Unit 1: Introduction

Q. In what situations are fumigants commonly used?
A. We rely on fumigants to treat processing plants, boxcars, and ships. Fumigation is one of the quickest and most effective ways to eliminate pests from processed food and commodities. We also use fumigation in quarantine. It helps to prevent pests from traveling from one location to another.

Q. What is a fumigant?
A. A fumigant is a pesticide that is a gas, or forms a gas, when applied. In a high enough concentration, this gas (vapor) has pesticidal action.

Q. How does being a gas contribute to a fumigant's effectiveness?
A. As a gas, a fumigant consists of separate molecules that are much smaller than the droplets of a fog or mist. Fumigants can penetrate very small spaces where pests live, such as those in flour. Fumigants can even penetrate seemingly solid items like brick, concrete, and wood.

Q. What is the first thing you should do when you detect a pest problem?
A. Identify the pest.

Q. Name two of the most important safety tools for fumigators.
A. Respirators and gas detectors.

Q. What is Integrated Pest Management (IPM)?
A. IPM is an ecological approach to pest control. It is based on the habitat and life cycle of the pest. It combines all appropriate pest control strategies including nonchemical and chemical management methods. IPM is dedicated to removing causes rather than simply treating symptoms. Prevention is key. The goal of an IPM program is to reduce pest numbers to an acceptable level in a way that is practical, cost effective, and safe for the environment.

Q. How does fumigation fit into an IPM program?
A. Fumigation is only one part of an IPM program. Because it is specialized, very toxic, and often expensive, fumigation is usually the last resort to a pest problem.

Q. Describe scouting. Explain its importance in effective pest management.
A. Scouting is checking or monitoring for pests in an area to determine what pests are present, how many of each kind are in the area, and how much damage they are causing. Scouting will help you determine if treatment is needed and/or if previous control measures were effective.

Q. List some of the advantages of fumigants.
A.
• They are effective against insects, rats, birds, mammals, and fungi.
• Most are fast acting.
• They are capable of providing total eradication.
• Human exposure is limited.
• Most fumigants, when used properly, do not leave residues on surfaces.
• There are several ways to apply fumigants.
• They penetrate and treat hard-to-reach areas.
• You can apply them without disturbing the commodity.
• They are usually readily available.
• You can use some fumigants in or near food without leaving harmful residues, tastes, or odors.

Q. List some problems with fumigants.

A.
• They are highly toxic to most living things, including humans.

• They require special protective equipment.
• They require highly trained applicators.
• They offer no residual control.
• They must be confined in a tightly sealed area to be effective.
• Some may injure seeds and reduce germination. Others may leave toxic residues, tastes, or odors.
• Response to problems and emergencies must be quick.
• Temperature requirements may be hard to meet.
• Some are expensive.
• Some are corrosive.
• They usually require a special license(s) or permit(s).
• Some fumigants are hard to remove from fumigated material.

Unit 2: Pest Identification, Biology, and Management

Q. Describe the difference between primary and secondary feeding insects.
A. Primary feeding insects are capable of destroying whole, sound grain. The most damaging primary feeders are those that develop within grain kernels. These insects feed on the "germinal" region (early growth) of the seed, reducing its nutritional value and its ability to sprout. Adult females of internal feeders deposit eggs on or in whole kernels. Larvae develop within the kernels. Secondary feeding insects feed only on damaged grains and seeds. The outer layer of the grain or seed must be damaged, cracked, holed, abraded, or broken. Secondary feeders live in grain storage areas or in flours, meals, and other processed cereal products.

Q. Is damp grain or dry grain more susceptible to insect infestation?
A. Damp grain

Q. What stage in a moth's life cycle causes damage to stored products?
A. The larval (caterpillar) stage

Q. A pest has spread silk webbing over some stored grain. Which of the following insects is most likely the cause?

• Indianmeal moth
• Rice weevil
• Grain mite
• Sawtoothed grain beetle

A. The Indianmeal moth

Q. If the kernels in the top few inches of grain in a bin each have a small hole in one end, what pest is most likely the cause?
A. The Angoumois grain moth

Q. On what grade of tobacco does the tobacco moth normally feed? Why?
A. The tobacco moth attacks the highest-priced tobacco grades since these contain the greatest amount of sugar.

Q. What environmental conditions do most cockroach species prefer?
A. Warm, moist conditions

Q. Which species of cockroach can withstand dry conditions?
A. The brownbanded cockroach

Q. Which of the four species of cockroaches discussed in this manual is the largest in size?
A. The American cockroach

Q. Describe three situations in which fumigation may be necessary to control cockroach infestations.
A.
1. When infestations are too severe for other pesticides (ex., mobile homes that have cockroaches living in walls, ceilings, under floors, and in other hard-to-reach areas).
2. When a high-value product is at stake.
3. In a storage facility where product turnover is too fast for baits to kill cockroaches before the next shipment.

Q. What are "hot spots"? Why are they of particular concern in stored grain?
A. Hot spots are areas in stored grain where temperatures are greater than 10°F higher than the rest of the grain. Hot spots indicate a high moisture content that favors insect and fungus activity.

Q. What type of trap allows you to monitor the flight activity of insect pests?
A. Paper sticky traps

Unit 3: Characteristics and Effects of Fumigants

Q. How can the molecular weight of a fumigant affect its ability to diffuse throughout a room?
A. Fumigants with molecular weights lower than 29 are lighter than air and may rise. Those with molecular weights higher than 29 are heavier than air and may sink. Both extremes may require you to use fans and other means to prevent stratification. **The weight of air is 29.**

Q. Where can you find information about the boiling point, flammability, sorptive capacity, and other properties of a specific fumigant?
A. In the label information.

Q. As a rule, at what temperature is fumigation most effective?
A. Above 60°F.

Unit 4: Characteristics and Effects of Fumigants

Q. What is Integrated Pest Management (IPM)?
A. IPM is an ecological approach to pest control. It is based on the habitat and life cycle of the pest. It combines all appropriate pest control strategies, including nonchemical and chemical management methods. IPM is dedicated to removing causes rather than simply treating symptoms. Prevention is key. IPM balances the level of control needed with any associated risks. The goal of an IPM program is to reduce pest numbers to an acceptable level in a way that is practical, cost-effective, and safe for people and the environment.

Q. Why is regular observation of food and stored products important in effective pest management programs?
A. Sampling and regular observation allow you to check for pests in an area to determine what pests are present, how many of each kind are in the area, and how much damage they are causing. Sampling and observation will help you determine if treatment is needed and/or if previous control measures were effective.

Q. List some of the advantages of fumigants.
A. 1. They are effective against insects, mites, and most other living things.

2. Most are fast acting.
3. They are capable of providing total eradication.
4. Human exposure is limited.
5. Most fumigants, when used properly, do not leave residues on surfaces.
6. There are several ways to apply fumigants.
7. They penetrate and treat hard-to-reach areas.
8. You can apply them without disturbing the commodity.
9. They are usually readily available.
10. You can use some fumigants in or near food without leaving harmful residues, tastes, or odors.

Q. List some problems with fumigants.
A. 1. They are highly toxic to most living things.
2. They require special protective equipment.
3. They require highly trained applicators.
4. They offer no residual control.
5. They must be confined in a tightly sealed area to be effective.
6. Some may injure seeds and reduce germination. Others may leave toxic residues, tastes, or odors.
7. Response to problems and emergencies must be quick.
8. Temperature requirements may be hard to meet.
9. Some are expensive.
10. Some are corrosive.
11. Some are flammable and explosive.
12. Some fumigants are hard to remove from treated material.

Q. How can you prevent pesticide resistance?
A. As a pest control operator, you can protect the effectiveness of pesticides by:
• Using IPM
• Using alternative controls and nonchemical controls whenever possible
• Using pesticides only when necessary
• Avoiding repeated use of the same pesticide
• Doing a thorough job when applying a pesticide (do not leave behind pests that can build up resistance and reproduce), and
• By fumigating only when nothing else works

Q. How often should you clean grain storage bins to prevent insect infestations?
A. Clean bins immediately after they are emptied and again at least two to three weeks before adding grain. Before storing fresh grain; clean the inside and outside of storage bins and buildings. You should also clean bins before applying “empty bin sprays.”

Q. Name several things you can do to reduce stored grain’s susceptibility to insects and disease.
A. 1. Clean and dry the grain before placing it into bins.
2. Always store grain in a steel bin that is weather-tight, rodent-proof, and mounted on a moisture-proof concrete base.
3. Remove as much fine material as possible or spread out the fines throughout the load
4. Level the surface of the grain so that it is not peaked.
5. When possible, store the grain in the fall when temperatures are cooler.

Q. What technique can you use to maintain ideal moisture levels and temperatures within a load of stored grain?
A. Aeration

Q. Why is it important to keep stored grain cool and dry when applying insecticides?
A. Insecticides tend to break down faster in areas with high temperatures and moisture.

Unit 5: Methods of Fumigation

Q. Describe two types of vaults used for fumigation.
A.
1. Vacuum chamber – A large steel structure in which fumigation is conducted at a reduced air pressure.
2. Atmospheric chamber – A small, isolated building built or modified for fumigation at normal air pressure.

Q. What is the biggest problem with tape and seal fumigations?
A. They are notoriously leaky.

Q. What extra step do you need to take when fumigating on a soil or wood surface and sealing tarps? Why?
A. Spread a section of the tarp beneath the material to be fumigated. Otherwise, fumigant can leak through the soil or wood.

Q. How is outdoor tarpaulin fumigation different from indoor tarpaulin fumigation?
A. When fumigating outdoors, the tarp must be of stronger material. **Obtaining a good ground seal is more challenging.** You must protect against unexpected bad weather outdoors. In general, **indoor tarpaulin fumigation is preferred**.

Q. Describe how to aerate a tarped stack of commodities.
A. Place a blower on one end of the load. Make an opening on the opposite end by lifting the tarp. Then turn on the blower and discharge the fumigant. If a breeze or steady cross ventilation is available, a blower may not be necessary. If you choose not to use a blower or cross ventilation, aerate the item or area by lifting the tarp at the corners. Then, slowly raise the sides until the tarp is completely removed.

Unit 6: Public and Personal Safety

Q. Name the three agencies that set regulations for the safe use of pesticides.
A. The Environmental Protection Agency (EPA), the Arkansas State Plant Board (ASPB), and the Occupational Safety and Health Administration (OSHA)

Q. List several things you can learn from reading the label information of a fumigant.
A. The label information will tell you how and where to use the product. It will give you detailed application and aeration instructions. It may note specific sites that should not be treated or application methods that are not permitted. The label information also describes specific safety precautions including what PPE to wear and basic first aid procedures.

Q. Name several precautions you must take when transporting a fumigant.
A.
1. Do not transport fumigants and people together in a closed vehicle.
2. Make sure fumigant containers are upright, secured, and protected against rear end collision.
3. Mark vehicles in which fumigants are being transported.
4. Do not use public transportation to transport fumigants.
5. Do not transport fumigants through tunnels unless you get permission from ADOT.
6. Do not remove valve protective covers until just before use.

Q. What are the two main routes of fumigation exposure?
A. Inhalation and skin contact

Q. Explain the difference between a TLV and a TLV-TWA.

A. A threshold limit value (TLV) is the maximum amount of fumigant that can be in the air before conditions are considered unsafe. It is used to monitor “short-term” exposure.
A threshold limit value-time weighted average (TLV-TWA) is the average concentration of fumigant for a normal 8-hour workday and a 40-hour workweek, to which workers may be repeatedly exposed, without adverse effect. It is used to monitor “long-term” exposure.

Q. Describe some symptoms of mild inhalation exposure to a fumigant. What should you do if you or a co-worker is experiencing any of these symptoms?
A. Mild exposure by inhalation can cause malaise (a feeling of sickness), ringing in the ears, fatigue, nausea, and pressure in the chest. Exposure to fresh air will usually relieve these symptoms.

Q. Why do some fumigant labels recommend that you remove jewelry and wear loose-fitting clothes during application?
A. Jewelry and tight clothing can trap fumigant gas next to the skin causing irritation or a burn.

Unit 7: Safety Equipment

Q. Name the two types of respirators most often used by fumigators. Describe the difference between them.
A. Atmosphere-supplying respirators draw air from outside a fumigation area or use canisters of pressurized air to supply a worker with breathable air. Air-purifying respirators (gas mask/canister combinations) use special canisters to remove particles and toxic vapors from the fumigated air.

Q. Name two types of atmosphere supplying respirators. Explain the advantages and disadvantages of each one.
A. A self-contained breathing apparatus (SCBA) gives the operator greater mobility but offers a limited amount of air. One tank of air usually lasts about one hour. The weight and bulk of a SCBA apparatus can also make strenuous work difficult. A supplied-air respirator (SAR), such as an airline respirator, has the advantages of longer continuous use and a lighter weight. However, because you are connected to a stationary source, movement may be restricted. In addition, if something cuts, burns, kinks, or crushes the hose, the wearer has no air.

Q. What can the temperature of an air purifying canister tell you?
A. If the canister is hot to the touch, you may be in an atmosphere richer in fumigant gas than is recommended. If the canister feels cool, it may be completely expired (no longer able to purify the air).

Q. Describe two “quick” ways you can make sure a respirator face piece fits properly.
A. 1. Pinch off the breathing tube and inhale so the face piece collapses. Hold your breath for 10 seconds. The face piece should stay collapsed for this time. If it does not, the mask does not fit properly and fumigant may leak in. 2. Press your thumb over the valve guard and exhale. Do you feel any air leaking out? If so, the mask does not fit properly and fumigant may leak in.

Q. What information do gas detectors provide?
A. Gas detectors indicate fumigant levels during treatment and aeration. They can detect leaks in structures or under tarps during fumigation. They can help determine the dosage requirements for future fumigation. Detectors also measure the success of aeration by monitoring the presence or absence of fumigant vapors.

Q. What is the most common type of thermal conductivity analyzer (TCA)?
A. The Fumiscope®

Unit 8: Common Fumigants

Q. Name a fumigant that is corrosive to metal discussed in this manual.
A. Phosphine

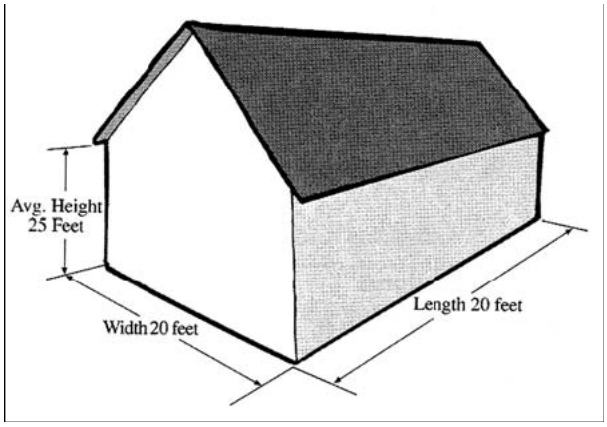
Q. Which of the fumigants discussed in this unit might be phased out in the future? Why? When might this occur?
A. At the time of this printing, methyl bromide is believed to contribute to the depletion of the earth's ozone layer. For this reason, the EPA has initiated action under the Clean Air Act to phase out the production and use of this fumigant. A 70-percent reduction in production was mandated by January 1, 2003. The complete phaseout of production was scheduled for January 1, 2005. The Environmental Protection Agency (EPA) is amending the regulations governing the phaseout of methyl bromide (MeBr) to allow for exempted production and import beyond the phaseout date of January 1, 2005, for critical uses and to address sales of pre- January 1, 2005 stocks of methyl bromide for critical uses.

Q. What is responsible for liberating Phosphine gas from its solid form?
A. Moisture in the air (humidity)

Q. What detection device is sensitive enough to check levels of sulfuryl fluoride before reentry into the treatment area?
A. Only approved detection devices of sufficient sensitivity, such as specific types of gas analyzers or infrared detection systems (ambient air analyzers), can be used to confirm a concentration of sulfuryl fluoride of 1 ppm or less. At the time of this writing, the sulfuryl fluoride product label requires the use of an INTERSCAN or MIRAN analyzer or similar approved device to measure gas concentrations for reentry.

Calculating the Volume of Buildings

Calculating the volume of a tobacco warehouse, flat grain storage building or similar structure is usually more involved. Most buildings are irregular in shape. They also may have peaked or gable roofs. To calculate the cubic content of such structures, first determine the area (square feet) of the space you plan to treat. Then multiply the area by the average height (feet).



Example 1: The rectangular building shown in Figure 2 is 80 feet long and 20 feet wide, with an average height of 25 feet. Calculate the volume (cubic content) of the building.

Area = length x width
= 80 ft x 20 ft
= 1,600 sq ft
Volume = area x average height
= 1,600 sq ft x 25 ft

= 40,000 cu ft

This is a very basic example. A fumigator must be able to calculate the cubic content of buildings much more complicated than this. He or she also must understand how to determine average height. The building in Figure 3 is still simple, but a little more complicated than Figure 2. A lean-to has been added to the main structure, and there is a crawl space, or "subarea."

Example 2: <u>YOU MUST BE ABLE TO CALCULATE THE TOTAL SQUARE FEET OF THIS STRUCTURE.</u>

To figure the volume in Figure 3, (cubic content) of this structure, use the same procedure outlined in Example 1, but calculate the volume of each section separately. Section 1 is the main section, not including the loft and subarea. Section 2 is the lean-to, not including the loft and subarea of that section. Section 3 is the loft area of the main structure. Section 4 is the loft area of the lean-to, and section 5 is the combined subareas below the main structure and the lean-to.

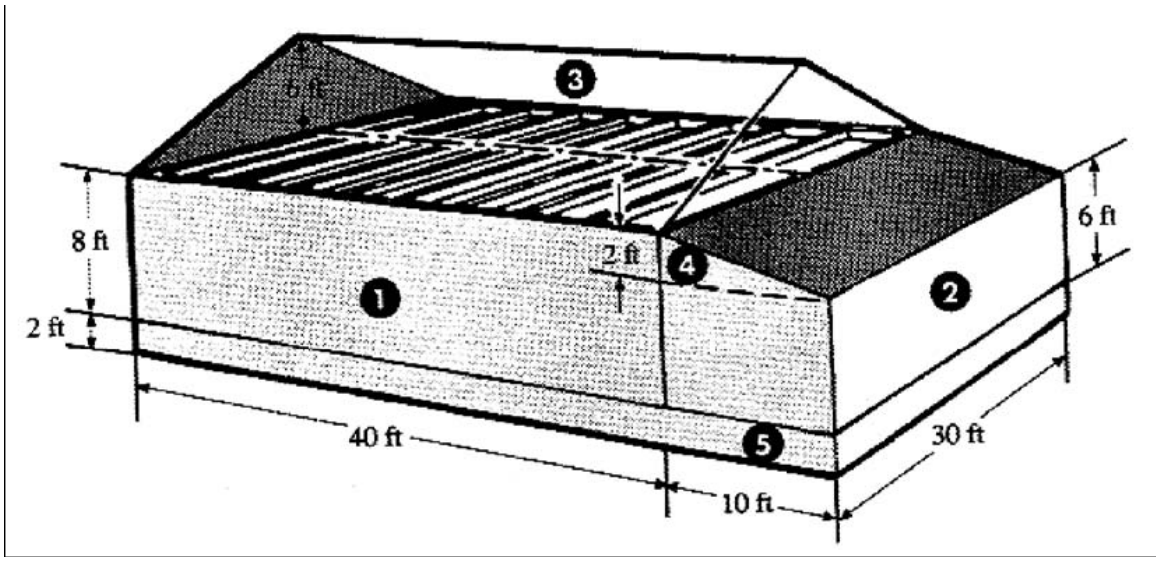


Figure 3

Volume of Section 1:
40 ft x 30 ft = 1,200 sq ft
1,200 sq ft x 8 ft = **9,600 cu ft**

Volume of Section 2:
30 ft x 10 ft = 300 sq ft
300 sq ft x 6 ft = **1,800 cu ft**

Volume of Section 3:
40 ft x 30 ft = 1,200 sq ft
1,200 sq ft x 3 ft (1/2 of loft height) = **3,600 cu ft**

Volume of Section 4:
30 ft x 10 ft = 300 sq ft
300 sq ft x 1 ft (1/2 of loft height) = **300 cu ft**

Volume of Section 5:
40 ft x 30 ft = 1,200 sq ft
30 ft x 10 ft = 300 sq ft
1,200 sq ft + 300 sq ft = 1,500 sq ft
1,500 sq ft x 2 ft (height of subarea) = **3,000 cu ft**

Total volume would be the sum of all area volumes:
9,600

1,800
3,600
300
3,000

Total square feet = 18,300

Calculating the Volume of Grain Bins

Grain bins are usually cylindrical, with cone-shaped caps. To calculate the volume (cubic content) of a grain bin, you must know how to figure the volume of a cylinder and a cone:

Volume of a cylinder = 3.14 x r^2 x h

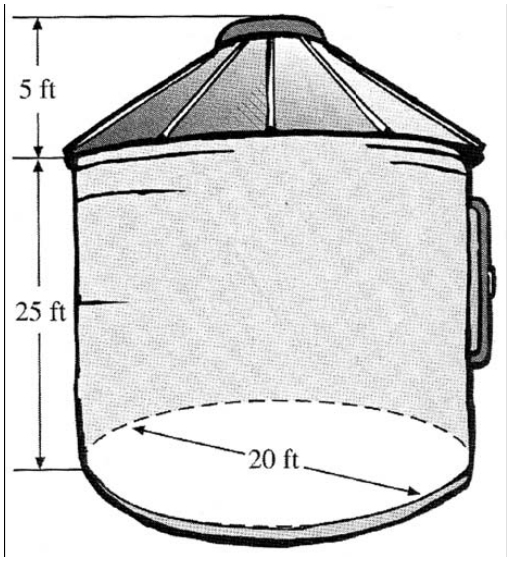
Volume of a cone = (3.14 x r^2 x h) divided by 3

r = radius (1/2 of the diameter of the circular base of the bin)

h = height of the cylindrical part of the bin

3.14 is a constant often called "pi" and represented as π

Example 1: Figure 6 shows a basic grain bin. The height of the cylindrical part of the bin is 25 feet. The diameter of the circular base of the bin is 20 feet. The height of the cone-shaped cap is 5 feet. With these dimensions, calculate the total volume (cubic content) inside the bin.



Volume of the cylindrical portion of the bin =
3.14 x (10 feet)^2 x 25 feet = 7,850 cubic feet

Volume of the cone-shaped cap =
3.14 x (10 ft)^2 x 5 feet = 1,570 cubic feet divided by 3

Total volume
523.3 cubic feet
7,850.0 cubic feet
+ 523.3 cubic feet
8,373.3 cubic feet