust in closed containers such as dumpsters, drums, or plastic bags. Don't dispose of dust in toilets.

Empty flasks that contained phosphine gas tablets or pellets may be recycled or disposed of in a landfill after they have been properly processed. To adequately clean flasks before disposal, flasks and stoppers may be triple rinsed and then punctured. A small number of empty flasks may be punctured and held outdoors in an open and secure area away from occupied buildings to allow complete reaction of any residues. Where triple rinsing is used, the rinsate may be disposed of in a landfill.

Note: DOT Transportation Regulations for most Fumigants

- Labels and Markings
 - Containers
 - Vehicles
 - Shippers are required to offer vehicle placards to transport vehicle drivers.
- Commercial Driver's License (CDL) with Hazmat Endorsement
- Shipping papers, vehicle manifest or bill of lading required.
- Incident Reporting
- Transportation of Hazardous Materials
 - DO NOT transport fumigants in the passenger compartment or trunk of a vehicle.
 - It is illegal to transport single cans of most fumigants.

Stored Commodities

Effective fumigation is possible when good storage practices are followed. For example, condensation and eventually caking and spoilage will occur if people fail to level grain peaks as outside temperatures drop during the fall and winter months. This same peaking will prevent even distribution of fumigants, allowing insects to survive in the areas that receive an insufficient amount of fumigant.

A fumigant is a tool that may be needed to help preserve the grain quality. Fumigants should only be used when needed, since they are the most hazardous type of pesticide treatment that can be used in grain treatment. In addition, fumigation is expensive and provides no long term residual protection.

Fumigation is needed when no other pesticide or control method can reach the insect infestation. If the insects are already inside the grain mass, no spray or dust can reach them. Fumigants act on most, if not all insect life stages of stored commodity pests. They control pests by diffusing through the space between grain kernels as well as through the kernel itself. Thus, fumigants are able to penetrate into places that are inaccessible to insecticide sprays or dusts.

In some parts of the country, field infestations can be heavy, with considerable internal feeding by the time the grain is harvested and brought in for storage. In these cases, especially if the infesting insects develop within kernels, the grain should be fumigated at the time of storage. Later, if the infestation is discovered throughout the grain mass, control could be difficult. Only a properly applied fumigant will circulate to all the pests.

Insect infestations can also occur in pockets deep within the grain mass. Special fumigation techniques are available to provide control in this situation, whereas insecticide sprays wouldn't be effective.

Fumigation isn't always practical. If grain is stored in the open, it would have to be covered with special gas retaining tarps. This would also be true of most open slat cribs or even wooden buildings. This procedure is very expensive and time consuming. While it's possible to find dosage recommendations for wooden buildings, the increased amount of fumigant required and the poor control often achieved make this practice cost prohibitive. Poor control often results in re-infestation just as large and damaging soon thereafter.

Fumigants exert their effect on grain pests only during the time in which the gas is present in the insects' environment. After the fumigant diffuses out of the grain, no residual protection is left behind, and the grain is again susceptible to re-infestation. The objective of fumigation, therefore, is to introduce a killing concentration of gas into all parts of the grain mass and to maintain that concentration long enough to kill all stages of insects present.



Insects and Related Arthropods

This section will identify several insects or related arthropods. Most of the identification, biology and behavior of these insects can be found in the Nevada Department of Agriculture's "Industrial and Institutional Control of Insects and Vertebrates" Volume III study manual and, therefore, will not be discussed in detail within this section. However, the most common infesters of stored commodities will be pointed out below. For information on the pests identifying features, biology and behaviors an applicator should consult an outside reference which deals with stored commodity pests, such as a handbook of pest control or other entomology / pest control guides.

Harborage Sites

Good sanitation is the foundation upon which a sound stored grain insect management program must be built. In many cases, severe insect infestation in grain bins develops from low level populations of pests that are able to exist in grain handling equipment or in and around the storage facilities. A thorough pre-harvest sanitation program can reduce these sources of insect infestations. The consequences of not cleaning up these infestations may not be seen until later in the storage cycle, after the insect population increases. The economic effects of poor pre-binning sanitation may include kernel destruction, commodity contamination, moisture and temperature problems resulting from the insect's metabolic processes, or structural damage to the bin due to the heat and moisture buildup.

Insect harborage sites may be classified as internal and external, with reference to the bin facilities. Internal harborage sites include grain residues on the bin floor, accumulations of grain clinging to bin walls, and the fines and kernels which build up beneath the bin floor and in the duct work of the drying system. The obvious, visible accumulations in the bin should be cleaned thoroughly when the bin is emptied. Accumulations beneath perforated floors mustn't be overlooked. Often, floor construction makes thorough cleaning hard, and the use of vacuum hoses is helpful. Treatment of the floor void area with a fumigant may have to substitute for cleaning, in some situations. Use of long handled brooms and shovels may be sufficient to clean out the bin area itself. Very thorough cleaning is necessary to reduce the likelihood of infestation. Properly dispose of grain and debris collected in the cleaning process.

External harborage sites is a catchall category that includes a number of sites around the bin that can contain small numbers of stored grain insect pests. Spillage near the auger, grain residues in harvesting equipment, and structures used to store animal feed are potential sources of stored grain pests. Auger pits are especially important sources of infestation. These areas must be watched carefully and kept clean. A comparatively small amount of spilled grain can provide enough insects to produce a serious infestation in stored grain.

The Pests - Identified

- ANGOUMOIS GRAIN MOTH - *Sitotroga cerealella*
- INDIAN MEAL MOTH - *Piodia interpunctella*
- GRANARY WEEVIL, RICE AND MAIZE WEEVILS - *Sitophilus granarius; Sitophilus oryzae; Sitophilus zeamais*
- CADELLE BEETLE - *Tenebroides mauritanicus*
- LESSER GRAIN BORER - *Rhyzopertha dominica*
- FLAT GRAIN BEETLE - *Cryptolestes pusillus*
- FLOUR BEETLES –
 - Confused flour beetle - *Tribolium confusum*
 - Red flour beetle - *Tribolium castaneum*
- MEALWORMS
 - Yellow mealworm - *Tenebrio molitor*
 - Dark mealworm - *Tenebrio obscurus*
- FOREIGN GRAIN BEETLE - *Stegobium paniceum*
- CIGARETTE BEETLES - *Lasioderma serricorne*
- DRUGSTORE BEETLES - *Stegobium paniceum*
- MERCHANT GRAIN BEETLE - *Oryzaephilus mercator*
- SAW- TOOTHED GRAIN BEETLE - *Oryzaephilus surinamensis*
- PSOCIDS - *Liposcelis spp*
- GRAIN MITE - *Acarus siro*

Target Pests and Commodities Subject to Fumigation

Most fumigation operations are directed toward a specific target pest or group or similar pests in a common or similar host; i.e. insect pests in stored grain, flour, meal, noodles, nuts and etc. If the infestation is light, the commodity can sometimes be used after fumigation. Even if the infestation is so heavy that the commodity will have to be destroyed after fumigation, fumigation may be warranted to prevent spread of the insects to uninfested items.

STORED GRAIN	FLOUR AND FLOUR PRODUCTS (fry and cake mixes, spaghetti, macaroni, noodles, etc.)
Granary weevil* Lesser grain borer* Saw-toothed grain beetle* Flat grain beetle Rice Weevil* Cadelle or flour worm* Red flour beetle Indian meal moth Angoumois grain moth Larger cabinet beetle Khapra beetle	Flour beetle (<i>Tribolium sp.</i>) Granary weevil* Saw-toothed grain beetle* Rice Weevil* Cadelle or flour worm* Indian meal moth Khapra beetle Cigarette beetle* Drugstore beetle* Mediterranean flour moth
SPICES	TOBACCO
Cigarette beetle* Drugstore beetle* Dermestids* Khapra beetle	Cigarette beetle* Drugstore beetle* Dermestids*

DEHYDRATED FOODS (soups, powdered milk)	NUTS AND DRIED FRUIT
Indian meal moth Dermestids* Khapra beetle	Indian meal moth Cadelle or flour worm* Saw-toothed grain beetle* Flour beetle (<i>Tribolium sp.</i>) Khapra beetle
DRIED PEAS AND BEANS	
Common bean weevil* Cowpea weevil* Khapra beetle	* = Pests which can penetrate paper or plastic packaging. Khapra beetle is not known to occur in the United States.

Pathogens

Storage rots or moldy grain may develop in grain storage bins if the moisture content of the kernels is excessive and the air temperature is high enough to permit fungus growth. More than 150 different species of fungi have been reported on cereal grains. The major storage fungi are species of the common molds, *Aspergillus* and *Penicillium*. Some species of fungi such as *Alternaria sp.* and *Fusarium sp.* can cause infection in the field and advanced decay in high moisture grains. Some of the fungi that grow in grains and other seeds before harvest or in storage produce toxins. One of the common storage fungi, *Aspergillus flavus*, produces several toxins, called aflatoxins, that cause problems when fed to animals and can cause cancer in humans.

Storage fungi cause loss of germination, dark germs (in wheat, designated germ damage or sick wheat), bin burning, mustiness and heating. These are the final results of invasion of grain by storage fungi. Storage fungi are the cause, not the result, of spoilage.

Depending on the commodity, toxin contamination is either a field problem, a storage problem, or a combination of the two. Since toxins are produced by fungi, they should be viewed as a potential danger anywhere fungi grow on materials which are used as food or feed. Fungal contamination is necessary for the production of toxins, but toxicity is certainly not the inevitable result of all fungal invasions. Fungi are almost universally present on and in cereal grains, nuts, and nearly all other plant materials, but toxicity seems to be the exception rather than the rule.

Fumigant- types Effectiveness

Understanding how fumigants react in grain and what influences their behavior is an essential step in developing the know how to effectively and safely use grain fumigants.

Sorption -- When a fumigant gas attaches itself to the surface of a grain kernel or penetrates into the kernel, it slows diffusion and disrupts penetration of the fumigant through the grain mass. However, some sorption must occur if the fumigant is to reach all stages of pest insects, especially those that develop within the kernel. The degree of sorption of individual components is the basis for selection of many of the liquid fumigant mixtures. These mixtures include chemicals which are sorbed at different rates, letting some fumigant vapors penetrate a grain mass readily while others are held near the surface of the grain mass. Some fumigants, when

sorbed into a kernel, react with materials in the grain to form other chemical compounds that may be permanent, thus forming residues. Fumigants containing bromide, such as MB, are especially subject to this type of chemical reaction, which has necessitated the establishment of residue limits or tolerances for the amount of bromide permitted in grain.

Temperature -- Temperature influences the distribution of fumigants in grain and affects their ability to kill insects. At temperatures below 60 degrees F, volatility of a fumigant is reduced significantly, sorption of fumigant vapors into the grain is increased, and distribution is less uniform throughout the grain mass. Gases move more slowly and insects breathe less at colder temperatures. Thus, it takes longer for the fumigant vapors to reach insects in the grain, less gas is actually available for controlling the pests, and since the insects are less active, less gas enters their bodies. Desorption may take longer at cold temperatures because grain retains more fumigants longer at lower temperatures, thus requiring prolonged ventilation periods.

Grain Moisture -- The moisture content of grain also influences the penetration of fumigant gases by altering the rate of sorption. In general, "tough grain" requires an increase in dosage or an extended exposure to compensate for the reduced penetration and increased sorption.

Grain Type and Condition -- Various grains have different characteristics that can affect fumigation. The surface area of individual grain kernels is an influencing factor in the dosage required to treat various commodities. Increased surface means greater sorption loss, which reduces the amount of fumigants left in the space between the grain kernels and further reduces the amount of fumigant available to penetrate throughout the grain. To compensate for this increased loss, higher dosage rates are required in sorghum than in wheat, especially when fumigants are used that are easily sorbed by the grain.

The type and amount of dockage in grain has a pronounced effect on the sorption and distribution of fumigants. When the grain mass contains large amounts of dockage such as crust, chaff or broken kernels, the fumigant vapors are rapidly sorbed by this material, and further penetration into the grain is impaired. Unfortunately, such areas are often sites that attract the greatest number of insects. When isolated pockets of dockage occur within a grain mass such as below grain spouts, fumigant vapors may pass around such pockets and follow the path of least resistance down through the intergranular area of the grain. Similar changes in fumigant distribution patterns may be obtained in grain that has settled or compacted unevenly during long storage periods or in storages vibrated by nearby traffic such as a railroad.

Insects -- Grain insect pests and their various developmental stages (egg, larva, pupa and adult) vary in their susceptibility and resistance to fumigants. Beetles and other insects that develop outside grain kernels are usually more susceptible to fumigants than certain moth and beetle species that develop inside grain kernels. The pupae and eggs, which breathe very little, are the hardest developmental stages to kill, while the young larvae are relatively susceptible.

Heavy infestations in which large amounts of dust, damaged grain, webbing, and cast skins have accumulated are harder to control because of the effect these materials have on the penetration and diffusion of grain fumigants.

Storage -- A fumigant, whether applied initially as a gas, liquid or solid, eventually moves through space, penetrates the grain, and is taken in by the insect in the form of a gas. The gas tightness of the grain bin, therefore, greatly influences the retention of the fumigant. Metal bins with caulked or welded seams or concrete bins will still lose some gas but are generally better suited for fumigation than loosely constructed wooden bins.

Although there are often label recommendations for fumigation of grain in wooden bins, the high dosages and poor control usually achieved normally make this type of fumigation uneconomical.

The size and shape of the storage structure affect both distribution and retention of fumigants. The height of a storage bin often determines the type of fumigant used and its method of application. Some liquid fumigants will readily penetrate substantial depths of grain, but solid fumigants may be more effective if mixed with the grain during transfer into the bins.

Winds and thermal or heat expansion are major factors influencing gas loss. Winds around a grain storage structure create pressure gradients across its surface, resulting in rapid loss of fumigant concentrations at the grain surface and on the downwind side of the storage. The expansion of head space air due to solar heating of roofs and walls followed by night time cooling can result in a "pumping" of the fumigant from the bin. Large flat storages that contain more grain surface than grain depth are especially susceptible to gas loss due to wind and heat expansion. The greatest gas loss often occurs at the grain surface, a location that often contains the highest insect populations. Furthermore, when the grain surface is uneven, with large peaks and valleys, the distribution of fumigants through the grain will also be uneven.

Air Movement -- Successful fumigation of stored grain requires an understanding of air movement within the grain mass. It's easy to think that the air between the kernels of grain in a bin is as immobile as the grain itself. This isn't true and is one of the reasons that fumigation sometimes fails, even when done by professional fumigators.

Air moves along the path of least resistance, with warm air moving upward and cold air moving downward. In a bin, there is usually air movement both up and down because of temperature the difference between the well insulated middle and the grain near the edge that is affected by outside temperature. Air movement upward can carry moisture that can condense on the surface and cause crusting. The resulting crust can also interfere with air and gas movement. Air will move easier through a grain mass composed of larger kernels, such as corn, and more slowly through those composed of smaller grains, such as grain sorghum. Air may move around a hot spot and carry a fumigant gas away from the critical area. Fumigant gases can penetrate these areas better than normal air, but the air movement can affect how much gas reaches and stays at these critical stress areas.

Gas movement in a grain mass is affected by other forces such as gravity, sorption, temperature, and moisture content, but an understanding of air movement is the first step in understanding the many forces that determine gas dispersion.

Preparing Bins -- Attention to proper sealing of grain bins prior to fumigation will often make the difference between success or failure of a treatment. A high degree of gas tightness is essential to achieve the required combination of gas concentration and time of exposure necessary to kill grain pests.

Metal storage bins are not gas tight, since they were originally designed to hold and

aerate grain. With proper sealing, they can be used for fumigation. It's important to recognize that the bins will vary in tightness, depending how well they are built. If the corrugated sections were caulked when put together and then bolted tight, they will be more effective when sealed. Loosely constructed wooden bins may have to be covered totally with a gas tight tarpaulin to retain enough fumigant to be effective.

Remember, the goal is to try to confine a gas for a sufficient length of time at a proper concentration to be lethal to the target pests. Sealing is extremely important and demands study and work, but there are professional techniques that can make the job more effective.

There are a number of places in a bin where gas can escape. The roof wall juncture looks tight from the outside, but examination from the inside will show a gap around the perimeter in many bins. This gap is hard to seal because it's usually dusty and may be damp. Cracks wider than one inch are even harder to seal. It's necessary to clean the dust from the surface before it can be taped or sealed with any other material.

An adhesive dispensed from a pressurized can may be used and then sealed with duct or furnace cloth tape since this is more effective here than masking tape. Use at least two inch and preferably three inch tape when sealing these cracks.

Polyurethane foams can be used to seal this gap, but they're expensive and hard to remove if the gap is needed for extra grain aeration. Insects can burrow into the foams and destroy their effectiveness, but they can provide a good seal for several years.

Another key area to seal is the gap between the bottom of the wall and the floor. Some manufacturers design the wall base to accept special sealants that can give a long term seal. Various sealing materials have been used, including one made with polyurethane impregnated with asphalt. Plain asphalt has also been used but doesn't have as much elasticity.

Roof ventilators can be covered with plastic bags. The bags are less likely to tear against sharp edges if a burlap bag is placed over the ventilator first. The plastic bag should be gathered in at the base, then taped in place. Be very careful in this work to avoid falling.

Bin doors are not gas tight when merely closed. They can be cleaned and sealed with masking tape, or if not used regularly, they can be sealed with foam-in plastic.

Aeration fans and their housing must be sealed to avoid gas loss. Normally, polyethylene glued to the air intake will be sufficient. However, the unit should be examined for other potential leaks.

Professional fumigators long ago found that it was hard to get tape or plastic to stick to the dusty surfaces of grain bins. Cleaning is necessary and helpful, but more is required. An expensive but useful tool is the pressurized can of tape primer. This can be obtained from the fumigant distributor or sometimes from an auto paint store. These materials give the surface a tacky feeling and help hold the tape on much better. They can be applied to the adhesive surface of a piece of tape to improve its sticking power. Although taping of a damp surface isn't recommended, it can sometimes be done with this material.

Another alternative to taping the eaves is to cover the entire roof with a plastic sheet formed into a bonnet or cap which drapes over the top of the bin and extends down past the roof joint. An adhesive sprayed or painted in a horizontal band around the outside bin wall will provide a point of attachment for the plastic sheet. The bonnet can then be secured by rope, using the corrugation grooves on the bin to reduce slippage. Obviously, this sealing method can only be partially completed before application of the fumigant in order to provide access to the grain surface.

Level the grain surface and break up any crusted areas that have formed. When grain is peaked, the action of fumigants is similar to rain on a hillside. The heavier than air gases simply slide around the peak, resulting in poor penetration and survival of pests in the peaked portion of the grain. Moldy or crusted areas near the grain surface are generally caused by moisture condensation when warmer air in the grain rises to the surface and encounters cold air above the grain. These areas are sometimes hidden from view just below the grain surface. Failure to locate and break up these areas will result in uneven penetration of grain fumigants and may lead to further deterioration of the grain from mold development and invasion of the grain by insects that feed on grain molds.

Application and Distribution

Liquid Fumigants can be applied in two principal ways:

1. Grain stream application.
2. Surface application.

Grain Stream Application -- In this method, liquid fumigant is added to a stream of grain entering a storage bin or being transferred from one bin to another. A measure rate of grain flow is needed in order to apply the correct amount of fumigant. Extra dosages can be applied to the beginning of the grain movement and at the end to insure adequate distribution of fumigant at the top and bottom of the mass. Grain shouldn't be fumigated unless it's infested.

Storage condition and construction materials also determine the amount of fumigant needed and its probable effectiveness. Turning also may cool the grain, which may reduce insect activity in the grain. It's most effective during fall and winter in the temperate zones.

Insect activity will cease at about 50 degrees F (10 degrees C), and over time, many will die.

DO NOT use liquid grain fumigants on ground materials – Animal losses have resulted from the addition of liquid fumigants to ground feed. The liquid tends to agglomerate the finer particles into “balls” which retain the fumigant in a liquid form.

Two disadvantages follow: (1) the gaseous vapors of the fumigant do not penetrate the ground material and therefore are less effective in countering an insect infestation and (2) the “balls” contain enough of the fumigant to have toxic effects on animals ingesting the feed. Conveying and handling of fumigated ground feed will not remove the fumigant like the same handling will do for whole grains. Insect infestation is best controlled by good housekeeping, cleaning and spraying bins and by use of liquid fumigants on whole grains only. Bagged feed has been treated by using a gaseous fumigant in tight storage. Bulk ground materials are almost impossible to treat effectively by any fumigant.

Solid Fumigants -- Solid fumigants may also be applied using the grain stream method, or they can be applied by probing them into the grain mass in a checkerboard fashion.

Other Fumigant Methods -

1. **One Pass Forced Aeration** – This method is quite similar to surface application in that the fumigant is applied to the top surface of the grain. Use of aeration equipment then speeds up the penetration of the vapors into the grain mass. The equipment is shut off as soon as fumigant is detected in the exhaust air.
2. **Recirculation Aeration** - Essentially the same as one pass forced distribution except that fumigant is recycled through the grain mass by appropriate ducting from exhaust ports to point of entry.



Dosage and Time of Exposure

Because fumigants act in the gaseous state, the dosage necessary to kill an insect is related to the concentration of gas surrounding the insect, the insect's respiration rate - which is related partially to temperature, and the time of exposure of the insect to the specific concentration of fumigant. There's a general relationship for most fumigants between concentrations and time: high concentrations require shorter exposure time and low concentrations require long exposure to achieve comparable kill.

Variations in recommended dosages are generally based on sorption differences of commodities and the relative gas tightness of different storage structures. For example, dosage requirements for sorghum are generally higher than for less sorptive commodities such as wheat, and dosages in wooden bins are higher than in steel or concrete bins.

Calculating Dosage -- All fumigant labels provide information on the recommended dosages required to effectively treat stored grain. Using less fumigant than is recommended can result in too low a concentration of gas to be effective. Using more fumigant than recommended is illegal, adds cost, and may not increase efficiency.

Dosages found on most liquid fumigant labels are expressed in gallons of fumigant to be applied per 1,000 bushels of grain. The required dosage varies with the formulation. Once the dosage recommended for the conditions of your fumigation have been identified from the label chart, you only need to calculate the number of bushels to be treated to determine the total fumigant dosage. The number of bushels in a bin may be calculated using one of the following formulas:

If the bin is round: Bushels = $0.6283 \times \text{diameter (ft.)} \times \text{diameter (ft.)} \times \text{grain depth (ft.)}$.

Example: An 18 foot diameter bin containing 15 feet of grain would equal:

$0.6283 \times 18 \times 18 \times 15 = 3,053.5$ bushels. If the recommended dosage is three gallons per 1,000 bushels, the total dosage required would be: $3,053.5$ divided by $1,000 = 3.053 \times 3 = 9.2$ gallons. If the recommended dosage was four gallons per 1,000 bushels, the total dosage required would be $3,072$ divided by $1,000 \times 4 = 12.28$ gallons.

Another method of calculating the number of bushels in circular bins is to multiply the grain depth by the number of bushels per foot of grain.

Example: A bin 18 feet in diameter contains 205 bushels of grain for each one foot depth. If the grain is 15 feet deep, the total bushels is obtained by multiplying $205 \times 15 = 3,075$ bushels.

Empty bins should be thoroughly cleaned and sprayed or fumigated before new grain is placed in the bin. The aeration duct and the raised perforated floor that distribute the air may be infested and are hard to reach with normal sprays.

Measuring gas concentrations

Much of this information is discussed in detail in the section entitled “Safety Precautions and Protective Devices”. However, a short discussion of these devices will be mentioned here relating to stored commodities. **Detection tubes** are probably the most versatile tools available for measuring gas concentrations. They're available for many industrial gases as well as almost all fumigants. The equipment used with the tubes is well built, durable, and manufactured by a number of suppliers. The initial cost of the equipment is moderate and can be amortized over hundreds of uses and many years. For most gases, they are sufficiently accurate.

The disadvantage of using these tubes is that they are designed for a single use on a single type of fumigant. Their cost of more than \$2 per tube can be burdensome when many readings are necessary. They aren't available for both high and low readings for all fumigants, so other detection tools may be needed. The tubes have a limited shelf life and aren't reliable after the expiration date. In addition, they have limited accuracy with some gases.

When a given quantity of air/gas mixture is drawn through the tube, a color change occurs in the reagents inside the tubes. This change can be easily read in parts per million.

To take a reading, it's necessary to first break the tips off the ends of the tube so that the air/gas mixture can be drawn through the tube. With some gases, it's necessary to break the tube in a second place and to mix two ingredients or to attach another tube containing different ingredients to the first tube.

The glass tips removed from the tubes should be disposed of properly to avoid any chance of food contamination or personal injury. If the tubes are to be retained, the tips should be covered with tape to mask them.

After the tip is removed, the tube is inserted into the pump according to the directional arrows. Instructions on the tube give the number of pump strokes required (example: $n = 3$ means three strokes) for a sample. Each stroke draws one tenth liter of air through the tube. New workers can learn to take accurate readings with a minimum of time and instruction.

If the air/gas sample is taken from a long monitoring hose, the hose line must be purged to give an accurate gas reading. Vacuum pumps are available that will speedup the purging operation. To ensure accuracy, it's better to purge too much than not enough. Naturally, readings should be taken in open air or other precautions taken to ensure that the purged air/gas mixture won't cause health problems.

With the Draeger methyl bromide tube, it's



very important that the tube is held in a vertical position when reading the ppm, or an improper gas reading may be obtained.

Most manufacturers have equipment called grab samplers that will take a single reading of the present concentration or long duration models designed to determine the average concentration of toxic gases or vapors a worker is exposed to over several hours.

Halide leak detectors have found uses in several industries. They are used to detect leaks of halogenated refrigerant gases, and they have been used to give reasonably accurate estimates of the concentration of methyl bromide related halogenated fumigant gases.

The propane fueled halide leak detector is the lowest cost fumigant detection instrument both in terms of initial purchase and in terms of cost per use. The gas is turned on and ignited, then adjusted so that the tip of the flame just pierces the copper ring. Air/gas mixtures are siphoned through the flexible tube, and a blue or green halo above the copper ring will indicate the presence of halogenated gas. It's important to keep the copper ring clean and to replace it periodically.

People vary in their ability to recognize shades of blue and green, but 25 ppm is the lowest concentration anyone could consistently recognize. This is adequate for spotting leaks in a structure but not for detecting five ppm, which is the presently recommended TLV for methyl bromide. Naturally, this instrument should never be used in an atmosphere where an open flame would be a hazard.

Volume Calculations / Formulas & Conversions

Cube	= length x width x height
Prism	= length x width x height ÷ 2
Warehouse	= cube (base) + prism (roof)
Pyramid	= length x width x height ÷ 4
House	= cube(s) + prism(s) + pyramids(s)
Cylinder	= π x radius ² x height
$\pi = 3.14$	radius = diameter ÷ 2
Cone	= π x radius ² x height ÷ 3
Grain bin	= cylinder + cone (roof)

1 acre = 43,560 sq. ft.

1 acre = 0.4 hectare

1 hectare = 2.47 acres

U.S. Bushel x 1.244 = ft³

ft³ x 0.8 = U.S. Bushel

°F = (°C x 1.8) + 32

°C = 0.555 (°F - 32)

16 oz/1000 ft³ = 1 lb/1000 ft³

oz/1000 ft³ = g/m³ = mg/l

Conclusion – Use Common Sense

It's essential that fumigators understand and follow the technical instructions that promote safe and effective fumigation of stored grain. It's just as important that fumigators remember to use good common sense when planning and carrying out a fumigation. Although it may be impossible to "teach" good common sense by writing instructions in study materials, the following comments are offered as reminders to exercise good judgment and to think ahead.

- Read and understand label directions. Demand information from the manufacturer and distributor. Don't use a fumigant without adequate training and confidence in your ability to do the job properly.
- Supply local medical personnel with fumigant and poison treatment information before using the fumigant.
- Preplan the entire job. Think through every step, and plan your reactions to possible problems and emergencies.
- Always work in pairs.
- Use, or have available, proper safety equipment. Make sure all equipment fits well and that all applicators are trained in and familiar with the use of necessary safety equipment.
- Don't take shortcuts; follow through with well planned and thorough application practices.
- Don't become complacent. Each job is a new challenge and a new situation in which an emergency may require rapid and proper reaction.

Summary

- Always read and follow the label directions.
- Fumigants are DEADLY. Treat them with care and respect.
- Plan and prepare for each step of the fumigation process.
- Know and use proper safety precautions.
- Properly store and maintain PPE and detection devices.
- Use a checklist to ensure all requirements are complete.
- Keep accurate and complete records.
- Never make assumptions. If you don't know, ask.

Fumigation Procedures – NAC 555.510

NAC 555.510 Fumigation procedures. ([NRS 555.380](#), [555.400](#))

1. Fumigation may be performed only under the supervision of a person who is certified pursuant to [NAC 555.600](#) to [555.700](#), inclusive.

2. The person exercising supervision over the fumigation shall be:

(a) Physically present at the premises being fumigated; and

(b) Available to provide immediate guidance and instruction to each person performing the fumigation.

3. Except as otherwise provided in subsection 4, the person exercising supervision over the fumigation shall ensure that:

(a) Before the commencement of fumigation, warning signs are posted in plainly visible locations on or in the immediate vicinity of all entrances to the area under fumigation and are not removed until:

(1) The fumigation and ventilation have been completed;

(2) Except as otherwise provided in paragraph (c), the premises have been tested and the concentration of the fumigant in the air is less than the level listed on the label of the fumigant as safe for reentry; and

(3) He determines the premises are safe for reentry.

(b) Ventilation is conducted with due regard for the public safety.

(c) If the label of the fumigant does not list a level of concentration of the fumigant in the air that the manufacturer has determined is safe for reentry, and the fumigant used is:

(1) Methyl bromide, chloropicrin or sulfuryl fluoride, the concentration of the fumigant in the air is 3 parts per million or less before he determines that the premises are safe for reentry;

(2) Aluminum phosphide or magnesium phosphide, the concentration of the fumigant in the air is 5 parts per million or less before he determines that the premises are safe for reentry; and

(3) Any fumigant other than those fumigants listed in subparagraph (1) or (2), he obtains from the manufacturer information concerning the level of concentration of fumigant in the air that the manufacturer has determined is safe for reentry and the level of concentration of fumigant in the air is the level determined to be safe by the manufacturer or less before he determines that the premises are safe for reentry.

(d) Warning signs are printed in red on a white background and include:

(1) The following statement, written in English and Spanish, in letters not less than 2 inches in height:

**DANGER/ PELIGRO
AREA UNDER FUMIGATION/ AREA BAJO FUMIGACION
DO NOT ENTER/ NO ENTRE**

(2) A skull and crossbones symbol that is not less than 1 inch in height;

(3) The name of the fumigant in use, the date and time the fumigant was injected; and

(4) The name, address and telephone number of the licensee performing the fumigation.

(e) The area to be fumigated is vacated by all occupants before the commencement of fumigation and all entrances to the area are locked, barricaded or otherwise secured against entry until the end of the exposure period, then opened for ventilation and relocked, barricaded or otherwise secured against reentry until he declares the area to be safe for reentry.

(f) Before the commencement of fumigation, the space to be fumigated is sealed in such a manner that tests taken before ventilation is begun will show that the required concentration of the fumigant released within the space has been retained therein in compliance with the manufacturer's recommendations.

(g) An adequate warning agent is used with all fumigants which lack such an agent if a warning agent is appropriate for use on the structure or other item being treated.

(h) At least one licensee and one person under the supervision of that licensee is present during:

(1) The release of the fumigant; and

(2) The ventilation process until the warning signs are removed from the premises.

(i) When conditions involving abnormal hazards exist, he takes such safety precautions in addition to those prescribed by this section as are reasonably necessary to protect the public health and safety.

4. If the requirements for use and warnings listed on the label of the fumigant are more stringent than the requirements set forth in subsection 3, the person exercising supervision over the fumigation shall ensure that the requirements listed on the label of the fumigant are satisfied.

5. In addition to the requirements set forth in subsection 3 or 4, the person exercising supervision over the fumigation of a structure that is used for human habitation or for business if employees or other persons occupy the structure shall ensure that:

(a) During the process of fumigation, the room, warehouse or apartment being fumigated, together with all rooms, units and apartments on the same floor and those above, below and adjacent thereto, are vacated by the occupants thereof.

(b) During the process of the fumigation, all rooms, units, apartments and hallways adjacent to the rooms, units, apartments or spaces undergoing fumigation are kept well ventilated and warning signs as prescribed in paragraph (d) of subsection 3 are kept posted at all entrances to these rooms, units or apartments during the time of the fumigation and thereafter until the premises:

(1) Are safely ventilated; and

(2) Have been tested and the concentration of the fumigant in the air is less than the level listed on the label of the fumigant as safe for reentry. Except as otherwise provided in this paragraph, such testing must be completed with a device which is specified on the label of the fumigant and which is calibrated to measure the smallest unit in which the concentration of the fumigant in the air is required to be measured. If the label of the fumigant does not specify the device to be used for such testing, a device that is calibrated in increments of 1 part per million must be used.

(c) A rooming or apartment house designed for four families or less is entirely vacated and closed against entry and occupancy while fumigation is being performed and thereafter until the premises:

(1) Are safely ventilated; and

(2) Have been tested and the concentration of the fumigant in the air is less than the level listed on the label of the fumigant as safe for reentry. Except as otherwise provided in this

paragraph, such testing must be completed with a device which is specified on the label of the fumigant and which is calibrated to measure the smallest unit in which the concentration of the fumigant in the air is required to be measured. If the label of the fumigant does not specify the device to be used for such testing, a device that is calibrated in increments of 1 part per million must be used.

6. The person exercising supervision over the fumigation shall ensure that:

(a) Each employee of the pest control business who is performing fumigation has been instructed in the use and administration of first aid and in the use and care of the safety equipment recommended by the Department or the manufacturer of the fumigant; and

(b) The following items are on the premises being fumigated and are in good working order:

(1) A first-aid kit that includes directions for artificial resuscitation;

(2) At least two gas masks or other respiratory protective devices that have been approved by the National Institute of Occupational Safety and Health and the Mine Safety and Health Administration;

(3) A testing device that satisfies the requirements set forth in subsection 5 to measure the concentration of the fumigant in the air during the fumigation process or the ventilation process;

(4) A complete label and any supplemental labels from the fumigant being used, including, without limitation, any instructions for the use of the fumigant published by the manufacturer of the fumigant; and

(5) For each type of fumigant being used, the antidote, if any, as prescribed by the manufacturer of the fumigant and the instructions for administering the antidote as prescribed by the manufacturer of the fumigant.

[Dep't of Agriculture, No. 55.39, eff. 8-1-74; A 1-17-77]—(NAC A 2-5-82; R033-01, 5-1-2002; R147-03, 1-22-2004)

Appendix A

Pest Photographs

Stored Commodity Pests

Structural Pests

Stored Commodity Pest Photos



Angoumois Grain Moth



Indian Meal Moth



Granary weevil



Cadelle Beetle—adult



Cadelle Beetle—larvae



Lesser Grain Borer



Flat Grain Beetle



Red Flour Beetle



Mealworm sp.—larvae



Mealworm sp.—adult



Foreign Grain Beetle — adult



Cigarette Beetle

Stored Commodity Pest Photos



Drugstore Beetle



Merchant Grain Beetle



Saw-Toothed Grain Beetle



Coffee Bean Weevil



Maize Weevil



Pea Weevil



Trogoderma sp.—larvae



Trogoderma sp.—adult



Khapra Beetle



Rice Weevil



Grain Mite



Psocids (Book Lice)

Structural Pest Photos



Bed Bug



Bostrichid Powderpost Beetle



Carpet Beetles



Lytic Powderpost Beetles



Anobiid Powderpost Beetles



Powderpost Beetles—Damage



Drywood Termites



Drywood Termite—Damage



Drywood Termite—Fecal Pellets



Formosan Subterranean Termites



Formosan Subterranean Termite—Damage

Appendix B

Sample Labels and MSDS's

Dow AgroSciences Vikane®

Dow AgroSciences Chloropicrin

Pestcon Systems, Inc. Fumitoxin®

Great Lakes Chemical Company METH-O-GAS® Q

Specimen Label

EPA Reg. No. 62719-4

Keep Out of Reach of Children

DANGER  **POISON**
PELIGRO

RESTRICTED USE PESTICIDE DUE TO INHALATION TOXICITY

For sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification.

 **Dow AgroSciences**

Vikane*

Specialty Gas Fumigant

*Trademark of Dow AgroSciences LLC

For control of: Existing infestations of insects and related pests such as (or including) drywood termites, Formosan termites, powder post beetles, death watch beetles, old house borers, bedbugs, cockroaches, clothes moths, rodents (rats, mice), and the larvae and adults of carpet beetles (except egg stage), oriental, American, and brown-banded cockroaches.

For use in: Dwellings (including mobile homes), buildings, construction materials, furnishings (household effects), shipping containers and vehicles including automobiles, buses, surface ships, rail cars, and recreational vehicles (but not including aircraft).

When fumigating, observe local, state, and federal rules and regulations including such things as use of chloropicrin, clearing devices, positive-pressure self-contained breathing apparatus, security requirements, and placement of warning signs.

Active Ingredient	
sulfuryl fluoride	99.8%
Inert Ingredients	0.2%
Total	100%

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazards to Humans and Domestic Animals

Extremely Hazardous Liquid And Vapor Under Pressure • Inhalation of Vapors May Be Fatal • Liquid May Cause Freeze Burns of Exposed Skin

Do not get in eyes, on skin, or on clothing. Vikane* gas fumigant is odorless. Exposure to toxic levels may occur without warning or detection by the user.

First Aid

In all cases of overexposure, such as nausea, difficulty in breathing, abdominal pain, slowing of movements and speech, numbness in extremities, get medical attention immediately. Take person to a doctor or emergency treatment facility.

If Inhaled: Get exposed person to fresh air. Keep warm and at rest. Make sure person can breathe freely. If breathing has stopped, give artificial respiration. Do not put anything in the mouth of an unconscious person. Call a poison control center or doctor for further treatment advice.

If Liquid Is On Skin or Clothing: Immediately apply water to contaminated area of clothing before removing. Once area has thawed, remove contaminated clothing, shoes, and other items covering skin. Wash contaminated skin area thoroughly or shower. Call a poison control center or doctor for treatment advice.

If Liquid Is In Eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment.

Note to Physician: Vikane is a gas which has no warning properties such as odor or eye irritation. (However, chloropicrin is used as a warning agent in conjunction with Vikane and is a known lachrymator). Early symptoms of exposure to Vikane are respiratory irritation and central nervous system depression. Excitation may follow. Slowed movement, reduced awareness, and slow or garbled speech may be noted. Prolonged exposure can produce lung irritation, pulmonary edema, nausea, and abdominal pain. Repeated exposure to high concentrations can result in significant lung and kidney damage. Single exposures at high concentrations have resulted in death. Treat symptomatically.

Liquid Vikane in the eye may cause damage due to refrigeration or freezing.

Notice: Read the entire label. Use only according to label directions. **Before buying or using this product, read “Warranty Disclaimer” and “Limitation of Remedies” elsewhere on this label.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.

Storage and Handling

Store in dry, cool, well ventilated area under lock and key. Post as a pesticide storage area. Do not contaminate water, food, or feed by storage.

Store cylinders upright; secured to a rack or wall to prevent tipping. Cylinders should not be subjected to rough handling or mechanical shock such as dropping, bumping, dragging, or sliding. Do not use rope slings, hooks, tongs, or similar devices to unload cylinders. Transport cylinders using hand truck or fork truck to which the cylinder can be firmly secured. Do not transport any cylinders in closed vehicles where they occupy the same common airspace as personnel. Transport securely only in an upright position.

Do not remove valve protection bonnet and safety cap until immediately before use. Replace safety cap and valve protection bonnet when cylinder is not in use.

When cylinder is empty, close valve, screw safety cap onto valve outlet, and replace protection bonnet before returning to supplier. Only the registrant is authorized to refill cylinders. Do not use cylinder for any other purpose. Follow registrant’s instructions for return of empty or partially empty cylinders.

Leak Procedures: Evacuate immediate area of leak. Use a NIOSH or MSHA approved positive pressure self-contained breathing apparatus (SCBA, not SCUBA) or combination air-supplied/SCBA respirator, such as manufactured by Ranger, Survivair, Scott, or MSA, for entry into affected areas to correct problem. Move leaking or damaged cylinder outdoors or to an isolated location, observing strict safety precautions. Work upwind if possible. Do not permit entry into leakage area by unprotected persons until concentration of fumigant is determined to be 5 parts per million (ppm) or less, as determined by a detection device with sufficient sensitivity such as an INTERSCAN or MIRAN gas analyzer. For more detailed information on the source and use of air monitoring devices or respirators, consult the Vikane Gas Fumigant Structural Fumigation Manual.

Cylinder and Product Disposal: Promptly return all empty cylinders to your distributor of Vikane. Follow proper cylinder handling directions above.

Pesticide wastes are toxic. Improper disposal of excess pesticide is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, consult your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

General Information

Before using, read and follow all label precautions and directions. Prior to the parties entering into a fumigation agreement, the Fact Sheet for Vikane must be provided to an adult occupant of the structure to be fumigated.

Vikane is a highly hazardous material and should be used only by individuals knowledgeable of the hazards of this chemical and trained in the use of required respiratory equipment, detector devices, emergency procedures, and in the proper use of this fumigant.

When used for fumigation of enclosed spaces, such as houses and other structures, warehouses, vaults, chambers, trucks, vans, boxcars, ships, and other transport vehicles, 2 persons trained in the use of this product, at least one being an applicator that is licensed/certified by the state, must be present during introduction of fumigant, reentry prior to aeration, and during the initiation of the initial aeration procedure. **Two persons need not be present if monitoring is conducted remotely (outside the area being fumigated).**

If fumigating for insect pests, do not apply when temperature at site of pest activity is below 40°F. This temperature may be measured at the slab foundation, sub-floor soil, or wherever the coolest part of the structure may be. This restriction does not apply when fumigating for rodents.

When fumigating a single unit/room within or connected to a larger structure (such as town houses, apartments, condominiums) all units of the entire structure must be vacated during the fumigation and aeration periods.

Remove edible items from the structure before the fumigation if they cannot be adequately sealed to prevent exposure to Vikane. Chloropicrin must be used as described on the label to warn of an ongoing fumigation.

Preparation for Fumigation

Structural Fumigation

Remove from the structure to be fumigated all persons, domestic animals, pets, and desirable growing plants. Remove mattresses (**except waterbeds**) and pillows completely enveloped in water proof covers or remove covers. Food, feed, drugs (including tobacco products), and medicinals (including those items in refrigerators and freezers) can remain in the structure if they are in plastic, glass, or metal bottles, cans, or jars with the original manufacturer’s air-tight seal intact. Food, feed, drugs (including tobacco products), and medicinals (including those items in refrigerators and freezers) not in plastic, glass, or metal bottles, cans, or jars with the original manufacturer’s air-tight seal intact, need to be removed from the fumigation site, or double bagged in Nylofume* bags, which are available from distributors of Vikane gas fumigant.

Note: Extinguish all flames, including pilot lights of water heaters, gas refrigerators, ranges, ovens, broilers, etc. Turn off or unplug all electrical heating elements such as those in heaters, pianos, organs, etc. Shut off automatic switch controls for appliances and lighting systems which will be included in the space to be fumigated.

Open operable internal doors, internal openings to attics and sub areas, storage chests, cabinets, drawers, closets, and appliances (such as washers, dishwashers, dryers, microwave or conventional ovens, etc.). Using electric fan(s) will help provide for forced distribution and aeration of basements and other dead air spaces to facilitate rapid dispersion of gas. Refrigerator and freezer doors may be left open if the units are turned off or disconnected and all food items have been removed. If the applicator chooses to leave sealed food items in closed refrigerators and freezers during the fumigation, the appliances should be opened when clearing the structure until the concentration of Vikane in them is 5 ppm or less.

Multi-unit Structures

When fumigating a single unit/room within or connected to a larger structure (such as town houses, apartments, condominiums) all units of the entire structure must be prepared as a fumigated structure, and all applicable rules, regulations and label instructions apply, such as occupant notification, structure preparation, posting, securing, and aeration. An adult occupant of each currently occupied unit must be provided with the Fact Sheet for Vikane. Ensure that all exterior entranceways and exterior doors of individual units are secured with secondary locks (see "Securing Structure Entrances") so that only the state licensed applicator in charge can gain access. Chloropicrin need only be used in units where Vikane is introduced. During aeration, check all units within the fumigated structure for Vikane concentration with an approved clearance device. If concentration of any non-fumigated units exceeds 5 ppm, use Aeration Procedure 1 or 2 to aerate the non-fumigated units based on the initial concentration of the fumigated unit(s).

Connected Structures

A connected structure is defined as any structure connected with the structure to be fumigated by construction elements (e.g. pipes, conduits, ducts, etc.) which may allow passage of fumigant between the structures. Any connected structure must be vacated during the fumigation process unless it is isolated from the structure to be fumigated by methods which prevent passage of the fumigant from the structure to be fumigated into the connected structure. Note: connected structures must be vacated if required by state laws or regulations. When it is necessary to vacate any connected structure, that structure shall be considered as a fumigated structure, and all applicable rules, regulations and label instructions apply, such as occupant notification, structure preparation, posting, securing, and aeration. Chloropicrin need only be used in structures where Vikane is introduced. Vikane concentration levels must be measured (see Aeration and Reentry) in any connected space or structure.

Tarpaulin Fumigation

Open operable windows. When tarping, use a highly resistant material such as a vinyl coated nylon, or polyethylene sheeting of at least 4 mil thickness. Seal all seams. Seal all low edges of the cover (such as with soil, sand, or weighted "snakes"). To minimize escape of gas through the soil and to avoid injury to nearby plants, wet soil outward from foundation to the cover if not sufficiently moist to act as a barrier for the gas.

Taped Fumigation

For fumigation sites that can be sealed with plastic, paper, or tape, seal adequately around doors, windows, vents, and other openings.

Chamber Fumigation

For chamber fumigation use a gas-tight chamber with adequate circulation.

Construction Materials, Furnishings (Household effects), and Vehicles

Follow preparations as appropriate in above paragraphs for chamber, taped fumigation, or tarpaulin fumigation to assure good confinement of the gas for the recommended period of exposure.

Fumigation of Surface Ships in Port

Surface ships in size up to and including large ocean-going ships may be fumigated with Vikane to control the various pests listed. The professional fumigator and the ship's captain (or owner) shall follow all applicable regulations including those listed in the Coast Guard, DOT, Title 46, Shipping, section Parts 147A.1-147A.43. Except for those persons involved in fumigation, no people, plants, or pets may be on-board during fumigation.

The person responsible for the fumigation must notify the master of the vessel, or his representative, of the requirements relating to personal protection equipment and detection equipment. Emergency procedures, cargo ventilation, periodic monitoring and inspections, and first aid measures must be discussed with and understood by the master of the vessel or his representative.

If leakage of the fumigant is detected, the person in charge of the fumigation shall take action to correct the leakage, or shall inform the master of the vessel, or his representative, of the leakage so that corrective action can be taken.

Edible commodities shall not be exposed to the chemical. If not removed from the vessel they shall be protected from exposure. The vessel must not be moved during the fumigation and aeration periods. If reentry is necessary before aeration is completed, positive pressure self-contained respiratory protection must be worn.

Warning Agent

Chloropicrin is a warning agent introduced into the structure during fumigation. In order to avoid direct exposure to the fumigant being released, chloropicrin must be released within the structure at least 5 to 10 minutes prior to introduction of the fumigant. Place a handful of wicking agent, (e.g., cotton) in a shallow chloropicrin evaporation container. Do not use chloropicrin evaporation containers or application equipment made of magnesium, aluminum, or their alloys, as chloropicrin may be severely corrosive to such metals. To enhance the distribution of chloropicrin throughout the structure, place the shallow chloropicrin evaporation container in the air stream of a fan. Pour chloropicrin over the wicking agent. When adding chloropicrin to evaporation containers, dispense no more than 3 fluid ounces per container. Use 1 fluid oz/ 10,000 to 15,000 cubic feet - (30 ml/283 to 425 cubic meters) of space to be fumigated. Establish at least one chloropicrin introduction site for each 45,000 cubic feet of space to be fumigated. Removal of all chloropicrin evaporation containers from the fumigated space during "Step (1)" of "Aeration Procedure 1 or 2" will aid in the dissipation of the warning agent from the structure.

Chloropicrin need not be used when fumigating railcars; however, a thorough walk-through inspection must be performed of each railcar with doors being immediately locked upon leaving each car, and a guard must be posted during fumigant introduction, exposure period, and aeration.

Chloropicrin is a warning agent which causes smarting of the eyes, tears, and discomfort, and has a very disagreeable pungent odor at very low concentrations. Chloropicrin must be used by a persons certified to apply Vikane or under their supervision. Fumigators must observe the precautionary statements and safety recommendations appearing on the label of this product.

Protective Clothing

Wear goggles or full face shield for eye protection during introduction of the fumigant. Do not wear gloves or rubber boots. Do not reuse clothing or shoes that have become contaminated with liquid Vikane until thoroughly aerated and cleaned.

Respiratory Protection

If the concentration of Vikane in the fumigated area (as measured by a detector device with sufficient sensitivity such as an INTERSCAN or MIRAN gas analyzer) does not exceed 5 ppm (20 mg/cubic meter), no respiratory protection is required. When this concentration is exceeded, all persons in the exposed area must wear a NIOSH or MSHA approved positive pressure self-contained breathing apparatus (SCBA, not SCUBA) or combination air-supplied/SCBA respirator such as manufactured by Ranger, Survivair, Scott, or MSA. Before using any make or brand of SCBA, learn how to use it correctly. Determine that it has an adequate air supply for the job at hand, that it fits properly, providing an adequate seal around the face, and that it is in good working order. For more detailed information on the source and use of air monitoring devices and respirators, consult the Vikane Gas Fumigant Structural Fumigation Manual.

Prefumigation Check: Check for potential leaks.

Securing Structure Entrances

To secure the structure against unauthorized entry during the fumigation exposure period and "Step (2)" of "Aeration Procedure 1 or 2", use a locking device or barricade on all exterior doors or doorways. A locking device or barricade must be demonstratively effective in preventing an exterior door or doorway from being opened using normal opening or entering processes by anyone other than the certified applicator in charge of the fumigation or persons in his/her on-site direct supervision. Consult state and local regulations for any supplementary instructions and local restrictions on securing against entry.

Dosage and Exposure Time

For fumigation to control drywood termites and non-egg stages of other insect and related structural and household pests, the Fumiguide* calculator(s) is to be used for the coordination of fumigant rates with soil or slab temperature, exposure period, and fumigant loss rate measured as half-loss-time (HLT). When control of the egg stage is desired or when fumigating for Formosan termites, use the indicated multiple factor of the drywood termite dosage (as determined by Fumiguide calculator(s)) for pests listed in the following table:

Pest	Dosage Factor (as a multiple of drywood termite dosage)
Rodentst	1/2X
Carpet Beetles†† and Cockroaches††	1X
Furniture Carpet Beetles†† and Bedbugs	3X
Old House Borers and Formosan Termites	4X
Clothes Moths	6X
Powder Post Beetles and Death Watch Beetles	10X

These dosages apply to dwellings, buildings, construction materials, furnishings, and vehicles.

† To determine the proper dose for rodent control, use 80°F as the calculating temperature. Unlike insects, rodents are warm blooded and do not require increased dosages at lower temperatures.

†† More than 1 fumigation may be needed to control the infestation after egg hatch.

For fumigation to control rodents, use sufficient gas to accumulate at least 36 ounce-hours following equilibrium, regardless of ambient air temperature. Refer to the Vikane Gas Fumigant Structural Fumigation Manual.

The Fumiguide B Calculator is to be used for unmonitored structures to coordinate fumigant rates with temperatures, a 20 to 24 hour exposure period, and an estimated HLT.

The Fumiguide Y Calculator is used in conjunction with Fumiguide B when fumigant concentrations are monitored and/or there are measured variations in exposure time.

The Fumiguide Calculator is a hand held microprocessor which performs the functions of both the Fumiguide B and Y calculators and includes relative humidity as a calculating factor.

These calculators, Directions For Use, and referenced literature may be obtained from Dow AgroSciences.

Introducing the Fumigant

Release the fumigant from outside the structure, tent, or vehicle. The release point(s) should be into a large open space(s) in the fumigation site(s). Release the fumigant through a suitable leak-proof tube with a minimum burst pressure of 500 pounds per square inch (psi). Direct the fumigant into the blast of air from a fan(s) having a capacity of at least 1,000 cubic feet per minute (cfm) for each pound of Vikane released per minute. Damage to household materials can occur if insufficient fan capacity is used for the rate of Vikane released. It is recommended that protective sheeting, such as polyethylene plastic under the shooting stand, shooting hose, and shooting fan can be used to further protect floors during application. **To Prevent Damage, Do Not Apply Fumigant Directly To Any Surface.**

Posting of Fumigated Areas

The applicator must post all entrances to the fumigated areas with signs bearing, in English and Spanish:

1. The signal word DANGER/PELIGRO and the SKULL and CROSSBONES symbol.
2. The statement, "Area under fumigation, DO NOT ENTER/NO ENTRE".
3. The date of fumigation.
4. Name of fumigant used.
5. Name, address, and telephone number of the applicator.

Only a certified applicator may authorize removal of placards, and only when the concentration of Vikane in the treated site is 5 ppm or less.

Aeration and Reentry

No one should be in treated areas if the level of Vikane is above 5 ppm unless provided with a NIOSH or MSHA approved positive pressure self-contained breathing apparatus (SCBA, not SCUBA) or combination air supplied/SCBA respirator, such as manufactured by Ranger, Survivair, Scott, or MSA. **Note: during the initial one hour aeration procedure, approved respiratory protection must be worn until the concentration of Vikane is confirmed not to exceed 5 ppm with an approved detection device.** Since the INTERSCAN and MIRAN gas analyzers give immediate readings, respiratory protection is not required when clearing with these instruments after having completed the initial 1 hour aeration procedure. If a reading indicates levels in excess of 5 ppm, leave the affected area immediately.

Only an approved detection device of sufficient sensitivity, such as the INTERSCAN or MIRAN, can be used to confirm a concentration of Vikane of 5 ppm or less. The INTERSCAN must be calibrated within one month prior to use as a clearance device. All other approved detection devices must be calibrated according to manufacturer recommendations. The concentration of Vikane must be monitored in breathing zones. Structure must remain posted for fumigation until cleared for reentry.

Select the appropriate procedure based on the fumigation rate:

All structures fumigated at 16 oz/MCF or less may be aerated using procedures 1 or 2.

All structures fumigated at concentrations greater than 16 oz/MCF must be aerated using procedure 2.

Aeration Procedure 1

These steps must be completed in sequence.

Step (1): Aerate structure with all operable windows and doors open, aided by the use of 1 or more fans, for a minimum of 1 hour. Total fan capacity, using one or more fans, shall be capable of displacing a total of 5,000 cfm.

Step (2): Secure structure and do not allow reentry for a minimum of 6 hours from the start of aeration (first opening of the seal). During this time structures must remain posted.

Step (3): After the minimum 6 hour waiting period, measure the concentration of Vikane in breathing zones of each room. If the concentration of Vikane is greater than 5 ppm, ventilate structure with operable doors and windows open for at least 10 minutes. Structure may be reoccupied when concentration is 5 ppm or less.

Aeration Procedure 2

These steps must be completed in sequence.

Step (1): Aerate structure with all operable windows and doors open, aided by the use of 1 or more fans, for a minimum of 1 hour. Total fan capacity, using one or more fans, shall be capable of displacing a total of 5,000 cfm.

Step (2): Secure the structure and do not allow reentry for a minimum of 8 hours from the start of aeration (first opening of the seal). During this time the structure must remain posted.

Step (3): After the minimum 8 hour waiting period, measure the concentrations of Vikane in breathing zones of each room. If the concentration of Vikane is greater than 5 ppm, ventilate structure with operable doors and window open for at least 10 minutes. Structure may be reoccupied when the concentration Vikane is 5 ppm or less.

For more detailed information on the source and use of air monitoring devices or respirators, consult the Vikane Gas Fumigant Structural Fumigation Manual. Do not reoccupy fumigation site, i.e. building, ship, vehicle or chamber, or move vehicle until aeration is complete. Warning signs must remain posted until aeration is determined to be complete.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperature, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used.

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the "Warranty Disclaimer" above and this "Limitation of Remedies" cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the "Warranty Disclaimer" or this "Limitation of Remedies" in any manner.

*Trademark of Dow AgroSciences LLC

Dow AgroSciences LLC • Indianapolis, IN 46268 U.S.A.

Label Code: D02-069-012

LOES Number: 010-01957

EPA-Accepted 01/02/01

Revisions:

1. Added shipping containers to the use site list.
2. Revised First Aid Statements.
3. Clarified "Direct Supervision" requirement such that two persons trained in the use of the product, at least one must be a state licensed/certified applicator, must be present during fumigant introduction, reentry prior to aeration, and initiation of the initial aeration procedure.
4. Deleted fish as a pet to be removed from the fumigated structure and added tobacco products to list of items requiring special attention as part of the structural fumigation preparation.
5. Added sections describing Multi-unit and Connected Structures.
6. Cited correct regulation for fumigation of surface ships in port.
7. Aeration and Reentry: Specified respiratory protection for initial one hour aeration procedure. Added clearance device calibration requirements. Step sequence of Aeration Procedures and total fan capacity specified. Added breathing zone measurements in each room.

MATERIAL SAFETY DATA SHEET



Emergency Phone: 800-992-5994
Dow AgroSciences LLC
Indianapolis, IN 46268

VIKANE* GAS FUMIGANT

Effective Date: 10/7/03
Product Code: 91503
MSDS: 000506

1. PRODUCT AND COMPANY IDENTIFICATION:

PRODUCT: Vikane* Gas Fumigant

COMPANY IDENTIFICATION:

Dow AgroSciences
9330 Zionsville Road
Indianapolis, IN 46268-1189

2. COMPOSITION/INFORMATION ON INGREDIENTS:

Sulfuryl fluoride	CAS# 002699-79-8	99.8%
Impurities Associated with the Active Ingredient		0.2%

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.

3. HAZARDOUS IDENTIFICATIONS:

EMERGENCY OVERVIEW

Hazardous Chemical. Colorless, odorless compressed gas. Evacuate immediate area if leak occurs. Excessive vapor concentrations are attainable and a single exposure may cause death. Toxic to pets, fish, wildlife, and avian.

EMERGENCY PHONE NUMBER: 800-992-5994

POTENTIAL HEALTH EFFECTS: This section includes possible adverse effects, which could occur if this material is not handled in the recommended manner.

EYE: Essentially non-irritating to eyes. Liquid may cause frostbite.

SKIN: Essentially non-irritating to skin. Liquid may cause frostbite. No adverse effects anticipated by skin absorption.

INGESTION: Moderate toxicity if swallowed. The oral LD₅₀ for rats is 100 mg/kg. Swallowing is unlikely because of the physical state.

INHALATION: Vapor concentrations are attainable which may be fatal with single exposure. Excessive exposure may cause severe irritation to upper respiratory tract (nose and throat) and lungs. The LC₅₀ for a 4-hour exposure for rats is 991-1122 ppm.

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: In animals, effects have been reported on the following organs: brain, central nervous system, kidney, lung, respiratory tract and thyroid gland. Observations in animals include convulsions and tremors. May cause fluorosis of teeth and bones.

CANCER INFORMATION: Did not cause cancer in laboratory animals.

TERATOLOGY (BIRTH DEFECTS): Birth defects are unlikely. Exposures having no effect on the mother should have no effect on the fetus. Did not cause birth defects in animals; other effects were seen in the fetus only at doses which caused toxic effects to the mother.

REPRODUCTIVE EFFECTS: In animal studies, did not interfere with reproduction.

4. FIRST AID:

EYES: In case of frostbite, immediately flush eyes with water; remove contact lenses, if present, after the first 5 minutes, then continue flushing eyes for at least 15 minutes. Obtain medical attention promptly preferably from an ophthalmologist.

SKIN: If shoes, gloves, or clothing covering skin become wet with sulfuryl fluoride, immediately apply water to contaminated clothing before removing. Once area has thawed, remove contaminated items covering skin. Wash thoroughly or shower.

INGESTION: If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Seek medical attention.

INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.

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NOTE TO PHYSICIAN: Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient. Sulfuryl fluoride is a gas, which has no warning properties such as odor or eye irritation (however, chloropicrin is used as a warning agent and is a known lachrymator). The prediction of possible human effects is based in part on observations made on laboratory animals. It is predicted that persons exposed to sulfuryl fluoride will show little evidence of intoxication at first, unless the concentration is very high (>400 ppm). Early symptoms of exposure to sulfuryl fluoride are respiratory irritation and central nervous system depression. Excitation may follow. Slowed movement, reduced awareness, and slow or garbled speech may be noted. It is essential to keep such an individual at bed rest for at least 24 hours. Clinical observations should be directed at the pulmonary, hepatic, and renal systems. Prolonged exposure can produce lung irritation, pulmonary edema, nausea, and abdominal pain. Repeated exposure to high concentrations can result in significant lung and kidney damage. Convulsions may ensue with respiratory arrest being the terminal event. Assisted respiration may be necessary. Clinical observation is essential. There is no known antidote for over-exposure to sulfuryl fluoride.

5. FIRE FIGHTING MEASURES:

FLASH POINT: Not applicable
METHOD USED: Not applicable

FLAMMABLE LIMITS

LFL: Not combustible
UFL: Not combustible

EXTINGUISHING MEDIA: Sulfuryl fluoride is not combustible. However, if cylinders are in a fire area, water can be used to keep them cool to help prevent discharge of product caused by melted fusible plugs on the cylinders. Use of water will also help to scrub out part of any hydrofluoric acid and sulfur dioxide, which may be formed by decomposition of the product in a fire.

FIRE & EXPLOSION HAZARDS: Cylinders exposed to fire may vent and release toxic gas through melted fusible plugs on cylinders. Although sulfuryl fluoride is not combustible, in temperatures exceeding 400°C (752°F), it will degrade to form hydrogen fluoride and sulfur dioxide.

FIRE-FIGHTING EQUIPMENT: Wear positive-pressure, self-contained breathing apparatus and full protective clothing. When fighting fires in atmospheres containing potentially high concentrations of sulfuryl fluoride, encapsulating protective suits should be worn due to possible formation of hydrofluoric acid. Protective suit material should be compatible with exposure to hydrofluoric acid.

6. ACCIDENTAL RELEASE MEASURES:

ACTION TO TAKE FOR SPILLS/LEAKS: Evacuate immediate area if cylinder begins to leak. Use a NIOSH or MSHA approved positive-pressure, self-contained breathing apparatus (SCBA) or combination air-supplied/SCBA respirator, such as manufactured by Ranger, Survivair, Scott, or MSA, for entry into affected areas to correct problem. For leaking cylinders occurring near structure being fumigated, place the cylinder inside the designated structure if it can be done safely. If leaking cylinder occurs elsewhere, move leaking or damaged cylinder outdoors or to an isolated location, observing strict safety precautions. Work upwind if possible. Do not permit entry into leakage area by unprotected persons until concentration of fumigant is determined to be 5 ppm or less, as determined by a detection device with sufficient sensitivity such as an INTERSCAN or MIRAN gas analyzer. For detailed information on the source and use of air monitoring devices or respirators, consult Dow AgroSciences at 800-992-5994.

7. HANDLING AND STORAGE:

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Handling: Keep out of reach of children. Do not breathe gas. Keep all unnecessary people and pets out of area containing sulfuryl fluoride gas. Storage: Store in original container and away from heat and dwellings.

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8. EXPOSURE CONTROLS/PERSONAL PROTECTION:

These precautions are suggested for conditions where a potential for exposure exists. Emergency conditions may require additional precautions.

EXPOSURE GUIDELINE: Sulfuryl fluoride: ACGIH TLV is 5 ppm TWA, 10 ppm STEL. OSHA PEL is 5 ppm TWA.

ENGINEERING CONTROLS: Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines. Lethal concentrations may exist in areas with poor ventilation.

RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS:

RESPIRATORY PROTECTION: Atmospheric levels should be maintained below exposure guideline. When respiratory protection is required, use a NIOSH approved self-contained breathing apparatus or positive-pressure airline with auxiliary self-contained air supply. For emergency and other conditions where the exposure guideline may be exceeded, use a NIOSH approved positive-pressure self-contained breathing apparatus or positive pressure airline with auxiliary self-contained air supply. In confined or poorly ventilated areas, use a NIOSH approved self-contained breathing apparatus or positive pressure airline with auxiliary self-contained air supply.

SKIN PROTECTION: No special skin protection should be needed. Skin contact with the liquid may cause freeze damage if the liquid is confined to the skin; do not wear gloves or rubber boots.

EYE PROTECTION: Use chemical goggles.

APPLICATORS AND ALL OTHER HANDLERS: Refer to the product label for personal protective clothing and equipment.

9. PHYSICAL AND CHEMICAL PROPERTIES:

BOILING POINT: -67°F (-55°C)
VAPOR PRESSURE: 15.2 atmospheres @ 20°C
VAPOR DENSITY: 4.3 g/L @ 20°C
SOLUBILITY IN WATER: Practically insoluble
SPECIFIC GRAVITY: 1.35 @ 20°C
APPEARANCE: Colorless
ODOR: Odorless compressed gas

10. STABILITY AND REACTIVITY:

STABILITY: (CONDITIONS TO AVOID) Cylinders may leak or rupture in a fire.

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) Strong base.

HAZARDOUS DECOMPOSITION PRODUCTS: Sulfur dioxide and hydrogen fluoride under fire conditions with hydrocarbons.

HAZARDOUS POLYMERIZATION: Not known to occur.

11. TOXICOLOGICAL INFORMATION:

MUTAGENICITY: In-vitro and animal genetic toxicity studies were negative.

12. ECOLOGICAL INFORMATION:

ENVIRONMENTAL FATE:

MOVEMENT & PARTITIONING:

Bioconcentration potential is low (BCF <100 or Log Pow <3). Potential for mobility in soil is very high (Koc between 0 and 50).

Log octanol/water partition coefficient (Log Pow) is estimated using a structural fragment method to be 0.41. Soil organic carbon/water partition coefficient (Koc) is estimated to be 6.124.

Henry's Law Constant (H) is estimated to be 3.28E-02 atm-M³/mole.

DEGRADATION & PERSISTENCE:

The hydrolysis half-life is 18 minutes to 3 days.

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ECOTOXICOLOGY:

Material is highly toxic to aquatic invertebrates on an acute basis (LC₅₀ or EC₅₀ is between 0.1 and 1 mg/L.
Acute immobilization EC₅₀ in water flea (*Daphnia magna*) is 0.62 mg/L.
Growth inhibition EC₅₀ in green alga (*Selenastrum capricornutum*) is 3.05 mg/L.
Growth inhibition EC₅₀ in green alga (*Selenastrum capricornutum*) is 0.83 mg/L.

13. DISPOSAL CONSIDERATIONS:

DISPOSAL METHOD: Promptly return all empty cylinders to Dow AgroSciences. Wastes are toxic. Improper disposal of excess waste is a violation of federal law. If these wastes can not be disposed of by use according to label instruction, consult your state pesticide or the hazardous waste representative at the nearest EPA regional office for guidance.

14. TRANSPORT INFORMATION:

U.S. DEPARTMENT OF TRANSPORTATION (DOT) INFORMATION:

Do not ship this material by air.

For all other modes of transportation:
SULPHURYL FLUORIDE/2.3/UN/2191/POISON
INHALATION HAZARD/ZONE D

15. REGULATORY INFORMATION:

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations.

U.S. REGULATIONS

SARA 313 INFORMATION: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372:

<u>CHEMICAL NAME</u>	<u>CAS NUMBER</u>	<u>CONCENTRATION</u>
Sulfuryl Fluoride	002699-79-8	99.8%

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

An immediate health hazard
A delayed health hazard
A sudden release of pressure hazard
A reactive hazard

TOXIC SUBSTANCES CONTROL ACT (TSCA): All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

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STATE RIGHT-TO-KNOW: The following product components are cited on certain state lists as mentioned. Non-listed components may be shown in the composition section of the MSDS.

CHEMICAL NAME	CAS NUMBER	LIST
Sulfuryl Fluoride	002699-79-8	NJ3 PA1

NJ3=New Jersey Workplace Hazardous Substance (present at > or = to 1.0%).

PA1=Pennsylvania Hazardous Substance (present at > or - to 1.0%).

OSHA HAZARD COMMUNICATION STANDARD: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RATINGS:

<u>Category</u>	<u>Rating</u>
Health	3
Flammability	0
Reactivity	1

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND): To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

16. OTHER INFORMATION:

MSDS STATUS: Revised Section: 2, 3, 4, 8, 11, 12 & 14
Reference: DR-0015-5588
Replaces MSDS dated: 5/22/01
Document Code: D03-069-447
Replaces Document Code: D03-069-446

The Information Herein Is Given In Good Faith, But No Warranty, Express or Implied, Is Made. Consult Dow AgroSciences for Further Information.

Specimen Label



Chloropicrin

Warning Agent

For Non-Pesticidal Use Only

For Use only by applicators certified to apply Vikane* gas fumigant or persons under their direct supervision.

NOTE: Chloropicrin Warning Agent is a highly hazardous material and must be handled only by individuals trained in its proper use. Consult Dow AgroSciences for correct procedure before using.

Active Ingredients:		
Chloropicrin	96.0%	
Inert Ingredients	4.0%	
Total	100.0%	

Contains 13.7 pounds of chloropicrin per gallon.

Keep Out of Reach of Children

**DANGER
PELIGRO**



POISON

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

IN ALL CASES OF OVEREXPOSURE, GET MEDICAL ATTENTION IMMEDIATELY BY TRANSPORTING TO AN EMERGENCY TREATMENT FACILITY.

First Aid

If inhaled: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

If case of skin contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing or other items covering the skin and shoes. Get medical attention.

Air expose shoes or clothing outside and do not wear until free of all traces of contamination.

If case of eye contact, immediately flush eyes with plenty of water for at least 30 minutes. Get medical attention immediately.

If swallowed, do not induce vomiting. Give large amounts of water or milk; get medical attention immediately.

Note to Physician: Chloropicrin is a volatile liquid that is an active ingredient in tear gas. As a gas it is a powerful lacrymator. Symptoms of overexposure are profuse lacrymation, respiratory distress and vomiting. Pulmonary edema may develop later.

Notice: Read the entire label. Use only according to label directions. **Before buying or using this product, read "Warranty Disclaimer" and "Limitation of Remedies" elsewhere on this label.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com (See Vikane)

Precautionary Statements

Hazards to Humans and Domestic Animals

DANGER

Causes Severe Burns Of Eye Or Skin. May Be Fatal If Absorbed Through The Skin. Causes Severe Burns of Mouth And Throat if Swallowed. May Be Fatal If Inhaled. May Cause Severe Allergic Respiratory Reaction. High Concentration Can Cause Lung Injury.

Do not get in eyes, on skin or on clothing. Avoid breathing gas/vapor. Do not take internally. Avoid prolonged or repeated respiratory contact. Use only with adequate ventilation. Wash thoroughly after handling.

Personal Protective Equipment

The following Personal Protective Equipment must be worn when handling and dispensing chloropicrin:

- **Chemical-resistant gloves (such as neoprene)**
- **Full face shield or chemical goggles**
- **Respiratory Protection:** When air concentrations exceed a level of 0.1 ppm, wear NIOSH approved positive pressure supplied-air respirator for organic vapors.

Chemical Hazard

Chloropicrin is severely corrosive of metal containers made of magnesium, aluminum, or their alloys.

Storage and Handling

Storage: Store upright in a cool, dry, well-ventilated area under lock and key. Store only in original container. Do not contaminate water, food or feed by storage or disposal.

Spill and Leak Procedures: Evacuate immediate area of spill or leak. Use a self-contained breathing apparatus (SCBA) for entry into affected area to correct the problem. Move the leaking or damaged containers outdoors or to an isolated location, observing strict safety precautions. Work upwind if possible. Allow spilled material to evaporate, or absorb onto vermiculite, dry sand, earth, or similar absorbent material. Thoroughly aerate absorbent materials outdoors prior to disposing on site or at an approved disposal facility. Do not permit entry into spill area or cleanup area by unprotected persons until the concentration of chloropicrin is determined to be less than 0.1 ppm, by testing with an approved detection device.

Disposal: Allow empty container to aerate with cap off within secure area, such as within the structure during fumigation. Replace cap. Dispose of in a sanitary landfill or by other approved state and local procedures.

Directions for Use

Chloropicrin is a warning agent introduced into the structure prior to fumigation with Vikane* gas fumigant. In order to avoid direct exposure to the fumigant being released, chloropicrin must be released within the structure at least 5 to 10 minutes prior to introduction of the fumigant.

Place a handful of wicking agent, (e.g., cotton) in a shallow chloropicrin evaporation container. Do not use containers or application equipment made of magnesium, aluminum, or their alloys, as chloropicrin may be severely corrosive to such metals. To enhance the distribution of chloropicrin throughout the structure, place the shallow chloropicrin evaporation container in the air stream of a fan. Pour chloropicrin over the wicking agent. When adding chloropicrin to evaporation containers, dispense no more than 3 fluid ounces per container. Use 1 fluid oz/10,000 to 15,000 cubic feet - (30 ml/283 to 425 cubic meters) of space to be fumigated. Use one introduction site per 20,000 to 45,000 cubic feet.

Removal of all chloropicrin evaporation containers from the fumigated space during "Step (1)" of "Aeration Procedure 1 or 2," referenced on the product label for Vikane, will aid in the dissipation of the warning agent from the structure.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Personal injury (possibly including death), property (including plant) damage, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including abnormal conditions (such as excessive wind or aeration), the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences. All such risks shall be assumed by buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, replacement of amount of product used.

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the "Warranty Disclaimer" above and this "Limitation of Remedies" cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences is authorized to vary or exceed the terms of the "Warranty Disclaimer" or this "Limitation of Remedies" in any manner.

*Trademark of Dow AgroSciences LLC
Dow AgroSciences LLC • Indianapolis, IN 46268 USA

Label Code: D02-152-001
Initial Printing

MATERIAL SAFETY DATA SHEET



Emergency Phone: 800-992-5994
Dow AgroSciences LLC
Indianapolis, IN 46268

Effective Date: 7/22/99
Product Code: 16651
MSDS: 006416

CHLOROPICRIN

1. PRODUCT AND COMPANY IDENTIFICATION:

PRODUCT: Chloropicrin

COMPANY IDENTIFICATION:

Dow AgroSciences
9330 Zionsville Road
Indianapolis, IN 46268-1189

2. COMPOSITION/INFORMATION ON INGREDIENTS:

Chloropicrin	CAS # 000076-06-2	96%
Trace quantities of water and HCl		4%

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR) 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.

3. HAZARDOUS IDENTIFICATIONS:

EMERGENCY OVERVIEW

Hazardous. Colorless liquid with intensely irritating tear gas odor. May cause severe eye irritation with corneal injury which may result in permanent impairment of vision, even blindness. Painful irritation of the eyes at 1 ppm or less; a concentration of 15 ppm for longer than 1 minute is intolerable to humans. Single prolonged exposure may result in the material being absorbed in amounts which could cause death. LD₅₀ for skin absorption in rabbits is 62 mg/kg. Oral LD₅₀ for male rats is 250 mg/kg. Single brief (minutes) inhalation exposure to easily attainable concentration may cause serious adverse effects, even death. Toxic to fish and aquatic organisms. DOT Classification is **CHLOROPICRIN, 6.1, UN1580, I, POISON-INHALATION HAZARD, HAZARD ZONE B.**

EMERGENCY PHONE NUMBER: 800-992-5994

POTENTIAL HEALTH EFFECTS: This section includes possible adverse effects which could occur if this material is not handled in the recommended manner.

EYE: May cause pain. May cause severe eye irritation with corneal injury which may result in permanent impairment of vision, even blindness. Vapors cause lacrimation, and painful irritation of the eyes at 1 ppm or less; a concentration of 15 ppm for longer than 1 minute is intolerable to humans because of the intense irritation produced.

SKIN: Short single exposure may cause severe skin burns. A single prolonged exposure may result in the material being absorbed in amounts which could cause death. The LD₅₀ for skin absorption in rabbits is 62 mg/kg. Vapors may irritate skin. May cause more severe response if skin is abraded (scratched or cut). Vapors may increase susceptibility to infections.

INGESTION: Single dose oral toxicity is moderate. The oral LD₅₀ for male rats is 250 mg/kg. Small amounts swallowed incidental to normal handling operations are not likely to cause injury; however, swallowing larger amounts may cause serious injury, even death. May cause severe burns of the mouth and throat. Ingestion may cause gastrointestinal irritation or ulceration. In animals, effects have been reported on the following organ: liver.

INHALATION: A single brief (minutes) inhalation exposure to easily attainable concentrations may cause serious adverse effects, even death. Excessive exposure may cause lung injury. May cause respiratory sensitization in susceptible individuals. Excessive exposure may cause methemoglobinemia, thereby impairing the blood's ability to transport oxygen. In humans, effects have been reported on the following organs: heart, kidney, and liver. Signs and symptoms of excessive exposure may include cyanosis, nausea, vomiting, diarrhea, abdominal cramps, and/or central nervous system effects. Initial symptoms due to low-level exposure may not seem severe but death may ensue due to delayed effects of lung injury and/or infection. DOT Classification is **CHLOROPICRIN, 6.1, UN1580, I, POISON-INHALATION HAZARD, HAZARD ZONE B.**

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: Effects have been reported on the following organ: stomach.

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Effective Date: 7/22/99
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CHLOROPICRIN

CANCER INFORMATION: Available data are inadequate to evaluate carcinogenicity.

TERATOLOGY (BIRTH DEFECTS): Birth defects are unlikely. Exposures having no effect on the mother should have no effect on the fetus. Did not cause birth defects in animals; other effects were seen in the fetus only at doses which caused toxic effects to the mother.

REPRODUCTIVE EFFECTS: In animal studies, has been shown not to interfere with reproduction.

4. FIRST AID:

EYES: Immediate and continuous irrigation with flowing water for at least 30 minutes is imperative. Prompt medical consultation is essential.

SKIN: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician if irritation persists. Call a physician if irritation persists. Destroy and dispose of leather items which cannot be decontaminated (i.e. shoes, watchbands, belts).

INGESTION: Do not induce vomiting. Call a physician and/or transport to emergency facility immediately.

INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.

NOTE TO PHYSICIAN: Methemoglobinemia may aggravate any pre-existing condition sensitive to a decrease in available oxygen, such as chronic lung disease, coronary artery disease or anemias. If burn is present, treat as any thermal burn, after decontamination. May cause tissue destruction leading to stricture. If lavage is performed, suggest endotracheal and/or esophageal control. No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient. Persons receiving a significant exposure to this material by inhalation should be observed 24-48 hours for delayed pulmonary edema.

5. FIRE FIGHTING MEASURES:

FLASH POINT: Not combustible
METHOD USED: Not applicable

FLAMMABLE LIMITS

LFL: Not applicable
UFL: Not applicable

EXTINGUISHING MEDIA: All conventional extinguishing media are suitable.

FIRE & EXPLOSION HAZARDS: Not a combustible. Heated material decomposes violently at 233°F (112°C) especially when in contact with metals. Toxic and irritating gases will emit.

FIRE-FIGHTING EQUIPMENT: Wear self-contained breathing apparatus and protective clothing, evaluate area, cool containers with water spray from remote location.

6. ACCIDENTAL RELEASE MEASURES:

ACTION TO TAKE FOR SPILLS/LEAKS: Evacuate immediate area of spill or leak. Use a NIOSH approved air purifying respirator approved for organic vapors, self contained breathing apparatus, or an air supplied respirator. Move leaking or damaged containers outdoors or to an isolated location. Allow spilled material to evaporate into dry sand, earth or similar absorbent material, which may be disposed on site, or at an approved disposal facility. Do not permit entry into spill area or clean-up area by unprotected persons until concentration of chloropicrin is determined to be less than 0.1 ppm. Contact Dow AgroSciences at 800-992-5994 for large spills.

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CHLOROPICRIN

7. HANDLING AND STORAGE:

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Avoid any possible contact with liquid or vapor. Measure chloropicrin concentration with a Matheson-Kitagawa detection device using tube 172. Store upright in a cool, dry, well ventilated area under lock and key. Post as a pesticide storage area. Do not contaminate water, food, or feed by storage or disposal. Persons moving or handling containers should wear protective clothing. Open container only in a well ventilated area wearing protective clothing and respiratory protection if necessary.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION:

These precautions are suggested for conditions where the potential for exposure exists. Emergency conditions may require additional precautions.

EXPOSURE GUIDELINE(S):

Chloropicrin: ACGIH TLV and OSHA PEL are 0.1 ppm. ACGIH classification is A4.

ENGINEERING CONTROLS: Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines. Lethal concentrations may exist in areas with poor ventilation.

RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS:

RESPIRATORY PROTECTION: Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required, use a NIOSH approved positive-pressure supplied-air respirator for organic vapors.

SKIN PROTECTION: Use protective clothing impervious to this material. Selection of specific items such as faceshield, gloves, boots, apron, or full body suit will depend on operation. Use gloves, impervious to this material, at all times. Safety shower should be located in immediate work area. Remove contaminated clothing immediately, wash skin area with soap and water, and launder clothing before reuse. Items which cannot be decontaminated, such as shoes, belts and watchbands, should be removed and destroyed.

EYE/FACE PROTECTION: Use chemical goggles. Wear a face-shield which allows use of chemical goggles, or wear a full-face respirator to protect face and eyes when there is any likelihood of splashes. Eye wash fountain should be located in immediate work area.

APPLICATORS AND ALL OTHER HANDLERS: Please refer to the product label for personal protective clothing and equipment.

9. PHYSICAL AND CHEMICAL PROPERTIES:

BOILING POINT: 233°F (112°C)
VAPOR PRESSURE: 18.3 @ 20°C
VAPOR DENSITY: Approximately 5.7 (Air = 1.0)
SOLUBILITY IN WATER: 0.2 g/100 g
SPECIFIC GRAVITY: 1.66
APPEARANCE: Colorless liquid
ODOR: Intensely irritating tear gas odor

10. STABILITY AND REACTIVITY:

STABILITY: (CONDITIONS TO AVOID) Unstable under fire conditions. Avoid temperatures above 140°F (60°C)

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) Organic amines, reducing agents and sulfuric acid. Incompatible with containers or equipment made of aluminum, magnesium or their alloys.

HAZARDOUS DECOMPOSITION PRODUCTS: Highly toxic phosgene and toxic nitrogen oxide.

HAZARDOUS POLYMERIZATION: Not known to occur.

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CHLOROPICRIN

11. TOXICOLOGICAL INFORMATION:

MUTAGENICITY: Has been shown to have mutagenic activity in bacteria. Animal mutagenicity studies were inconclusive.

12. ECOLOGICAL INFORMATION:

ENVIRONMENTAL FATE

MOVEMENT & PARTITIONING: Bioconcentration potential is low (BCF <100 or Log Pow <3). Potential for mobility in soil is high (Koc between 50 and 150). Measured log octanol/water partition coefficient (Log Pow) is 2.09. Log octanol/water partition coefficient (Log Pow) is estimated using a structural fragment method to be 1.32. Soil organic carbon/water partition coefficient (Koc) is estimated to be 36.05-62. Log air/water partition coefficient (Log Kaw) is -1.15. Henry's Law Constant (H) is estimated to be 2.15E-03 atm-M3 mole.

DEGRADATION & PERSISTENCE: Tropospheric half-life is estimated to be 4.8 hours. Theoretical oxygen demand (ThOD) is calculated to be 0.10 p/p.

ECOTOXICOLOGY: Material is highly toxic to fish on an acute basis (LC₅₀ is between 0.1 and 1.0 mg/L). Acute LC₅₀ in fathead minnow (*Pimephales promelas*) is 0.3 mg/L.

13. DISPOSAL CONSIDERATIONS:

DISPOSAL METHOD: Do not contaminate food, feed, or water by storage or disposal. Wastes are toxic. Improper disposal of excess waste is a violation of federal law. If wastes cannot be used according to the label directions, dispose of in accordance with all applicable local, state or federal requirements. Contact your state pesticide or environmental control agency, or the hazardous waste representative at the nearest EPA regional office for guidance.

14. TRANSPORT INFORMATION:

For DOT regulatory information, if required, consult transportation regulations, product shipping papers or contact your Dow AgroSciences representative. DOT Classification is **CHLOROPICRIN, 6.1, UN1580, I, POISON-INHALATION HAZARD, HAZARD ZONE B.**

15. REGULATORY INFORMATION:

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations.

U.S. REGULATIONS

SARA 313 INFORMATION: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372:

CHEMICAL NAME CAS NUMBER CONCENTRATION

Chloropicrin	000076-06-2	96%
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SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

An immediate health hazard
A delayed health hazard

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CHLOROPICRIN

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TOXIC SUBSTANCES CONTROL ACT (TSCA): All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

STATE RIGHT-TO-KNOW: The following product components are cited on certain state lists as mentioned. Non-listed components may be shown in the composition section of the MSDS.

CHEMICAL NAME	CAS NUMBER	LIST
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Chloropicrin	000076-06-2	NJ2 NJ3
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NJ2=New Jersey Environmental Hazardous Substance (present at greater than or equal to 1.0%).

NJ3=New Jersey Workplace Hazardous Substance (present at greater than or equal to 1.0%).

OSHA HAZARD COMMUNICATION STANDARD: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RATINGS:

Health	4
Flammability	0
Reactivity	3

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND): To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

16. OTHER INFORMATION:

MSDS STATUS: Revised Sections 3, 9, 10 & 15
Reference: DR-0001-6375
Replaces MSDS Dated: 7/20/99
Document Code: D03-000-002
Replaces Document Code: D03-000-001

The Information Herein Is Given In Good Faith, But No Warranty, Express Or Implied, Is Made. Consult Dow AgroSciences For Further Information.

PRECAUTIONARY STATEMENTS

Hazards To Humans And Domestic Animals

DANGER: FUMITOXIN® Pellets or dust can be fatal if swallowed. Do not get in eyes, on skin, or on clothing. Do not eat, drink or smoke while handling aluminum phosphide fumigants. When a sealed container is opened, allowing material to come in contact with moisture, water or acids, toxic phosphine gas will be released. If a garlic odor is detected, refer to the section on Industrial Hygiene Monitoring in the Applicator's Manual for appropriate monitoring procedures. Pure phosphine gas is odorless; the odor is due to a contaminant. Since an odor may not be detected under certain circumstances, the absence of a garlic odor does not mean that phosphine gas is absent. Observe proper application, re-entry, aeration, and disposal procedures specified elsewhere in the labeling to prevent overexposure to phosphine.

Physical and Chemical Hazards

Aluminum phosphide Pellets and partially spent dust will release phosphine gas if exposed to moisture from the air or if it comes into contact with water, acids and many other liquids. Piling of Pellets or dust from their fumigation may cause a temperature increase and confine the release of gas so that ignition could occur. It is recommended that you open aluminum phosphide products in open air or near a fan, which exhausts outside immediately. Never open in flammable atmosphere because on rare occasions a flash may occur. When opening, point the container away from the face and body. These precautions will also reduce the applicators' exposure to phosphine gas. Pure phosphine gas is practically insoluble in water, fats 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 humidity. Metal such as copper, brass, and other copper alloys, and precious metals such as gold and silver are susceptible to corrosion by phosphine, especially at high temperatures and humidity. Thus, items such as small electric motors, smoke detectors, brass sprinkler heads, batteries and battery chargers, forklifts, temperature monitoring systems, electrical switchgear, communication devices, computers, calculators, watches, and other electronic equipment should be protected or removed before fumigation. Phosphine will also react with certain metallic salts and therefore, such items as photographic film, copying papers and some inorganic pigments, etc. should not be exposed.

Note to Physician: Aluminum phosphide fumigants react with moisture from the air, water, acids and many other liquids to release phosphine gas. Mild inhalation exposure causes malaise (indefinite feeling of sickness), ringing of ears, fatigue, nausea, and pressure in the chest, which is relieved by removal to fresh air. Moderate poisoning causes weakness, vomiting, pain just above the stomach, chest pain, diarrhea and dyspnea (difficulty in breathing). Symptoms of severe poisoning may occur within a few hours to several days, resulting in pulmonary edema (fluid in lungs) and may lead to dizziness, cyanosis (blue or purple skin color), unconsciousness, and death. In sufficient quantity, phosphine affects the liver, kidneys, lungs, nervous system and circulatory system. Inhalation can cause lung edema (fluid in lungs) and hyperemia (excess of blood in a body part), small perivascular brain hemorrhages and brain edema (fluid in brain). Ingestion can cause lung and brain symptoms but damage to the viscera (body cavity organs) is more common. Phosphine poisoning may result in (1) pulmonary edema, (2) liver elevated serum GOT, LDH and alkaline phosphatase, reduced prothrombin, hemorrhage and jaundice (yellow skin color) and (3) kidney hematuria (blood in urine) and anuria (abnormal or lack of urination). Pathology is characteristic of hypoxia (oxygen deficiency in body tissue). Frequent exposure to concentrations above permissible levels 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 his own judgment: In its milder forms, symptoms of poisoning may take some time (up to 24 hours) to make their appearance, and the following is suggested:

1. Give complete rest for 1-2 days, during which the patient must be kept quiet and warm.
2. Should patient suffer from vomiting or increased blood sugar, appropriate solutions should be administered. Treatment with oxygen breathing equipment is recommended as is the administration of cardiac and circulatory stimulants.

In cases of severe poisoning (Intensive Care Unit recommended):

1. Where pulmonary edema is observed, steroid therapy should be considered and close medical supervision is recommended. Blood transfusions may be necessary.
2. In cases of manifest pulmonary edema, venesection should be performed under vein pressure control. Heart glycosides (I.V.) (in case of hemoconcentration, venesection may result in shock). Upon progressive edema of the lungs, immediate intubations with a constant removal of edema fluid and oxygen overpressure respiration, as well as measures required for shock treatment are recommended. In case of kidney failure, extracorporeal hemodialysis is necessary. There is no specific antidote known for this poisoning.
3. Mention should be made here of suicidal attempts by taking solid phosphide by mouth. After swallow ing, emptying of the stomach by vomiting, flushing of the stomach with diluted potassium permanganate solution or a solution of magnesium peroxide until flushing liquid ceases to smell of carbide, is recommended. Thereafter, apply medicinal charcoal.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling. THIS PRODUCT IS FOR USE AGAINST INSECTS WHICH INFEST STORED COMMODITIES, AND CONTROL OF BURROWING PESTS.

General Information: PESTCON FUMITOXIN® is a fumigant which when applied according to label instructions is activated by atmospheric humidity. FUMITOXIN® has been found effective against many stored product insects and their pre-adult stages - that is eggs, larvae, and pupae. Refer to the Applicator's Manual for specific species and commodities, which may be fumigated.

Refer to the Applicator's Manual for detailed precautions, recommendations and directions for use.

THIS PRODUCT MUST BE ACCOMPANIED WITH AN APPROVED APPLICATOR'S MANUAL. READ AND UNDERSTAND THE ENTIRE LABELING. CONSULT WITH YOUR STATE LEAD PESTICIDE REGULATORY AGENCY TO DETERMINE REGULATORY STATUS, REQUIREMENTS, AND RESTRICTIONS FOR FUMIGATION USE IN THAT STATE. CALL PESTCON SYSTEMS, INC. IF YOU HAVE ANY QUESTIONS OR DO NOT UNDERSTAND ANY PART OF THIS LABEL.

RESTRICTED USE PESTICIDE

DUE TO ACUTE INHALATION TOXICITY OF HIGHLY TOXIC PHOSPHINE GAS

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

Fumitoxin® PELLETS

ACTIVE INGREDIENT - ALUMINUM PHOSPHIDE 55%
INERT INGREDIENTS 45%
TOTAL 100%



KEEP OUT OF REACH OF CHILDREN
DANGER/PELIGRO - POISON



PRECAUCION AL USUARIO: Si usted no les ingles, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.

FIRST AID:

Symptoms of overexposure 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.

If inhaled:

- Move person to fresh air.
- If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible.
- Keep warm and make sure person can breathe freely.
- Call a poison control center or doctor immediately for treatment advice.

If swallowed:

- Have a person drink one or two glasses of water and induce vomiting by touching back of throat with finger, or if available administer syrup of ipecac.
- Do not give anything by mouth to an unconscious person.

If on skin or clothing:

- Brush or shake material off clothes and shoes in a well ventilated area.
- Allow clothes to aerate in a ventilated area prior to laundering.
- Do not leave contaminated clothing in occupied and/or confined areas such as automobiles, vans, motel rooms, etc.
- Wash contaminated skin thoroughly with soap and water.

If in eyes:

- Hold eye open and rinse slowly and gently with water for 15-20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
- Call a poison control center or doctor for further treatment advice.

HOT LINE NUMBER

Have the product container or label or applicator's manual with you when calling a poison control center or doctor, or going for treatment. You may also contact PESTCON SYSTEMS, INC. - (252) 237-7923/1-800-548-2778 or CHEMTREC - 1-800-424-9300 for emergency medical treatment.

See side panels for additional precautionary statements.

Manufactured for:

PESTCON SYSTEMS, INC.

1808 FIRESTONE PARKWAY
WILSON, NC 27789
TELE: 252-237-7923

Fax: (252) 237-3259
E-mail: info@pestcon.com
Internet: www.pestcon.com

EPA REG. NO. 72959-2-5857
EPA EST NO. 5857-NC-001
NET CONTENTS: APPROX. 1,660 PELLETS
NET WEIGHT 1000G (2LBS. 3.28 OZ.)

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storing pesticides in the same areas used to store these commodities.

Storage Instructions:

1. Store FUMITOXIN® in a dry, well-ventilated area away from heat, under lock and key. Post as a pesticide storage area.
2. Do not store in buildings where humans or domestic animals reside. Keep out of reach of children.
3. FUMITOXIN® Pellets are supplied in gas-tight, resealable aluminum flasks. Do not expose the product to atmospheric moisture any longer than is necessary and seal tightly before returning flasks to storage.
4. The shelf life of FUMITOXIN® is virtually unlimited as long as the containers are tightly sealed.

Pesticide Disposal:

Do not contaminate water, food or feed by storage or disposal.

Unreacted or partially spent FUMITOXIN® is acutely hazardous. Improper disposal of excess pesticide is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance. For specific instructions, see Disposal Instructions and Spill and Leak Procedures in the Applicator's Manual.

Some local and state waste disposal regulations may vary from the following. Disposal procedures should be reviewed with appropriate authorities to ensure compliance with local regulations. Contact your state Pesticide or Environmental Control Agency or Hazardous Waste Specialist at the nearest EPA Regional Office for guidance.

Container Disposal:

Triple rinse flasks and stoppers with water. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities. Rinsate may be disposed of in a sanitary landfill, by pouring it out onto the ground or by other approved procedures. It is permissible to remove lids and expose empty flasks to atmospheric conditions until residue in the flask is reacted. Then puncture and dispose of in a sanitary landfill or other approved site, or by other procedures approved by state and local authorities.

If properly exposed, the residual dust remaining after a fumigation with FUMITOXIN® will be a grayish-white powder and contain only a small amount of unreacted aluminum phosphide. However, residual dust from incompletely spent FUMITOXIN® may require special care.

Spill and Leak Procedures:

General Precautions and Directions

A spill, other than incidental to application or normal handling, may produce high levels of phosphine gas and, therefore, attending personnel must wear self-contained breathing apparatus (SCBA) or its equivalent when the concentration of phosphine gas is unknown. Other NIOSH/MSHA approved respiratory protection may be worn if the concentration of phosphine gas is known. Do not use water at any time to clean up a spill of FUMITOXIN®. Water in contact with unreacted FUMITOXIN® will greatly accelerate the production of phosphine gas which could result in a toxic and/or fire hazard. Wear gloves of cotton or other material when handling aluminum phosphide.

Return all intact aluminum flasks to cardboard case or other suitable packaging which has been properly marked according to DOT regulations.

Notify consignee and shipper of damaged cases.

If aluminum flasks have been punctured or damaged so as to leak, the container may be temporarily repaired with aluminum tape or the FUMITOXIN® may be transferred from the damaged flask to a sound metal container which should be sealed and properly labeled as aluminum phosphide. Transport the damaged containers to an area suitable for pesticide storage for inspection. Refer to the Applicator's Manual for more detailed Spill and Leak procedures. Further information and recommendations may be obtained, if required, from PESTCON SYSTEMS, INC.

WARRANTY: Seller warrants that this product conforms to its commercial description and when used according to label directions under normal conditions of use, it is reasonably fit for the purposes stated on the label. Seller makes no other warranty, either express or implied, and Buyer assumes all risks should the product be used contrary to label instructions.

Classified by UL, Inc. as to fire hazard only when used specifically as directed in the instructions on this container, and supplemental labeling. FUMITOXIN® is noncombustible, but exposure to moist air or water releases flammable and toxic phosphine gas. Spontaneous ignition may result if contacted by water, acids or chemicals.



MATERIAL SAFETY DATA SHEET: ALUMINUM PHOSPHIDE, FUMITOXIN®

	<u>US EPA REG. NO.</u>	<u>DISTRIBUTOR NO.</u>	<u>CANADA REG. NO.</u>
FUMITOXIN® TABLETS	72959-1	72959-1-5857	19227
FUMITOXIN® PELLETS	72959-2	72959-2-5857	19226
FUMITOXIN® BAGS	72959-3	—	—

SECTION I – PRODUCT INFORMATION

Distributor:

Pestcon Systems, Inc.
1808 Firestone Parkway
Wilson, NC 27893
Phone: 252-237-7923 (800-548-2778)
Fax: 252-243-1832 or 252-237-3259
E-mail: info@pestcon.com
Internet address: www.pestcon.com

Manufacturer:

People's Republic of China

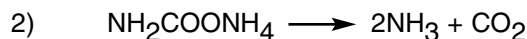
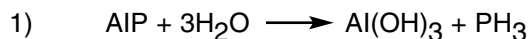
EMERGENCY TELEPHONE NOS.:

Emergency: - Chemtrec (800) 424-9300 – International: 202-483-7616
Emergency and Information: Pestcon Systems, Inc. 252-237-7923 / 800-548-2778
Date of Revision: April 2004 — Form msds/phosphine

SECTION II – HAZARDOUS INGREDIENTS INFORMATION

Identity:

Fumitoxin and Aluminum Phosphide (AIP) – react with water to produce phosphine, hydrogen phosphide. PH₃ as shown in Equation 1. is formulated with 55% aluminum phosphide and also contains ammonium carbamate (AC) and inert ingredients. Ammonium carbamate releases ammonia and carbon dioxide as shown in Equation 2.



AIP	CAS No. 20859-73-8
PH ₃	CAS No. 7803-51-2
Al(OH) ₃	CAS No. 21645-51-2

NH ₂ COONH ₄	CAS No. 1111-78-0
NH ₃	CAS No. 7664-41-7
CO ₂	CAS No. 124-38-9

NFPA Chemical Hazard Ratings:

Flammability Hazard 4
Health Hazard 4
Reactivity Hazard 2
Special Hazard W

SARA Physical and Health Hazards:

Fire
Reactivity
Immediate (Acute)

Inhalation Exposure Limits:

Component	OSHA PEL		ACGIH TLV		NIOSH IDLH (ppm)
	TWA (ppm)		TWA (ppm)	STEL (ppm)	
Hydrogen Phosphide*	0.3		0.3	1.0	50
Ammonia	50		25	35	300
Carbon Dioxide	5,000		5,000	30,000	40,000

SECTION III – PHYSICAL CHARACTERISTICS

Boiling Point:

AIP > 1000°C
PH₃ -87.7°C

Vapor Pressure:

AIP 0mm Hg
PH₃ 40mm Hg @ -129.4°C
AC 100mm Hg @ 26.7°C

Specific Gravity of Vapors (Air=1):

AIP N/A
PH₃ 1.17

Solubility in Water:

AIP Insoluble, reacts
PH₃ 26cc in 100 ml water at 17°C
AC Very soluble, reacts

Appearance and Odor:

Fumitoxin and aluminum phosphide have a greenish-gray color and the hydrogen phosphide (phosphine, PH₃) gas produced by these chemicals has an odor described as similar to garlic, carbide or decaying fish.

Specific Gravity:

AIP 2.85

Melting Point:

AIP > 1000°C

PH₃ -133.5°C

SECTION IV – FIRE AND EXPLOSION HAZARD DATA**Flash Point:**

Aluminum phosphide, and Fumitoxin are not themselves flammable. However, they react readily with water to produce hydrogen phosphide (phosphine, PH₃) gas which may ignite spontaneously in air at concentrations above its LEL of 1.8% v/v. UEL of hydrogen phosphide is not known.

Extinguishing Media:

Suffocate flames with sand, carbon dioxide or dry extinguishing chemicals.

Special Fire Fighting Procedures:

Do not use water on metal phosphide fires.

Respiratory Protection:

Wear NIOSH/MSHA approved SCBA or equivalent respiratory protection.

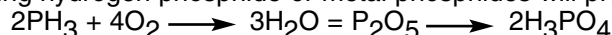
Protective Clothing:

Wear gloves when handling Fumitoxin tablets, pellets or dust.

Unusual Fire and Explosion Hazards:

Hydrogen phosphide-air mixtures at concentrations above the lower flammable limit of 1.8% v/v, PH₃ may ignite spontaneously. Ignition of high concentrations of hydrogen phosphide can produce a very energetic reaction. Explosions can occur under these conditions and may cause severe personal injury. **Never allow the buildup of hydrogen phosphide to exceed explosive concentrations.** Open containers of metal phosphides in open air only and never in a flammable atmosphere. Do not confine spent or partially spent dust from metal phosphide fumigants as the slow release of hydrogen phosphide from these materials may result in the formation of an explosive atmosphere. Spontaneous ignition may occur if large quantities of aluminum phosphide are piled in contact with liquid water. This is particularly true if quantities of these materials are placed in moist or spoiled grain which can provide partial confinement of the hydrogen phosphide gas liberated by hydrolysis.

Fires containing hydrogen phosphide or metal phosphides will produce phosphoric acid by the following reaction:

**SECTION V – REACTIVITY DATA****Stability:**

Fumitoxin and aluminum phosphide are stable to most chemical reactions, except for hydrolysis. They will react with moist air, liquid water, acids and some other liquids to produce toxic and flammable hydrogen phosphide gas. Hydrogen phosphide may react vigorously with oxygen and other oxidizing agents.

Incompatibility:

Avoid contact with water and oxidizing agents.

Corrosion:

Hydrogen phosphide gas 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 by phosphine. 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 electrical equipment may be damaged by this gas. Hydrogen phosphide will also react with certain metallic salts and, therefore, sensitive items such as photographic film, some inorganic pigments, etc., should not be exposed.

Hazardous Polymerization:

Will not occur.

SECTION VI – HEALTH HAZARD INFORMATION**Routes of Entry:**

The dermal toxicity of aluminum phosphide is very low. The LD₅₀ via the dermal route is greater than 5,000 mg per kilogram for a 1-hour exposure. Primary routes of exposure are inhalation and ingestion.

Acute and Chronic Health Hazards:

Fumitoxin and aluminum phosphide are highly acute toxic substances. The LC₅₀ for hydrogen phosphide gas is about 180 ppm for a 1-hour inhalation exposure. The acute oral toxicity of the Fumitoxin formulations was found to be 11.5 mg/kg of body weight. Aluminum phosphide and phosphine are not known to cause chronic poisoning.

Carcinogenicity:

Aluminum phosphide and phosphine are not carcinogenic and are not listed as such by NTP, IARC or OSHA.

Signs and Symptoms of Exposure:

Aluminum phosphide tablets, pellets and dust react with moisture from the air, acids and many other liquids to release hydrogen phosphide (phosphine, PH₃) gas. Mild exposure by inhalation causes malaise (indefinite feeling of sickness), ringing in the ears, fatigue, nausea and pressure in the chest which is relieved by removal to fresh air. Moderate poisoning causes weakness, vomiting, pain just above the stomach, chest pain, diarrhea and dyspnea (difficulty in breathing). Symptoms of severe poisoning may occur within a few hours to several days resulting in pulmonary edema (fluid in lungs) and may lead to dizziness, cyanosis (blue or purple skin color), unconsciousness, and death.

Emergency and First Aid Procedures:

Symptoms of exposure to this product are headaches, 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.

If inhaled: - Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth if possible. Keep warm and make sure person can breathe freely. Call a poison control center or doctor for further treatment advice.

If swallowed: - Call a poison control center or doctor immediately for treatment advice. Have person drink one or two glasses of water and induce vomiting by touching back of throat with finger, or if available administer syrup of ipecac. Do not give anything by mouth to an unconscious person.

If on skin or clothing: - Brush or shake material off clothes and shoes in a well-ventilated area. Allow clothes to aerate in a ventilated area prior to laundering. Do not leave contaminated clothing in occupied and/or confined areas such as automobiles, vans, motel rooms, etc. Wash contaminated skin thoroughly with soap and water.

If in eyes: - Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for further treatment advice.

SECTION VII – PRECAUTIONS FOR SAFE HANDLING
--

Spill Cleanup Procedures:

If possible, dispose of spilled Fumitoxin by use according to label instructions. Freshly spilled material which has not been contaminated by water or foreign matter may be replaced into original containers. Punctured flasks or containers may be temporarily repaired using aluminum tape. If the age of the spill is unknown or if the product has been contaminated with soil, debris, water, etc. gather up the spillage in small open buckets having a capacity no larger than about 1 gallon. Do not add more than about 1 to 1.5 kg (2 to 3 lbs.) to a bucket. If on-site wet deactivation is not feasible, transport the uncovered buckets in open vehicles to a suitable area. Wear gloves when handling Fumitoxin tablets and pellets.

Respiratory protection may be required during cleanup of spilled material. If the concentration of hydrogen phosphide is unknown, NIOSH/MSHA approved SCBA or its equivalent must be worn.

Small amounts of spillage, from about 4 to 8 kg (9 to 18 lbs.) may be spread out over the ground in an open area to be deactivated by atmospheric moisture. Alternatively, spilled Fumitoxin may be deactivated by the wet method as described in the following:

Wet Deactivation of Spilled Fumitoxin:

1. Deactivating solution is prepared by adding the appropriate amount of low sudsing detergent to water in a drum or other suitable container. A 2% solution or 4 cups of detergent in 30 gallons is suggested. The container should be filled with deactivating solution to within a few inches of the top.
2. The material is added slowly to the deactivating solution and stirred so as to thoroughly wet all of the product. This should be carried out in open air and respiratory protection may be required. At no time should the deactivation drum be covered.
3. No more than about 45 to 50 lbs. of Fumitoxin should be added to 15 gallons of water-detergent mixture.
4. Allow the mixture to stand, with occasional stirring, for about 36 hours. The resultant slurry of dust will then be safe for disposal.
5. Dispose of the slurry of deactivated material, with or without preliminary decanting, at a sanitary landfill or other suitable site approved by local authorities. Where permissible, this slurry may be poured into a storm sewer or out onto the ground.

For Assistance:

Contact – PESTCON SYSTEMS, INC.
Telephone: 252-237-7923 / 800-548-2778
Fax: 252-243-1832 / 252-237-3259
Internet Address: www.pestcon.com
E-mail: info@pestcon.com
or
Chemtrec: 800-424-9300

Disposal of Spent Fumitoxin:

When being disposed of, spilled or partially reacted Fumitoxin is considered hazardous wastes under existing Federal Regulations. If properly exposed, the grayish-white residual dust after a fumigation will not be a hazardous waste and normally contains only a very small amount of unreacted aluminum phosphide. This waste will be safe for disposal. However, the spent residual dust from incompletely exposed Fumitoxin may require special care.

Triple rinse tablet and pellet flasks and stoppers with water. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities. Rinsate may be disposed of in a storm sewer, sanitary landfill or by other approved procedures. Or, it is permissible to remove lids and expose empty flasks to atmospheric conditions until the residue in the flasks is reacted. Then puncture and dispose of in a sanitary landfill or other approved site, or by other procedures approved by state and local authorities.

Some local and state waste disposal regulations may vary from the following recommendations. Disposal procedures should be reviewed with appropriate authorities to ensure compliance with local regulations. Contact your State Pesticide or Environmental Control Agency or Hazardous Waste Specialist at the nearest EPA Regional Office for guidance.

1. Confinement of partially spent residual materials, as in a closed container, or collection and storage of large quantities of dust may result in a fire or explosion hazard. Small amounts of hydrogen phosphide may be given off from unreacted aluminum phosphide, and confinement of the gas may result in a flash.
2. In open areas, small amounts of spent residual dust may be disposed of on site by burial or by spreading over the land surface away from inhabited buildings.
3. Residual dust from Fumitoxin may also be collected and disposed of at a sanitary landfill, or other approved sites or by other procedures approved by Federal, State or Local authorities.
4. From 3 to 5 kg (7 to 10 lbs.) of spent dust from 2 to 3 flasks of Fumitoxin may be collected for disposal in a 1-gallon bucket. Larger amounts, up to about one-half case, may be collected in burlap, cotton or other types of porous cloth bags for transportation in an open vehicle to the disposal site. Do not collect dust from more than 7 flasks of tablets, 10 flasks of pellets (about 11 kg or 25 lbs.) in a single bag. Do not pile cloth bags together. Do not use this method for partially spent or "green" dust. **Caution:** Do not collect dust in large drums, dumpsters, plastic bags or other containers where confinement may occur.

Precautions to be taken in Handling and Storage:

Store Fumitoxin products in a locked, well-ventilated area away from heat. Post as a pesticide storage area. Do not store in buildings inhabited by humans or domestic animals.

Other Precautions:

1. Do not allow water or other liquids to contact Fumitoxin tablets, pellets or their dust.
2. Do not pile up large quantities of Fumitoxin during fumigation or disposal.
3. Once exposed, do not confine Fumitoxin or allow hydrogen phosphide concentrations to exceed the LEL.
4. Open containers of Fumitoxin only in open air. Do not open in a flammable atmosphere. Hydrogen phosphide in the head space of containers may flash upon exposure to atmospheric oxygen.
5. Fumitoxin Tablets and Pellets are restricted use pesticides due to acute inhalation toxicity or highly toxic phosphine gas. For retail sale and use only by certified applicators or persons under their direct supervision and only for those uses covered by the certified applicator's certification.
6. See EPA accepted labeling for additional precautions and directions for use.

SECTION VIII – CONTROL MEASURES

Respiratory Protection:

NIOSH/MSHA approved full-mask with approved canister for phosphine (hydrogen phosphide, PH_3) may be worn at concentrations up to 15 ppm. At levels above this or when the hydrogen phosphide concentration is unknown, NIOSH/MSHA approved SCBA or equivalent must be worn.

Protective Clothing:

Wear gloves when handling aluminum phosphide tablets, pellets or dust.

Eye Protection:

None required.

Ventilation:

Local ventilation is generally adequate to reduce hydrogen phosphide levels in fumigated areas to below the TLV/TWA. Exhaust fans may be used to speed the aeration of silos, warehouses, shipholds, containers, etc.

We believe the statements, technical information and recommendations contained herein are reliable, but they are given without warranty or guarantee of any kind, expressed or implied, and we assume no responsibility for any loss, damage, or expense, direct or consequential, arising out of their use.

**RESTRICTED USE PESTICIDE
DUE TO ACUTE TOXICITY**

For retail sale to and use only by Certified Applicators or persons under their direct supervision, and only for those uses covered by the Certified Applicator's certification.

METH-O-GAS® Q

COMMODITY FUMIGANT

FOR QUARANTINE/REGULATORY USE ONLY
SUPERVISION BY REGULATORY AGENT REQUIRED

ACTIVE INGREDIENTS: Methyl bromide.....100%

This product weighs 14.4 pounds per gallon.



DANGER • PELIGRO • POISON
KEEP OUT OF REACH OF CHILDREN



Si Usted no entiende la etiqueta, busque a alguien para que se la explique a Usted en detalle. (If you do not understand the label, find someone to explain it to you in detail).

STATEMENT OF PRACTICAL TREATMENT.

- In all cases of overexposure, get medical attention immediately. Take person to a doctor or emergency treatment facility.
- IF INHALED: Remove exposed person from contaminated area. Keep warm. Make sure person can breathe freely. If breathing has stopped, apply artificial respiration. Do not give anything by mouth to an unconscious person. If not unconscious, rinse mouth out with water.
- IF ON SKIN: Immediately remove contaminated clothing, shoes, and any other item on skin. Wash contaminated skin area thoroughly with soap and water.
- IF IN EYES: Hold eyelids open and flush with a steady, gentle stream of water for at least 15 minutes.

SEE BACK PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS



P.O. BOX 2200
WEST LAFAYETTE, IN 47996-2200
U.S.A.

NET WT. _____

LOT Number _____

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS

DANGER

Extremely hazardous liquid and vapor under pressure. Liquid or vapor can cause serious skin or eye injury which may have a delayed onset. Do not get liquid on skin, in eyes or on clothing.

Do not breathe vapor. Inhalation may be fatal or cause serious acute illness or delayed lung or nervous system injury. Methyl bromide vapor is odorless and nonirritating to skin and eyes during exposure. Exposure to toxic levels may occur without warning or detection by the user.

NOTE TO PHYSICIAN. Early symptoms of overexposure are dizziness, headache, nausea and vomiting, weakness and collapse. Lung edema may develop in 2 to 48 hours after exposure, accompanied by cardiac irregularities; these effects are the usual cause of death. Repeated overexposures can result in blurred vision, staggering gait and mental imbalance, with probable recovery after a period of no exposure. Blood bromide levels suggest the occurrence, but not the degree, of exposure. Treatment is symptomatic.

AIR CONCENTRATION LEVEL. The acceptable air concentration level for persons exposed to methyl bromide is **5 ppm (20 mg/m³)**. The air concentration level is measured by a direct reading detection device, such as a Matheson-Kitagawa, Draeger, or Sensidyne.

AERATION AND REENTRY. After fumigation, treated areas must be aerated until the level of methyl bromide is **5 ppm** or less. Do not allow entry into the treated area by any person before this time, unless protective clothing and a respiratory protection device (NIOSH/MSHA approved self-contained breathing apparatus (SCBA) or combination air-supplied/SCBA respirator) is worn.

PERSONAL PROTECTIVE EQUIPMENT (PPE). Applicators and other handlers must wear:

Loose-fitting or well ventilated long-sleeved shirt and long pants.
Shoes and socks.
Full-face shield or safety glasses with brow and temple shields (Do NOT wear goggles). When the acceptable air concentration level is above **5 ppm** and a respirator is required, protect the eyes by wearing a full-face respirator. No respirator is required if the air concentration level of methyl bromide in the working area is measured to be **5 ppm** or less. A respirator is required if the acceptable air concentration level of **5 ppm** is exceeded at any time. The respirator must be one of the following types: (a) a supplied-air respirator (MSHA/NIOSH approval number prefix TC-19C) OR (b) a self-contained breathing apparatus (SCBA) (MSHA/NIOSH approval number prefix TC-13F).

ENVIRONMENTAL HAZARDS

This product is toxic to fish and wildlife. Keep out of lakes, streams and ponds. Do not contaminate water by cleaning of equipment or disposal of wastes.

SPILL AND LEAK PROCEDURES. Evacuate immediate area of spill or leak. Use a NIOSH/MSHA approved self-contained breathing apparatus (SCBA) or combination air-supplied/SCBA respirator for entry into spill area to correct problem. Allow spill to evaporate. Do not permit entry into spill area by persons without appropriate respiratory protection until concentration of methyl bromide is determined to be **5 ppm** or less. Remove leaking containers to an isolated area and cover with polyethylene sheeting of 4 mil or greater thickness. Seal by placing the outside edges of sheeting in a trench and cover with soil. Tamp soil down so edges will not pull loose. Discharge the contents under the sheeting and do not disturb for at least 48 hours.

Contaminated soil, water, and other cleanup debris is a toxic hazardous waste. Report spill to the National Response Center (800-424-8802) if the reportable quantity of 1000 lbs. is exceeded.

PHYSICAL AND CHEMICAL HAZARDS

Contents under pressure. Do not use or store near heat or open flame. In fires fueled by other materials, Meth-O-Gas® Q may liberate hazardous gases. Meth-O-Gas® Q, used as a gaseous fumigant, is generally non-corrosive under dry conditions. However, the use of liquid methyl bromide with aluminum, magnesium, zinc and alkali metals may result in the liberation of toxic gases, and possible fire and explosion. In addition, the use of liquid methyl bromide may cause severe corrosion of containers and equipment made of these metals.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

This fumigant is a highly hazardous material and should be used only by individuals trained in its proper use. Before using, read and follow all label precautions and directions.

All persons working with this fumigant must be knowledgeable about the hazards, and trained in the use of required respirator protection equipment and detector devices, emergency procedures, and proper use of the fumigant.

STORAGE, HANDLING AND DISPOSAL

Storage and Handling of Cylinders. Store in a secure manner either outdoors under ambient conditions or indoors in a well-ventilated area. Post as a pesticide storage area.

Do not contaminate water, food, or feed by storage. Store cylinders upright, secured to prevent tipping, as allowed by design.

Cylinders should not be subjected to rough handling or mechanical shock such as dropping, bumping, dragging, or sliding. Do not use rope slings, hooks, tongs or similar devices to unload cylinders.

Transport cylinders using hand truck, fork truck or other device to which the cylinder can be firmly secured. Do not remove valve protection bonnet and safety cap until immediately before use. Replace safety cap and valve protection bonnet when cylinder is not in use.

When cylinder is empty, close valve, screw safety cap on to valve outlet, and replace protection bonnet before returning. Only the registrant, or his designee, is authorized to refill cylinders. Do not use cylinders for any other purpose.

Disposal of Pesticide. Pesticide wastes are toxic. Improper disposal of excess pesticide is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

Disposal of Cylinders. To insure proper return of empty or partial cylinders, make return shipping arrangements with the seller of the product.

METH-O-GAS®Q may be used for quarantine/regulatory commodity fumigation only. Supervision by regulatory agent is required. This fumigant is a highly hazardous material and should be used only by individuals trained in its proper use. You must carefully read and understand the accompanying use directions, GLK 398B, in order to use METH-O-GAS® Q. Observe all safety and precautionary statements as set forth in the accompanying use directions, GLK 398B. All fumigation directions, including dosage rates, exposure times and aeration periods are given in the accompanying use directions, GLK 398B.

STATEMENT OF WARRANTY AND LIABILITY

Seller warrants that this product complies with the specifications expressed in this label and GLK 398B. SELLER MAKES NO OTHER WARRANTIES; AND DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS FOR THE INTENDED PURPOSE. Seller's liability for default, breach, or failure under this label shall be limited to the amount of the purchase price. Seller shall have no liability for consequential damages.

Many pesticidal chemicals are poisonous and may leave a toxic residue on the plants to which they are applied. The U.S. Environmental Protection Agency has established maximum amounts of such pesticidal chemicals that may remain on raw agricultural products, and it is the user's responsibility to see that there is no residue on such crops in excess of these amounts. The "Directions for Use" are based on the best available information, and if followed carefully should not leave excessive residues. However, Great Lakes Chemical Corporation assumes no responsibility as to their accuracy nor for any loss due to excessive residues.

EPA REG. NO. 5785-41

EPA EST. NO. 5785-AR-01

MOGQ-1 REV.AR-41-D

**RESTRICTED USE PESTICIDE
DUE TO ACUTE TOXICITY**

For retail sale to and use only by Certified Applicators or persons under their direct supervision, and only for those uses covered by the Certified Applicator's certification.

DIRECTIONS FOR USE OF THE PRODUCT

**METH-O-GAS® Q
COMMODITY FUMIGANT**

**FOR QUARANTINE/REGULATORY
USE ONLY**

SUPERVISION BY REGULATORY AGENT REQUIRED

EPA REGISTRATION NUMBER
5785-41

DANGER

PELIGRO

Si Usted no entiende la etiqueta, busque a alguien para que se la explique a Usted in detalle. (If you do not understand the label, find someone to explain it to you in detail.)

**READ THIS BOOKLET AND ENTIRE LABEL CAREFULLY PRIOR TO
USE. USE THIS PRODUCT ACCORDING TO LABEL INSTRUCTIONS.**



P.O. BOX 2200
WEST LAFAYETTE, IN 47996-2200
U.S.A.

®Registered trademark of Great Lakes Chemical Corporation.

©Copyright 1994 Great Lakes Chemical Corporation.

MOGQ-2 REV. GLK398B

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1

STATEMENT OF WARRANTY AND LIABILITY

Seller warrants that this product complies with the specifications expressed in this label. SELLER MAKES NO OTHER WARRANTIES; AND DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS FOR THE INTENDED PURPOSE. Seller's liability for default, breach, or failure under this label shall be limited to the amount of the purchase price. Seller shall have no liability for consequential damages.

Many pesticidal chemicals are poisonous and may leave a toxic residue on the plants to which they are applied. The U.S. Environmental Protection Agency has established maximum amounts of such pesticidal chemicals that may remain on raw agricultural products, and it is the user's responsibility to see that there is no residue on such crops in excess of these amounts. The "Directions for Use" are based on the best available information, and if followed carefully should not leave excessive residues. However, Great Lakes Chemical Corporation assumes no responsibility as to their accuracy nor for any loss due to excessive residues.

No respirator is required if the air concentration level of methyl bromide in the working area is measured to be 5 ppm or less.

A respirator is required if the acceptable air concentration level of 5 ppm is exceeded at any time. The respirator must be one of the following types: (a) a supplied-air respirator (MSHA/NIOSH approval number prefix TC-19C) OR (b) a self-contained breathing apparatus (SCBA) (MSHA/NIOSH approval number prefix TC-13F).

WORK SAFETY REQUIREMENTS

1. Do not wear jewelry, gloves, goggles, tight clothing, rubber protective clothing, or rubber boots when handling. Methyl bromide is heavier than air and can be trapped inside clothing and cause skin injury.
2. If liquid fumigant splashes or spills on clothing or shoes, remove them at once.
3. Immediately after contamination remove outer clothing, shoes, and socks and do not reuse until thoroughly aerated or ventilated. Keep such clothing and shoes outdoors until thoroughly aerated. Then follow the PPE manufacturers instructions for cleaning/maintaining PPE. If there are no such instructions for washables, use detergent and hot water. Keep and wash PPE and work clothing separately from other laundry.
4. Discard clothing, shoes and other absorbent materials that have been drenched or heavily contaminated with this product. Do not reuse them.
5. Follow PPE manufacturer's instructions for cleaning/maintaining protective eyewear and respirators.

2

**PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS
DANGER**

Extremely hazardous liquid and vapor under pressure. Liquid or vapor can cause serious skin or eye injury which may have a delayed onset. Do not get liquid on skin, in eyes or on clothing.

Do not breathe vapor. Inhalation may be fatal or cause serious acute illness or delayed lung or nervous system injury. Methyl bromide vapor is odorless and nonirritating to skin and eyes during exposure. Exposure to toxic levels may occur without warning or detection by the user.

USER SAFETY RECOMMENDATIONS

Users should:

- * Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- * Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- * Remove PPE immediately after handling this product. As soon as possible, wash thoroughly and change into clean clothing.

AIR CONCENTRATION LEVEL

The acceptable air concentration level for persons exposed to methyl bromide is 5 ppm (20 mg/m³). The air concentration level is measured by a direct reading detection device, such as a Matheson-Kitagawa, Draeger, or Sensidyne.

AERATION AND REENTRY

After fumigation, treated areas must be aerated until the level of methyl bromide is 5 ppm or less. Do not allow entry into the treated area by any person before this time, unless protective clothing and a respiratory protection device (NIOSH/MSHA approved self-contained breathing apparatus (SCBA) or combination air-supplied/SCBA respirator) is worn.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear:

Loose-fitting or well ventilated long-sleeved shirt and long pants.
Shoes and socks.
Full-face shield or safety glasses with brow and temple shields (Do NOT wear goggles). When the acceptable air concentration level is above 5 ppm and a respirator is required, protect the eyes by wearing a full-face respirator.

STATEMENT OF PRACTICAL TREATMENT

In all cases of overexposure, get medical attention immediately. Take person to a doctor or emergency treatment facility.

IF INHALED: Remove person from contaminated area. Keep warm. Make sure person can breathe freely. If breathing has stopped, apply artificial respiration. If not unconscious, rinse mouth out with water. Do not give anything by mouth to an unconscious person.

IF ON SKIN: Immediately remove contaminated clothing, shoes, and any other item on skin. Wash contaminated skin area thoroughly with soap and water.

IF IN EYES: Hold eyelids open and flush with a steady, gentle stream of water for at least 15 minutes.

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NOTE TO PHYSICIAN

Early symptoms of overexposure are dizziness, headache, nausea and vomiting, weakness and collapse. Lung edema may develop in 2 to 48 hours after exposure, accompanied by cardiac irregularities; these effects are the usual cause of death. Repeated overexposures can result in blurred vision, staggering gait and mental imbalance, with probable recovery after a period of no exposure. Blood bromide levels suggest the occurrence, but not the degree, of exposure. Treatment is symptomatic.

ENVIRONMENTAL HAZARDS

This product is toxic to fish and wildlife. Keep out of lakes, streams and ponds. Do not contaminate water by cleaning of equipment or disposal of wastes.

4

SPILL AND LEAK PROCEDURES.

Evacuate immediate area of spill or leak. Use a NIOSH/MSHA approved self-contained breathing apparatus (SCBA) or combination air-supplied/SCBA respirator for entry into affected area to correct problem. Allow spill to evaporate. Do not permit entry into spill area by persons without appropriate respiratory protection until concentration of methyl bromide is determined to be 5 ppm or less. Remove leaking containers to an isolated area and cover with a polyethylene sheeting of 4 mil or greater thickness. Seal by placing the outside edges of sheeting in a trench and cover with soil. Tamp soil down so edges will not pull loose. Discharge the contents under the sheeting and do not disturb for at least 48 hours.

Contaminated soil, water, and other cleanup debris is a toxic hazardous waste. Report spill to the National Response Center (800-424-8802) if the reportable quantity of 1000 pounds is exceeded.

PHYSICAL AND CHEMICAL HAZARDS

Contents under pressure. Do not use or store near heat or open flame. In fires fueled by other materials, Meth-O-Gas[®] Q may liberate hazardous gases. Meth-O-Gas[®] Q, used as a gaseous fumigant, is generally non-corrosive under dry conditions. However, the use of liquid methyl bromide with aluminum, magnesium, zinc and alkali metals may result in the liberation of toxic gases, and possible fire and explosion. In addition, the use of liquid methyl bromide may cause severe corrosion of containers and equipment made of these metals.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

This fumigant is a highly hazardous material and must be used only by individuals trained in its proper use. Before using, you must read and obey all label precautions and directions.

All persons working with this fumigant must be knowledgeable about the hazards, and trained in the use of required respiratory protection equipment and detector devices, emergency procedures, and proper use of the fumigant.

This is a limited use label for quarantine/regulatory purposes and is to be used by or under the supervision of a State or Federal agency. Tables I through IV present a summary of treatments for raw agricultural commodities, processed commodities, and non-food and/or non-feed commodities abbreviated from the USDA/APHIS Plant Protection and Quarantine Treatment Manual. For more detailed guidance and information on treatment conditions, dosage rates, treatment periods, monitoring requirements, etc., refer to that Manual. Additional requirements may be imposed by the USDA/APHIS Manual, official government correspondence or documents, or the supervising regulatory agent at the fumigation.

The registrant assumes no responsibility for loss or damage due to required quarantine and trade fumigations using this product. Nursery stock and plant materials are generally intolerant of excessive exposure to this product and damage may occur. The condition of the material at the time of treatment will determine its reaction to treatment. Some of the factors that must be fully considered prior to fumigation of nursery stock and plant materials are the method of packing, degree of root exposure, ventilation, temperature, delays in transit, and broken dormancy.

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STORAGE, HANDLING AND DISPOSAL

Storage and Handling of Cylinders. Store in a secure manner either outdoors under ambient conditions or indoors in a well-ventilated area. Post as a pesticide storage area.

Do not contaminate water, food, or feed by storage. Store cylinders upright, secured to prevent tipping, as allowed by design.

Cylinders should not be subjected to rough handling or mechanical shock such as dropping, bumping, dragging, or sliding. Do not use rope slings, hooks, tongs or similar devices to unload cylinders. Transport cylinders using hand truck, fork truck or other device to which the cylinder can be firmly secured. Do not remove valve protection bonnet and safety cap until immediately before use. Replace safety cap and valve protection bonnet when cylinder is not in use.

When cylinder is empty, close valve, screw safety cap on to valve outlet, and replace protection bonnet before returning. Only the registrant, or his designee, is authorized to refill cylinders. Do not use cylinders for any other purpose.

Storage and Handling of Cans. Store 1 and 1.5 pound cans indoors in a locked, dry, well-ventilated area. Do not attempt to store partially emptied cans. Keep empty cans in a well-ventilated location for at least 12 hours before disposal. Do not reuse empty cans.

Disposal of Pesticide. Pesticide wastes are toxic. Improper disposal of excess pesticide is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

Disposal of Cylinders. To insure proper return of empty or partial cylinders, make return shipping arrangements with the seller of the product.

Disposal of Cans. Before disposal, empty the can by using the product according to the label. Keep empty cans in a well-ventilated location for at least 12 hours before disposal. Empty cans can be recycled in some recycling programs. Otherwise, dispose of empty cans in a sanitary landfill, or by other procedures approved by state and local authorities.

COMMODITY, FOOD, AND FEED FUMIGATION DIRECTIONS. THE FOLLOWING PRECAUTIONARY PROCEDURES MUST BE FOLLOWED FOR ALL USES.

When used for fumigation of enclosed spaces (e.g., warehouses, grain bins or elevators, vaults, chambers, trucks, vans, railroad cars, ships, and other transport vehicles, and tarpaulin-covered commodities), two persons trained in the use of this product must be present during introduction of the fumigant, initiation of aeration, and after aeration when testing for reentry. Two persons do not need to be present if application, aeration, monitoring and/or testing is conducted remotely (outside the area being fumigated).

Do not fumigate with this product when the space, commodity, or structure (excluding dwellings) to be fumigated is below 40°F for control of insects or below 20°F for control of rodents and other warm-blooded pests. Fumigation at different temperatures may be allowed or required under APHIS or other governmental quarantine treatment schedules.

If monitoring indicates concentration of fumigant is insufficient to be effective for the target pest, additional fumigant may be added as required; but, concentration is not to exceed prescribed rates of application.

When fumigating tanks, silos, etc., of stored bulk flour, empty or draw down flour to less than one meter deep. Do not introduce liquid methyl bromide into flour storages. Set up fans or air circulation to avoid localized high concentrations of methyl bromide when shooting gaseous methyl bromide into the storage. Do not overdose flour storages. It is recommended that the fumigant be applied outside flour storages that are inside buildings and allowed to drift in through open hatches.

PLACARDING OF FUMIGATED AREAS

The applicator (or supervisor of the application) must placard all entrances to the fumigated area with signs bearing:

- skull and crossbones symbol.
- "DANGER/PELIGRO,"
- "Area under fumigation, DO NOT ENTER/NO ENTREE,"
- "Methyl Bromide Fumigant in use,"
- the date and time of fumigation, and
- name, address, and telephone number of the applicator.

Do not allow entry by unprotected persons into the fumigated area until the signs are removed. Do not remove warning signs until the fumigated area and the treated commodity are completely aerated. To determine whether aeration is complete, each fumigated site or vehicle must be tested and shown to contain 5 ppm or less of methyl bromide in the airspace around and, when feasible, in the mass of the commodity. If 5 ppm or less of methyl bromide is detected, the warning sign may be removed. However, if greater than 5 ppm of methyl bromide is detected, the warning signs must be transferred with the commodity to the new site. Workers who transfer or handle incompletely aerated commodity must be informed and appropriate measures must be taken (i.e. ventilation or respiratory protection) to prevent exposures from exceeding 5 ppm of methyl bromide.

A. Chamber and Vault Fumigation.

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All precautionary procedures as outlined immediately following COMMODITY, FOOD, AND FEED FUMIGATION DIRECTIONS must be followed.

Load the chamber with the material to be fumigated, close exhaust ports, turn on circulating fan and close chamber door. Determine the proper rate of application and exposure time from appropriate table. Introduce the fumigant into the chamber by releasing it into the air stream in front of a blower or fan, passing it through a vaporizer, or allowing it to evaporate from a shallow pan. All controls should be outside the chamber.

At the end of the exposure period, aerate by opening the exhaust port, turning on the exhaust fan and opening the chamber door slightly or an inlet port to permit fresh air to enter. At the end of the aeration period, check fumigant concentration with a detection device. See Aeration and Reentry Section.

8

B. Vacuum Chamber Fumigation.

All precautionary procedures as outlined immediately following COMMODITY, FOOD, AND FEED FUMIGATION DIRECTIONS, must be followed.

Place articles to be fumigated in the steel chamber and draw the vacuum (25-27 inches mercury). Release fumigant into the chamber (usually through an appropriate heating unit to insure complete non-destructive vaporization of methyl bromide). See appropriate table for rates of application and exposure times. At the end of the exposure time, release the vacuum and change the air in the chamber at least two times. A vacuum of 15 inches mercury should be drawn for this purpose. After purging chamber, check fumigant concentration with a detection device. See Aeration and Reentry Section.

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C. Railroad Car, Truck, Van, Trailer or Air and Sea Container Fumigation.

All precautionary procedures as outlined immediately following COMMODITY, FOOD, AND FEED FUMIGATION DIRECTIONS, must be followed.

Railroad car should be placed on seldom used trackage or siding so that it will not have to be moved while under fumigation. Park vehicle or container out of traffic area; if possible on the lee side of a building to protect from winds. Do not fumigate while strong winds are blowing. Seal the doors, ventilators and other openings. If vehicle or container can not be adequately sealed, cover with tarpaulin or plastic sheeting. See Tarpaulin Fumigation Section.

The end(s) of the shooting line(s) should be anchored inside an evaporation pan unless a volatizer is used to apply gaseous fumigant. Use a fan or blower to aid in even distribution of the fumigant. Always apply fumigant from outside the vehicle. Place warning signs on doors and as needed to be easily visible. Secure or lock vehicle or container to ensure it is not moved before aeration. **DO NOT FUMIGATE VEHICLES IN TRANSIT.**

Consult appropriate table for specific articles, rates of application and exposure times.

After the appropriate exposure period, open the unit and aerate at least one hour. The vehicle must be aerated to 5 ppm or less before movement is allowed. The vehicle may then be resealed for shipment. See Aeration and Reentry Section.

D. Tarpaulin Fumigation.

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All precautionary procedures as outlined immediately following COMMODITY, FOOD, AND FEED FUMIGATION DIRECTIONS, must be followed.

The article or stacked articles should be placed on a concrete floor or other air-tight surface. If the floor or surface is not air-tight, it may be made so by sealing or covering it with additional tarpaulin or polyethylene sheeting. Provide a space on top of the stack for a gas expansion dome to facilitate distribution. Evaporating pans are essential for the volatilization and uniform dispersion of fumigant except where a vaporizer is used. Shallow pans or basins made of plastic or metal (except aluminum) are satisfactory for this purpose. Use one evaporator pan for each 1000 cubic feet contained under the tarp. For delivery of *Meth-O-Gas*[®] Q from outside the tarpaulin, do not use polyvinyl tubing; polyethylene tubing is recommended. Anchor one end of each tube into an evaporating pan with tape or a suitable weight. This ensures that the liquid will be directed into the evaporating pan. Place evaporating pan(s) with anchored applicator tubing in the center of the expansion dome. Extend the free ends of the polyethylene tubes outside the area to be covered. Cover and seal the stack with a gas tight tarpaulin or polyethylene sheeting of 4 mil or greater thickness. Allow a margin of at least two feet at the base of the stack for sealing. Sweep around the stack to provide a clean surface for sealing the tarpaulin. Seal tarpaulin to floor by sand and/or water snakes, by taping or by means of moist soil or sand.

Attach each polyethylene tube to a can applicator or cylinder valve outlet and release fumigant. Use a cylinder dispenser or scale to meter small amounts from cylinders. Special units are available for use of 1 and 1.5 pound cans that combine opener and evaporating pan functions, and are designed to be used with all parts under the tarpaulin. Fans normally should be used in tarp fumigations to aid in the even distribution of fumigant. A vaporizer or heat exchanger may be required and is also useful to aid in application and distribution of the fumigant. Dosage rates and exposure times are shown in Tables 1 through IV. At the end of the exposure period, unseal opposite ends of the tarpaulin and allow to aerate for at least one hour before completely removing the tarp. Check fumigant concentration with a detection device before allowing unprotected persons to enter the area. See Aeration and Reentry Section.

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E. Warehouse, Grain Elevator, Food Processing Plant, Restaurant, And Other Structures Containing Commodities.

All precautionary procedures as outlined immediately following COMMODITY, FOOD, AND FEED FUMIGATION DIRECTIONS, must be followed.

Check with appropriate municipal and county authorities before fumigating to be completely familiar with local regulations. Ordinances may require watchmen or locks, during fumigation and/or notification of the nearest fire station.

1. **Preparation for Fumigation.** Remove or protect the following items from the structure to be fumigated: 1) all food and feed commodities not included in Tables I, II or IV; 2) medicinals not sealed in metal or glass; 3) pets (including fish and birds); 4) furs, horsehair articles, and leather goods sensitive to methyl bromide; 5) rubber goods (natural latex); 6) carbonless carbon forms and blueprints; 7) cinder blocks; 8) articles containing sulfur; 9) live cultures.

Prior to fumigation, extinguish all open flames and turn off all high temperature electrical equipment including laboratory ovens, pilot lights, gas refrigerators, oil burners, etc. *Meth-O-Gas*[®] Q in the presence of intense heat from such sources may generate some hydrobromic acid which may be injurious to commodities and equipment.

2. **Sealing the Building.** The most important part of the fumigation is the preparation and sealing of the structure. A thorough sealing job is necessary. Avoid fumigating under windy conditions.

Sealing of the building begins with the closing of all external openings to the building. Wrap roof ventilators, chimneys and other large openings with a tarpaulin or plastic sheet and seal with duct or other appropriate tape. Screened and small openings may also be sealed with a wide, commercial duct or masking tape. Cleaning of the surfaces to be taped and the use of commercial spray-on adhesives will improve sealing.

For masonry or metal structures, seal all cracks and other air leaks with caulking material or tape, and seal cracks around doors, windows, vents and other openings. Wooden structures and others that can not be readily sealed may be completely enveloped with an impervious tarpaulin. Seal securely all seams between tarps and seal the lower edges of the tarp to the ground with moist soil or with sand or water snakes. To prevent escape of gas through the ground and avoid injury to nearby plants, wet the soil to a depth of six inches for a distance of one foot outward from the edge of the tarp.

Exterior doors and windows should be tightly sealed and locked. Large exterior doors may require additional efforts to seal properly. Check for cracks around the eaves, in the floor and roof, and seal them.

Storage or work areas in a building that are not to be fumigated should be carefully sealed off. Adjoining buildings sharing a common wall should be cleared of occupants before fumigation. If this is not feasible, seal with a gas tight tarp or polyethylene sheeting (thickness of 4 ml or greater) to prevent spread of the fumigant to undesirable areas. In all such cases where the adjoining building is occupied, it should be checked frequently with a suitable gas detector during fumigation to ensure the safety of the occupants. Check local regulations for specific requirements.

Doors or hatches on milling machinery should be opened prior to fumigation. These include elevator boots, conveyor lids, settling chamber doors, dust trunks, and any other openings that will allow fumigant into the equipment. Inside doors, openings to attics and crawlspaces, cabinets, lockers, and drawers should also be opened to facilitate treatment and aeration. "Dead" spouts are particularly difficult to penetrate and should be opened before the fumigation.

Set up fumigant application equipment and fans as necessary to achieve uniform fumigant concentrations and to facilitate thorough aeration after the exposure period. The choice of a fan or fans depends upon fan capability to perform the desired function without jeopardizing the success of the fumigation. Small battery operated fans may be suitable in very small situations. A fan with tubing attached may be useful for internal recirculation of the fumigant within a building or space to aid in reaching and maintaining equalized concentrations. Adequate fans should also be available to effectively aerate difficult to ventilate situations because of construction or unexpected wind direction or calm. It may be possible to use heating system fans or other installations already in a building for improved circulation or distribution of Meth-O-Gas[®] Q, as well as aid in ventilation after the exposure period. All fans used for the fumigation should be running when fumigant is being introduced, and left running until uniform distribution has been accomplished. Fumigators should not enter a space or building under fumigation to turn fans off or on.

See appropriate table for rate of application and exposure times.

3. Fumigating the Structure. Inside Release. Cylinders should be placed by a team of two people and the location of each cylinder in the building should be mapped. The cylinders should be arranged so that the fumigators can walk away from the released gas as they open each subsequent cylinder. It is recommended that polyethylene sheeting or something functionally similar be used underneath cylinders and at the point of release to prevent staining or damage to floor surfaces. Narrow cylinders should be secured to prevent tipping.

Cylinders should be placed within a room for best distribution into all areas. Cylinders should be placed in a normal upright position and the shipping caps removed. Standpipes or curved pipes directed up and away from the cylinder can be attached. Polyethylene, nylon or similar tubing, possibly divided with tees or crosses, or other equipment can also be attached to facilitate distribution of the gas within the room or space to be fumigated.

Place warning signs or placards on all entrances to the building. Signs and placards should conform to all local, state, and federal regulations. It is best to inform police, fire and health officials that a fumigation process is about to begin. Observe the location of the nearest outside telephone for use in case of an emergency.

Practice or review the shooting procedure so that the operation will be done efficiently and safely. Respiratory protection equipment should be checked for leaks and other problems before the "practice session". While wearing respiratory protection, quickly open and close the cylinder valves to make certain they are in working order and thus avoid delay during the actual release.

Applicators should not be in the building longer than 30 minutes while releasing the gas. If it is impossible for one team to do it within this time period, additional experienced teams should be used. Two people should work together while the gas is being released and when entering the structure during aerating and testing.

Fumigators should always remain in sight of each other from the time they open the first cylinder until the time they leave the building together. While the fumigant is being released, it is advisable to have additional people, with respiratory protection equipment ready, waiting outside to assist if necessary. One member of the team should record the release of the fumigant from each cylinder so that none are missed. After making sure fumigation area is vacated, immediately lock and seal the last exit. If guards are used, they should remain on duty during release, exposure, and aeration periods to prevent unauthorized entry.

4. Fumigating the Structure. Outside Release. Releasing the fumigant from outside the space to be fumigated is possible in some situations and can minimize applicator exposure to the fumigant. Prepare the building as outlined previously.

Secure the ends of each "shooting" line or hose to each point where the fumigant is to be released, using evaporating pans or plastic sheeting to prevent possible damage to some surfaces. Run each line to the cylinder(s) or manifold located outside the area to be treated. Connect each line to the cylinder(s) or manifold.

When fumigating storages of bulk grain or other bulk commodities, such as silos, grain bins, tanks, etc., the fumigator should plan sealing and fumigant distribution to effectively fumigate all the target pests contained in the sealed space. The fumigant can be applied in several locations such as the top and bottom of the storage. For bulk commodities more than 20 feet deep, a permanent or temporary fumigant recirculation system should be considered. When recirculating fumigant through a closed loop system, plan to run fans long enough to achieve at least three complete cycles.

After making sure fumigation area is vacated, immediately lock and seal the last exit. If guards are used, they should remain on duty during release, exposure, and aeration periods to prevent unauthorized entry.

Open the valves to release the fumigant. Respiratory equipment must be available in the event of a major leak or equipment failure.

5. Aerating the Building. When the exposure period is complete, aeration generally should be started by opening previously sealed doors and windows on the ground floor. Ventilators accessible from the outside should be opened at this time.

After partial aeration, a team of at least two trained people with appropriate respiratory protection, should begin opening windows or remaining sealed openings, starting at the lower floors and working upward. Fans should be on to assist aeration. Aeration is usually complete in four hours depending upon weather conditions and cross ventilation. No one should be allowed inside the building without respiratory protection until the methyl bromide concentration is 5 ppm or less in the worker areas.

Contact the police, fire and health officials previously notified of the fumigation and inform them that it has been completed.

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F. Shipboard, In Transit Ship or Shiphold Fumigation.

IMPORTANT. Shipboard, in transit ship or shiphold fumigation is also governed by the U.S. Coast Guard Regulations. Refer to and comply with those regulations prior to fumigation.

Prior to fumigating a vessel for in transit cargo fumigation, the master of the vessel or his representative and the fumigator must determine whether the vessel is suitably designed and configured so as to allow for safe occupancy by the ship's crew throughout the duration of the fumigation. If it is determined that the design and configuration of the vessel does not allow for safe occupancy by the ship's crew throughout the duration of the fumigation, then the vessel must not be fumigated unless all crew members are removed from the vessel. The crew members must not be allowed to reoccupy the vessel until the vessel has been properly aerated and a determination has been made by the master of the vessel and the fumigator that the vessel is safe for occupancy (5 ppm or below).

The person responsible for the fumigation must notify the master of the vessel or his representative of the requirements: 1) relating to the use of respiratory protection equipment; 2) relating to the use of detection equipment; and 3) that a person qualified in the use of this equipment must accompany the vessel with cargo under fumigation. Emergency procedures, cargo ventilation, periodic monitoring and inspections, and first aid measures must be discussed with and understood by the master of the vessel or his representative.

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

Using appropriate gas detection equipment, monitor spaces adjacent to areas containing fumigated cargo and all regularly occupied areas for fumigant leakage. If leakage above 5 ppm is detected, the area should be evacuated of all personnel, ventilated, and action taken to correct the leakage, before allowing the area to be reoccupied. Do not enter fumigated areas except under emergency conditions. If necessary to enter a fumigated area, wear a NIOSH/MSHA approved self-contained breathing apparatus (SCBA) or combination air-supplied/SCBA respirator (personal protection equipment). Never enter fumigated area alone. At least one other person, wearing personal protection equipment, should be available to assist in case of an emergency.

If necessary to enter holds prior to discharge, test spaces directly above cargo surface for fumigant concentration, using an appropriate gas detector and while wearing personal protection equipment. Do not enter without respiratory protection, unless fumigation concentrations are at or below 5 ppm, as indicated by a suitable detector.

If the fumigation is not completed and the vessel aerated before the manned vessel leaves port, the person in charge of the vessel shall ensure that there be on board the vessel during the voyage: 1) at least two NIOSH/MSHA approved self-contained breathing apparatus (SCBA) or combination air-supplied/SCBA respirators; 2) one gas detection device; and 3) a person qualified in their operation.

Fumigation of any ship, shiphold, or a portion of the vessel (e.g., galley) requires careful planning. All precautionary procedures as outlined previously must be followed. Aeration should be planned so that it can be safely and effectively conducted. Adequate supplemental fans to ventilate quarters, decks, bottom of shipholds, etc., should be available for use. Tubing attached to fans or used as a temporary exhaust stack for aeration should also be prepared in advance. Recirculation systems for fumigation of grain and other commodities in shipholds must be installed before loading.

The master of the vessel or his representative and the fumigator should discuss security of an unoccupied vessel under fumigation and make arrangements to prevent unauthorized boarding. If a crew member will need to board such a vessel for a necessary ship function (e.g., boiler check) the crew member must be trained in the proper use of respiratory protection equipment. The fumigator should test all passageways and areas where the crew member will be entering to determine if fumigant concentrations exceed 5 ppm in the air. If concentrations exceed 5 ppm, then required respiratory equipment must be worn.

See appropriate table for rates of application and exposure times.

TABLE I APPLICATION SUMMARY FOR STORED RAW AGRICULTURAL COMMODITIES ⁽¹⁾ METH-O-GAS [®] Q (NOT PROCESSED FOOD)				
COMMODITY	PESTS CONTROLLED	TOLERANCE	DOSAGE	EXPOSURE
		(ppm)	(lb/1000 ft ³)	TIME (HRS)
Tree Nuts and peanuts (e.g. almonds, Brazil nuts, bushnuts, butternuts, cashews, filberts, hickory nuts, macadamia nuts, pecans, pistachios, walnuts, etc.)	confused flour beetle, saw toothed grain beetle, dermestids, Indian meal moth, drugstore beetle, cigarette beetle, warehouse moth, rusty grain beetle, cadelle, groundnut bruchid, pecan weevil, almond moth, nut weevil, nut fruit tortrix	200	1.5-3.5	16-24
		200	2.5-3.5 ^(a)	2-5 ^(a)
		200	4-6	4-6
Chestnuts		200	4 ^(a)	5 ^(a)
		200		
Apples	oriental fruit moth, codling moth, apple maggot, apple curculio, twig borer, melon fruit fly, Mediterranean fruit fly, Oriental fruit fly, cherry fruit fly, brown mite, green peach aphid, scales, thrips	5	1.5-4	2
Apricots		20	1.5-4	2
Blueberries		20	1.5-2	2-3.5
Cherries		20	1.5-4	2
Nectarines		20	1.5-4	2
Peaches		20	1.5-4	2
Pears		5	1.5-4	2
Plums		20	1.5-4	2
Quinces		5	1.5-4	2
Strawberries		60	1.5-3	2
Prunes	20	1.5-4	2	
Barley	coffee bean weevil, Australian spider beetle, saw toothed and merchant grain beetles, dried fruit beetles, Indian meal moth, confused flour beetle, warehouse moth, common grain mite, granary weevil, lesser grain borer, rusty grain beetle, angoumois grain moth, rice weevil, cadelle, drugstore beetle, cigarette beetle, flat grain beetle, Mediterranean flour moth, red flour beetle, common bean weevil, copra beetle, rice moth, foreign grain beetle, almond moth, mealworms, bruchids, weevils, mite, khapra beetle, seed beetles	50	2-9	4-24
Corn		50	2-9	4-24
Oats		50	2-9	4-24
Popcorn		240	1.5-9 ^(a)	2-3 ^(a)
		240	2-9	4-24
Rice		50	2-9	4-24
Rye		50	2-9	4-24
Sorghum (grain)		50	2-9	4-24
Dried Peas and Beans	125	3-4	4-24	

TABLE I (continued)

COMMODITY	PESTS CONTROLLED	TOLERANCE (ppm)	DOSAGE (lb/1000 ft ³)	EXPOSURE TIME (HRS)
Faba Beans (dried)		125	3-4	4-24
		125	3 ^(a)	5 ^(a)
Wheat		50	2-9	4-24
Copra		100	1.5-3.5	16-24
Asparagus	aphids, asparagus beetle, armyworms, cabbage looper, European corn borer, pink bollworm, Japanese beetle, pod borers, Oriental fruit fly, Mediterranean fruit fly, corn earworm, green stink bug, sawbugs, spider mites, cabbage maggots, lygus bug, melon aphid, pickleworm, carrot rust fly, stink bug, bean leaf beetle, Mexican bean beetle, Diabrotica beetle, cucumber beetle, squash bug, false chinch bug, loopers, symphylans, blister beetles, onion maggot, onion thrips, mealybugs, pepper maggot, Colorado potato beetle, potato psyllid, tuber moth, sweet potato weevil, tuberworm, squash bug, squash vine borer, earwigs, darkling beetle, external feeding insects	5	1.5-4	2
Beans (all)		20	1.5-4	2
Beets (roots)		20	1.5-2	2-3.5
Cabbage		20	1.5-4	2
Carrots		20	1.5-4	2
Citron		20	1.5-4	2
Cucumbers		5	1.5-4	2
Eggplant		20	1.5-4	2
Jerusalem Artichokes		5	1.5-4	2
Melons (e.g., cantaloupe, honeydew melon, muskmelon, watermelon)		20	2-4	2
Okra		30	1-3.5	2
Onions		20	2-3	4
Parsnips (roots)		30	2-3	2-4
Peas (with pods)		50	1-3	1.5-2
Sweet Corn		50	2-3	3-4
Peppers		30	2-4	2
Pimentos		30	2.5	3
Pineapples		20	2-6	2-6
Potatoes		75	2.5-3 ^(b)	2 ^(b)
Pumpkins		20	1.5-2.5	2
Radishes	30	2-3	2-4	
Rutabagas	30	2.5-3	2	
Squash (summer)	30	1.5-4	2	
Squash (winter)	20	1.5-4	2	
Squash (zucchini)	20	1.5-2.5	2	
Sugar Beets (roots)	30	2-3	2-4	
Sweet Potatoes	75	2-4 ^(b)	3-4.5 ^(b)	

TABLE I (continued)				
COMMODITY	PESTS CONTROLLED	TOLERANCE	DOSAGE	EXPOSURE
		(ppm)	(lb/1000 ft ³)	TIME (HRS)
Tomatoes		20	2-3	3-4
Turnips (roots)		30	2-3	2-4
Yams		30	2.5-4 ^(b)	3-4.5 ^(b)
Cipolini Bulbs	<i>Exosoma lusitanica</i> , mites	50	2-4 ^(c)	2-4 ^(c)
Cocoa Beans	cocoa moth, cigarette beetle, confused flour beetle, bruchids, warehouse moth, flat grain beetle, coffee bean weevil, coffee rust, Indian meal moth	50	1-2	16-24
Coffee Beans		50	1.5 ^(a)	3 ^(a)
		75	2-3	16-24
Garlic	<i>Brachycera spp.</i> , <i>Dyspessa ulula</i> , brown wheat mite, onion maggot, onion thrips	50	2-3 ^(c)	1.5-4 ^(c)
Horseradish (roots)	<i>Baris lepidi</i>	30	2-3 ^(c)	2 ^(c)
Salsify Roots	armyworm, flea beetle, leafhoppers, stink bugs, tarnished plant bug	30	2-3	2-3
Hay (alfalfa)	alfalfa weevil, cereal leaf beetle	50	2-3	16-24
Grapefruit ⁽²⁾	<i>Anastrepha spp.</i> , <i>Proeulia spp.</i> , <i>Leptoglossus spp.</i> , <i>Megalometis spp.</i> , <i>Naupactus spp.</i> , <i>Listroderes spp.</i> , <i>Conoderus spp.</i> , <i>Brevipalpus spp.</i> , ants, aphids, citrus scale, citrus mites, leaf rollers, fruit flies, white flies, thrips, California orangedog, mealybugs, orange tortrix, vine moth, spiders	30	2-3	2
Grapes		20	1.5-4	2-4
Kumquat		30	2-3	2
Lemons ⁽²⁾		30	1.5-3	2
Lime ⁽²⁾		30	2-3	2
Oranges ⁽²⁾		30	2-3	2
Tangelos ⁽²⁾		30	2-3	2
Tangerines ⁽²⁾		30	2-3	2
Baled Tobacco		drugstore beetle, cigarette beetle, tobacco beetle, tobacco moth		2-3 4 ^(a)
Processed Tobacco (e.g., cigars)			2-3 4 ^(a)	16-24 4 ^(a)

(1) Consult APHIS Treatment Manual for additional treatment conditions and commodities.

(2) Tolerance of fruit to methyl bromide may vary with variety of fruit. Check with local authorities or Great Lakes Chemical Corporation for additional information.

(a) Vacuum chamber fumigation

(b) Fumigation below 70°F may result in damage.

(c) Partial vacuum (15 inches mercury)

TABLE II APPLICATION SUMMARY FOR PROCESSED FOOD ⁽¹⁾ METH-O-GAS [®] Q				
COMMODITY	INSECTS CONTROLLED	TOLERANCE (ppm)	DOSAGE (lb/1000 ft ³)	EXPOSURE TIME (HRS)
Dried Fruits (e.g. apples, apricots, cherries, dates, peaches, prunes, raisins)	saw-toothed grain beetle, merchant grain beetle, dried fruit beetle, Indian meal moth, confused flour beetle, spider beetles, cigarette beetle, warehouse moth, carob moth, raisin moth, mites, fruit flies	125	1-2	16-24
Figs (dried)		250	1-2	16-24
Cheese (e.g., Parmesan and Roquefort)	cheese mites, cheese skipper, cheese maggot	325	1-2	16-24
Eggs (dried)	larder beetle, mites	400	1-2	16-24
Hams and Cured Meats	cheese skipper, larder beetle, red legged ham beetle, mites	325	1-2	16-24
Processed Foods and Processed Grains	saw-toothed grain beetle, flat grain beetle, flour beetles, cigarette beetle, Indian meal moth, psocids, rusty grain beetle, drugstore beetle, spider beetles, Mediterranean flour moth, mealworms, warehouse beetle, warehouse moth, mites, spider beetles, foreign grain beetle, khapra beetle	125	1-12	12-48
Spices and Herbs (dried)		400	2-3	16-24
Animal Feed (e.g., pet food)		400	1-2	16-24

⁽¹⁾ Consult APHIS Treatment Manual for additional treatment conditions and commodities.

TABLE III METH-O-GAS [®] Q APPLICATION SUMMARY FOR STRUCTURES OR VEHICLES ASSOCIATED WITH RAW OR PROCESSED COMMODITIES ⁽¹⁾			
TREATMENT SITE	PESTS	RATE (lb/1000 ft ³)	EXPOSURE TIME (hrs)
Warehouse ⁽²⁾ , Shipboard, Railroad Car, Truck, Air and Sea Containers, Grain Elevator, Poultry Houses, Food Processing Plant, Restaurants, Feed Room, Grain Bin	cockroaches, confused flour beetle, rice weevil, granary weevil, saw toothed grain beetle, rusty grain beetle, lesser grain borer, cadelle, khapra beetle, drugstore beetle, larder beetle, carpet beetle, copra beetle, coffee bean weevil, groundnut bruchid, common bean weevil, dried fruit beetle, golden spider beetle, Australian spider beetle, cigarette beetle, angoumois grain moth, Mediterranean flour moth, warehouse moth, Indian meal moth, common grain mite, snails	1-9	10-72
	rats, mice and brown tree snakes (<i>Boiga irregularis</i>)	0.2-0.4	8-16
	fungi and some bacteria (e.g., <i>Solmonella spp.</i>)	3-4	24-36

⁽¹⁾ At temperatures below 60°F, increase the dosage by 1/2 lb per 1,000 cu. ft. for every 10°F drop in temperature or use an approved procedure to heat the fumigant. No additional fumigant is required for rats and mice. Do not fumigate fungi and some bacteria when inside temperatures are less than 70°F.

⁽²⁾ Seed in warehouses should not be fumigated at rates greater than 1 lb/1000 ft³. Seed temperatures should not exceed 85°F and moisture should not exceed 12%. Ambient temperature should not exceed 85°F and relative humidity should not exceed 85%.

NOTE: Remove or protect any food and feed commodities not listed in Tables I, II, or IV before fumigating structures. Also remove or protect any commodity with specific commodity exposure times less than the times listed in this table.

TABLE IV APPLICATION SUMMARY FOR NON-FOOD PRODUCTS ⁽¹⁾ METH-O-GAS [®] Q			
MATERIALS AND PRODUCTS	PESTS CONTROLLED	DOSAGE (lb/1000 ft ³)	EXPOSURE TIME (hrs)
Cotton (i.e., lint, bulk, baled, seed)	Pink bollworm, boll weevil, kharpa beetle, Coleoptera, Lepidoptera	3-11	3-25
Plants, Bulbs, Corms, Tubers, Rhizomes and Roots	Mealybugs, scale insects, aphids, Coleoptera, Japanese beetle, Hemiptera, thrips, ants, Homoptera, Lepidoptera, mites, thrips	1-4.5	1-4.5
Christmas Trees	Gypsy moth, Pine shoot borer, Homoptera, Hymenoptera, Coleoptera, Lepidoptera, insects	1.5-5 ^(a)	2.5-4.5 ^(a)
Propagative Seeds	<u>Scolytus</u> spp., <u>Callosobruchus</u> spp., <u>Cryptophlebia illepidia</u> , <u>Helicella</u> spp., Coleoptera, Lepidoptera, mites	1-4	2-24
Machinery, packing & bagging material, miscellaneous non-food cargo, (e.g., ceramic, marble, brassware, handicrafts, burlap, appliances)	khapra beetle, woodboring insects, Coleoptera, mites, spiders, snails, brown tree snakes (<i>Boiga irregularis</i>), cockroaches, Coleoptera, Lepidoptera	2-15	24-72
Soil and soil contaminated miscellaneous non-food cargo (e.g., farm and military equipment, machinery, construction equipment, bagging material, roots, etc.)	nematodes, weed seeds, insects spiders, brown tree snakes (<i>Boiga irregularis</i>)	4-20	8-24
Vehicles and outdoor equipment, furnishings, and materials	gypsy moths, rodents, cockroaches	1.5-4.5	2.5-16
Logs and lumber	oak wilt and other timber pathogens	12-15	48-72
Forest and plant products (e.g., lumber, firewood, driftwood, pallets, crates, paper, cardboard, carvings, grapevine wreaths, dried plants, Spanish moss, bamboo and wicker, mulch, etc.)	khapra beetle, woodborers, bark beetles, termites, carpenter ants, horntails, old house borer, powder post beetles, Hymenoptera, Coleoptera, woodworm, wharf borer, wood wasps, mites, Lepidoptera, spiders, brown tree snakes (<i>Boiga irregularis</i>)	3-9	16-24
Beehives and Beekeeping Equipment, Beeboards	greater wax moth, mites, insects, diseased and feral bees	1.5-2	16-24

⁽¹⁾ Consult APHIS Treatment Manual for additional treatment conditions and commodities.

^(a) Damage possible. Reduce by cutting trees at least 2 weeks prior to fumigation.



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SECTION I - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Meth-O-Gas⁰ 100, Meth-O-Gas⁰ Q, Methyl Bromide (MUP)
Manufacturer: Great Lakes Chemical Corporation
Address: P.O. Box 2200 City: West Lafayette
State: Indiana Zip: 47996-2200
Emergency Telephone Number: 1-800-949-5167
Information Telephone Number: 1-765-497-6100 Fax: 1-765-497-6123
Chemtrec Phone: 1-800-424-9300; Internationally call 703-527-3887
Effective Date: 08/22/2003 Supersede Date: 01/03/2001
MSDS Prepared By: Regulatory Affairs Department/Great Lakes Chemical Corporation
Synonyms: Meth-O-Gas, Bromomethane
Product Use: EPA Registered Pesticide
Chemical Name: Methyl bromide
Chemical Family: Alkyl bromide

Additional Information

No information available

SECTION II - COMPOSITION/INFORMATION ON INGREDIENTS

Table with 4 columns: INGREDIENT NAME, CAS No., %, EXPOSURE LIMITS. Rows include Dimethyl ether, Methyl bromide, and Methyl chloride with their respective CAS numbers and exposure limits.

*Indented chemicals are components of previous ingredient.

Additional Information

EPA Fumigation Limit = 5 ppm

SECTION III - HAZARDS IDENTIFICATION

Emergency Overview: Colorless gas at normal temperatures and pressures
Odorless

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SECTION III - HAZARDS IDENTIFICATION

Highly toxic. May be fatal if inhaled.
Toxic. Harmful if swallowed.
Contact can result in chemical burns.
Respiratory distress
Lung damage
Cardiac arrest
May cause central nervous system effects.
Ingestion, inhalation and skin absorption

Relevant Routes of Exposure:
Signs and Symptoms of Overexposure:

Symptoms appear slowly and include: dizziness, blurred vision, lassitude, sensation of fatigue, staggering gait, slurred speech, nausea, vomiting, lack of appetite, and loss of muscle coordination. High concentrations can cause convulsions, very high concentrations cause lung damage. Prolonged skin and eye contact can cause burns.

Medical Conditions Generally Aggravated By Exposure:

Dermatitis
Respiratory disorders

Potential Health Effects: See Section XI for additional information.

Eyes: Chemical burns are possible.
Blurred vision

Skin: Chemical burns are possible.

Ingestion: Toxic. May be harmful if swallowed.

Inhalation: Highly toxic. May be fatal if inhaled. May cause respiratory distress, cardiac arrest and nervous system effects.

Chronic Health Effects: Chronic overexposure may cause neurotoxic effects including peripheral nerve damage and central nervous system effects, respiratory effects and cardiac effects.

Methyl bromide has been classified as Group 3 by IARC. An IARC Group 3 material exhibits limited evidence for carcinogenicity in experimental animals and no human data.

Based on an epidemiology study, methyl bromide may be associated with an increase in prostate cancer risk in both private and commercial pesticide applicators.

May cause genotoxic effects.

Carcinogenicity:

NTP:	No	ACGIH:	No
IARC:	No	OTHER:	No
OSHA:	No		

Additional Information

No information available

SECTION IV - FIRST AID MEASURES

Eyes: In all cases of overexposure, get medical attention immediately.
Take person to a doctor or emergency treatment facility.
If in eyes, hold eyelids open and flush with steady gentle stream of water for at least 15 minutes.

Skin: In all cases of overexposure, get medical attention immediately.
Take person to a doctor or emergency treatment facility.

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SECTION IV - FIRST AID MEASURES

	If on skin, immediately remove contaminated clothing, shoes, and other items covering skin. Wash contaminated skin area thoroughly with soap and water.
Ingestion:	In all cases of overexposure, get medical attention immediately. Take person to a doctor or emergency treatment facility. Do not give anything by mouth to an unconscious person.
Inhalation:	In all cases of overexposure, get medical attention immediately. Take person to a doctor or emergency treatment facility. If inhaled, remove exposed person from contaminated area. Keep warm. Make sure person can breathe freely. If breathing has stopped, give artificial respiration. Give oxygen if needed. If not unconscious, rinse mouth out with water.
Antidotes:	No information available
Notes to Physicians and/or	
Protection for First-Aiders:	No information available

Additional Information

No information available

SECTION V - FIRE FIGHTING MEASURES

Flammable Limits in Air (% by Volume):	~10-15%
Flash Point:	None
Autoignition Temperature:	Not available
Extinguishing Media:	All conventional media are suitable.
Fire Fighting Instructions:	Wear a self-contained breathing apparatus and protective clothing to prevent skin and eye contact in fire situations.
Unusual Fire and Explosion Hazards:	Under fire conditions, toxic and irritating fumes may be emitted. Containers can explode in fire situations. Use water spray to cool containers exposed to heat. Non-flammable in concentrated form. See Flammable Limits in Air. Methyl bromide is ignitable by a high energy spark at the flammability limits listed above.
Flammability Classification:	Non-flammable gas
Known or Anticipated Hazardous Products of Combustion:	Hydrogen bromide and/or bromine Carbon monoxide and carbon dioxide

Additional Information

No information available

SECTION VI - ACCIDENTAL RELEASE MEASURES

Accidental Release Measures:	Evacuate immediate area of spill or leak. Use a NIOSH/MSHA approved self-contained breathing apparatus (SCBA) or combination air-supplied/SCBA respirator for entry into affected area to correct problem. Move leaking or damaged cylinders or containers outdoors or to an isolated location, observing strict safety precautions. Work upwind if possible. Allow spill to evaporate. Do not permit entry into spill area by persons without appropriate respiratory protection until concentration of methyl bromide is determined to be less than 5 ppm.
Personal Precautions:	See Section VIII.

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SECTION VI - ACCIDENTAL RELEASE MEASURES

Environmental Precautions: No information available

Additional Information

No information available

SECTION VII - HANDLING AND STORAGE

Handling:

Use appropriate personal protection equipment.
Avoid eye, skin and clothing contact.
Do not breathe mist or vapor.
Cylinders should not be subjected to rough handling or mechanical shock such as dropping, bumping, dragging, or sliding. Do not use rope slings, hooks, tongs, or similar devices to unload cylinders. Transport cylinders using hand truck, fork truck or other device to which the cylinder can be firmly secured. Do not remove valve protection bonnet and safety cap until immediately before use. Replace safety cap and valve protection bonnet when cylinder is not in use. When cylinder is empty close valve, screw safety cap onto valve outlet, and replace protection bonnet before returning to shipper. Only a registrant is authorized to refill cylinders. Do not use cylinders for any other purpose.

Storage:

Store upright in a cool, dry, well-ventilated area under lock and key. Post as a pesticide storage area.
Store cylinders upright, secured to a rack or wall to prevent tipping.
Keep container tightly closed.

Other Precautions:

Methyl bromide has no odor at dangerous levels and is extremely hazardous.
Do not contaminate water, food, or feed by storage or disposal.

Additional Information

No information available

SECTION VIII - EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls:

No information available

Ventilation Requirements:

Use local ventilation to keep levels below established threshold values.
Use mechanical ventilation for general area control.
Ventilation is essential when indoors.

Personal Protective Equipment:

Eye/Face Protection:

Full face shield or safety glasses with brow and temple shields. Do NOT wear goggles.

Skin Protection:

Do not use gloves.
Loose-fitting or well ventilated long-sleeved shirt and pants. Shoes and socks. Do NOT wear jewelry, gloves, tight clothing, rubber protective clothing, or rubber boots when handling.

Respiratory Protection:

If the concentration of methyl bromide as measured by detector tube exceeds 5 ppm at any time, all persons in fumigation area must wear NIOSH/MSHA approved SCBA.

Consult the OSHA respiratory protection information located at 29CFR 1910.134 and the American National Standard Institute's

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SECTION VIII - EXPOSURE CONTROLS/PERSONAL PROTECTION

Practices of Respiratory Protection Z88.2.

Other Protective

Clothing or Equipment:

Pump and detector tubes for determining methyl bromide concentrations.

Exposure Guidelines:

See Section II.

Work Hygienic Practices:

Make sure piping is empty before doing maintenance work. All persons working with methyl bromide should be trained in the hazards, use of required respirator equipment, emergency procedures and in the proper use of methyl bromide as a fumigant where applicable.

Additional Information

No information available

SECTION IX - PHYSICAL & CHEMICAL PROPERTIES

Appearance:	Colorless gas at normal temperatures and pressures. Colorless liquid below boiling point of methyl bromide.	Percent Volatile:	Not available
Boiling Point:	38.5 degrees F (3.6 degrees C)	pH Value:	Not available
Bulk Density:	Not available	pH Concentration:	Not available
Color:	Colorless	Physical State:	Gas
Decomposition Temperature:	Not available	Reactivity in Water:	Not water reactive
Evaporation Rate:	Not available	Saturated Vapor Concentration:	Not available
Freezing Point:	Not available	Softening Point:	Not available
Heat Value:	Not available	Solubility in Water:	1.75 g/100 g of water at 68 degrees F
Melting Point:	Not available	Specific Gravity or Density (Water=1):	1.7 at 0 degrees C
Molecular/Chemical Formula:	CH ₃ Br	Vapor Density:	~3.27
Molecular Weight:	94.94	Vapor Pressure:	1400 at 68 degrees F, 2600 at 104 degrees F
Octanol/Water Partition Coefficient:	Not available	Viscosity:	Not available
Odor:	Odorless	Volatile Organic Compounds:	Not available
Odor Threshold:	Not available	Water/Oil Distribution Coefficient:	Not available
Particle Size:	Not available	Weight Per Gallon:	14.45 pounds

Additional Information

Latent heat of fusion: 62.987 kJ/kg at -93.6 degrees C

Heat of transition: 4.998 kJ/kg at -99.4 degrees C

Specific heat ratio, gas: 1.227 at 101.325 kPa at 25 degrees C

SECTION X - STABILITY AND REACTIVITY

Stability:

Stable under normal conditions of handling and use.

Conditions to Avoid:

None known

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SECTION X - STABILITY AND REACTIVITY

Incompatibility With Other Materials:

Aluminum
Magnesium
Zinc
Alkali metals
Strong bases

Hazardous Decomposition Products:

Thermal decomposition may produce the following:
Hydrogen bromide and/or bromine
Carbon monoxide and carbon dioxide

Hazardous Polymerization: Conditions to Avoid:

Will not occur
None

Additional Information

No information available

SECTION XI - TOXICOLOGICAL INFORMATION

VALUE (LD50 OR LC50)	ANIMAL	ROUTES	COMPONENTS
3,120 ppm/15 Minutes	Rat	Acute Inhalation	Methyl Bromide
302 ppm/8H	Rat	Acute Inhalation	Methyl Bromide
214 mg/kg	Rat	Acute Oral	Methyl Bromide

Toxicological Information:

An inhalation LCLo of 60,000 ppm for 2 hours has been found in humans. Methyl bromide is a poison and can cause respiratory distress, cardiac arrest and central nervous system effects. Overexposure may cause neurotoxic effects from which recovery may be slow.

Methyl bromide demonstrates genotoxicity in several test systems at levels above the TLV.

In a two year inhalation cancer bioassay with rats at 3, 30 and 90 ppm no tumors were observed.

In a two generation inhalation reproduction study with rats at 3, 30 and 90 ppm the no observed effect level was 3 ppm. At the higher doses organ weight variation was observed in some offspring.

In a 24 month chronic dietary study in rats, a no observable effect level (NOEL) for systemic toxicity of microencapsulated methyl bromide was considered to be 50 ppm (equivalent to 2.20 mg/kg/day for males and 2.92 mg/kg/day for females). The low observable effect level (LOEL) was considered to be 250 ppm (equivalent to 11.10 mg/kg/day for males and 15.12 mg/kg/day for females) based on reduced food consumption, body weight gains and body weights noted during the first 12 to 18 months of the study. Methyl bromide was not oncogenic upon dietary administration for two years.

In a two year inhalation study in B6C3FI mice, exposed to levels of 0, 10, 33 or 100 ppm for 6 hours per day, 5 days per week, degenerative changes in the cerebellum and cerebrum, myocardial degeneration and cardiomyopathy, sternal dysplasia, and olfactory epithelial necrosis and metaplasia were observed. There was no evidence of carcinogenic activity.

In an EPA/NIH sponsored epidemiology study entitled Agricultural Health Study, pesticides were evaluated based on cancer related deaths and questionnaire results provided by farmers, nursery workers and commercial pesticide applicators in Iowa and North Carolina. Results associated methyl bromide with an increase in prostate cancer risk in pesticide applicators. Exposures to methyl bromide were not confirmed. Incidence and intensity estimations were based solely on self-reporting via a questionnaire. Although the interpretation of the data collected in the study led to a statistically significant increase in prostate cancer risk for methyl bromide applicators, the authors could not rule

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out the possibility that the observations may have occurred by chance alone and findings need to be confirmed.

Additional Information

No information available

SECTION XII - ECOLOGICAL INFORMATION

Ecological Information: These products are toxic to fish and wildlife. Keep out of lakes, streams and ponds. Do not contaminate water by cleaning of equipment or disposal of wastes.

Additional Information

No information available

SECTION XIII - DISPOSAL CONSIDERATIONS

Disposal Considerations: Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

Additional Information

Return empty cylinders freight collect to the Great Lakes Chemical Corporation location from which shipment was made. Close cylinder valve by turning clockwise until hand tight. Disconnect lines. Replace safety caps and bonnet. Return partial cylinders only after consulting Great Lakes Chemical Corporation for proper shipping instructions.

SECTION XIV - TRANSPORT INFORMATION

U.S. DOT

Proper Shipping Name:	Methyl Bromide	ID Number:	UN1062
Hazard Class:	2.3	Labels:	Poison Gas
Packing Group:	N/A	Packaging Exceptions:	None
Special Provisions:	3, B14, T50	Bulk Packaging:	314, 315
Non-Bulk Packaging:	193	Air Cargo Limit:	25 kg
Passenger Air/Rail Limit:	Forbidden	Other Stowage:	40
Vessel Stowage:	D		
Reportable Quantity:	1000 lb		

AIR - ICAO OR IATA

Proper Shipping Name:	Forbidden	ID Number:	N/A
Hazard Class:	N/A	Packing Group:	N/A
Subsidiary Risk:	N/A	Packing Instructions:	N/A
Hazard Labels:	N/A	Packing Instruction -	
Air Passenger Limit Per		Cargo:	N/A
Package:	N/A	Special Provisions	A2, A126
Air Cargo Limit Per		Code:	
Package:	N/A		

WATER - IMDG

Proper Shipping Name:	Methyl Bromide	ID Number:	UN1062
Hazard Class:	2.3	Subsidiary Risk:	N/A
Packing Group:	N/A		
Medical First Aid Guide			
Code:	NA		

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SECTION XIV - TRANSPORT INFORMATION

Additional Information

Poison Inhalation Hazard

EmS No. F-C, S-U

CERCLA RQs:

Methyl bromide = 1,000 lb

Methyl chloride = 100 lb

SECTION XV - REGULATORY INFORMATION

U.S. Federal Regulations:

The components of this product are either on the TSCA Inventory or exempt (i.e. impurities, a polymer complying with the exemption rule at 40 CFR 723.250) from the Inventory.

These products are offered as EPA registered pesticides.

SARA 313

The following materials are subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372:

Methyl Bromide (De Minimus Concentration = 1%)

Methyl Chloride (De Minimus Concentration = 1%)

CERCLA Reportable Quantities:

Methyl Bromide = 1,000 lb

Methyl Chloride = 100 lb

SARA RQ:

Methyl Bromide = 1000 lb

OSHA Highly Hazardous Chemicals::

Methyl Bromide, TQ = 2,500 lb

Methyl Chloride, TQ = 15,000 lb

In compliance with Section 611 of the Clean Air Act:

WARNING: Contains methyl bromide, a substance which harms public health and environment by destroying ozone in the upper atmosphere.

State Regulations:

Methyl bromide:

New Jersey Right To Know Hazardous Substance List (1% reporting limit)

Pennsylvania Environmental Hazard List

Massachusetts Extraordinarily Hazardous Substance (1 ppm reporting limit)

Dimethyl Ether:

New Jersey Special Health Hazard Substance List (0.1% reporting limit)

Pennsylvania Hazardous Substance List (1% reporting limit)

Massachusetts Substance List

Methyl Chloride:

New Jersey Special Health Hazard Substance List (0.1% reporting limit)

Pennsylvania Environmental Hazard List

Massachusetts Substance List

International Regulations:

This material (or each component) is listed on the following inventories:

Canada - DSL

EU - EINECS

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SECTION XV - REGULATORY INFORMATION

Australia - AICS

Japan - ENCS

Korea - ECL

Philippines - PICCS

China - List I

Canadian Disclosure List (1%) - Methyl chloride

Canadian WHMIS Hazard Class and Division = A., D.1.a

SARA Hazards:

Acute: Yes

Chronic: Yes

Reactive: No

Fire: No

Pressure: No

Additional Information

The above regulatory information represents only selected regulations and is not meant to be a complete list.

SECTION XVI - OTHER INFORMATION

NFPA Codes:

Health: 3

Flammability: 1

Reactivity: 0

Other: N

HMIS Codes:

* indicates chronic health hazard.

Health: 3*

Flammability: 1

Reactivity: 0

Protection: X

Label Statements:

Not available

Other Information:

Abbreviations:

(L) = Loose bulk density in g/ml

LOEC = Lowest observed effect concentration

MATC = Maximum acceptable toxicant concentration

NA = Not available

N/A = Not applicable

NL = Not limited

NOAEL = No observable adverse effect level

NOEC = No observed effect concentration

NOEL = No observable effect level

NR = Not rated

(P) = Packed bulk density in g/ml

PNOC = Particulates Not Otherwise Classified

PNOR = Particulates Not Otherwise Regulated

REL = Recommended exposure limit

TS = Trade secret

Additional Information

Information on this form is furnished solely for the purpose of compliance with OSHA's Hazard Communication Standard, 29CFR 1910.1200 and The Canadian Environmental Protection Act, Canada Gazette Part II, Vol. 122, No. 2 and shall not be used for any other purpose.

Revision Information:

Section III - Chronic Health Hazards

Section XI - Toxicological information

Section XIV - DOT Special Provisions, Air Special Provisions, EmS No.

Appendix C

Aluminum Phosphide DOT Exemption for Transportation in Private Motor Vehicles



U.S. Department
of Transportation
**Research and
Special Programs
Administration**

400 Seventh St., S.W.
Washington, D.C. 20590

MAR 4 2003

DOT-E 10753
(EIGHTH REVISION)

EXPIRATION DATE: January 31, 2005

(FOR RENEWAL, SEE 49 CFR § 107.109)

1. GRANTEE: Pestcon Systems, Inc.
Wilson, North Carolina
2. PURPOSE AND LIMITATION:
 - a. This exemption authorizes the transportation in commerce of an aluminum phosphide based pesticide which meets the definition of a Division 4.3 material to be shipped as aluminum phosphide pesticide, a Division 6.1 material. The aluminum phosphide pesticide must be shipped in a limited number of specially designed containers transported by private motor vehicle. The motor vehicles used under the terms of this exemption are not required to be placarded. This exemption provides no relief from the Hazardous Materials Regulations (HMR) other than as specifically stated herein.
 - b. The safety analyses performed in development of this exemption only considered the hazards and risks associated with transportation in commerce.
3. REGULATORY SYSTEM AFFECTED: 49 CFR Parts 106, 107 and 171-180.
4. REGULATIONS FROM WHICH EXEMPTED: 49 CFR § 172.504 in that placarding is not required, except as specified herein.
5. BASIS: This exemption is based on the application of Pestcon Systems, Inc. dated February 3, 2003, submitted in accordance with § 107.109.

MAR 4 2003

6. HAZARDOUS MATERIALS (49 CFR § 172.101):

Hazardous Materials Description			
Proper Shipping Name	Hazard Class/ Division	Identi- fication Number	Packing Group
Aluminum phosphide pesticides	6.1	UN3048	I

7. PACKAGING AND SAFETY CONTROL MEASURES:

- a. Packaging authorized is a combination packaging of a UN4G fiberboard box with inner aluminum canisters.
- b. Individual aluminum canisters may not contain more than 1.5 kilograms of aluminum phosphide pesticide and must be adequately cushioned from one another in the outer specification 4G fiberboard box.
- c. A single motor vehicle or a single completed combination package may not contain more than 21 kilograms of aluminum phosphide.
- d. Packages must be stowed within metal boxes or metal compartments within each motor vehicle.

8. SPECIAL PROVISIONS:

- a. Distributors for Pestcon Systems, Incorporated and licensed pest control operators using Pestcon's "Aluminum phosphide pesticide" product are authorized to transport the packages covered under the terms of this exemption and § 173.22a.
- b. A current copy of this exemption must be maintained at each facility where the package is offered or reoffered for transportation.
- c. Only private motor vehicles used in pest control operations are authorized to transport the packages covered by the terms of this exemption.

d. Each inner and outer package must be labeled POISON and DANGEROUS WHEN WET. The inner packages may be labeled in accordance with § 172.407(f), which authorizes labels conforming to specifications in the UN Recommendations. (The Recommendations permit packages with dimensions that cannot accommodate the required 4"x4" label to use smaller labels, see 13.4.1). Vehicles transporting these packages need not display DANGEROUS WHEN WET placards.

e. The outside of each package must be marked "DOT-E 10753".

f. Drivers must have been instructed as to necessary safeguards and proper procedures in the event of unusual delay, fire or accident.

g. The use of exceptions for materials of trade under § 173.6 is prohibited under the terms and conditions of this exemption.

9. MODES OF TRANSPORTATION AUTHORIZED: Motor vehicle.
10. MODAL REQUIREMENTS: A current copy of this exemption must be carried aboard each motor vehicle.
11. COMPLIANCE: Failure by a person to comply with any of the following may result in suspension or revocation of this exemption and penalties prescribed by the Federal hazardous materials transportation law, 49 U.S.C. 5101 et seq:
 - o All terms and conditions prescribed in this exemption and the Hazardous Materials Regulations, 49 CFR Parts 171-180.
 - o Registration required by § 107.601 et seq., when applicable.

Each "Hazmat employee", as defined in § 171.8 who performs a function subject to this exemption must receive training on the requirements and conditions of this exemption in addition to the training required by §§ 172.700 through 172.704.

No person may use or apply this exemption, including display of its number, when the exemption has expired or is otherwise no longer in effect.

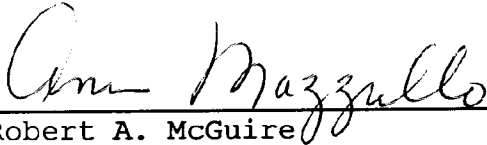
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12. REPORTING REQUIREMENTS. The carrier is required to report any incident involving loss of packaging contents or packaging failure to the Associate Administrator for Hazardous Materials Safety (AAHMS) as soon as practicable. (Sections 171.15 and 171.16 apply to any activity undertaken under the authority of this exemption.) In addition, the holder(s) of this exemption must inform the AAHMS, in writing, of any incidents involving the package and shipments made under the terms of this exemption.

Issued in Washington, D.C.:



Robert A. McGuire
Associate Administrator
for Hazardous Materials Safety

MAR 4 2003

(DATE)

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Research and Special Programs Administration, Department of Transportation, Washington, D.C. 20590.
Attention: DHM-31.

Copies of this exemption may be obtained by accessing the Hazardous Materials Safety Homepage at <http://hazmat.dot.gov/exemptions> Photo reproductions and legible reductions of this exemption are permitted. Any alteration of this exemption is prohibited.

PO: sln