

Unit 7. Safety Equipment

Learning Objectives

After reading this unit, the reader will be able to:

- Choose the most appropriate safety equipment for structures, commodity and soil fumigation.
- Test, fit, maintain and use a respirator properly.
- Select and operate gas detection devices properly.

Fumigants are some of the most toxic pesticides available. Even moderate exposure can be lethal to you and others. Proper use of safety equipment is critical.

This unit describes some of the basic safety equipment used in commodity and soil fumigation. By reading it, you will learn how these devices work and how to use them properly. If safety equipment fails, consequences can be deadly. This unit will help you prevent these failures by properly selecting and maintaining equipment.

Terms to Know

Air-Purifying Respirator – A device that uses special filter media to remove toxic vapors, gases and particles from the air. The filter media come in the form of cartridges, canisters or pre-filters. These fit on a facepiece and are specific for one type of chemical (for example, organic vapors). Air-purifying respirators are also called gas mask/canister combinations.

Ambient Air Analyzer – A gas detection device that measures the amount of infrared light absorbed by a gas at a selected wavelength. This tells you what gas is present and its concentration.

Antidote – A remedy that may counteract the effects of a pesticide.

Atmosphere – The body of air that surrounds a given area. Breathable atmosphere consists largely of nitrogen and oxygen with small amounts of carbon dioxide and other gases.

Atmosphere-Supplying Respirator – A device that draws air from outside a fumigation area or uses cylinders of pressurized air to supply a worker with breathable air.

Calibrate – To measure and adjust a gas detector so that it reads accurately for the fumigant you use.

Facepiece – The part of a respirator that fits over your nose, mouth, face and/or entire head.

Fumiscope® – A type of thermal conductivity analyzer that measures the concentration of specific fumigants. It is lightweight, portable and operates on 115 volt alternating current (AC) or battery power.

Neutralize – To counteract the effect of a harmful substance such as a pesticide.

Parts Per Million (PPM) – The number of parts of a substance in one million parts of another substance. For example, if a gas detector reads “5 ppm,” it means that there are five parts of fumigant to every one million parts of air.

Respirator – A device that protects the respiratory tract from irritating and poisonous gases, fumes, smokes and dusts.

Self-Contained Breathing Apparatus (SCBA) – A type of atmosphere-supplying respirator that supplies fresh air from a cylinder that is carried by the user. Air enters a mask that tightly covers the entire face.

Supplied-Air Respirator (SAR) – A type of atmosphere-supplying respirator that supplies air from a compressed air tank that is located outside of the fumigation area.

Thermal Conductivity Analyzer (TCA) – An instrument designed to measure the concentration of fumigant gases within a chamber or other enclosure during fumigation.

Respiratory Protection Equipment

A respirator is as important to a fumigator as a parachute is to a paratrooper. Both are critical to on-the-job safety. If either device is not regularly inspected, maintained and used correctly, results could be deadly. Remember that fumigants are some of the most toxic pesticides. Breathing even small amounts of these chemicals can be fatal.

Training is crucial for the safe and effective use of respirators. To use respirators during fumigation, you or your employer must establish a formal respiratory protection program. This program must meet all of the requirements

outlined in the Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard (29 CFR 1910.134). These include written operating procedures for the maintenance, cleaning and storage of the respiratory equipment. This program must also contain guidelines for educating respirator users. The information in this manual is not a substitute for the OSHA requirement.

There are two main types of respirators used in fumigation: atmosphere-supplying respirators and air-purifying respirators.

NOTE: All respirators used by fumigant applicators must be approved by NIOSH (National Institute of Safety and Health). The specific type of respirator required may vary depending on the health of the applicator, the type of fumigant you use and the conditions of its use.

Atmosphere-Supplying Respirators

Atmosphere-supplying respirators draw air from outside a fumigation area or use canisters of pressurized air to supply a worker with breathable air.

Fumigators use two main types of atmosphere-supplying respirators: the self-contained breathing apparatus (SCBA) and the supplied-air respirator (SAR). Training is critical for the use of any SCBA or SAR.

Self-Contained Breathing Apparatus (SCBA)

An SCBA consists of a full-face mask attached to a tank of air carried on the back of the worker. The cylinder of compressed air supplies air to a regulator. The regulator reduces the pressure and delivers breathable air to the facepiece. SCBAs also have an alarm to warn the user when the air supply is low.

Because you carry your air, you do not need to be connected to a stationary source of air. This gives you



the mobility of a canister mask (described later in this unit) and does not restrict movement. However, the weight and bulk of an SCBA often makes strenuous work difficult.

Do not confuse SCBA with SCUBA (self-contained underwater breathing apparatus). These systems are very different. You cannot interchange their uses.

There are two types of SCBA respirators: a demand regulator and a positive pressure regulator.

Demand Regulator

A demand or negative pressure regulator supplies air to the facepiece when the wearer inhales. This creates a vacuum. Facepieces must fit snugly or contaminated air may leak in.

Positive Pressure Regulator

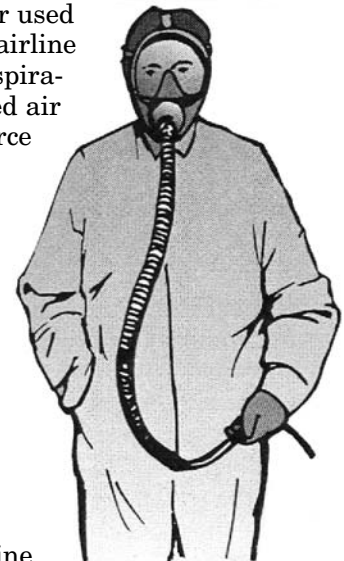
A positive pressure regulator allows continuous airflow into the facepiece. The constant positive pressure in the facepiece forces any leaks out of the facepiece.

Supplied-Air Respirators (SAR)

Like SCBAs, supplied-air respirators are equipped with a full-face mask that delivers air to the fumigator from a compressed air tank or from an ambient air pump. With supplied-air respirators, however, the air tank or pump is located outside the fumigation area.

The most common supplied-air respirator used by fumigators is the "airline respirator." Airline respirators supply compressed air from a stationary source through a long hose. Airline respirators have demand, pressure demand or continuous-flow designs. Air is supplied to a facepiece, helmet, hood or a complete suit depending on the level of protection needed.

The demand or pressure-demand airline respirator operates



Airline respirator

much like a demand SCBA respirator. The difference is that an airline system supplies air through a hose connected to a stationary air source, whereas the fumigator carries the SCBA air supply.

Continuous-flow airline respirators provide breathing air continuously rather than on demand. These are much like the positive pressure SCBA respirators. Instead of a regulator, however, these respirators have an airflow valve that partially controls the airflow. In addition, air is supplied by a stationary source, whereas SCBA air tanks are portable.

There are several advantages to airline respirators. Unlike SCBA respirators, airline respirators provide long, continuous use. They are lightweight and offer minimal breathing resistance and discomfort. Airline respirators also have a moderate initial cost and a low operating cost.

Unfortunately, there are drawbacks to airline respirators as well. For example, if something cuts, burns, kinks or crushes the hose, the wearer has no air. Also, compressors may fail or the storage tank may become empty. For these situations, there are airline respirators with auxiliary air supplies. Airline respirators can also restrict movement. Because the wearer is attached to a long hose (200 feet maximum) there are limits to how far and in what direction he or she can move.

Air-Purifying Respirators

Air-purifying respirators combine a tight or loose-fitting facepiece with a specific filter media. When you breathe in, you draw air from outside the respirator, through filter media and into the mask. The filter media absorb impurities as the air passes through. Air-purifying respirators are also called “gas mask/canister combinations.”

NOTE: The three most common types of filter media used with air-purifying respirators are canisters, cartridges or pre-filters. For simplicity, we will refer to all three types of filters as “canisters” for the remainder of this manual.

Many air-purifying respirators have tight-fitting full facepieces. These are similar to the facepieces used for SCBAs and SARs. However, the valves and gaskets for facepieces used with atmosphere-supplying respirators are very different than those used for air-purifying respirators. Do not use them interchangeably. You

can also use half-mask air-purifying respirators in some fumigation situations.

Another option is the “powered air-purifying respirator.” Some powered air-purifying respirators do not include a gas mask at all. Instead, they use a small electrical motor to pull air through a pre-filter and cartridge. The motor then moves the filtered air through a hose to a helmet where the air blows down over the face of the wearer.

Gas mask/canister combinations are approved only for specific fumigants. There are many different types of canisters. Each one is color coded with stripes. The stripes indicate limitations and approved uses for quick and easy recognition. For example, a gray stripe around the top of a canister indicates the presence of a filter that removes dust and other particles. Other color combinations identify canisters for specific fumigants.



Gas mask/canister combination respirator

Before using any air-purifying respirator, make sure you have been fit-tested and approved by a licensed health care professional. In addition, be sure that all parts and replacement parts meet manufacturer specifications.

How long a canister will last depends on several things:

- The type of canister
- The size of the canister
- The type and concentration of gas in the surrounding air
- The length of exposure
- The rate of breathing
- Whether there is more than one gas present
- The temperature and humidity at the time of use

Never use a canister after the expiration date. An expiration date is usually listed somewhere on the canister. OSHA requires you to develop a cartridge change-out schedule when the canister does not have an end of service life indicator (ESLI). This schedule must be specific to the treatment site, the type of fumigant you use, the concentration of the fumigant, the exposure time, the temperature and humidity in the treatment area and other factors.

How Air-Purifying Respirators Work

When properly assembled and fitted, air-purifying respirators protect against the gases or vapors listed on the canister label. Powered air-purifying respirators pull air through the canister, which then neutralizes or absorbs harmful gases and vapors. For other types of air-purifying respirators, inhalation by the wearer pulls air through the canister. The purified air then passes through corrugated rubber tubing into the molded channels of the facepiece. Some of these channels direct the purified air to the lenses to reduce fogging.

When you exhale, air is expelled from the facepiece through a valve designed to permit normal conversation. This valve also serves as a drain for moisture produced by breathing. An inhalation valve at the bottom of the canister prevents the exhaled air from passing out through the canister.

Always read the label information to determine which type of respirator to use. Wearing the proper personal protective equipment (PPE) will protect you and your coworkers. It is also the law.

Care of Respiratory Protection Equipment

All applicators should have their own respirator and canister. Do not share your canisters with others. In fact, it is best if you do not reuse canisters at all. If you must reuse a canister, keep a written record of the date used, length of time used and gas concentration. Destroy or mutilate the tops of canisters that are no longer usable. Never reuse a canister if it has been used in an emergency.

Clean and disinfect your respirator after each use and at least once a month. To sanitize

masks, prepare a solution of cleaner-sanitizer (available through your respiratory protection supplier) and warm water. Immerse the mask in this solution. Scrub the interior and exterior of the mask with a sponge. Rinse the mask with warm water and air dry. If you are not able to sanitize the mask immediately, wipe out the interior with a clean cloth. Use soap and warm water if possible.

During cleaning, inspect the mask. Look for any loose connections and rubber deterioration. Check the integrity of the facepiece seal. For air-purifying respirators, inspect the inhalation valves, exhalation valves and straps. Keep a record of all cleanings and inspections.

After cleaning and inspection, place the mask in its carrying case to protect it against dust, sunlight, heat, extreme cold, moisture or damaging chemicals.

If your respirator needs repairs, be sure to use parts designed specifically for that respirator and approved by the manufacturer. Only experienced persons should repair a respirator. Atmosphere-supplying respirators must be sent to the manufacturer for repair.

Fitting and Testing the Respirator

Respirators come in different sizes. Be sure yours is the right size for you. In addition, respirators must be fit-tested to their user. For a firm and comfortable fit of your facemask, adjust the headbands in this order:

1. Make sure the straps lie flat against your head.
2. Tighten the lower or neck straps.
3. Tighten the head cradle straps.
4. Place both hands on the headband or head cradle and position it on the crown of the head.
5. Repeat steps one and two.
6. Tighten the forehead or front strap a few notches.

The mask should feel comfortable, while forming a tight seal against your face. Facial hair will prevent a tight seal. Workers with beards and/or large mustaches must shave. OSHA requires that respirators fit properly and that you test their facepiece-to-face seal.

There are two types of “fit tests,” qualitative and quantitative. Qualitative fit tests rely on subjective sensations – taste, irritation and smell – of the respirator wearer to a particular test agent. Quantitative tests use measuring instruments to measure face seal leakage. The type of test you should use depends on many things.

Once you find a respirator with a good fit, testing is not over. You must also check the respirator each time you wear it. Here are two quick field tests. These are called “user seal checks.”

Negative Pressure Test

The negative pressure test allows you to check full-face and half-face tight-fitting respirators for proper fit before each use. First, pinch off the breathing tube or cover the inhalation valves with the palm of your hand. Then, inhale to create “negative pressure.” The facepiece should collapse. Hold your breath for 10 seconds. A respirator with a tight seal will remain collapsed while you hold your breath. If it is leaking, check the cartridge connections, valves and straps and repeat the test.

Positive Pressure Test

The positive pressure test is usually included in the manufacturer instructions. First, place the palm of your hand or thumb over the exhalation valve. Then, exhale gently into the respirator, causing “positive pressure” inside the facepiece. If you do not feel any air leaking out of the facepiece, the respirator fits properly. If it is leaking, adjust the straps and test again. If the leak persists, inspect the respirator for problems. Check the hoses and connections to make sure they are tight and in good condition. A new rubber washer for the mask hose is supplied with each new canister. This washer must be in place when attaching the hose to the canister. Otherwise, vapors can enter through the mask hose. Be sure to check for this washer. If the leak still exists, try installing a new corrugated breathing tube. If this takes care of the leak, destroy the defective breathing tube. If, after removing your hand from the canister inlet, you find you cannot breathe, the canister has a blockage. Destroy and replace the canister. If the respirator is an air-supply type, check the facepiece and breathing tube. If the respirator is an SCBA, check the air tank for amount of air,

leaks and valve efficiency. For SARs, test the valves, connections and hoses.

Use of Respiratory Protection Equipment

No matter what type of fumigation you are performing, your respirator should be ready to use at all times. When it is not in use, have it on hand for emergencies. Keep the following list nearby. It will help you to inspect and use your mask properly.

- Before using any air-purifying respirator, make sure that all parts and replacement parts meet manufacturer specifications.
- If you use an air-purifying respirator, check the canister for an expiration date. If canisters are used more than once, be sure enough time remains. When in doubt, use a new canister.
- Select the proper canister for the fumigant you plan to use. The canister label will indicate for which fumigant(s) it is approved.
- If you use a new canister, install the new washer that comes with it. Remove the tape that covers the intake port on the bottom of the canister.
- Connect the mask and canister.
- Put the mask on while you are in fresh air.
- Check for proper fit and leaks.
- Check the time. Note when you should be out of the fumigated area.
- Enter the contaminated area slowly. Return to fresh air immediately if you notice irritating gases, odors or symptoms of distress.

After completing the job:

- Clean and inspect the respirator.
- Record the date of cleaning. If you plan to reuse the canister, record how long you used it. Also, note the fumigant and its concentration.
- If you used all of the canister’s time, mutilate the top so that it cannot be reused and discard it.
- Return the respirator to its carrying case. Place both items in a proper storage area.

When fumigating raw agricultural commodities, be sure to:

- First, monitor the air quality. If the air contains less than 19.5% oxygen, it is deficient. Use an air-supplying respirator and not a gas mask/canister combination. When in doubt, always use an air-supplying respirator.
- Check the time. Note when you should be out of the fumigated area.
- Enter the contaminated area slowly. Return to fresh air immediately if you notice irritating gases, odors or symptoms of distress.

Gas Detection Equipment

Gas detectors monitor and record gas concentrations before, during and after treatment. They are a part of every fumigator's operational and safety equipment for treatments within enclosed spaces and structures. However, gas detectors are rarely used with soil fumigation.

You can use detectors to eliminate some of the common hazards associated with fumigation. Use them to:

- Indicate fumigant levels during treatment
- Detect excessive leaks in a building or poor tarp seals, and determine the dosage requirements for future fumigation

Detectors also measure the success of aeration by monitoring the presence or absence of fumigant vapors.

Be sure the accuracy and range of your detector is suitable for the fumigant you plan to use. Some detectors are more sensitive than others are. Calibrate your detector for each fumigant you use. Be sure you know how to read it.

There are several gas detectors from which to choose. The following are some of the most commonly used in fumigation.

Halide Gas Detectors

The halide gas detector indicates the presence and approximate concentration of halide gases – gases that contain any of five nonmetallic halogen elements: fluorine, chlorine, bromine, iodine and astatine. It is most

commonly used to measure levels of methyl bromide. It reliably measures gas concentrations of 50 parts per million (ppm) or greater.

Halide detectors consist of:

- A fuel tank
- A valve assembly (to regulate fuel flow), a burner head assembly (where the fuel and air mix and unite)
- The reaction plate or cone assembly (where the visible flame reacts to halogen gases)

An attached search hose feeds the air mixture to the burner head assembly for testing. The fuels used include kerosene, alcohol, acetylene, and propane. These are available at refrigeration supply dealers.

To operate a halide detector, hold a lit match in the window opening of the burner tube. Turn the valve slowly to the left. After the copper plate or cone turns red, adjust the flame to the smallest size to maintain that color. The detector is now ready to test the air. Hold the open end of the search hose on, in or near the article or area to be tested. As air passes over the heated plate or cone, the flame color will change if a halogen gas is present. The color and intensity of the flame indicates the concentration of the gas. A color chart with corresponding gas concentrations comes with each detector.

NOTE: If you use a halide detector at night, the flame will have a bluish cast. You must consider this when reading the results.

Unfortunately, no halide detectors are accurate for determining exactly how much gas is present. They will only give you an estimate.

Because halide detectors have an open flame, you must adhere to all safety precautions. Even when the detector is not in operation, do not store it in a frequently inhabited room. The fuel is a flammable gas under pressure and may explode. Do not use halide detectors in the presence of flammable or explosive gases such as gasoline vapors.

Do not use halide detectors in mills, grain elevators or other enclosures where there is a possibility of a dust explosion. Always read the label to determine the flammability of the product you are using.

Halide detectors need little maintenance. The burner head orifice is very small.

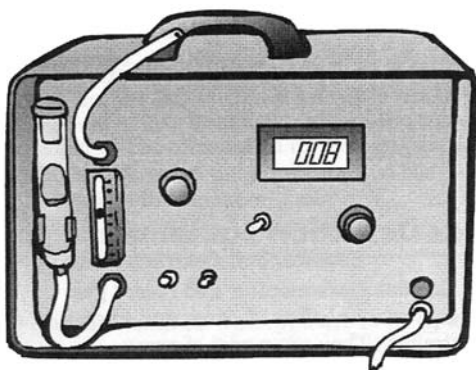
Prevent dust and other debris from clogging it. Occasionally, you will need to replace the reaction plate or cone.

The halide gas detector has been used for many years. It is an operational as well as a safety device. By detecting leaks, it can help you to reduce harmful gas levels outside the treatment area. This will increase the safety and efficacy of your operation. As a precaution, use a halide detector regularly in rooms that house fumigation chambers. This is particularly important when the building also contains offices or other work areas.

NOTE: Do NOT use a halide detector to determine whether fumigant levels are safe for reentry. While the halide detector is useful for detecting low levels of halogenated fumigants, it should NOT be used to detect harmful concentrations of these fumigants. The reentry threshold concentrations for a number of fumigants are lower than the detection limit of the halide detector.

Thermal Conductivity Analyzers

Thermal conductivity analyzers (TCAs) measure the concentration of fumigant gases within a chamber or other enclosure during fumigation. Several types of TCAs are available.



Fumisscope®

The Fumisscope® is one of the most common TCAs. It is primarily used to measure methyl bromide concentrations. The Fumisscope® is lightweight, portable and comes in a compact cabinet. It operates on 115 volt AC (alternating current) or battery power. In a Fumisscope®, electrical currents pass through a wire exposed to the sampled air. The temperature of the wire is affected by the composition of the air around

it. The hotter the wire, the higher the fumigant concentration. The fumigant concentration is displayed on the Fumisscope® meter.

When using TCAs, keep in mind that most of them are sensitive to several gases, not just the one for which you are testing. For a true reading, you must eliminate other gases. For example, carbon dioxide (CO₂) may occasionally be a problem. If a prefumigation test indicates high levels of CO₂, place a tube of sorbing material such as sodium hydrate in the sampling line. It will absorb CO₂, allowing the TCA to give you a more accurate reading.

When you run long sample lines into the fumigated area, use a small pump to draw air from the test point to the end of the line. This speeds up the readings.

NOTE: Like the halide detector, TCAs should NOT be used to determine whether fumigant levels are safe for reentry. They cannot measure gas concentrations below 5 ppm.

Glass Detector Tubes

Glass detector tubes or “color diffusion detector tubes” are another gas detection option. Unlike other detectors, glass tubes are disposable. You can only use them once. Glass detector tubes are often more sensitive and more specific than halide detectors and TCAs. They can detect specific fumigants at lower levels than other gas detectors.

Glass detector tubes are “fumigant specific.” That means you will need to purchase a different set of tubes for each type of fumigant you use. Their operation is simple. Place one tube in the area you wish to test. Break the seal. Use a manual pump to draw a measured amount of air through the tube. Different pumps and tubes require a different number of pump strokes. Follow manufacturer recommendations. A color reaction will occur indicating the fumigant concentration. A color chart with corresponding concentrations is printed directly on the tube.



Detector tubes are available for many fumigant gases. Both high-range and low-range tubes are available for some fumigants. Use the high-range tubes to determine gas concentrations during fumigation. Use the low-range tubes to assure safe working conditions after aeration and before reentry.

Ambient Air Analyzers

Some ambient air analyzers or “infrared detection systems” use infrared spectrophotometers to detect and measure gas concentrations. This is how they work. When infrared radiation strikes a gas, certain wavelengths of the radiation are absorbed. The spectrophotometer measures this absorption. The amount of radiation absorbed indicates the gas concentration. Most ambient air analyzers can be calibrated at the factory to detect a single gas. Others are equipped with a fixed infrared filter.

Portable units weigh about 18 pounds. They are equipped with both AC and battery power. Each unit has two scales. The lower scale is accurate from 0 to 15 ppm. Use it to check fumigation sites before reentry. The upper scale functions as a leak detector during fumigation. It detects concentrations from 0 to 150 ppm.

Gas Analyzers

Gas analyzers detect leaks during fumigation. They also determine if a site is ready for reentry. Several models are available. The most popular are lightweight and battery powered. Most are designed to monitor concentrations of a particular gas. One model uses a pump to draw an air sample through a tiny furnace. Any fumigant present passes through a sensor that detects how much gas is present. Readings are given in ppm.

Other Protection Equipment

Whenever possible, provide two-way radio communication between workers applying fumigants and those outside. Also, keep on hand:

- An emergency air-supplying respirator, especially if canister-type respirators are being used
- Antidotes where applicable
- A safety harness or rescue belt
- Basic first aid equipment

Test Your Knowledge

Q. Name the two types of respirators most often used by fumigators. Describe the difference between them.

- A. 1. An atmosphere-supplying respirator draws air from outside a fumigation area or uses cylinders of pressurized air to supply a worker with breathable air.
2. An air-purifying respirator or “gas mask/canister combination” uses special canisters to remove particles and toxic vapors from fumigated air.

Q. Name two types of atmosphere-supplying respirators. Explain the advantages and disadvantages of each one.

- A. 1. A self-contained breathing apparatus (SCBA) gives the operator greater mobility but offers a limited amount of air. The weight and bulk of an SCBA apparatus can also make strenuous work difficult.
2. 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 does the stripe around the top of an air-purifying canister indicate?

- A. The type of material the filter in the canister will remove from the air.

Q. If an air-purifying canister has expired, what should you do to it before you throw it away?

- A. Destroy or mutilate the top so that it is no longer usable.

Q. Describe the procedure for fitting a respirator mask.

- A. 1. Make sure straps lie flat.

2. Tighten neck straps.
3. Tighten side straps.
4. Push headband pad downward.
5. Repeat steps one and two.
6. Tighten front strap a few notches.

Q. Describe the two methods currently accepted by OSHA to fit test a respirator.

- A. 1. Qualitative fit tests rely on subjective sensations – taste, irritation and smell of the respirator wearer to a particular test agent.
2. Quantitative tests use measuring instruments to measure face-seal leakage.

Q. Once you find a respirator with a good fit, testing is not over. Describe two “user seal checks” you should perform each time you wear your respirator.

- A. 1. Negative Pressure Test: Pinch off the breathing tube and inhale so the face-piece collapses. Hold your breath for 10 seconds. The facepiece should stay collapsed for this time. If it does not, the mask does not fit properly and fumigant may leak in.
2. Positive Pressure Test: 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 type of gas is dangerous to measure with a halide detector? Why?

A. A flammable gas because halide detectors operate with an open flame. Always read the label information to determine the flammability of the product(s) you use.

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

A. The Fumiscopes®.

Q. When using a TCA, how can you avoid a false reading due to the presence of gases other than the one you are measuring?

A. Place a material that will sorb the gas you do not want to measure into the sampling line.

Q. What type of gas detector is disposable?

A. Glass detector tubes.

Q. What types of gas detection equipment can be used to determine whether fumigant levels are safe for reentry?

A. Glass detector tubes, ambient air analyzers and gas analyzers.